ABSTRACT

An Overview of Research in Manual Therapy

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Manual therapy techniques are often used to augment the healing process by professionals such as massage therapists, athletic trainers, and physical therapists. The term manual therapy includes a wide variety of techniques such as stretching, massage, joint mobilization, Active Release Technique, Strain-Counterstrain, Myofascial Release, and the Graston Technique. Though a wide variety of manual therapy techniques are extensively used, the evidence based research to support these techniques remains relatively low. This thesis will review the different types of manual therapy, take an in-depth look at the research behind the Graston Technique, and examine the future of research in manual therapy.

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AN OVERVIEW OF RESEARCH IN MANUAL THERAPY

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CHAPTER ONE

Different Forms of Manual Therapy

Manual therapy is an important tool that is used in massage therapy, athletic training, and physical therapy. Manual therapy is a series of techniques which often utilizes the therapist's hands to augment the healing process. This thesis will be divided into three chapters. The first chapter will explain manual therapy and outline research of different manual therapy techniques, including stretching, massage, joint mobilization, Active Release Technique, Strain-Counterstrain, and Myofascial Release. The second chapter will take an in-depth look at a specific instrument-assisted soft-tissue mobilization practice, the Graston Technique. The third chapter will discuss the role and future of research in manual therapy.

Manual therapy is defined as the "use of hands-on techniques by a clinician to treat, evaluate, and manipulate the soft tissue of a patient" (Swann & Graner, 2002). It is a field that includes the techniques of stretching, massage, joint mobilization, Active Release Technique, Strain-Counterstrain, and Myofascial Release. These techniques are often used as complementary therapy to augment the healing process by such professionals as massage therapists, athletic trainers, and physical therapists. Though these techniques are widely used, they are often lacking in evidenced-based support of their usefulness

The first technique often used to help the healing process is stretching. There are a variety of different types of stretching techniques, including static stretching and

proprioceptive neuromuscular facilitation (M. Stone et al., 2006). There still remains disagreement on which type of stretching is most effective in increasing flexibility, stiffness, strength and stretch tolerance. These factors are often essential in preventing injury and decreasing discomfort in injuries (M. Stone et al., 2006). One study by Davis et al. focused on comparing the effectiveness of these three stretching methods on hamstring flexibility. Static stretching is often used to increase muscle length. It is reported to activate the Golgi tendon organ (GTO), which is thought to produce autogenic inhibition in the muscle. It has been shown that static stretching is most effective when the stretch lasts from 30 seconds performed once a day for at least six weeks. Proprioceptive neuromuscular facilitation (PNF) relaxes the muscle before stretching in order to use muscle inhibition to further the stretch. Though there are several types of PNF stretching, the study focused on agonist contraction.

Davis' study divides nineteen people into one of four groups. The first group performed an active self-stretch which was maintained for 30 seconds. Group two was given a manual static stretch when lying down in the supine position. The third group conducted a proprioceptive neuromuscular facilitation incorporating the theory of reciprocal inhibition (PNF-R) stretch, where their hip was passively flexed to a 90 degree angle and passively extended until a good stretch was perceived. The subjects were then instructed to straighten their knee concentrically against passive resistance from the examiner. The fourth group served as a control with no stretching exercises. This stretching routine was performed three times per week for four weeks. The participants were evaluated at two and four weeks of treatment.

The study found that the effectiveness of the stretching techniques depended on the length of the stretching programs. At the two week evaluation the only significant increase in flexibility over the baseline was in the hamstrings subjected to the static stretching. By the fourth week evaluation, all three stretching techniques produced significant improvements in flexibility from the baseline. Though static stretching technique was significantly increased over the control, it was not significantly higher than the other stretching groups. The study found that static stretching for thirty seconds, three times a week for four weeks was effective in increasing hamstring length. The study also notes that the study has a limited sample size and the results should not be generalized. Clearly, there is room for further studies in comparing the effectiveness of PNF stretching techniques to static stretching (Davis, Ashby, McCale, McQuain, & Wine, 2005).

Massage has been a practice that has been used in muscle relaxation and healing for thousands of years (Swann & Graner, 2002). Massage has been defined by "a mechanical manipulation of body tissues with rhythmical pressure and stroking for the purpose of promoting health and well-being" (Weerapong, Hume, & Kolt, 2005). There have been many different types of massage used in different parts of the world. The most widely used techniques used in healing include effleurage, petrissage, friction, and tapotment. Effleurage is defined as the gliding motion over the skin in a continuous movement. Petrissage is a lifting, wringing, or squeezing of soft tissue through kneading motion with the practitioner's hands. Friction massage is applied pressure through the fingers and tapotment is the rapid striking of hands over various parts of the tissue

(Weerapong et al., 2005). Indications of what type of massage technique to use depends on the clinician's desired response and the patient's needs (Swann & Graner, 2002).

A study by Young et al. (2005) examined the effect of effleurage in the recovery from fatigue in the thumb's adductors. The study measured the maximal force of the isometric adduction of the thumb and the maximal gradient of force development as the steepest slope of the force-time curve. The participants included twelve right-handed males with no history of upper limb or hand injury, trauma or disease. The subjects were divided into two groups to receive rest or massage in the nondominant hand at the first session. The protocol of rest included audio stimuli in the form of beeps with a four to eight second resting interval between beeps. In the group that received treatment underwent five minutes of effleurage massage performed by an experienced osteopath. The subjects from each protocol was then instructed to push a button with maximal effort and release as quickly as possible

The study found that there was not a significant difference in maximal force before or after the massage protocol or between the groups. It must be noted that this study evaluated the effect of effleurage on small muscles which has a different configuration of muscle fiber types than larger muscles. This study showed a large variation of responses to the fatiguing exercises due to the variation of fiber type quantities. Other studies have shown that the effect of massage may be largely subjective, but it might still have a positive psychological effect. Further studies are needed to see if effleurage massage's effect is largely psychological or also has a physiological effect on fatigue recovery (Young, Gutnik, Moran, & Thompson, 2005).

The various types of friction massages have been widely used in rehabilitation to treat acute and chronic soft-tissue injuries. These techniques include deep transverse friction, which is championed and developed by Cyriax, and the Graston Technique. Deep transverse friction has been hypothesized to increase blood flow, decrease pain, and even transmit a tensile stress to the tissue (Clayton, 2009). The friction massage must be applied at the site of the lesion and the clinician's fingers must move transversely as a single unit to be effective (Stasinopoulos & Johnson, 2004). Deep friction massage has a reputation for being very painful and places extensive strain on the clinician's hands. The Graston Technique was developed to help reduce the strain on the clinician's hands. This technique is a systematic approach of using concave, double-beveled instruments to massage soft tissue (Stow, 2011). The Graston instruments are thought to provide greater penetration and specificity, as well as improving the palpatory skill of the clinician (Hammer & Pfefer, 2005). Both deep transverse friction and the Graston Technique need additional evidence-based research to evaluate the efficacy of use during rehabilitation.

Joint mobilization is a form of manual therapy that is often used to control pain and increase joint range of motion (ROM). There are several different theories as well as different techniques of joint mobilization. Most of the different techniques and theories focus on using traction and joint gliding to increase mobility. It has been theorized that joint mobilization creates tension in the joint capsules which activates mechanoreceptors for modification of nociceptor-generated pain impulse transmission. Theoretically, for joint mobilization to be an effective treatment in controlling pain, there needs to be a large volume of mechanoreceptors in the joint (Kahanov & Kato, 2007). A significant

problem with the current theories and suggestions concerning joint mobilization is that they weren't based on research (Yang, Chang, Chen, Wang, & Lin, 2007).

A study by Yang et al. (2007) compared three different mobilization techniques in the management of frozen shoulder syndrome. Frozen shoulder syndrome is a condition classified by the progressive loss of active and passive shoulder movement. The researchers focused on evaluating mid-range mobilization (MRM), end-range mobilization (ERM), and mobilization with movement (MWM) in comparing joint mobilization techniques. The subjects of the study reported to have a stiff shoulder for at least 3 months and limited ROM and were randomly placed in one of two groups with different mobilization treatments. Group one received a treatment design including MRM-ERM-MRM-MWM. The second group completed a MRM-MWM-MRM-ERM treatment plan. The plans were designed to counterbalance the order effects of the treatments. An independent outcome assessor evaluated the participants and baseline, three weeks, and at twelve weeks.

Participants were give joint mobilization treatments twice a week for 30 minutes and were not allowed to do home exercises. Mid-range mobilization was performed by placing the humerus in a position of 40 degrees abduction and held in the position with ten to fifteen repetitions. End-range mobilization was performed after an assessment to determine the end of the subject's ROM. The subject's humerus was brought to maximal range for ten to fifteen repetitions. Mobilization with movement was performed by using the therapist's hand over the aspect of the head of the humerus and a counter pressure to the scapula to sustain a slow active shoulder movement. The study tested the outcomes with a Flexi-level Scale of Shoulder Function and a FASTRAK motion analysis. The

study found that there were significant improvements in FLEX-SF, arm elevation, scapulohumeral rhythm, humeral external rotation, and humeral internal rotation for both ERM and MWM in both groups. The only significant difference between ERM and MWM occurred in the measurement of scapulohumeral rhythm. ERM and MWM were shown to be more effective than MRM in increasing mobility and functionality. This study's had a hard time with subjects participating until completion because it is often hard to retain subjects who do not show marked improvement with the therapies (Yang et al., 2007).

Active Release Techniques is probably the most popular soft-tissue therapy techniques. It is based on the theory that constant micro-trauma can lead to tight and weak muscles, degeneration, and inflammation. In the application of ART therapy the therapist applies deep tension using their fingers to the affected site while the tissue is actively and passively moved from the shortened to a lengthened position (Miners & Bougie, 2011). ART is based on the theory of cumulative trauma disorder, where soft tissue injury results from repetitive injuries (Drover, Forand, & Herzog, 2004). The therapy is aimed at removing adhesions in the tissue that form due to decreased circulation and inflammation (Spina, 2007). Most of the research done on ART is in the form of case studies that combine ART with other treatments. There are precious few experimental studies on the ART therapy.

A clinical outcome pilot study by Drover et al. (2004) is one of the few studies on Active Release Therapy. The study examines if ART could be used to influence strength and muscle inhibition as a treatment of unilateral anterior knee pain. The study included nine subjects, four male and five females, who had a history of anterior knee pain and no

history of knee surgery or instability. The mean length of anterior knee pain complaint was 2.8 years. The study measured strength through the Biodex System 3 Dynamometer and muscle inhibition through an interpolated twitch technique.

Treatment intervention was the protocol described by lower extremity ART for the patella tendon, vastus medialis, vastus intermedius, vastus lateralis, and rectus femoris. After the treatment was given, an electrode was placed to stimulate the leg. The experimental leg was tested and two minutes posttreatment, contralateral leg followed with treatment. The study found that the mean percentage of muscle inhibition was greater than the normal reference population of similar age and knee angle. Muscle strength and inhibition did not significantly change between baseline and post treatment. This contradicted several anecdotal tales of clinicians reporting strength gains right after treatment. The authors provided two possible theories to explain the discrepancy. The inconsistency could be explained due to the afferent information from the quadriceps being insufficient to overcome neuroinhibitory feedback or the possibility that multiple treatment sessions may be necessary (Drover et al., 2004).

Strain-counterstrain, otherwise known as Positional Release Therapy, is a manual therapy technique that was developed in the 1950s and ‘60s by Lawrence H. Jones. This technique is constructed around helping the patient find a comfortable, though oftentimes unconventional position. The patient would then slowly return to a normal position to relieve pain. This technique is used to treat dysfunctions of the muscle spindles, rather than lesions (J. A. Stone, 2000). The dysfunctions of the muscle create tender points, or points of intense, tender muscle and fascial tissue (Lewis & Flynn, 2001). The therapist identifies the dysfunction and determines the position of greatest

comfort for the patient. The patient then holds the position for 90 seconds while the therapist places gentle pressure on the tender point. It has been found that treating proximal tender points may help dissolve distal points (J. A. Stone, 2000).

A study by Wong et al. (2011) examined the effect of strain counterstrain on forearm strength and compared it to sham positioning. This research was done in response to a pilot study by Perreault et al. that found no support for using strain counterstain over a placebo treatment (Perreault, Kelln, Hertel, Pugh, & Saliba, 2009). The study by Wong et al. (2011) set out to determine if the findings on strain counterstrain were better than a sham treatment consisting of touch and passive positioning on forearm pronator and supinator muscles. The study consisted of twelve subjects with tenderness of the teres pronator and supinator muscles on the anterior surface of the proximal forearm. The subjects were divided in to a control group receiving the sham treatment and the group to receive the strain counterstrain treatment.

The subjects attended three sessions over a three week period. The first session included the testing of the subject's initial strength in the pronator and supinator muscles. The second session included a pre and post treatment test of strength and the sham or strain counterstrain treatment. The third session was focused on a follow-up strength assessment. The strengths were tested using a Baseline Hydraulic Dynamometer. The sham treatment consisted of passively positioning the elbow in a 45 degree of flexion and a neutral forearm position and holding the arrangement for 90 seconds. This study found that the baseline strengths were the same in both groups, but the post-treatment showed significant increases in the pronator and supinator strength of the strain counterstrain forearms. In contrast, the sham positioning did not increase the

strength in the forearm. This suggests that the strain counterstrain technique has some value other than what can be attributed to human touch. More research is needed to explore the mechanism that strain counterstrain works to increase muscle strength (Wong, Moskovitz, & Fabillar, 2011).

Myofascial Release is a manual therapy technique that concentrates on muscle tissue that is tight or in spasm. These areas of tightness are often known as myofascial trigger points. In using this technique the clinician locates the trigger points by palpating for a taut band of tissue. The most tender spot on the band of tissue is identified as the trigger point. There are two main types of myofascial techniques. The first technique includes placing direct, focused pressure on the spasm and the other technique compromises of placing a slow, sweeping pressure on the area of tension. The direct pressure is theorized to break up adhesions and muscle spasms, while the sweeping pressure promotes extensibility in the soft tissue. These techniques call for pressure to be applied for 60 to 90 seconds but can be held for as long as five minutes. There has been agreement in the research that myofascial release helps relieve pain through increasing soft tissue extensibility and the breaking-up of muscle spasms. A draw-back of myofascial release is the amount of time it takes to treat a single patient. This problem can be helped through the use of self myofascial release with the use of a foam roller. Through this technique the patient can use their body weight to provide pressure while rolling back and forth on the foam roller (Paolini, 2009).

The main question in research, when dealing with myofascial release, is if myofascial release can be evidenced-based. A discussion paper by Robert Kidd discusses why myofascial release will never be evidenced based. Kidd argues that

myofascial release is an art form and because it is an art form, the technique is very hard to quantify. He points out that although there are many theories and scientific reasons why myofascial release might work, there is little evidence is available to prove that the technique actually does work. Kidd brings up the point that many variables need to be controlled. These variables include the practitioner's clinical judgment, and the patient-physician interactions. This includes the judgment calls that practitioners make from patient to patient due to the feel and electromagnetic signals picked up through the hands. Kidd makes the point that tissues often release in unpredictable ways and the practitioner must constantly sense and adjust to the muscle's actions. He points out that even if all the variables could be accounted for any difference in outcome would have to be ascribed to the manual therapist's use of the technique rather than the technique itself (Kidd, 2009).

The discussion of whether or not myofascial release can be a truly evidence-based therapy technique has an ominous ring for all of manual therapy. It brings to light the question of if you can scientifically quantify techniques that have so many different variables. One has the factor of the therapist's perceptions that can vary from patient to patient and the factor of the particular patient. Some patients can respond better to certain techniques than others. Manual therapy is primarily based on the patient's and the clinician's perceptions. Manual therapy is faced with the difficulty of finding new and inventive ways to quantify these perceptions to provide evidence that the different modalities work. Researchers are also faced with the challenge of providing evidence to

support the most effective technique for treating different injuries. So far, there has been very little research on manual therapy techniques, but this lack of research is starting to be addressed.

CHAPTER TWO

A Closer Look at the Graston Technique

Instrument-assisted (also known as augmented) soft tissue mobilization originated from the therapeutic technique of friction massage, prominently advocated by James Cyriax (Sevier & Wilson, 1999). Cyraix's technique involves deep, localized massage preformed at the exact site of the lesion (Stasinopoulos & Johnson, 2004). The massage involves pressure from the therapist's fingers applied transversely to the involved tissue (Stasinopoulos & Johnson, 2004). Cyriax's deep transverse friction massage is theorized to make scar tissue more mobile, to facilitate healing through inducing controlled micro-trauma, and to aid the alignment of soft tissue fibers to normal. Though Cyriax's technique is often used, it was often reported to place great strain upon the clinician's hands (Stasinopoulos & Johnson, 2004). This concept was expanded with the use of soft tissue mobilization instruments in order to improve the clinician's ability to perform soft tissue mobilizations. The designed instruments normally have angled edges and are guided in longitudinal strokes over the affected soft tissue. These devices work to alert the clinicians to areas of irregular fibrosis and allowed them to massage the site of irregularity (Sevier & Wilson, 1999). One major technique of instrument-assisted soft tissue mobilization built upon Cyriax's Technique is the Graston Technique (Hammer & Pfefer, 2005; Miners & Bougie, 2011; Stow, 2011).

The Graston Technique was originally developed by a competitive water skier who had injured his knee. When he didn't respond to therapy, he decided to experiment with

tools that mimicked his therapist's manual techniques (Stow, 2011). This experimental process was furthered by the TherapyCare Resources Inc. in an outpatient clinic in 1994 ("History of the Graston Techniqe," n.d.). The Graston Technique eventually developed into to a systematic approach of using concave, double-beveled instruments to massage soft tissue (Howitt, Wong, & Zabukovec, 2006; Stow, 2011). The instruments come in six different shapes and sizes that can be used to massage different shapes on the body ("A Synopsis," n.d.; Stow, 2011). The Graston tools provides controlled microtrauma to the affected areas (Hammer & Pfefer, 2005). This type of instrument-assisted soft tissue mobilization is thought to hold an advantage over Cyraix's massage technique because the Graston instruments are thought to provide greater penetration and specificity, as well as improving the palpatory skill of the clinician (Hammer & Pfefer, 2005). The Graston Technique is thought to increase the production of extracellular matrix fibroblasts, breakdown collagen cross-linkages, develop ion transport, and increase blood flow (Howitt, Jung, & Hammonds, 2009; Looney, Srokose, Fernández-de-las-Peñas, & Cleland, 2011; Stow, 2011). Graston Technique is theorized to be very effective but the documentation on the Graston Technique and instrument-assisted soft tissue mobilization is scarce. Though the research is limited, experimental and case studies on the topic have produced findings in favor of the Graston Technique.

Research Studies

The experimental study by Davidson et al. (1997) was based of the hypothesis that frictional massage can aid tendon healing by augmenting the inflammatory process to conclusion so that later stages of healing could occur. The study divided male Sprague-

Dawley rats into four groups with five rats per group. The groups were divided into Group A as the control group, Group B with induced tendinitis, Group C with induced tendinitis with augmented soft tissue massage (ASTM), and Group D with only ASTM. The tendonitis was induced by an incision of the tendon and an injection of collagenase at the site to model chronic tendon inflammation. In the groups receiving ASTM, the treatment was performed on the Achilles tendon for three minutes on four days, three weeks after the operation. This study of augmented soft tissue mobilization tested gait analysis, light microscopy, electron microscopy, and immunoelectron microscopy.

The results of the gait analysis showed the group with induced tendonitis and ASTM returning to their original pattern within the time frame of the study, though both groups with induced tendonitis improved with time. Under the light microscopy it was found that though both groups induced with tendonitis had an increase in fibroblast numbers, the group with both tendonitis and ASTM had the largest significant increase in fibroblasts. The electron microscopy showed that activated fibroblasts were observed in all the groups except for the control group. This suggests that ASTM may facilitate the activation of fibroblasts which are associated with collagen synthesis and is an initial step in tendon healing. Immunoelectron microscopy showed all four group's tendons equally stained with antibodies to Type I and Type III collagen. There were, however, numerous foci of intense Type III collagen staining in the group with induced tendonitis and ASTM treatment. It was hypothesized that this represented localized areas of newly synthesized Type III collagen. This study appeared to show that the ASTM promoted healing and earlier recovery of function after a collagenase injury (Davidson et al., 1997).

An experimental study by Burke et al. (2007) was a pilot study completed to compare the Graston Technique against manual soft tissue mobilization in treating Carpal Tunnel Syndrome. The study population included patients with Carpal Tunnel Syndrome with a pain rating of 33 mm or greater on the visual analog scale and two other clinical findings including sensory deficits of touch and limited ROM. The patients were randomized into one of two control groups; twelve patients completed the trial in the group subjected to the Graston Technique and ten patients completed the trial in the group receiving manual Soft Tissue Mobilization. For the group subjected to the Graston Technique, the treatment consisted of a warm-up exercise, Graston Technique of the forearm-wrist-hand area, followed by stretching and strengthening, and ice.

The patients assigned to the Soft Tissue Mobilization group received the same basic treatment as that in the Graston Technique group except the soft-tissue mobilization was performed by the clinician's hands. The in-clinic treatment was augmented by home exercises dealing with closed-kinetic chain of the upper extremities. The patients received two treatments per week for the first four weeks and then one treatment per week for the following two weeks, resulting in ten treatments. The outcomes of the treatments were measured through sensory and motor nerve conductions as an evaluation of the median nerve, a subjective test including self-reported pain, and a physical exam assessing the sensory and motor functions of the hand including testing ROM and strength. There were no significant differences in the clinical improvements between the two manual therapies. Though the two therapies did not show differences in effectiveness, the patient outcomes and satisfaction with the treatment provides

confirmation of the clinical effectiveness of soft tissue mobilization for Carpal Tunnel Syndrome (Burke et al., 2007).

A study by Loghmani & Warden (2009) tested the ligament mechanical and morphological properties in the healing of medial collateral ligament (MCL) injuries with use of instrument-assisted cross-fiber massage (IACFM). The study used fifty-eight female Sprague-Dawley rats. Fifty-one of the rats underwent a surgery to create bilateral MCL injuries on their knees by creating a transected cut at the joint line and the remaining seven served as controls. The massage was performed with the Graston Technique number six instrument which allowed force to be applied through the tip to the small rat knee ligaments. The IACFM was started one week after the operation and induced injury and was performed while the animals were under anesthesia. The rats were divided in to two treatment groups, the first group of thirty-one animals received treatment three times per week for three weeks while the second group of twenty rats was treated three times per week for ten weeks. The left MCL was the only knee that received treatment in the rats. The other knee did not receive IACFM and served as an internal control. The group of animals that received treatment for nine sessions were euthanized at four weeks and the group that received treatment for thirty sessions were euthanized at twelve weeks. The treatment method was tested through mechanical testing, scanning electron microscopy, and a histological assessment.

At four weeks the IACFM-treated ligaments could resist a greater force, had greater stiffness and energy to failure than the contralateral non-treated ligaments. At twelve weeks the IACFM-treated ligaments had greater stiffness but there was no difference in ultimate force between the treated and non-treated ligaments. The light

microscopy of the ligaments from injured animals appeared to have scar morphology with extracellular matrix disorganization and hypercellularity, especially at the four week interval. The ligaments treated with IACFM seemed to have greater cellularity with longitudinally orientated collagen fiber bundles than in the contralateral non-treated ligaments. The IACFM-treated ligaments also seemed to have improved collagen fiber bundle formation and orientation within the scar region at the twelve week interval. The histological assessment showed that at four weeks, the injured region had a thickened, pinkish scar and at twelve weeks the area was more difficult to see. There were no visible differences between the IACFM-treated and non-treated ligaments at either four or twelve weeks after the induced injury. This study appears to show that instrument-assisted cross-fiber massage speeds up early tissue-level healing after ligament injury, but does not do much to augment healing. It supports the theory that IACFM has an underling effect on collagen and may present a cellular response gained from the mechanical stimulus to the extracellular matrix (Loghmani & Warden, 2009).

The case series completed by Looney et al. (2011) studied the usefulness of the Graston Technique in managing plantar fasciitis (PF). Participants were recruited from clinics and had the chief complaint of plantar heel pain, tenderness of the calcaneal tuberosity, and a Lower Extremity Functional Scale score of 65 or less. There were ten patients participating in the trial, seven of which were female and three of which were male. They all received eight treatments over a time frame of three to eight weeks with one to two sessions per week. The Graston Technique treatment lasted about fifteen minutes, followed by two repetitions of static stretches focused on the triceps surae, soleus, and plantar fascia, and ice for fifteen to twenty minutes. The patients

complimented the treatment with a home stretching program. The mean duration of symptoms was 32.4 weeks with a standard deviation of 31.1 weeks and 70% of the patients had a successful outcome. The study reported that 30% of patients did not reach a successful outcome and 10% experienced a worsening of symptoms. This might suggest that a subset of patients with PF who may respond favorably to the Graston Technique. It must be noted that this study had significant limitations including the small study size, no control group, it is possible that some patients could have had a condition other than PF, and there was no way to tell of the patients were actually compliant with the home stretching exercises (Looney et al., 2011).

Case Studies

Hammer & Pfefer (2005) discussed the use of the Graston Technique in treating a patient with subacute lumbar compartment syndrome. The patient was a 59-year-old male who complained of intermittent lumbar pain for two weeks. His usual treatment of bed rest and analgesics had no effect and the pain continued, especially when in a forward-flexed position. The patient's posterior spinal fascia was stressed even while passively flexing while sitting. The patient was tested through flexion tests and the areas of complaint were assessed and treated using the Graston Technique. The patient was given two sets of three stretches to complete twice a day at home. The patient was asymptomatic at the time of discharge, after six visits with two visits per week. From the results of this case study the Graston Technique with stretching seems promising in the treatment of subacute lumbar compartment syndrome. It was hypothesized that the

instrument-assisted soft tissue mobilization and stretching normalized the intramuscular pressures (Hammer & Pfefer, 2005).

A case study was published by Howitt et al. (2006) describing the treatment of the trigger thumb using both the Graston Technique and the Active Release Technique. The patient was a 42-year-old male who had a clinical diagnosis of trigger thumb that was confirmed with a diagnostic ultrasound. When examined, palpable adhesions were found in the right thumb's flexor pollicis longus tendon. The patient was treated by a certified provider and the treatment was followed by a post-treatment of ice. The treatment sessions occurred two times per week for four weeks, which equaled to a total of eight treatment sessions. Throughout the treatment the patient gained full ROM without pain and decreasing pain when the capsule was deeply palpitated. By the final treatment, there was no pain and when full flexion was forced there was only a little bit of irritation at the capsule. When contacted by telephone two and fourteen months after discharge, the patient reported no re-aggravation of the condition. The patient felt better and was satisfied with the outcome of therapy (Howitt et al., 2006).

Another case study by Howitt et al. (2009) described the treatment and effects of the conservative treatment of a tibialis posterior strain. The 41-year-old male novice triathlete incurred the injury through a swimming-related incident that brought on an immediate cramping sensation and swelling posterior to the right medial malleolus. During an examination palpitation, plantar flexion, passive dorsiflexion, eversion and inversion caused severe discomfort. The patient was diagnosed with a first degree tibialis posterior strain. The patient was treated with electrical stimulation, therapeutic ultrasound, Active Release Technique, Graston Technique, and a post-treatment icing.

At the fourth treatment, thirteen days post-injury, the pain had decreased and the patient walked without a limp. One month after the injury the patient returned to training when a diagnostic ultrasound did not show a muscle tear and revealed limited inflammation. The patient attended treatment seven times over six weeks and returned to training one month after the injury. This case study shows that tibialis posterior strains can be treated with such soft tissue techniques as the Graston Technique (Howitt et al., 2009).

A case study by Miners & Bougie (2011) was published discussing the effect of treating Chronic Achilles tendinopathy using techniques such as the Active Release Technique and the Graston Technique. The patient was a 40-year-old male training for a marathon. The patient dramatically increased the amount of running and through doing this, worsened the symptoms of stiffness and discomfort in his Achilles. The patient sought treatment but the treatment of therapeutic ultrasound, general massage, stretching, and needle acupuncture provided only momentary relief. After a year of decreased physical activity the patient attended the clinic. There he was examined and diagnosed with chronic bilateral Achilles tendinopathy. This study used the hypothesis that overuse injuries are caused by localized portions of structural degeneration rather than inflammation.

Miners & Bougie ‘s hypothesis led to a treatment plan of heat pack, stationary cycling, Graston Technique, Active Release Technique, slow eccentric calf lowering exercises, and static gastrocnemius and soleus stretching with an ice pack. The patient attended two treatments per week for three weeks followed by one treatment every seven to ten days for a further three treatments. At the sixth visit the patient’s pain level was decreased by 50% and discomfort decreased in the mornings and after exercise. The

patient believed the condition to be almost completely resolved, resumed training, and was discharged with a home therapy protocol for another three weeks. At the follow-up, seven months later, the patient reported almost no pain and the ability to complete a varied training routine. This study showed a rapid recovery of chronic Achilles tendinopathy compared to the 12 month recovery time reported by other literature. It brings out the hypothesis that tendinopathy can be treated by soft tissue therapy and tissue rehabilitation provided by techniques like the Graston Technique (Miners & Bougie, 2011).

Discussion

The research currently available seems to favor the use of the Graston Technique for a variety of abnormalities. Although this is true, there are some limitations to the evidence of the Graston Technique's effectiveness. The foremost problem in this area is the lack of research on the technique. The Graston Technique neither has a good depth or scope of research and evidence backing its claims. There are many directions that further research might take. There have been suggestions to compare the Graston Technique with other manual techniques and compare their effectiveness (Hammer, 2008). Research also needs to be done to assess the different types of injuries for which the Graston Technique would be best utilized (Howitt et al., 2009, 2006; Loghmani & Warden, 2009; Looney et al., 2011; Miners & Bougie, 2011).

There are both benefits and drawbacks to using the Graston Technique in a clinical setting. The primary benefit of using the Graston Technique may reside in the reports of decreased strain on the clinician's hands (Burke et al., 2007). Though the tools may be

better for the clinicians, the Graston Technique may not be an improvement over manual soft-tissue mobilization. The study by Burke et al. reports that there was no difference in patient satisfaction or clinical improvements between manual soft-tissue mobilization and instrument-assisted soft-tissue mobilization (Burke et al., 2007). The major drawback against widespread use of the Graston Technique seems to be the cost of the instruments and the time needed to become proficient in using the instruments (Stow, 2011). Only more evidence and additional research can show the true benefit of the Graston Technique in relation to the drawbacks of the technique.

CHARTS

Research Articles

Study	Participants	Measurements	Findings
Davidson et al. (1997)	20 Male Sprague-Dawley rats divided into four groups becoming a control (A), induced tendinitis (B), tendinitis plus ASTM (C), and ASTM alone (D).	Gait analysis, Light Microscopy, Electron Microscopy, and Immunoelectron Microscopy.	ASTM treatment improves limb function and recruitment and activation of fibroblasts to facilitate tendon healing.
Burke et al. (2007)	22 Patients with Carpal Tunnel Syndrome divided into two groups: Graston Technique (n= 12) and Soft Tissue Mobilization (n= 10).	Sensory and motor latencies, Subjective Test Battery, Range of Motion, Isometric Strength, Clinical Tests and Sensory Function, and Patient Satisfaction.	Manual therapy increased ROM and grip strength in wrists affected with Carpal Tunnel Syndrome and improvements were not different between the manual therapy techniques.
Loghmani et al. (2009)	58 Female Sprague-Dawley rats; 51 received surgery to induce bilateral MCL injuries and 7 serving as control. 31 rats received Graston treatment 3X/week for 3 weeks, 20 rats received treatment 3X/week for 10 weeks.	Mechanical testing, scanning electron microscopy, and histological assessment.	Instrument assisted cross-fiber massage (IACFM) treated ligaments were 43% stronger, 40% stiffer, and 57% more able to absorb energy than the contralateral untreated injured ligaments.
Looney et al. (2010)	10 Patients; 3 Male and 7 Female with plantar heel pain.	Success of treatment based on Global Rating of Change, reports of pain through Numeric Pain Rating scale, and perceived level of disability measured by LEFS.	A treatment with both Graston Technique and a home stretching program experienced a significant and meaningful improvement.

Case Studies

Study	Patient	Treatment	Findings
Hammer et al. (2005)	59-year-old male with intermittent lumbar pain diagnosed with lumbar compartment syndrome.	Treating the posterior fascia, fascia overlying the hamstrings bilaterally, sacrum, and right hip rotators through the Graston Technique including 2 sets of 3 stretches to continue at home.	Was discharged asymptomatic after 6 visits at 2 visits per week. This led to a hypothesis that intramuscular pressures were normalized after instrument-assisted soft tissue mobilization and stretching.
Howitt et al. (2006)	42-year-old male with a diagnosis and ultrasound confirmation of trigger finger.	Treated with Active Release Technique (ART) and Graston Technique and an post-treatment icing.	Had 8 visits over a 4 week time period. Through that time period pain decreased during ROM. At 2 and 14 months after discharge there were no other complications or re-aggravations.
Howitt et al. (2009)	41-year-old male with acute right ankle pain diagnosed as 1st degree tibialis posterior strain brought on through swimming during triathlon training.	Treated with medical acupuncture, electrical stimulation, therapeutic ultrasound, Active Release Therapy below and above the injury, Graston Technique to the medial malleolus, and post-treatment ice and elevation	Had 7 visits over a 6 week period (including a two week break from treatment). During treatment inflammation, pain and a sign of a limp decreased. Patient did not have complications or re-aggravations.
Miners et al. (2011)	40-year-old male with intermittent bilateral Achilles Pain for approximately 3.5 years.	Treatment included heat pack, stationary cycling, Graston Technique, Active Release Therapy, and slow eccentric calf lowering exercises. Home Therapy including ice, calf stretching, and eccentric heel lowering exercises were also prescribed.	Had 9 visits over a 8 week period. During treatment pain was reduced 50% by the 6th visit and was considered completely resolved at time of discharge.

CHAPTER THREE

The Future of Research in Manual Therapy

Looking to the future of research within the field of manual therapy several things must be evaluated. First, one needs to examine whether or not manual therapy is even a science. What use is inconclusive and unproven research if manual therapy is indeed deemed an art? Can an effective style of research be found so that evidence based research can accurately inform clinicians of the effectiveness of manual therapy techniques? Second, one should look at how evidence based research can be effective in informing clinicians. Research in itself is useless without people to review and implement the findings that research has to offer. How can research be better implemented in clinical settings? Finally, one should fully explore why future research in manual therapy is important. Why is it important for manual therapy to become an increasingly researched-based practice? Why not leave manual therapy to tradition and the status quo? This chapter will discuss if manual therapy is an art or a science, the implementation of evidence-based research in a clinical setting, and why it is important for manual therapy to be evidence-based.

One of the foremost questions in manual therapy today is: can manual therapy be evidenced based. Is manual therapy an evidence-based science or a mutable art form? These complex questions lie at the heart of research in manual therapy. If manual therapy is indeed solely an art, is research even needed to prove its worth? If firmly a science research should show that A + B always equals C and every variable can be

quantitated and easily controlled. Unfortunately for researchers and the clinicians attempt to evaluate and implement the research, this question is not one simply answered. Many factors must be evaluated in answering this question.

In evaluating whether manual therapy is an art or a science one should examine differences between therapists and patient-therapist related factors, internal and external validity, and the differences between qualitative and quantitative methodology. The difference between therapists and patient-therapist relationships has shown to be a powerful factor and is a nigh impossible factor to control (Kidd, 2009). Many manual therapy techniques rely on is the innate ability of the therapist. A therapist relies on sensing of signals given off by the patient. How these signals are received and acted upon all depends on the skill and experience of the therapist (Farrell & Jensen, 1992). A more skilled therapist is able to receive more signals from the patient and will better know how to react to the signals given. A therapist is able to pick up on such signals as the condition of the skin and underlying muscles through touching the patient. They can tell the therapist skin temperature and texture as well as which muscle are tense. In myofacial release the process of touching the patient can give information about exactly where that patient's trigger points are located (Fitzgerald, McClure, Beattie, & Riddle, 1994).

Touching the patient does not only have the ability to pick up signals from the patient but also is a part of the patient-therapist relationship that is often known as the 'laying on of hands'. A simple Google search including 'hands' and 'healing' can show that hands have been very important in many cultures' spiritual and religious based healing practices. Current research has agreed that hands and touch are very important in

the healing process. Touch has been shown to influence patients in more than a mechanical way. Touch has been shown to transfer electromagnetic signals which have biological effects. It also has been shown to have biological effects on patients such as changing their heart rate and brain wave activity. A simple touch has been shown to change functions such as heart rate and brain wave activity (Kidd, 2009). In addition to the 'laying of hands' factor, the mental and emotional state of the patient and how this state is influenced by the therapist can come into play regarding the outcome of the technique (Farrell & Jensen, 1992). This can fall, in part, under a placebo effect. Psychological and social factors of the patient and between the patient and therapist can be, in part responsible for the success or failure of a treatment (M. Jones, Edwards, & Gifford, 2002).

The innate ability of therapists and the interactions between therapists and their patients pose a great problem regarding validity in research. There are two types of validity that need to be evaluated: internal and external validity. Internal validity's main function is to act within a study. It attempts to show causation (Milanese, 2011). Researchers control for- or eliminate the influence- of outside factors. External validity, as its name implies, is focused between studies. It evaluates the generalizability of studies. A strong external validity is proven by being able to replicate another study using the primary study's same conditions (Shepard, Jensen, Schmoll, Hack, & Gwyer, 1993). This directly effects the evaluation of a manual therapy technique's effectiveness. If one study reports a high effectiveness and another attempt to replicate the study reports that the technique is relatively ineffective, it is difficult to come to the correct conclusion of the efficacy of the technique. Studies need both internal and external

validity to come to accurate conclusion, both causally and generally, about treatments and treatment methods. They are both necessary to determine what would be useful and helpful in treating patients.

In evaluating the interactions between therapists and their patients there is concern with both internal validity and external validity. The patient-therapist relationship could differ due to a few reasons, mainly including the differences in 'laying of hands' could make in different patients. The difference in effect of the patient-therapist relationship between patients cannot be controlled for due to the fact that every human is different (Farrell & Jensen, 1992). This can lead to variations within a study, and thus disrupt internal validity, depending on the patient sample size. The patient-therapist relationship can also vary between therapists, disturbing external validity during study replication attempts. In the case of the innate ability of therapist, the main problem lies in external validity. The results could vary in the replicability of the study due to the differences between therapists (Kidd, 2009). This could lead to a discrepancy between the reported effect of a treatment in different studies. Human interactions could play a large role in treatment and that factor is hard to control for in randomized control trials and other quantitative research techniques.

Human interactions can have a significant impact in regards to quantitative research techniques in manual therapy research. Thus, in evaluating the ability of manual therapy to be evidence-based, one should examine the differences between quantitative and qualitative research methodology. In thinking about the differences between quantitative and qualitative research, one needs to examine the thought processes behind the methodologies. There are two main paradigms that guide research today, positivism

and phenomenology. Positivism is founded on the idea of discovering one, all-encompassing, objective reality. The philosophy aims to use order and control to discover cause-and-effect relationships (Farrell & Jensen, 1992; Milanese, 2011; Shepard, Jensen, Schmoll, Hack, & Gwyer, 1993). In schools today this perspective and its resulting methodology is the most often taught in schools today as the scientific method. It is most often used in what is commonly known as the 'hard' (such as physics, chemistry, and biology) sciences as the primary way of discovering reproducible scientific laws. This methodology often produces quantitative results.

Another paradigm behind research arose in Germany in the mid-1800. It was termed phenomenology, or hermeneutics. This philosophy strove to understand how a human factor shaped research. Because humans are all different and multi-faceted, the perspective operated under the assumption that there were multiple realities, instead of one all-encompassing reality. The paradigm studied observable experiences and how they appeared through the perspective of the humans participating in the study. The method rested on the belief that individuals needed to be understood and not separated from their environments. Data collected during a phenomenological study would be used to explain why variances occurred under different conditions (Shepard et al., 1993). Unlike positivism, phenomenology's main aim is to explain and interpret human behavior. This paradigm is often used to conduct research in the 'soft' sciences (such as sociology, psychology, and anthropology). This methodology often produces qualitative results.

The most common and often cited as the most powerful design in health care research is a positivist philosophy called randomized controlled trials (Milanese, 2011).

Randomized controlled trials focus on the use of a control group, the randomization and blinding of subjects, and a therapists and outcome assessment. Like many types of positivistic research, randomized controlled trials are limited by the inherent external validity problems in the study's findings (Milanese, 2011). This can be explained for through the fact that positivist studies attempt to control for human factors, which cannot always be accounted for in the field of manual therapy. This decreases the trial's usefulness because it impacts the therapist's knowledge of a technique's efficacy and its applicability in a variety of clinical settings. Though this is the case, randomized controlled trials can still hold valuable information if the inherent weaknesses are taken into account.

One can come to the conclusion that manual therapy is in fact both an art and a science. Manual therapy is a science because it focuses on the physiological responses to a variety of different actions performed by a therapist. Physiological processes are highly biological and can be easily controlled for, and one formal form or reality can be found in a positivist experiment (Farrell & Jensen, 1992). On the flip side, it would be remiss to ignore human factors such as the relationship between the therapist and patient. Much of clinical research, and even practice, has been trying to ignore the mind while treating the body. In doing so, the current scientific culture has been throwing out the baby with the bathwater. Humans are not just flesh, muscles, and bones. The human mind is a powerful tool which is often forgot in modern medicine.

Since manual therapy can be described as both an art and a science, one can draw the conclusion that manual therapy research can in fact be evidence-based. Though it can be evidence-based, because it is both an art and a science it cannot be evidence-based

through only one research paradigm (Farrell & Jensen, 1992). Although it seems contradictory, one needs to consider one ultimate reality and multiple realities when researching and evaluating research in manual therapy. Research must address both the human condition and immutable physiological responses when evaluating the effectiveness of manual therapy. In neglecting one side or another, a complete and holistic picture of treatment methodology cannot be formed. Thus, in order for research to be completely evidence-based a new research methodology must be formed. The new methodology must draw from both positivistic and phenomenological to make a bridge between the two paradigms. A complete picture of the efficacy of manual therapy techniques can only be seen through this merge.

Now that it has been determined that manual therapy can indeed be evidence-based another important question must be addressed. Can the results from evidence-based research be implemented in a clinical setting? In answering this question, one must first look at the problems that permeate current attempts to use research to influence clinical practices. These problems fall into two main categories, problems with the body of research and the skill of clinician.

There are several problems found within the current body of research. One of the most prominent of these problems is the lack of definition in manual therapy research. Definitions are very important in any type of research. They provide uniformity amongst researchers and clinicians alike. Manual therapy covers a wide variety of different techniques and different ways of implementing those techniques if definitions are not clearly defined, precise communication can never occur. Clarity in operational definitions are also extremely important. Operational definitions work to clarify the

implementation of treatment techniques in research. A current problem in research today is that authors of research often define the use of a technique as "described by Maitland." This is problematic because what one author describes as "described by Maitland" is not necessarily what another researcher or clinician would consider as "described by Maitland" (Fitzgerald et al., 1994). If not completely clear a lack of definitions in research could result in a very strange game of telephone, with everyone thinking that they are talking about the same thing but in fact are holding completely different ideas.

Another problem in the current body of research is the low volume of research available. Manual therapy is often used to treat a number of complex issues. It is also often used in conjunction with a variety of other treatments. Treatments are also often altered and added to in both major and minor ways by researchers to fit with factors that may present a specific case. This variety of issues and treatments makes it hard to evaluate a specific manual therapy technique and its efficacy (Fitzgerald et al., 1994). Especially with the randomized controlled trial research design, finding a significant amount of research is extremely hard. It is necessary in randomized controlled trial research to control for everything that can possibly be controlled for to leave the manual therapy technique bare for evaluation. The number of manual therapy techniques, supplemental treatments, and diagnoses leaves a large variety of possibilities in research (Maher, Sherrington, Elkins, Herbert, & Moseley, 2004). Clinicians are often left to predict the treatment's effect on specific diagnoses. The large body of possibilities and

relatively small body of research in specific areas of practice often forces researchers and clinicians alike to rely upon low levels of evidence and generalizations to evaluate techniques.

There are a number of barriers preventing a wide flow of information and research accessibility, especially to practicing clinicians. Research is available on the internet from databases, but many of the databases cost a substantial amount to access full research articles. Databases do not always have complete coverage from all journals that publish manual therapy research. Online databases also do not have older publications in manual therapy research. Most of the oldest research found in databases today stem from the late 1980 to the early 1990s (Maher et al., 2004). Research accessibility is absolutely essential to the propagation and integration of manual therapy research into clinical practice.

Problems with the body of manual therapy research are only one side of the larger issue of using research to influence and improve clinical practices. The other side of the issue lies with the abilities of the particular clinician to evaluate and implement the findings in the research. Historically this has been a rather large problem, though it is slowly in the process of being rectified (Maher et al., 2004). Clinicians often have a hard time assessing the quality of research and correctly understanding the implications of research. Therapists that have trouble assessing research can use the PEDro database to check for a study's internal validity and statistical completeness. Cochrane systematic reviews are also helpful in providing an unbiased view of literature to therapists. Though clinicians can use such tools to assess research, the most powerful tool is one cultivated through schooling. Professional schools need to increase development of analytical skills

in assessing research and encouragement of research in the field of manual therapy (Connolly, Lupinnaci, & Bush, 2001). Increasing teaching about research and its interpretation goes hand in hand with professional schools increasing their assistance in helping future therapists and researchers to become better critical thinkers (M. A. Jones, 1992). Thinking and analytical skills are just as important in clinical settings as technical skills. Analysis is essential in every aspect of life. It can help a researcher create solid research methodology, a clinician determine if certain research is applicable to a certain practice or patient, and even help make clinicians better diagnosticians.

The final question that one should ask is why is research in manual therapy important? Why are evidence-based findings necessary in this hard to define and tumultuous tool of physical therapy? The first reason that manual therapy has to fight on to become more evidence-based is the current flow of modern medicine. Modern medicine has become increasingly focused on research. People want to find out if, why, and how treatments work. Our society has become one focused on efficiency. People like knowing what practices work the best. This push towards knowledge has also been accompanied by an increasing demand for accountability throughout many spectrums of the healthcare community, including insurance agencies and health-conscious consumers (Jette, 1995). The internet has made knowledge more accessible to everybody and in response more people want to know how and why treatments are being performed (Maher et al., 2004). Without a thorough examination of manual therapy traditions accountability often suffers. Often when treatments have not been accounted for, insurance agencies and other funding companies withdraw their backing of a particular

treatment. And where there is no money, patients are the ones who suffer by not receiving proper treatment.

Research is also essential because physical therapists need to test theories. Physical therapists need to validate or disprove these many theories because clinical reasoning and treatment methodology is only as good as the information on which it is based. The more information that therapists have about conditions and their treatments, the better they become at diagnosing and decision making (Farrell & Jensen, 1992). Lack of knowledge about how and why a procedure or therapy works can only hinder the patient's healing process (M. A. Jones, 1992). Jules M. Rothstein (1992) stated in Physical Therapy Journal: "In the absence of dialogue, growth and refinement are not possible" (Rothstein, 1992). Without growth, any discipline will grow stagnant. In taking on the profession, therapists have gained the duty to further manual therapy, and physical therapy as a whole, as much as possible. As in all fields, practitioners have the responsibility and should have the desire to gain as much information as possible about their practice. In fact, if therapists fail to further the field they are doing a disservice to the pioneers of manual therapy and the therapists of the past (Connolly et al., 2001). Tradition is not something to be clung to like an old comfort blanket, but something that can be used to challenge and advance a subject. Manual therapy needs to rise to the challenge handed down through tradition. Therapists need to strive through research to come to a deeper and fuller understanding of current practices in physical and manual therapy.

BIBLIOGRAPHY

A Synopsis. (n.d.). *Graston Technique: Simple Technology Improving Injury Treatment and Rehabilitation*. Retrieved April 2, 2012, from http://grastontechnique.com/AboutUs/ASynopsis.html

Burke, J., Buchberger, D. J., Carey-Loghmani, M. T., Dougherty, P. E., Greco, D. S., & Dishman, J. D. (2007). A pilot study comparing two manual therapy interventions for carpal tunnel syndrome. *Journal of manipulative and physiological therapeutics*, *30*(1), 50–61.

Clayton, P. (2009). The Use of Deep Transverse Frictions in the Treatment of Acute and Chronic Soft-tissue Injuries. *SportEX Dynamics*, (22), 21–24.

Connolly, B. H., Lupinnaci, N. S., & Bush, A. J. (2001). Changes in Attitudes and Perceptions About Research in Physical Therapy Among Professional Physical Therapist Students and New Graduates. *Physical Therapy*, *81*(5), 1127–1134.

Davidson, C. J., Ganion, L. R., Gehlsen, G. M., Verhoestra, B., Roepke, J. E., & Sevier, T. L. (1997). Rat tendon morphologic and functional changes resulting from soft tissue mobilization. *Medicine & Science in Sports & Exercise*, *29*(3), 313.

Davis, D. S., Ashby, P. E., McCale, K. L., McQuain, J. A., & Wine, J. M. (2005). The Effectiveness of 3 Stretching Techniques on Hamstring Flexibility Using Consistent Stretching Parameters. *Journal of Strength & Conditioning Research (Allen Press Publishing Services Inc.)*, *19*(1), 27–32.

Drover, J., Forand, D., & Herzog, W. (2004). Influence of active release technique on quadriceps inhibition and strength: a pilot study. *Journal of Manipulative & Physiological Therapeutics*, *27*(6), 408–413.

Farrell, J. P., & Jensen, G. M. (1992). Manual therapy: a critical assessment of role in the profession of physical therapy. *Physical Therapy*, *72*(12), 843–852.

Fitzgerald, G. K., McClure, P. W., Beattie, P., & Riddle, D. L. (1994). Issues in determining treatment effectiveness of manual therapy. *Physical Therapy*, *74*(3), 227–233.

Hammer, W. I. (2008). The effect of mechanical load on degenerated soft tissue. *Journal of Bodywork and Movement Therapies*, *12*(3), 246–256.

Hammer, W. I., & Pfefer, M. T. (2005). Treatment of a case of subacute lumbar compartment syndrome using the Graston technique. *Journal of manipulative and physiological therapeutics*, *28*(3), 199–204.

History of the Graston Techniqe. (n.d.). *Graston Technique: Simple Technology Improving Injury Treatment and Rehabilitation*. Retrieved March 30, 2012, from http://grastontechnique.com/AboutUs/CompanyHistory.html

Howitt, S., Jung, S., & Hammonds, N. (2009). Conservative treatment of a tibialis posterior strain in a novice triathlete: a case report. *The Journal of the Canadian Chiropractic Association*, *53*(1), 23.

Howitt, S., Wong, J., & Zabukovec, S. (2006). The conservative treatment of trigger thumb using graston techniques and active release Techniques®. *The Journal of the Canadian Chiropractic Association*, *50*(4), 249.

Jette, A. M. (1995). Outcomes research: shifting the dominant research paradigm in physical therapy. *Physical Therapy*, *75*(11), 965–970.

Jones, M. A. (1992). Clinical reasoning in manual therapy. *Physical Therapy*, *72*(12), 875–884.

Jones, M., Edwards, I., & Gifford, L. (2002). Conceptual models for implementing biopsychosocial theory in clinical practice. *Manual therapy*, *7*(1), 2–9.

Kahanov, L., & Kato, M. (2007). Therapeutic modalities. Therapeutic effect of joint mobilization: joint mechanoreceptors and nociceptors. *Athletic Therapy Today*, *12*(4), 28–31.

Kidd, R. F. (2009). Why myofascial release will never be evidence-based. *International Musculoskeletal Medicine*, *31*(2), 55–56. doi:10.1179/175361409X412575

Lewis, C., & Flynn, T. W. (2001). The Use of Strain-Counterstrain in the Treatment of Patients with Low Back Pain. *Journal of Manual & Manipulative Therapy (Journal of Manual & Manipulative Therapy)*, *9*(2).

Loghmani, M. T., & Warden, S. J. (2009). Instrument-assisted cross-fiber massage accelerates knee ligament healing. *J Orthop Sports Phys Ther*, *39*(7), 506–514.

Looney, B., Srokose, T., Fernández-de-las-Peñas, C., & Cleland, J. A. (2011). Graston instrument soft tissue mobilization and home stretching for the management of plantar heel pain: a case series. *Journal of Manipulative and Physiological Therapeutics*, *34*(2), 138–142.

Maher, C. G., Sherrington, C., Elkins, M., Herbert, R. D., & Moseley, A. M. (2004). Challenges for evidence-based physical therapy: accessing and interpreting high-quality evidence on therapy. *Physical Therapy*, *84*(7), 644–654.

Milanese, S. (2011). The use of RCT's in manual therapy–Are we trying to fit a round peg into a square hole? *Manual therapy*, *16*(4), 403–405.

Miners, A. L., & Bougie, T. L. (2011). Chronic Achilles tendinopathy: a case study of treatment incorporating active and passive tissue warm-up, Graston Technique®, ART®, eccentric exercise, and cryotherapy. *The Journal of the Canadian Chiropractic Association*, *55*(4), 269.

Paolini, J. (2009). Review of myofascial release as an effective massage therapy technique. *Athletic Therapy Today*, *14*(5), 30–34.

Perreault, A., Kelln, B., Hertel, J., Pugh, K., & Saliba, S. (2009). Short-Term Effects of Strain Counterstrain in Reducing Pain in Upper Trapezius Tender Points. *Athletic Training & Sports Health Care: The Journal for the Practicing Clinician*, *1*(5), 214-221.

Rothstein, J. M. (1992). Manual therapy: A special issue and a special topic. *Physical Therapy*, *72*(12), 839–841.

Sevier, T. L., & Wilson, J. K. (1999). Treating lateral epicondylitis. *Sports Medicine*, *28*(5), 375–380.

Shepard, K. F., Jensen, G. M., Schmoll, B. J., Hack, L. M., & Gwyer, J. (1993). Alternative approaches to research in physical therapy: positivism and phenomenology. *Physical Therapy*, *73*(2), 88–97.

Spina, A. A. (2007). External coxa saltans (snapping hip) treated with active release techniques: a case report. *Journal of the Canadian Chiropractic Association*, *51*(1), 23–29.

Stasinopoulos, D., & Johnson, M. (2004). Cyriax physiotherapy for tennis elbow/lateral epicondylitis. *British journal of sports medicine*, *38*(6), 675–677.

Stone, J. A. (2000). Strain-counterstrain. *Athletic Therapy Today*, *5*(6), 30–31.

Stone, M., Ramsey, M. W., Kinser, A. M., O'Bryant, H. S., Ayers, C., & Sands, W. A. (2006). Stretching: Acute and Chronic? The Potential Consequences. *Strength & Conditioning Journal (Allen Press)*, *28*(6), 66–74.

Stow, R. (2011). Instrument-Assisted Soft Tissue Mobilization. *International Journal of Athletic Therapy & Training*, *16*(3), 5–8.

Swann, E., & Graner, S. J. (2002). Uses of manual-therapy techniques in pain management. *Athletic Therapy Today*, *7*(4), 14–17.

Weerapong, P., Hume, P. A., & Kolt, G. (2005). The Mechanisms of Massage and Effects on Performance, Muscle Recovery and Injury Prevention. *Sports Medicine*, *35*(3), 235–256.

Wong, C., Moskovitz, N., & Fabillar, R. (2011). The effect of strain counterstrain (SCS) on forearm strength compared to sham positioning. *International Journal of Osteopathic Medicine*, *14*(3), 86–95. doi:10.1016/j.ijosm.2010.11.004

Yang, J., Chang, C., Chen, S., Wang, S., & Lin, J. (2007). Mobilization techniques in subjects with frozen shoulder syndrome: randomized multiple-treatment trial. *Physical Therapy*, *87*(10), 1307–1315. doi:10.2522/ptj.20060295

Young, R., Gutnik, B., Moran, R., & Thompson, R. (2005). The effect of effleurage massage in recovery from fatigue in the adductor muscles of the thumb. *Journal of Manipulative & Physiological Therapeutics*, *28*(9), 696–701.