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A follow-up of patient reported outcomes in chronic plantar heel pain participants treated with Graston Technique: A mixed methods approach

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A FOLLOW-UP OF PATIENT REPORTED OUTCOMES IN CHRONIC PLANTAR HEEL PAIN PARTICIPANTS TREATED WITH GRASTON TECHNIQUE: A MIXED METHODS APPROACH

An Abstract of a Dissertation

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Doctor of Education

Approved:

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ABSTRACT

Chronic Plantar Heel Pain (CPHP), commonly known as “plantar fasciitis,” is a condition that is estimated to affect 10% of the American population. A treatment for CPHP and other soft tissue overuse conditions that is increasing in popularity is the use of metal instruments for deep tissue massage for 10 minutes, twice a week for six weeks, called the Graston Technique.

The purpose of this study is to longitudinally examine the foot pain and function of participants who received Graston Technique treatment approximately two years before this study. A mixed methods design where quantitatively, three self-reported survey instruments were utilized, and qualitatively, an interview regarding foot pain and function, as well as quality of life, was completed.

This study is motivated by three research questions: (1) Will participants treated with Graston Technique for CPHP report a maintenance or decrease in pain levels two years posttreatment? (2) Will participants treated with Graston Technique for CPHP report a maintenance or improvement in functional outcomes two years posttreatment? (3)What are the lived experiences of participants treated with Graston Technique for CPHP?

The findings of this case series design demonstrate that 13 out of 15 participants maintained or improved pain levels and functional outcomes near two years posttreatment. Qualitatively, 10 out of 15 of the participants described having foot pain at the cessation of treatment, with the pain subsiding a few months later. This could occur from the long-term mechanical changes that Graston Technique can impose on

degenerated tissue, such as in CPHP. The findings support that Graston Technique may be an effective treatment for CPHP to maintain pain and functional levels two years after the treatment has ended.

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DEDICATION

This dissertation is dedicated to my wife Jennifer, also my daughters Marissa and Delaney, who have supported me through this entire process. I am also grateful for the encouragement of my parents, Richard and Ann Garrett, who have wholeheartedly supported me through my entire education, from reading to me as toddler through graduate school.

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CHAPTER 1

INTRODUCTION

In recent years, health care professionals in the physical rehabilitation field have increased the use of instrument-assisted soft tissue massage (IASTM) with their patients in order to treat chronic and sub-acute injuries. IASTM involves the clinician using uniquely shaped instruments to perform a deep tissue massage, with the intent of facilitating the healing process. One form of IASTM, the Graston Technique (TherapyCare Resources, Indianapolis, IN), is defined as: “an advanced form of soft tissue mobilization that is primarily used to detect and release scar tissue, adhesions, and fascial restrictions” (p. 9).[1] It is also theorized that it creates a controlled inflammatory response in the body, and enables healing of connective tissues by increasing the number of cells that promote healing to the injured area.[1,2] One commonly injured area is the plantar fascia of the sole of the foot, which can lead to the chronic condition of plantar fasciitis.

Plantar fasciitis is the common nomenclature used to describe foot pain on the plantar surface of the foot, typically where the plantar fascia attaches to the heel bone (calcaneus). Use of the suffix “itis" for this condition can be misleading, however, as biopsy research has shown that inflammation does not occur.[3] It is more correctly a degeneration of the plantar fascia tissue, so it in fact, should be referred to as plantar fasciosis.[4] While many use the term plantar fasciosis or plantar fasciopathy to describe this condition, the term chronic plantar heel pain (CPHP)[5] is utilized in order to encompass all the possible pathologies for chronic pain and dysfunction of the plantar fascia and calcaneus.

Statement of the Problem

Clinicians are increasingly using IASTM as a treatment modality for overuse and chronic soft tissue disorders. IASTM research is greatly limited with the vast majority of research articles being individual case studies of various soft tissue injuries, which are rated low on the Oxford Scale of Evidence.[6] Whereas the amount of evidence is minimal, a literature review shows that there is a paucity of research investigating the longitudinal outcomes of IASTM, for any specific injury, including CPHP.

Purpose

The purpose of this mixed methods study is to evaluate long term foot pain and function of CPHP participants who received Graston Technique with approximately two years follow-up (range 21-31 months, mean 25 months). A convergent parallel mixed methods design[7] will be utilized, which involves concurrent collection of quantitative and qualitative data, with independent analysis, and then merging. In this study, three self-reported outcome instruments will be used and presented as a case series to test the theory that Graston Technique maintains long term decreases in pain and increases in functional outcomes for participants previously treated with CPHP. The qualitative interviews will employ Narrative Inquiry,[8] allowing for the same CPHP participants to "tell their story" regarding the treatment and longitudinal experience. The purpose for amassing both quantitative and qualitative data is to amalgamate the two forms of data to bring greater insight into the problem than would be acquired by either type alone.[7]

Significance

Chronic Plantar Heel Pain involving the plantar fascia resolves 80% of the time with conservative treatment,[9] however, for some people, symptoms can linger for years. Difficult cases are sometimes referred to as "recalcitrant," meaning "hard to manage" or "not responsive to treatment,"[10] and were described by DiGiovanni[11] as lasting for more than 10 months. For some CPHP patients, certain treatments such as corticosteroid injections and even surgery provide temporary relief, however, the pain and functional limitations return.[3]

The prevailing theory is that plantar fascia degenerates and thickens with CPHP, especially after one year post onset of symptoms.[5,12] Graston Technique is a deep tissue massage that releases scar tissue and adhesions while remolding the fascia,[1] which can possibly lead to decreased pain with increased function. Currently, there are no studies that demonstrate treatment with IASTM resulting in decreased plantar fascia thickness, however, studies have reported a correlation between increased plantar fascia thickness and increased pain[13] with a decrease in thickness after a corticosteroid injection.[14] Whereas, current IASTM literature has described decreases in pain and increases in function with immediate results, this study examined participants' pain and function longitudinally for an average of two years after the treatment was completed.

Research Questions

This study examined the longitudinal results of CPHP patients using quantitative and qualitative methods. Particularly, the following research questions are addressed:

1. Will participants treated with Graston Technique for CPHP report a maintenance or decrease in pain levels two years posttreatment?
2. Will participants treated with Graston Technique for CPHP report a maintenance or improvement in functional outcomes two years posttreatment?
3. What are the lived experiences of participants treated with Graston Technique for CPHP?

Delimitations

This study was restricted to participants of Garrett and Neibert (unpublished data, 2015) “Graston Technique as a Treatment for Patients with Chronic Plantar Heel Pain: A Randomized Controlled Trial,” who completed a 12 session regimen of the investigative Graston Technique treatment. The previous study took place from May 2012 to May of 2013, with 19 participants meeting eligibility requirements for the current study.

Limitations

Efforts will be made to keep limiting factors from affecting the outcome of the research. Limitations include:

1. This study is limited to the perceptions of CPHP patients who participated in a study by Garrett and Neibert (unpublished data, 2015).
2. This study is limited to the participants’ honesty and objectivity of reporting foot pain and function as measured by a self-reporting survey instrument and interview.

3. The participants' initial diagnosis by a physician was indeed a plantar fascia injury, and not an associated differential diagnosis (i.e. nerve entrapment, bone spur, or other pathology).

Definition of Terms

Instrument Assisted Soft Tissue Massage (IASTM)- A method of deep tissue massage utilizing a hand held device made of various materials, and of unique shapes and sizes.

Chronic Plantar Heel Pain (CPHP)- A term to describe injury to the plantar fascia near or at the attachment on the calcaneus (heel bone). A more appropriate term than plantar fasciitis, which implies that the plantar fascia is inflamed.

Graston Technique (GT) – A type of IASTM where a clinician uses stainless steel instruments of various sizes with convex and concave shapes to provide a deep tissue massage.

Augmented Soft Tissue Massage (ASTYM)- An alternative type of IASTM where a clinician uses plastic instruments of various shapes and sizes to provide a deep tissue massage.

Foot Health Status Questionnaire (FHSQ)- An outcome instrument used to measure self-reported foot pain, foot function, general foot health, shoes, general health, physical activity, social capacity, and vigour. A score of 100 represents optimal health, and zero represents worst health.

McGill Pain Questionnaire (MPQ)- An outcome instrument used to measure self-reported pain, by choosing adjectives that describe pain. Participants can score between 0-78, with zero representing no pain.

Visual Analog Scale (VAS) – An outcome instrument used to measure pain. Participants mark a vertical line on a 100m scale, with 0 representing no pain and 100mm worst pain imaginable.

CHAPTER 2

REVIEW OF LITERATURE

The purpose of this review is to evaluate the relevant literature regarding the plantar fascia, CPHP, IASTM and the functional outcome instruments utilized: Foot Health Status Questionnaire (FHSQ), McGill Pain Questionnaire (MPQ) and Visual Analog Scale (VAS). Specifically, foot anatomy and biomechanics will be examined, particularly how it pertains to the plantar fascia. Also, CPHP issues, including pathophysiology, nomenclature, symptoms, risk factors, rates of occurrence and common treatments will be analyzed. This review continues with evidence-based literature involving IASTM, specifically Graston Technique and Augmented Soft Tissue Massage (ASTYM), and concludes with the three self-reported outcome instruments applied in this dissertation.

Plantar Fascia and Associated Foot Anatomy

In anatomical terms, the word ‘plantar’ refers to the sole of the foot, which is derived from the Latin word ‘planta’ of the same meaning.[15] Fascia is a connective tissue located throughout the body, providing covering and structure to muscles, tendons, and organs. According to Tabor’s Medical Dictionary[16] fascia can be defined in two ways, as deep fascia “a fibrous membrane covering, supporting, and separating muscles” or as superficial fascia “the subcutaneous tissue that connects the skin to the muscles” (p. 778). An aponeurosis is a more organized thickened band of fascia, such as in the palm of the hand, or the plantar surface of the foot.[17] In many medical references, the term ‘fascia” and “aponeurosis” are used interchangeably; Tabor[16] defines aponeurosis as “a flat fibrous sheet of connective tissue that attaches muscle to bone or other tissues; may sometimes serve as fascia" (p. 151). Therefore, Tabor defines fascia and aponeurosis as synonymous, therefore, the term plantar fascia will be used to describe the superficial connective tissue on the sole of the foot.

Historically, many of the great anatomists refer to the plantar fascia indirectly. Galen[18] circa 175 A.D., described an "outgrowth" on the bottom of the foot from the heel that prevents the skin of the sole of the foot from getting folded over. Italian anatomist Andreas Velsalius[19] (circa 1543), described an "exceedingly thick membrane acting as an intimate covering not unlike the broad tendon in the hand" (p. 28). In the drawings of Leonardo da Vinci during the early 1500's,[20] da Vinci makes no reference to the plantar fascia, as he focuses on the bones and muscles of the foot.

On the plantar surface of the foot, the plantar fascia lies just beneath the skin within the superficial layer of tissues, thusly covering three more layers of muscles at deeper levels of the foot.[21] After the superficial plantar fascia, Netter[21] defines the first layer of muscles as the flexor digitorum brevis, abductor hallucis, and abductor digiti minimi, which are intrinsic to the foot. The second layer includes the flexor digitorum longus and flexor hallucis longus, which are extrinsic, as they are tendinous through the plantar aspect of the foot. The second layer also includes the intrinsic lumbrical and quadratus plantae muscles. The third and deepest layer of the plantar aspect of the foot include the: adductor hallucis, flexor hallucis brevis, and flexor digiti minimi brevis, which are all classified as intrinsic muscles.

The plantar fascia originates on the tubercle (bony prominence) of the inferomedial surface of the calcaneus.[3] It shares an origin more superficial to the skin surface to the flexor digitorum brevis, abductor hallucis, and the medial head of the quadratus plantae muscles.[22] From the origin, the plantar fascia expands anteriorly towards the toes, forming a triangular shape.[4,22] At approximately the mid-point of the foot, the plantar fascia divides into five bands, lengthening anteriorly to become continuous with the flexor tendons at the toes.[23] More specifically, Hicks[24] describes insertion points of the plantar fascia at the: deep transverse ligament, the fibrous sheaths of the flexor tendons, and the base of the proximal phalanges.

There are three separate structures of the plantar fascia; the lateral band (away from the midline of the body, beneath the 5th toe), the medial band (toward the midline of the body, in the medial arch), and the central band, which is often referred to as the plantar aponeurosis.[23] The lateral band and medial band experience great variation between individuals,[4,22] to the extent that they are considered insignificant for function and injury pathology, therefore, the term plantar fascia typically describes the central band.[3,4,22]

The foot and ankle involves 26 bones, 34 joints, and over 100 muscles and ligaments.[25] It is a very dynamic structure that has flexibility to adapt to uneven terrain, and it is an unyielding complex withstanding heavy weight bearing loads.[25] Houglum and Bertoti[25] describe the ‘daily functions’ of the foot and ankle as: support of body weight, control and balance on standing, regulation on uneven surfaces, compensation for knee and hip malalignments, shock absorption with locomotion, elevation with standing on the toes, climbing or jumping, and operating machinery (e.g., operating pedals while driving a car).

There are three segments of the foot: the rearfoot and midfoot, which both contain the tarsal bones, and the forefoot, which contains the metatarsals and phalanges (toes). On the plantar surface, these segments comprise three arches; the medial longitudinal arch, the lateral longitudinal arch, and the transverse arch. The medial longitudinal arch has the greatest length and the highest elevation, as it spans from the 1^{st} metatarsal phalangeal joint (ball of the foot) to the calcaneus. The lateral longitudinal arch extends from the 5^{th} metatarsal phalangeal joint (little toe) to the calcaneus, and is lower and shorter compared to the medial side. The transverse arch traverses the midfoot from medial to lateral and is normally concave when the foot is non weight bearing. However, during weight bearing, the metatarsal phalangeal joints, or the forefoot, are flexible to conform to the shape of the ground or other irregular surface.[25]

Researchers have attempted to define the plantar fascia as a tendon or ligament from a histological standpoint, however, some clinicians suggest[4] that it is similar to both. The midsubstance of the plantar fascia primarily consists of collagen fibers in a wavy or crimped pattern.[4] Fibrocytes, which are responsible for the production of collagen, are embedded amongst the collagen in longitudinal rows. Perry[26] describes the plantar fascia as “a broad, dense band of longitudinally oriented collagen fibers that are virtually nonelastic” (p. 13).

When analyzing the histology of the plantar fascia in cadavers, Stecco et al[27] surmised that plantar fascia tissue is comprised of type I collagen fibers that lie longitudinally in a proximal to distal direction, however, a few fibers present in a horizontal plane at the proximal and distal insertions. It was also discovered that the plantar fascia contains many Ruffini and Pancinian corpuscles, which are mechanoreceptors that allow for mechanical pressure or distortion feedback to enter the central nervous system. They also propose that these mechanoreceptors allow the plantar fascia to prevent muscle overuse in the sole of the foot, “The fascia could be seen as a coachman guiding the muscles in the sole of the foot and helping to coordinate all these structures during movement” (p. 673).[27]

The plantar fascia is innervated by the tibial nerve as is extends distally through the lower leg. At the posterior aspect of the medial malleolus, the tibial nerve splits into: the medial calcaneal nerve, the lateral plantar nerve, the first branch of the lateral plantar nerve, and the medial plantar nerve.[28] The lateral plantar nerve innervates many of the intrinsic foot muscles and skin of the lateral one-third of the sole of the foot. The first branch of the lateral plantar nerve innervates the abductor digiti minimi, flexor digitorum brevis, and quadratus plantae muscles, and has great anatomical variation between individuals. It is hypothesized that the first branch of the lateral plantar nerve provides the plantar fascia sensory pain at the medial calcaneal tubercle, with pain from entrapment of the medal calcaneal nerve being possible, though not as common.[29] The medial plantar nerve innervates the skin of the medial two-thirds of the sole of the foot, and also innervates the: abductor hallucis, flexor hallucis brevis, and flexor digitorum brevis.[28]

In summary, the foot is a complex system of bones and soft tissue. The plantar fascia specifically is a dense band of soft tissue made up of collagen fibers[4,26,27] working in conjunction with muscles, tendons, ligaments, and bones.[21] Whereas it is important to understand the anatomy, it is also important to examine the biomechanics of the foot and ankle and the relationship of how the soft and bony tissues move upon each other.

Plantar Fascia Biomechanics

Hicks[30] created two metaphors regarding the shape of the bones and the connections of the soft tissues of the foot. He postulated that the calcaneus, mid-foot, and metatarsals formed an arch structure, with the plantar fascia securing the ends. Along with the arch, the bone structure of the foot could metaphorically create a "truss" such as the roof of a house, with the plantar fascia serving as the "tie beam."[30] His conclusion was that both descriptions are accurate, sometimes concurrently, depending on weight bearing and if the toes are in extension.[30]

In his landmark study, Hicks[24] also created a metaphor for the function of the plantar fascia in regards to extension of the toes, describing it as a "windlass" mechanism, as regarding to the sail of a maritime vessel. The function of a windlass is to pick up the slack in a cable or rope.[31] The plantar fascia simulates a rope anchored at the calcaneus that traverses the sole of the foot, across the metatarsal phalangeal joint, and attaches to tissues at the proximal phalangeal bones at the toes.[32] Extension of the toes winds the plantar fascia around the metatarsal head, as if a cable is being wound one-quarter of a turnabout the drum of a windlass,[24] thus shortening the distance between the calcaneus and the phalanges, and elevating the medial longitudinal arch.[32,33] The plantar fascia becomes taut with toe extension (eg, during the propulsion or push-off phase of gait while weight bearing) which is considered the foundation of the windlass mechanism.[32]

Similarly, it is hypothesized that the plantar fascia functions more as a ‘primitive windlass’ or as the hypozomata of an ancient Greek boat, or trireme.[31] The hypozomata was a tight band of rope attached stem to stern which maintained the integrity of the vessel. Veil and Esnault[31] studied the height of medial arch of the foot in 60 participants while the toes were in neutral, flexion, and extension. In females, the arch on average raised 0.6 mm (an increase of 12.18%) during toe extension, while raising 0.8 mm in males (an increase of 15.20%), thus confirming that that toe extension tightens the plantar fascia and elevates the arch, which is postulated by the windlass mechanism.[24]

Many studies examine the contribution of the plantar fascia to maintain foot structure by investigating the medial arch height of the foot after plantar fascia rupture or surgical release. Murphy et al[34] evaluated the height of the medial, lateral, and transverse arches of cadaveric feet after release of the plantar fascia at the origin in one-third increments from medial to lateral. They noted a progressive drop in all the arches as each one-third of the plantar fascia was severed, with the complete release causing the greatest drop in elevation of all the arches. They concluded that a common lateral midfoot pain suffered by some patients after plantar fascia release is due to the arches dropping causing strain on other supporting structures, specifically the plantar calcaneocuboid ligament and joint capsule.

A similar study, conducted by Thordarson et al[35] measured arch height and arch length in cadaveric feet with the plantar fascia being severed in one-fourth increments from medial to lateral. They also added the components of measuring the arch length and height not only with the toes at rest or neutral but also with the toes at 30º of extension, and at maximal extension. They concluded that there was a progressive decrease in arch height and length as a result of each one-fourth release of the plantar fascia, and it was also a progressive decrease in the two stages of toe extension, with full release having the greatest impact.

Huang et al[36] investigated twelve cadaveric lower extremities in a neutral position, with axial loading of 50, 100, and 150 pounds. The plantar fascia, plantar ligaments, and spring ligament were sectioned in certain sequences, and the height of the medial longitudinal arch was measured. They deduced that of the three, the plantar fascia was the most important in maintaining the medial longitudinal arch, as it held 25% of the arch stiffness, compared to 10% by the plantar ligaments, and 2% by the spring ligament.

A biomechanical model of the foot deduced that the plantar fascia withstands as much as 14% of the entire loading of the foot, leaving the other 86% to the intrinsic muscles, the tendons of the extrinsic muscles, and the arch structure itself.[37] Also, it is presumed the effect of a plantar fascia release lowers the load bearing capacity of the foot, leading to faster fatigue of the structure, resulting in a person with flat feet not being able to perform a long march.[37]

Chen et al[38] examined eight cadaveric specimens, measuring the plantar fascia bundle at the midfoot where it splits toward each metatarsal head. Instead of resection of the entire plantar fascia, they resected the medial bundle that progresses to the great toe. They concluded that extension of the great toe increases by a mean of 10.16^{o}, without a change in medial longitudinal height. Also, they measured that between specimens, the 2nd bundle was the widest and the thickest; therefore, the medial longitudinal arch could be maintained after a first bundle resection.

Ker et al[39] analyzed one cadaver foot with a device that mimicked the midstance phase of gait. They concluded that the plantar fascia can store kinetic energy (strain) in the early midstance phase of gait, and produce an elastic recoil in the late phase of midstance. It was metaphorically described as “a rubber ball bouncing along” (p. 147), and they concluded that running is more energy efficient due to the strain energy stored in the medial longitudinal arch.

In order to discuss the function of the plantar fascia, there needs to be a basic understanding of foot and ankle biomechanics. There are two positions that describe foot and ankle mechanics during gait: pronation and supination. Of these two positions, they are different depending on if the extremity is in weight bearing (closed chain) or non-weight bearing (open chain). With open chained motion, the talus is fixed in position, while in closed chained motion, the talus moves to adapt to stress and terrain.[40]

A weight bearing foot is pronated when there is plantar flexion of the talus on the calcaneus, adduction of the talus, medial rotation of the tibia, and calcaneal eversion (rearfoot valgus). This is also known as ‘pes planus’ or “flat foot” position.[40] Supination in weight bearing is the opposite; dorsi flexion of the talus on the calcaneus, abduction of the talus, lateral rotation of the tibia, and calcaneal inversion (rearfoot varus), creating a "pes cavus" foot or "high arch."[40]

In a non-weight bearing (open chained) position, the talus is fixed in position, so the calcaneus and foot move about the talus.[40] With non-weight bearing supination, the foot and calcaneus invert, adduct, and plantar flex in relation to the talus. Again, the opposite effect occurs with non-weight bearing pronation, as the foot and calcaneus evert, abduct, and dorsi flex at the talus.[40]

Perry[26] describes the forces that occur to the heel at different phases of the gait cycle. At heel strike, the calcaneus and talus have a valgus or eversion load that maximizes at the late stages of midstance, thus the foot and ankle are in pronation. From midstance to terminal (push off) phase of gait, the calcaneus and talus begin a varus or inversion load, or supination, through the swing phase. Perry postulates that the maximal pronation that occurs during the midstance phase minimizes rotatory forces on the ankle bones, but causes the greatest strain on the plantar fascia and intrinsic muscles of the plantar surface of the foot. He concludes that this can lead to repetitive microtrauma causing chronic injury.[26]

As described by Hicks,[24] the plantar fascia is taught with weight bearing plantar flexion, as in the terminal or push off stance of gait, and active or passive great toe extension. Gu and Li[41] confirmed this in a finite element biomechanical model study, surmising that peak stress on the plantar fascia at the push off phase of gait. This force in the push off phase was five times the force of the plantar fascia in the heel strike motion of gait.

An in-vivo investigation by Kappel-Bargas et al[42] studied the effect of the windlass mechanism on gait, by analyzing great toe dorsiflexion on rearfoot motion with a biomechanical analysis of twenty participants. Their findings were in agreement with Hicks[24] in regards to the windlass mechanism, and with Sarrafian[33] that calcaneal inversion (rearfoot varus) creates elevation of the medial longitudinal arch. Furthermore, they were able to differentiate two separate groups within the research participants based upon the time the medial longitudinal arch was elevated when the great toe was extended, describing them ‘delayed onset’ and ‘immediate onset.’ The authors hypothesized that the immediate onset group may be subjected to greater strain on the plantar fascia during weight bearing and toe extension, possibly leading to CPHP. Conversely, the delayed onset group may be susceptible to overuse injuries, as hyperpronation occurs due to late activation of the windlass mechanism.[42]

In order to evaluate medial longitudinal arch height during the early and late terminal phase of gait (push off), Sharkey et al[43] examined arch height in cadavers with the normal foot, central plantar fascia band resection, and complete plantar fascia resection. A pulley system imitated contraction of the gastroc/soleus complex, tibalis posterior, peroneus longus and brevis, and the flexor digitorum muscles. They concluded that an intact plantar fascia is the most effective in maintaining the elevation of the medial longitudinal arch. With only central band resection, the tension of the tibialis posterior muscle was able to support the medial longitudinal arch, but was not able to compensate for a complete plantar fascia resection.

Erdemir et al[44] measured plantar fascia tension in seven cadaveric feet during gait with a fiberoptic transducer. A device simulated gait by applying tension to six lower leg muscle groups, and approximate body weight was measured on a force plate. They determined that plantar fascia tension increased during stance and reached peak tension in the late stance phase of gait, with the maximum tension averaging 96% ± 36% of body weight.

A similar conclusion was made by Gefen[45] regarding plantar fascia tension, however, his methods were in living participants using fluoroscopy, with the elongation of the plantar fascia to estimate tension during gait. He concluded that the plantar fascia went through the most rapid elongation at the mid-stance of gait, and the elongation was significantly slower at terminal stance (push off).

Scott and Winter,[46] in a biomechanical model, estimated that forces on the plantar fascia in the mid-stance and push-off phase of walking at 1.3 times body weight, and 2.9 times body weight during running. Giddings et al[47] estimated the loads on the plantar fascia at 1.8 to 2.2 times body weight with walking gait and 3.7 to 4.8 times body weight during running in a biomechanical analysis of one live subject. As with Scott and Winter,[46] Giddings et al[47] found the peak level of force at the late mid stance phase of gait.

Many researchers are taking note of the importance of the intrinsic muscles during plantar fascia loading. Angin et al[48] used diagnostic ultrasound to measure the cross sectional area of the intrinsic and extrinsic muscles of the foot, as well as the plantar fascia, between normal participants and participants suffering from flat feet (pes planus).

They discovered that participants with pes planus have a significantly smaller cross-sectional area and thickness of the abductor hallucis, flexor hallucis brevis, and peroneals. The same participants have significantly greater thickness and cross sectional area of the flexor digitorum longus and flexor hallucis longus, thus suggesting that these extrinsic muscles may hypertrophy to provide medial longitudinal arch support for the weaker intrinsic muscles. Also, in the pes planus group, the plantar fascia was significantly thinner in the mid and fore foot regions (but not at the origin on the calcaneus), thus suggesting reduced load bearing.[48]

In summary, the aforementioned paragraphs describe the biomechanical importance of the plantar fascia in maintaining medial longitudinal arch structure during standing, walking, and running. This gives a sense of how CPHP can be very painful and debilitating during physical activity, or occupations that require numerous hours of standing.

Chronic Plantar Heel Pain (CPHP)

The term ‘plantar fasciitis’ was first documented by Wood in 1812, however, he attributed it to being a side effect of tuberculosis.[49] Plantar fasciitis is described as a pinpoint tenderness and degeneration of the proximal central band of the plantar fascia.[50] The most common areas of pain are at the plantar fascia insertion at the medial calcaneal tubercle,[50] and possibly along the medial longitudinal arch.[51] It is widely thought that repetitive tensile strain produces microscopic tears and chronic degeneration at the origin.[4]

In the past, plantar fasciitis has gone by many other aliases: jogger's heel, heel spur syndrome, plantar fasical insertitis, calcaneal enthesopathy, subcalcaneal bursitis, subcalcaneal pain, stone bruise, calcaneal periostitis, neuritis, and calcaneodynia to name a few.[52] The terms plantar heel pain (PHP) and chronic plantar heel pain (CPHP) have been used in recent times, however, some are now using the term heel pain syndrome (HPS) as an initial diagnosis.[22]

Hossian and Makwana[22] categorize the differential diagnosis for causes of heel pain by four categories of foot structures: plantar fascia, other foot soft tissues, calcaneus, and nerves. Relative to the plantar fascia itself, heel pain could be caused by a fasciosis at the insertion or away from the insertion. A plantar fascia rupture at the origin may also be cause of pain. A rare disorder called plantar fibromatosis causes a severe thickening and contracture of the plantar fascia; also severe arthritic conditions (e.g. Reiter's syndrome) are rare but may be the cause of heel pain.[3] Other soft tissues involved in heel pain could be the calcaneal fat pad, an inflamed bursa sac, or tendonitis, most commonly of the flexor hallucis longus.[22]

Many calcaneal pathologies can lead to heel pain, such as a calcaneal stress fracture, or an infection causing osteomyelitis. Inflammatory conditions such as seronegative arthropathy, inflammatory bowel disease, gout, or rheumatoid arthritis could also be underlying causes of pain. Benign and malignant cancerous tumors such as osteomas, lipomas, and sarcomas, may also be symptomatic. Metabolic disorders including osteomalacia, Paget's disease, and hyperparathyroidism may also cause heel pain symptoms.[22]

Whereas the majority of heel pain can be attributed to plantar fascia pathology, Alshimi et al[28] attributes nerve entrapment as a possible secondary etiology in difficult plantar fascia cases. Entrapment of Baxter's nerve (first branch of the lateral plantar nerve) and the medial calcaneal nerve can be an underlying cause of heel pain, as can entrapment of the tibial nerve as with tarsal tunnel syndrome. Finally, a radicular pain from the 1st sacral nerve may be the specific pathology[22] resulting in heel pain.

To summarize, there are a myriad of causes for CPHP, from physical to metabolic to systemic. Most commonly, when the connective tissue of the plantar fascia is chronically involved, the tissue becomes degenerated[3,4] and thickens.[5] This leads to a controversy in the nomenclature of the condition itself.[4]

Plantar Fasciitis vs Plantar Fasciosis

Inflammation is a natural process to repair damaged tissues in the body. It is typically a three part overlapping process of the initial inflammation phase (1-6 days), proliferation phase (3-20 days), and maturation phase (9 days and after).[53] The initial inflammation is characterized with the common symptoms of: localized heat, redness, swelling, pain, and loss of function, which allows for clot formation. The proliferation phase entails cells called fibroblasts laying down collagen in the injured area, therefore initiating the repair process. Finally, the maturation phase is the process where the collagen comes to fruition and typically replaces the injured tissue as scar tissue.[53] Medical terminology has attached the suffix "-itis" to describe this process.[54]

"The term 'fasciitis' is a misnomer" (p.587), Ryan[3] profoundly states in a systematic review of plantar fasciitis treatments in 2008. He infers that past research concludes from a histopathological standpoint, that inflammation is rarely the cause of plantar fascia etiology, but rather a degeneration of the tissue, as there is an increase in ground substance, collagen fiber disorganization, and increased number of fibroblasts. Wearing et al[4] agrees, stating: “Consequently, the mechanism underlying the development of plantar fasciitis may be related to advanced fascial degeneration, and more akin to that of tendinosis (tendon degeneration) than that of tendinitis or insertitis” (p. 599).

One of the first to histopathologically study plantar fasciitis was Snider et al[55] in 1983. They performed 11 plantar fascia releases in nine long-distance runners with chronic plantar heel pain, and a tissue sample was taken from the free end of the plantar fascia after resection. Upon histological examination, the specimens were shown to one of four histologic variations: collagen degeneration, angiofibroplastic hyperplasia (less mature fibrocytes and blood vessels), chondroid metaplasia, or calcification of degenerated matrix. The chondroid metaplasia and calcification of degenerated matrix could be a result of heel spurs, and they concluded that plantar fasciitis is “the result of repetitive collagen microtrauma that causes degeneration with subsequent inadequate attempts at repair and healing” (p. 219).[55] Leach et al[49] performed a similar study on 15 plantar fascia release surgeries, and found similar results to Snider et al, however he described the plantar fascia pathology results as chronic granulomatous tissue and mucinoid degeneration.

Lemont et al[54] examined tissue samples from 50 plantar fasciitis patients and found that none of them had signs of inflammation. The authors concluded that the term plantar fasciosis is more appropriate terminology for the disorder, and that corticosteroid injections should be reconsidered as a treatment, as injections might lead to eventual plantar fascia rupture.[54]

Fabrikant and Park[13] theorized plantar fasciitis versus plantar fasciosis:

> The plantar fasciitis/fasciosis disease process actually constitutes a continuum. Perhaps heel pain may begin as a traction and/or pressure plantar fasciitis with softening and thickening early onward, where it responds to injections and biomechanical rest afforded by orthotics in the form of stretch and pressure limitation of the plantar fascia. At an indeterminate future date, as a result of long-term chronic stretch and focal pressure on the fluid enhanced plantar fascia, the plantar fascia develops fiber fragmentation and myxoid degeneration, and morphs into plantar fasciosis similar to the Achilles tendinosis (pp. 82-83).

Whereas plantar fasciitis was first identified to be a degenerative disorder in the 1980’s,[49,55] it was not until the 21st century for authors[3,4,13,54] to attempt a change from the culture of “plantar fasciitis” to “plantar fasciosis” to “chronic plantar heel pain.” No matter what nomenclature is utilized, the condition typically presents the same common symptoms and appearance in the healthcare setting.

CPHP Symptoms and Clinical Presentation

The physician’s diagnosis of plantar fasciitis (CPHP) is made by taking a thorough patient history accompanied by a detailed physical examination.[56] The patient history will typically present a gradual, insidious onset of symptoms,[3,50,56,57] as CPHP rarely results from traumatic onset.[3] A very common subjective symptom described by the patient is sharp medial arch pain with the first steps out of bed in the morning, or after being seated for several hours.[3,22,50,56-58] The first steps are most painful and sometimes the patient instinctively practices partial weight bearing on that foot, however, usually after an indefinite amount of time the pain subsides and the patient can return to normal weight bearing.[3,50] The pain may return though, after continued or prolonged standing, or increased activity.[58]

Upon the physical examination, there is commonly focal tenderness to palpation at the origin of the plantar fascia at the medial calcaneal tubercle.[3,50,57-59] However, the point tenderness can continue anteriorly to the midfoot,[29] and is often referred to as a mid-plantar fascia strain.[56] The pain can be very intense, to the extent that the patient becomes very apprehensive and possibly pulls the foot away from the clinician.[57] The pain may also be exacerbated by passive dorsiflexion of the digits in the more severe cases,[3,52,58,59] and this technique is known as the windlass maneuver.[57] The clinical exam should also include an evaluation for neurovascular disorders; checking for tarsal tunnel syndrome, paresthesias, and manual muscle testing.[50] Also, other calcaneal disorders, such as fat pad atrophy, and calcaneal stress fracture should be investigated.[3,50]

In recent years, diagnostic ultrasound has been used as an imaging instrument to assist in the diagnosis of plantar fascia pathology. In a systematic review of imaging for CPHP, McMillian et al[5] evaluated 11 studies using ultrasound as a diagnostic instrument. Based on the meta-analysis, the mean range of non-injured plantar fascia thickness is 2.17 mm to 4 mm, while the thickness of the ipsilateral, symptomatic plantar fascia has a mean range of 2.9 mm to 6.1 mm. Based on this work, with some statistical outliers, it is widely accepted that a plantar fascia thickness of 4.0 mm or higher would serve as a benchmark for a pathological plantar fascia.[5]

While CPHP symptoms and clinical presentation tend to show a similarity among patients, it is also important to understand the risk factors for what part of the patient population is most susceptible to the condition. However, the literature is not as clear to what segment of the population is at most risk for CPHP.

Risk Factors for CPHP

Irving et al[60] wrote a systematic review of risk factors for chronic plantar heel pain (CPHP). An extensive literature search was performed, followed with a checklist system called the Quality Index to rate articles for methodological quality. Due to the robustness of the assessment, only 16 articles were used for the review, with Quality Index grades of 38-90%, however, 13 of the 16 articles had a grade of 60% or higher. With the very rigorous standards, it was found that, from an evidence-based research standpoint, many risk factors are inconclusive. Perhaps the strongest evidence (five studies) propose that there is correlation between body mass index (BMI) and CPHP in the non-athletic population, and that the higher the BMI, the higher the risk for CPHP. In regards to age, one article was found to be unbiased, and suggested that there was a trend toward the 50-59 age range, and possibly lower into the 40's, but otherwise no formal conclusions could be made. Concurrently no conclusions were made regarding ankle range of motion with lack of dorsiflexion, due to limited evidence.[60]

The lack of ankle range of motion, especially foot dorsi flexion, has been widely thought to be a contributor to CPHP. Irving et al[60] surmised that strong evidence is limited with this theory. However, a study by Riddle et al[61] concluded via odds ratios that participants with 6º-10º of dorsiflexion were 2.9 times more likely to develop CPHP, while 1º-5º of dorsiflexion were 8.2 times more likely, and 0º or less were 23.3 times more likely.

Foot structure (i.e. cavus foot or planus foot) was inconclusive according to Irving et al,[60] as results were conflicting and the validity and reliability of measuring static calcaneal pitch angle and foot print variables were questionable. Regarding dynamic foot motion, results were also inconclusive and conflicting as the evidence was low quality. Results of the review were much of the same for the relationship of the first metatarsal phalangeal joint extension range of motion and CPHP. In regards to calcaneal spurs, there was described a presence of spurs in patients with CPHP, however it is difficult to determine if the subject developed CPHP due to the spur first, developed the spur due to CPHP, or simultaneously.[60]

The review[60] assessed the relationship between prolonged standing and CPHP. While there is an association between occupation and long periods of standing, the evidence is inconclusive as no uniform definition of prolonged standing or type of surface has been established. It was concluded that there is a lack of strong evidence regarding risk factors for chronic plantar heel pain, with the best evidence being the aforementioned correlation between BMI and CPHP in the non-athletic population.

In a systematic review by Beeson,[62] risk factor articles were collected for what he calls "plantar fasciopathy" and indexed into two subtopics of "Intrinsic" and "Extrinsic" risk factors. Intrinsic subtopics were: age, obesity, gender, ethnicity, biomechanical dysfunction and anatomical variants, systemic diseases, major trauma, estrogen levels, vascular perfusion, antibiotics, and genetic. Extrinsic subtopics were: physical load on ligament, occupation, environment, lifestyle, sleep posture, and sport. Beeson[62] deduced many hypotheses from his review. Plantar fasciopathy typically affects the middle aged and older, as degenerative changes to tissue are common in the aging process. Women tend to have higher rates of this condition as compared to men, with no real understanding as to why. Beeson agrees with Irving et al[60] that BMI over 30 is a risk factor in the non-athletic population. Beeson postulates that it is difficult to surmise whether the lack of ankle dorsi flexion in the research is a mitigating factor or result of the condition, however, some research is suggesting that tight hamstrings may increase forefoot loading, therefore increasing the windlass mechanism force on the insertion. Finally, Beeson also describes inappropriate footwear, training errors, surfaces, hyperpronation, and a general lack of fitness as possible risk factors.

In conclusion, in regards to CPHP risk factors there is very little evidence to support many theories of what can cause the condition, however, it is agreed that the strongest evidence[60,62] supports a BMI of over 30 and an age range of 40-60. When examining the etiology of CPHP, it is also practical to investigate the incidence and prevalence of the condition as well, to know how commonly practitioners encounter this condition in the clinical setting.

Rates of Occurrence of CPHP

From 1995-2000, it was estimated by tracking ICD-9 codes that in the United States 1,005,000 patients per year sought treatment for plantar fasciitis at primary care physician or outpatient hospital clinics.[63] However, others have estimated that two million or more Americans sought treatment annually for proximal plantar fasciitis during the same time period.[64] It was also estimated that plantar fasciitis made up 1% of all office visits for orthopedic surgeons, and that 10% of the population suffers from the condition at some point in their lifetime.[63]

The economic burden of plantar fasciitis was estimated to be a minimum of $192 million to a maximum of $376 million in 2007.[65] This took into account office visits, drugs, and therapy treatments, without including possible diagnostic imaging or surgery costs, therefore, the authors deemed this as an underestimation.[65] CPHP also places a significant financial burden on insurance companies, and can lead to lack of productivity and quality of life for paitents.[65] For some patients, the symptoms may last long term, leading to expensive diagnostic imaging and treatment protocols.[65] There is no universal agreement on one treatment of choice for plantar heel pain, however, a conservative approach to patient management is widely utilized.[57]

CPHP Common Treatments

While research is increasing regarding heel pain treatments, there is still great debate concerning the best management of the condition.[50] Many studies suggest, regardless of the treatment applied, that 80-85% of plantar heel pain patients will have improvement or resolution of symptoms within the first six months of the onset of symptoms.[9,66]

In a clinical practice guideline,[67] a panel of ten podiatrists created a document based on the consensus of current clinical practice and literature review to serve as a recommendation for heel pain treatment. This panel created a three “tier” model or “ladder” model for plantar heel pain treatment. The first tier or “initial tier” of treatment lasts up to six weeks, and includes: padding and strapping, stretching exercises, over the counter arch supports/heel cups, activity modification, shoe recommendations, oral anti-inflammatories, home cryotherapy, or corticosteroid injection.

The second tier of treatments are implemented from approximately the six week to six month mark. This includes: a repeated corticosteroid injection, custom orthotics, night splints, casting, weight loss, formal physical therapy, or botulinum toxin injection. Molloy[68] also discusses prolotherapy injections and platelet-rich plasma (PRP) injections as options, however, very limited evidence exists as to the effectiveness of these methods. The third tier of treatments are for after the six month mark and include: surgery, extracorporeal shock wave therapy (ESWT), or re-evaluation of the initial diagnosis.

In 2014, the American Physical Therapy Association released clinical practice guidelines[69] for its members regarding heel pain and plantar fasciitis. Common physical therapy treatments for CPHP were evaluated on the best evidence. Many interventions received an “A” rating of strong evidence for the large amount of randomized controlled trials. This included manual therapy (joint mobilizations and gastrocnemius/soleus trigger point therapy), plantar fascia specific and gastrocnemius/soleus stretching, taping of the foot to prevent pronation, orthotics, and night splints. Many forms of traditional therapy received a “C” rating for low evidence. This includes: low-level laser, phonophoresis, and therapeutic ultrasound. Interestingly enough, there is no mention of IASTM (Graston Technique, or ASTYM) in the document whatsoever.

In a 2014 evidence-based review of plantar fasciopathy treatments for practicing Physiatrists, Berbrayer and Fredericson[70] rated various treatments using the Australian FORM framework for evidence based guidelines. Three treatments were labeled high evidence by the authors: plantar fascia stretching with achilles tendon stretching, corticosteroid injection by ultrasound, and ESWT. Many treatments were classified at medium evidence, this includes: over the counter arch supports, iontophoresis, arch taping, custom orthotics, botulinum toxin A, and night splints. Low evidence treatments involved oral non-steroidal inflammatory drugs, acupuncture, and manual therapies that include deep tissue mobilization as in the Graston Technique. However, the authors write: “the authors theorize that deep tissue mobilization may be an effective adjunct therapy for the treatment of subacute plantar fasciopathy ”(p. 163).

To summarize, in the three different CPHP clinical practice guidelines of Podiatrists, Physical Therapists, and Physiatrists, the use of IASTM is only mentioned specifically in the Physiatrist document. While it is hard to ascertain the exact number, there are thousands of clinicians in Athletic Training, Physical Therapy, and Chiropractic using one of the many forms of IASTM for CPHP, however, it is minimally backed by medical research. One treatment that was performed in the initial study of this dissertation along with Graston Technique was plantar fascia specific stretching (PFSS). Per the Graston Technique manual,[1] a treatment regimen consists of a warm up, treatment, stretching, and strengthening. Therefore, PFSS was incorporated during every treatment session for each investigative group in the initial study.

<u>Plantar Fascia Specific Stretching (PFSS)</u>

As previously stated, there is great debate whether a lack of calf muscle (gastrocnemius, soleus, Achilles tendon) flexibility is a factor contributing to chronic plantar heel pain.[60-62] While it has been reported that 83% of chronic plantar heel pain participants have limited ankle dorsiflexion,[71] the debate is if there were range of motion restrictions before the injury, or if the deficit is a result of the injury.[60, 62]

In a critically appraised topic paper, Garrett and Neibert[72] described how the literature does not support gastrocnemius/soleus stretching as a stand-alone treatment for CPHP. Similar conclusions were made by Sweeting et al[73] in a systematic review of stretching as a treatment of plantar heel pain. They concluded that stretching is inconclusive as treatment for chronic plantar heel pain, however, stretching of the plantar fascia itself tends to be more beneficial than stretching of the gastrocnemius/soleus complex.

The benefits of plantar fascia specific stretching (PFSS) have been documented in four studies. DiGiovanni et al[74] randomly assigned 82 chronic heel pain participants into a PFSS group, or into an Achilles tendon stretching program. Both groups stretched 10 times for 10 seconds three times per day, for eight weeks. Results of Foot Function Index outcome measure demonstrated a significant difference in pain, activity, satisfaction, and increased improvement in the PFSS group. Two years later, a longitudinal follow-up study was completed,[75] where at the conclusion of the previous study, the participants of both the PFSS and Achilles Tendon stretching groups were instructed to incorporate PFSS as needed for symptoms. After two years of PFSS, both groups had a significant difference in Foot Function Index aspects of: pain at its worst, and first steps in the morning pain compared to the baseline score. While there was a significant difference between the two groups in the first study after eight weeks, there were no significant differences after two years.

A PFSS protocol based upon the DiGiovanni et al studies[74,75] was investigated by Rompe et al[76] in comparison to a group that received three weeks of radial shock wave therapy at one time per week. The PFSS group, which performed PFSS three times a day for eight weeks, had significant differences in all the variables of the Foot Function Index at two months and four months, however, there were no significant differences at the 15 month follow up. The authors concluded that PFSS was a superior therapy to radial shock wave therapy.

Since previous studies have documented the benefits of PFSS, Renan-Ordine et al[77] compared a PFSS group to a PFSS group that also received manual trigger point therapy of the gastrocnemius and soleus musculature. Significant differences for the trigger point therapy group were reported in the SF-36 Questionnaire outcomes of: Physical Function, Bodily Pain, General Health, and Emotional Role. The authors suggest that trigger points of the posterior lower leg possible play a role in chronic plantar heel pain.

Whereas recently, the evidence for PFSS has shown potential for treating CPHP, another therapy that has grown in popularity is IASTM, or one specific form of IASTM, the Graston Technique. As previously mentioned, stretching directly after treatment is recommended during a Graston Technique protocol, with the theory being that the treated tissue needs to be stressed in order to promote remolding of the tissue.[1]

The story of how Graston Technique was discovered and developed is quite fascinating. It took a great deal of trial, error and development for it to become what it is today. Truly, it is a chronical of ‘necessity being the mother of invention.’

Graston Technique History

The use of instruments or tools in augmenting massage traces back centuries to the gua sha technique in ancient China.[78] More recently, the Graston Technique was developed by David Graston in the late 1980's and early 1990's. David Graston was a machinist by trade and also competed as a professional water skier, but in 1987, his career was disrupted when he dislocated his knee while water skiing. After a major reconstructive surgery and long term rehabilitation, he still lacked normal range of motion. He was shown by a therapist how to perform cross friction massage with his hands, and while his knee improved, he later had to undergo carpal tunnel surgery from performing the massage. This is where he developed the concept of using instruments for massage in order to save the providers hands.[79] The first prototype Graston developed was a wooden roller, which was found to not allow deep massage to the tissue, so the next prototype developed was made of aluminum, which progressed to the steel instruments.[79] The steel instruments provided resonating sensations to the clinician's hands in order find soft tissue lesions that may have not be felt by the injured subject.[79]

In the mid 1990's, a conflict developed between David Graston and a rehabilitation services corporation, which resulted in Graston losing all the rights to the concept he created. Currently, the "Graston Technique" belongs to TherapyCare Resources of Indianapolis, Indiana,[1] while David Graston has created plastic massage instruments termed Sound Assisted Soft Tissue Massage (SASTM).[79]

The use of tools to augment soft tissue massage goes back centuries to ancient times.[78] Within the last 20 years, there has been an increase in use of IASTM by healthcare practitioners.[79] With the prevalence of evidence based practice in health care, it is imperative to recognize the effect of IASTM on soft tissues, beginning at the cellular level.

Instrument Assisted Soft Tissue Massage and Histological Studies

The effects of IASTM on soft tissues of lab rats revert to the late 1990's. Davidson et al[80] was one of the first investigations of the long term effect of IASTM on soft tissues, as the Achilles tendons of lab rats were studied in four treatment groups. However, a different but similar technique to the Graston Technique was applied, using Augmented Soft Tissue Massage (ASTYM). ASTYM (Performance Dynamics, Muncie, IN) is an IASTM technique that uses plastic instruments and longer strokes than the metal instruments of the Graston Technique. The lab rats were separated into four treatment groups, a control group, a tendinitis group, a tendinitis with ASTYM group, and an ASTYM only group. A tendinitis was created by a procedure of injecting a collagenase onto the Achilles tendon. Four treatments were performed post injection on days 21, 25, 29, and 33 to the ASTYM groups, and tendons were harvested a week after the final treatment for analysis. Results showed an increase in fibroblasts in the tendinitis, tendinitis with ASTYM, and ASTYM groups, however, there was a significant difference in fibroblasts for the tendinitis with ASTYM group compared to the other groups. The authors concluded that: "ASTYM may initiate fibroblast activation, which eventually leads to collagen synthesis" (p. 318).

A similar study was performed on lab rats where they were separated into six groups: tendinosis, tendinosis with light ASTYM, tendinosis with medium ASTYM, tendinosis with heavy ASTYM, and a control group. The three ASTYM groups received treatment on days 21, 25, 29, 33, 37, and 41, with the Achilles tendons harvested seven days after the final treatment. Results showed a significant difference in fibroblast recruitment with the tendinosis with heavy ASTYM group, suggesting that the more the pressure of the IASTM, the greater the amounts of fibroblasts.[81]

Loghmani and Warden[2] also studied IASTM on lab rats, as they severed the medial collateral ligament and examined the strength, stiffness, and absorption of energy before failure during the healing process. They discovered significant differences in strength, stiffness, and absorption for the IASTM group than the control group at four weeks post injury with improved collagen formation observed microscopically as well. However, when examined at 12 weeks the groups showed minimal differences, with stiffness being the only significant difference and with collagen looking the same. The authors concluded that in lab rats, IASTM can cause significant early positive changes in the healing process, but the healing process stabilizes by the three-month mark.

A similar study also examined IASTM on medial collateral ligaments of lab rats, using a Doppler scanner to examine perfusion of blood through the healing process. They discovered that perfusion and vascularity was significantly more for the IASTM group after the 4^{th} and 9^{th} treatment sessions, and one week after the final treatment.[82]

Hammer[83] surmises that IASTM provides mechanical loading that stimulates fibroblasts in the extracellular matrix, which reproduces collagen, elastin, and other growth factors. He continues that with degenerative conditions such as CPHP, IASTM produces a controlled inflammatory process that increases blood flow, fibroblasts, and other nutrients, therefore promoting healing. Hammer states: “The effect of Graston Technique on reducing pain by decreasing fibrosis might be based on the fact that the pain in the plantar fascia is related to the amount of fascial thickness” (p. 254). It is hypothesized that the controlled inflammatory process from IASTM in an area of excessive fibrosis (e.g. thick plantar fascia) can result in the remodeling of tissues through the proper alignment of collagen and elastin fibers.[84]

IASTM Publications

After an extensive search, the first IASTM study was an abstract published by Sevier et al[85] in 1995. Forty participants with lateral epicondylitis were randomly assigned into a Graston Technique group and an iontophoresis with manual cross friction massage group. Participants were tested for third digit eccentric torque, joint angle, power, and work with an isokinetic dynamometer, they were also tested for grip strength with a hand dynamometer. Participants were tested at 1, 4, 8 and 12 weeks, with results showing significant differences and improvements in variables for the Graston Technique group within the testing times. There was a significant difference in finger power and grip strength between the two treatment groups, however, there was no significant differences within the iontophoresis group between the testing times.

Currently, there are two known randomized controlled trials utilizing the IASTM method ASTYM, which is an IASTM method similar to Graston Technique, however the instruments are made of plastic. Wilson et al[86] examined twenty participants with patellar tendonitis. Participants were randomly assigned to either the traditional treatment (stretching, strengthening, modalities, and ice) group, or the same treatments plus the

ASTYM treatment group. At the end of the study, all the participants in the ASTYM group (10/10) reported complete resolution of symptoms, while a little over half (6/10) in the traditional therapy group reported resolution of symptoms. There were no significant differences in outcome measures between the two groups.

In an additional randomized controlled trial, Sevier and Stegink-Jansen[87] investigated 107 participants with chronic lateral elbow tendonopathy. Participants were randomly assigned to ASTYM treatment twice a week for four weeks, or eccentric exercise with stretching for four weeks. The ASTYM group had a higher resolution rate than the eccentric exercise group, greater gains with the Disability of the Arm Shoulder and Hand Scale (DASH) outcome instrument, and greater gains with maximum grip strength. The authors concluded that the improvements maintained for 6 and 12 months after the study was completed.

McCrea and George[88] performed a case series on eight participants with various knee tendonopathies, by giving them five physical therapy sessions with included ASTYM treatment. All the participants showed improvement in the Lower Extremity Functional Scale (LEFS) outcome measure, with four of the eight participants describing a clinically meaningful improvement in pain scores, and five of the eight with clinically meaningful improvement in the LEFS.

A retrospective case series[89] was also performed on breast cancer patients who had a mastectomy, and suffered from a lack of shoulder range of motion due possibly to the adhesions at the scar sites. Participants significantly increased their shoulder abduction and flexion from pre testing compared to post. Participants also self-reported that they were able to perform more tasks of daily living with less disability.

In the meantime, numerous case studies have been published demonstrating the benefits of IASTM, however, many of these case studies have had one or more other treatment modalities (e.g. rest, manipulation) performed concurrently. The most robust case study regarding ASTYM was documented in a study by Melham et al.[90] The subject was a 20 year old football player with a right ankle that had multiple sprains and two orthopedic surgeries. Four months after his second surgery, he started having significant pain with activity, and decreased range of motion. He was evaluated to have significant loss of function, scar tissue around the ankle joint, and an immature scarring at the surgical site. The subject was treated two times per week for seven weeks with ASTYM and the normal protocol of range of motion exercises, flexibility exercises, and cryotherapy. After the treatment regimen, the subject reported no pain, had increased ankle range-of-motion at all planes, and had the appearance of a mature surgical scar on his ankle. The authors deduced that the subject's disability came from excessive (and immature) scar tissue formation that was alleviated by the ASTYM technique.[90] The other ASTYM case studies have published positive benefits for: chronic ankle pain,[91] chronic elbow pain,[92,93] carpal tunnel syndrome,[94] Achilles tendinopathy,[95] after bilateral total knee replacement surgery,[96] and after patellar fracture surgery.[97]

Research specifically for the Graston Technique instruments have taken a similar path as ASTYM, with having numerous case studies and limited randomized controlled trials. Burke et al,[98] studied 26 patients who fit the eligibility criteria for mild carpal tunnel syndrome. Participants were randomly assigned to a Graston Technique group or soft tissue mobilization (STM) group, while both groups continued to receive physical therapy. The authors assessed the following outcomes: nerve conduction measurements of the median nerve via electrodiagnosis, subjective tests including the visual analog scale and Katz diagrams, and evaluating manual special tests (i.e. Tinel's sign, Phalen's test). Measurements were assessed at: baseline, after six weeks of treatments, and three months after the last treatment. The results of this study showed that both groups improved significantly on all outcome measurements, but not significantly different between the Graston and STM groups. They concluded that both manual therapy interventions improve the symptoms and signs of carpal tunnel syndrome. However, the results do not suggest that Graston Techique is superior over STM, but the toll taken on the clinician's hands may be decreased by using the instruments.[98]

In a pilot study involving participants with lateral epicondylitis, Blachette and Normand[99] randomly assigned 27 participants to a Graston Technique group or a control group of lateral epicondylitis education and ergonomic training. They discovered that both groups improved with the outcome measures from pretest, posttest, and three month follow up, with no significant differences in the outcome variables between groups.

Looney et al[100] treated ten patients suffering from 'plantar heel pain' with Graston Technique and measured their Global Rating of Change, the Numeric Pain Rating Scale (NPRS), and the Lower Extremity Functional Scale (LEFS). Participants had one or two treatments a week, for three to eight weeks, averaging a total of 6.9 treatments. Results showed there were significantly more successful outcomes than unsuccessful, and that there was also significant improvement in the NPRS and LEFS from baseline to posttests.

The only currently known randomized controlled trial with the Graston Technique used participants with chronic ankle instability. Thirty-six participants were randomly assigned to one of three groups. All the groups received dynamic balance training, with Graston Technique, sham treatment, and control (no other treatment) being the difference between the groups. All the groups showed improvement in the outcome measures of Foot and Ankle Ability Measure, range of motion, VAS, and Star Excursion Balance Test from pre to posttest, with the Graston Technique group having the greatest increase. However, there were no significant differences among the groups.[101]

As with the ASTYM technique, the number of case studies regarding the Graston Technique are abundant. Benefits have been described with: chronic Achilles tendinopathy,[83,102] Costochondritis,[103] tibialis posterior strain,[104] trigger thumb,[105] subacute lumbar compartment syndrome,[106] supraspinatus tendonitis,[83] ACL reconstruction rehabilitation,[107] De Quervains tenosynovitis,[108] lateral epicondylitis,[109] proximal interphalangeal joint finger injury,[110] and after patellar tendon repair surgery.[111]

Two case studies regarding Graston Technique and Chronic Plantar Heel Pain were discovered. Daniels and Morrell[84] treated a 10 year old football player with bilateral plantar fasciitis once a week for six weeks. They incorporated chiropractic joint manipulation, Graston Technique, stretching and strengthening of the hip flexors, and gluteal muscles. After the treatment regimen, the subject reported the end of symptoms and increase in activities of daily living. This continued for three months after the last treatment session. Interestingly, the Graston Technique was performed on the gastrocnemius and soleus exclusively, and not the plantar fascia itself.

The other Graston Technique plantar fascia case study was presented by Hammer[83] on a 50 year old female with symptoms for over three months. She was treated twice a week for six weeks, treating the hamstrings, gastrocnemius, soleus, and plantar fascia with Graston Technique and stretching, as Achilles tendon tightness was considered to be part of the problem. At the conclusion of the treatment, she considered herself 95% better, and discontinued treatment.

Recent literature of IASTM treatment has focused on range of motion, rather than injury. Laudner et al[112] randomly assigned thirty five asymptomatic collegiate baseball players to a Graston Technique treatment group and control group. After one treatment of Graston Technique to the posterior shoulder, the intervention group had significantly more horizontal adduction and internal rotation range of motion than the control group. The contrary was surmised by Vardiman et al[113] when examining the effect of Graston Technique on range of motion, strength, and muscle biopsies of the gastrocnemius, as there were no significant differences in any of the variables examined. They concluded that the only effect of Graston Technique was increased pain and loss of function of the treatment leg.

Lastly, Markovic[114] evaluated hip and knee range of motion utilizing a different IASTM instrument, the Fascial Abrasion Technique (FAT) tool (Niagara Falls, Ontario, Canada) on twenty male soccer players compared to foam rolling. He concluded that both the FAT tool and foam rolling significantly increased range of motion from baseline, with the FAT tool group having greater gains, and maintaining those gains better over a 24 hour period than foam rolling. It is important to note that the aforementioned articles regarding IASTM and range of motion were after a single application of treatment, while the Graston Technique manual[1] recommends a protocol of two sessions a week for six weeks in order to gain long term effects.

In summary, much of the IASTM evidence has shown favorable outcomes for many conditions, however, most of the IASTM research are case studies that often use IASTM in conjunction with a variety of other treatments. Much of the research also used a myriad of functional outcomes tests in order to measure change in the participants' pain and function. For this investigation, the Foot Health Status Questionnaire, McGill Pain Questionnaire, and Visual Analog Scale outcome assessments were utilized.

Foot Heath Status Questionnaire

There are many instruments to measure the health, pain, and function of the foot as well as the ankle. Some examples include the Foot Function Index (FFI), Foot and Ankle Disability Index (FADI), Foot and Ankle Ability Measure (FAAM), and Lower Extremity Functional Scale (LEFS) to name a few. For this study, the Foot Health Status Questionnaire (FHSQ) will be utilized (Appendix A).

The FHSQ (Care Quest, Brisbane, Australia) was developed in the mid 1990's by Bennett and Patterson[115] in Australia. They described it as an instrument "To measure foot health related quality of life" (p. 88). The FHSQ is made up of three sections, with the first section containing 13 questions that fall within four domains: foot pain, foot function, footwear, and general foot health. The subject answers a Likert scale from one (good foot health, no pain) to five (poor foot health, severe pain). The Foot Health Status Questionnaire Data Analysis Software© (Version 1.03) tabulates the answers for the four domains and produces a result from 0-100, with zero dignifying a lower state of foot health, and the maximum of 100 representing an ideal state of foot health.[115]

The second section is comprised of 20 questions that examine basic measures of health in general, and is similar to the common Short Form 36 questionnaire. The third section gathers demographic data including: socio-economic status, life satisfaction, and co-morbidity. [115] The third section was not relevant for use in this study, as it is participant demographic data regarding socioeconomic status, so no data from that section was collected.

The survey developers used 111 participants to compare the FHSQ to the validated Foot-Function Index (FFI), while also studying the test-retest reliability, and validity of the FHSQ concurrently.[116] It was concluded that the FHSQ has a high amount of content, criterion and construct validity, with a Chonbach's α of 0.85 to 0.88, and test-reliability of 0.74-0.91. For validity, a goodness-of-fit index was 0.90, and the comparative fit index (CFI) was 0.96,[116] with the CFI being above the recommended 0.95 for high content validity.[117]

Landorf and Keenan[118] contrasted the FFI and FHSQ to evaluate the health related quality of life of plantar fasciitis (CPHP) participants who had been given orthotics after four weeks. They concluded that the FHSQ was more responsive to change than the FFI in evaluating health related quality of life of the participants treated with orthotics for plantar fasciitis. In response to this study, Martin and Irrgang[119] in a survey of self-reported foot and ankle outcome instruments described that the FHSQ had content, construct, and reliability evidence,[116] and responsiveness specifically to plantar fasciitis.[119]

While statistical significance is commonly used by researchers, there is a concept of clinical significance of the subject, where the participants' perception of whether the treatment is beneficial. Landorf and Radford[120] examined 175 plantar fasciitis patients, by having them complete the FHSQ, FFI, and Visual Analog Scale, also, participants completed a 'global change' by answering 'no change' or 'a little change.' The answers from the global change were compared to the other instruments in order to calculate a minimal important difference. The results for the FHSQ were that Foot pain needed to increase by 14, Foot Function by seven, and General Foot Health by nine for there to be a minimal clinically important difference for the subject. The Visual Analog Scale minimal clinically important difference was nine point improvement as well.

While the reliability and validity of the FHSQ is documented and widely accepted, Trevethan[121] presented some problems with both the FFI and FHSQ. For the FHSQ, he questioned the expertise of the panel, which initially created 46 questions before narrowing it down to the current 13. He also questioned the redundancy of the questions within the domains (especially the pain domain) therefore increasing the burden on the participant. He claims that criterion validity has not been assessed, and that there is weak evidence of construct validity. While taking these claims into consideration, Riskowski et al[122] summarizes the FHSO with: "With high validity and an independent study assessing minimal important differences, this foot-related patient-reported outcome measure has well detailed psychometric properties and is one of the most common foot surveys" (p. S234).

In summation, the FHSQ is foot-specific outcome measure which can be more sensitive to plantar fascia injuries.[119] While the FHSQ measures pain, function, health and quality of life, this study also employed two pain specific outcome instruments, the MPQ and VAS.

McGill Pain Questionnaire

The McGill Pain Questionnaire (MPQ) was developed in 1975 at McGill University, Montreal, Quebec, by prominent pain author Dr. Ronald Melzack.[123] The instrument consists of a page of 78 words that are adjectives describing pain, which are categorized into 20 groups (Appendix B). Participants are instructed to only circle the one word that best applies for each group, if none of the words of a group describe the participant's pain, the group should be left blank. Words in each group are scored in a hierarchy based on how severe the word describes pain. For example, one group has the words: pinching, pressing, gnawing, cramping, or crushing. Pinching is tabulated as one point, pressing as two points, gnawing as three, cramping as four and crushing as five points, with leaving the group blank serving as zero. Melzack[123] has classified the groups into three major dimensions of pain: sensory (group 1-10), affective (group 11-15), evaluative (group 16), and miscellaneous (group 17-20). A final score is tabulated with zero as no pain for the participant, with 78 serving as the maximum level of pain that the participant can suffer.

Melzack[123] tested reliability of the MPQ instrument by having 10 participants take the questionnaire at three different intervals of day 1, 3, and 5, calculating a mean of 70.3% for the consistency of choosing the same subclasses. Graham et al[124] found similar results in cancer patients over four intervals with a mean consistency of choosing the same subclasses ranging from 66 to 80.4%. In a study of chronic low back pain,[125] the test-retest reliability co-efficients for the three dimensions of pain were 0.83 overall, with sensory being 0.76, affective 0.78, and evaluative 0.47. In a study of 120 participants with rheumatoid arthritis, Roche et al[126] used the MPQ three times over a six year period, there were no significant differences in the scores, with the pain scores remaining consistent over the time period. A study[127] of six different groups of participants immersing their arms in ice water (cold pressor task) produced a remarkable degree of consistency with MPQ scores. Pearce and Morley[128] used the Stroop color-naming task in participants with chronic pain to analyze the MPQ for construct validity, and were able to support their hypothesis that the pain participants would select more words than the control group. In a study[129] of participants with knee osteoarthritis, the MPQ correlated with depression, anxiety and fatigue. Hawker et al[130] evaluated the MPQ in a systematic review of pain scales, and concluded that: "The MPQ is a valid and reliable tool that evaluates both the quality and quantity of pain through use of unique pain descriptors" (p. S243).

Visual Analog Scale

The Visual Analog Scale (VAS) is a common method used to measure pain intensity (Appendix C). The scale entails a piece of paper with a horizontal 10 cm line with vertical lines on each end. The left vertical line states underneath it “no pain,” while the right vertical line states “worst pain imaginable.” The participant is asked to place a vertical mark on the horizontal line that best describes the pain in the last 24 hours. A metric ruler is used by the clinician to measure from the left or “no pain” side in millimeters, registering a score between 0 and 100, with the higher the score representing the worst pain.[130]

Reliability for the VAS was high in patients with rheumatoid arthritis,[131] with literate patients at r=0.94, however, illiterate patients were r=0.71. In a systematic review of the VAS for reliability and validation, McCormack et al[132] referenced nine articles demonstrating validity with other pain scales, with seven out of the nine significant at a p=0.05 level. Downie and colleagues[133] also showed a strong correlation between the VAS, numeric rating scale, and simple descriptive scale, in 100 participants with chronic rheumatoid diseases. A systematic review of pain scales used in common pain journals in 2003, Litcher-Kelly et al[134] found the VAS was used most often, at nearly 60% of the time. In a systematic review of instruments for measuring pain in rheumatoid arthritis participants, Hawker et al[130] appraise the VAS as simple and adaptable to many patients, and has been widely accepted since the 1970’s.

Summary

At the completion of the review of literature, there are notable conclusions to be made that are relevant to this study. First, the plantar fascia is an important connective tissue for foot function.[24,27,30-32,35-40,42,43] Second, CPHP, in most cases, is a degenerative condition of the plantar fascia.[3,4,13,49,54,55] Third, IASTM can be utilized as a treatment for degenerative conditions,[1,83-87,94,98,99,109] and finally, research for IASTM as a treatment for CPHP is limited to three publications in the literature.[83,84,100] Therefore, this study attempts to fill the void of the shortage of Graston Technique research for CPHP, and follow-up results of two years.

CHAPTER 3

METHODS

The objective of this study was to longitudinally measure patient-reported pain and function of chronic plantar heel pain participants for an average of two years after the conclusion of a Graston Technique treatment regimen. Additionally, a narrative perspective of each participant was acquired through a qualitative interview. The research design is a mixed methods approach, utilizing the convergent parallel design as described by Creswell and Plano-Clark,[7] which involves both quantitative and qualitative 'strands' of data from each participant. Quantitative data was gathered with three pain and function instruments and presented as a case series. Dekkers et al[135] describes that a case series "samples patients with both a specific outcome and a specific exposure" (p. 37). For this study, the exposure will be a previous 12 session regimen of IASTM, and the outcome will be pain and function measures, along with a qualitative interview of life experiences with chronic plantar heel pain treatment.

For the qualitative strand, interviews were conducted with the participants to provide more detail and give greater insight to their experience with the injury and treatment. This design allowed the quantitative and qualitative data to be collected at the same time at one meeting. This design places more weight on the quantitative data (pain and function instruments), and adds qualitative data (interviews) to enhance the study and achieve more depth.[7]

Previous Investigation

A convenience sample of 22 participants with the previous investigation (T.R.G., unpublished data, 2015) were recruited in two ways. First, after Institutional Review Board (IRB) approval, an announcement was posted in a university wide informational email in which interested participants could respond to the principal investigators. Second, eight local podiatrists agreed to give an informational pamphlet to patients whom were diagnosed with chronic plantar heel pain, with no undue influence or coercion, as per IRB protocol.

Interested participants would call the primary investigators of the study, and answer questions regarding inclusion/exclusion criteria, including contraindications of IASTM. Inclusion criteria included: physician diagnosis of chronic plantar fasciitis, symptoms for a minimum of three months, and no corticosteroid injections within 30 days. Exclusion criteria were: diabetes, previous plantar fascia release surgery, and direct trauma or acute plantar fascia injury. Contraindications for IASTM are numerous, and participants were asked the common contraindications for any manual massage technique.[1]

Participants were randomly assigned to one of three groups: Graston Technique, effleurage, or control at their first visit. Upon the first visit, demographic and consent forms were signed, height and weight measured, and pretesting of the Foot Health Status Questionnaire (FHSQ), McGill Pain Questionnaire (MPQ), and Visual Analog Scale (VAS) completed.

Participants were required to complete two sessions a week (not on consecutive days) for six weeks, resulting in twelve total sessions. Each session began with five minutes of stationary cycling as a warm up. This was followed by the treatment phase of the session, with the participant prone on a treatment table with the knee flexed, and the plantar surface of the foot exposed. The participants were blinded by hanging a sheet from the ceiling to the participants posterior thigh, so they could not visually look and see the treatment performed. The Graston group received ten minutes of the investigative treatment, which entailed four minutes of instrument #4 (large convex instrument), four minutes of instrument #3 (small concave instrument), and three minutes of instrument #2 (small convex instrument). The effleurage group received eight minutes of light touch massage with the clinicians' fingertips, while the control group received no treatment for eight minutes. When the treatment phase of the session was completed, participants performed plantar fascia specific stretching (PFSS) where the ipsilateral hand pulls the metatarsal head and toes into extension, while the contralateral hand stabilizes the calcaneus, as described by DiGiovanni et al[74,75] of ten repetitions for ten seconds hold of the stretch. Participants were asked to only perform PFSS after the treatment phase, and not as part of a home exercise program.

After the twelfth treatment session, outcome instrument measures (FHSQ, MPQ, and VAS) were administered as a posttest. Participants in the effleurage and control groups were offered an additional twelve sessions involving the Graston Technique, and completed a third set of the outcome measures after completing the phase of treatment.

Results of the outcome measures of the three different groups, indicated there was a significant difference between group posttests for the FHSQ-Foot Function (P=0.02) and visual analog scale (P=0.034) between the Graston and effleurage group. The FHSQ-General Foot Health scores between the Graston and control groups were significantly different (p=0.02), otherwise, there were no other significant differences for the five variables among the three groups.

Current Investigation

The first purpose of this study was to ascertain self-reported pain and function outcomes of chronic plantar heel pain participants who received the Graston Technique from twelve sessions that ended a minimum of 1.5 years ago. This would determine if Graston Technique provides long-term relief, as participants in the previous study performed posttests after the twelfth treatment. The second purpose of this study was to collect qualitative data (via interview) about the participants' pain and function, as well as their attitudes toward their experiences with the healthcare system and CPHP. This allows the qualitative data to provide more insight to the quantitative survey instruments using the collaborative parallel design, as described by Creswell and Plano-Clark.[7]

Upon IRB approval, an attempt was made to contact participants of the previous study who completed the Graston Technique phase (n=19) via email or telephone. Fifteen chose to take part in the follow-up study, while two declined and two had moved on from the last known contact information. A one hour meeting was scheduled at a meeting place convenient for the participant. Initially, a qualitative interview (See Appendix D) gave the participant the opportunity to describe their past and current foot pain and function, activities of daily living, and treatment experiences. After the interviews were completed, participants manually completed the Foot Health Status Questionnaire (FHSQ), McGill Pain Questionnaire (MPQ), and Visual Analog Scale (VAS) instruments to measure quantitatively the current status of the participants' chronic plantar heel pain.

Data Analysis

Upon completion, the three survey instruments were analyzed as intended by the creators. The FHSQ[115, 116] was analyzed by entering the data into FHSQ 2.0 software (Care Quest, Brisbane, Australia) that accompanies the written survey when purchased. This software calculates eight variable scores of: foot pain, foot function, shoes, general foot health, general health, physical activity, social capacity, and vigour.

The McGill Pain Questionnaire[123] was analyzed using a key that assigned a value to each word as created by Melzack. The word that was circled in each group had a value of 1-5, and if no words were circled in a group, that value was zero. A word that described a higher intensity of pain had a higher value, and a word that described a lesser intensity of pain had a lower value. The possible score range of the MPQ is 0-78, with zero being no pain reported.

The visual analog scale[130] is a 10 centimeter line where the participant marks a vertical line in between "no pain" and "worst pain imaginable" to describe their current foot pain status. Completed VAS data was measured by a third party using a stainless steel metric ruler producing a score of 0-100, with zero being no foot pain. Group means and standard deviations for the instrument outcomes were calculated using SPSS Statistics 23 (Armonk, New York).

The qualitative interviews were all conducted by the same primary investigator, recorded with a Sony recorder, downloaded to a laptop, and transcribed to a word processor manually using Express Scribe transcription software version 5.69 (NCH Software, Greenwood Village, Colorado, USA). Qualitative reporting took place in the form of a narrative, where participants ‘tell their story’ regarding their personal experience with chronic plantar heel pain before, after, and two years after IASTM treatment.[136] Emphasis was placed “on ‘what’ is in the story, rather than ‘how’ it is told, ‘to whom’ and for what reasons” (p.54).[8] Therefore, themes regarding the ‘what’ for foot pain and function were gathered to provide more in-depth analysis.

Transcripts were analyzed and coded for themes. Initially each transcript was read to get a sense of the participants’ responses and recognize themes. A second and third review was completed to code themes that emerged. The transcript reviews concluded with a count of the frequency of themes throughout the interviews.

Further analysis of amalgamating the quantitative and qualitative data followed the work of Creswell and Plano-Clark[7] for analyzing mixed methods research. Both sets of data converged utilizing the “side-by-side comparison for merged data analysis” (p.223) where the quantitative and qualitative results will be presented together so there can be easy comparison. This allows for the presentation to be the method for communicating the merged conclusions.[7]

<u>Trustworthiness</u>

Trustworthiness was established by utilizing methods of triangulation, negative case analysis, member checking, and external audit.[7,137] Triangulation established validity by utilizing the three survey instruments that all measured foot pain, and by inquiring about foot pain during the interview. This allowed for the participants' self-reporting of foot pain to be compared by four different methods.

Regarding qualitative validity, Glesne[137] describes 'negative case analysis' as "conscious search for negative cases and unconfirming evidence so that you can refine your working hypotheses" (p.37). For this study, negative cases of where participants did not respond well to the Graston Technique will be discussed in the results section. Further evaluation of these cases may check any personal biases that may appear during the study.[137]

Trustworthiness of the qualitative data involved the participants to member check, and participants were given the opportunity read over their transcribed interview to verify accuracy in the message discussed. Finally, the interviews that make up the qualitative data underwent an external audit for themes by a member of my dissertation committee, who has five years of academic qualitative research experience in the healthcare field. This professor verified the themes comprehended from the interviews, by reviewing a random sample (33%) of the data.

CHAPTER 4

RESULTS

The purpose of this study was to determine if participants suffering from CPHP who were treated with Graston Technique maintained their decreased levels of pain and increased levels of function longitudinally for nearly a two year span after the initial treatment ended. Also, this study seeks to establish participants' affective insights to how they perceived the Graston Technique treatment they received in general.

Results are presented as a "side-by-side comparison for merged data analysis" (p.223) utilizing the convergent design of mixed methods research.[7] This is where quantitative and qualitative data were acquired at the same time, analyzed independently of each other, and then presented together. The data from all 15 participants was merged for comparison of the results.

A convenience sample of 15 participants (78%) out of an eligible pool of 19 agreed to participate. Of the four who did not participate, two declined and two had moved on from the last telephone number listed from the previous study. The 12 females and three males in the current study had an average age of 53.4 (SD ±10.1) years, with a range of 30.6 to 72.7 years when the follow-up data was collected. The average amount of time from the last treatment in the previous study to the follow-up data collection was 25.5 months (SD ± 3.2 months), with a range of 21 to 31 months. In the previous study, participants reported experiencing CPHP for a self-reported average of 44.33 months (or 3 years 8 months) with an SD of ± 47.9 (range three months to 144 months). Body Mass Index (BMI) had a range of 21.3 to 42.5, with a mean of 30.8 (SD ± 5.9), with 25-29 considered overweight, and greater than 30 considered obese. Neither skewness nor kurtosis were significant (z>1.96) for any of these variables. Mean results for the seven Foot Health Status Questionnaire (FHSQ) variables, McGill Pain Questionnaire (MPQ), and Visual Analog Scale (VAS) at pretreatment, posttreatment, and follow-up are presented in Table 1.

Table 1: Means and Standard Deviations of pre, post, and follow-up of quantitative variables.

	Pretreatment	Posttreatment	Follow-up
Foot Pain	39.6 (±22.7)	78.4 (±11.0)	88.4 (±22.8)
Foot Function	50.4 (±27.2)	88.7 (±18.8)	91.7 (±24.2)
General Foot Health	40.8 (±31.1)	69.8 (±20.3)	81.3 (±25.3)
General Health	80.6 (±21.9)	83.3 (±22.9)	82.7 (±22.2)
Physical Activity	61.5 (±30.7)	84.4 (±19.6)	87.4 (±21.4)
Social Capacity	82.5 (±26.2)	94.2 (±13.2)	95.0 (±13.2)
Vigour	51.6 (±17.1)	62.9 (±11.2)	67.5 (±18.2)
McGill Pain Questionnaire	29.3 (±13.4)	9.8 (±6.5)	4.8 (±7.8)
Visual Analog Scale	52.2 (±21.6)	11.9 (±12.3)	7.2 (±18.2)

For Foot Pain, Foot Function, General Foot Health, Physical Activity, Social Capacity and Vigour, higher scores are optimal.
For McGill Pain Questionnaire and Visual Analog Scale, lower scores means less foot pain.

Participant Outcomes

Participant “Allen”

Allen was 45 years old with a BMI of 22.3 when he received the Graston Technique in the initial study for CPHP, and he had symptoms for an approximate duration of eight months. Quantitative data of the pre, post and follow-up scores for Allen are presented in Table 2.

Table 2: Quantitative scores for participant "Allen."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	29.3	25	72.5	100	50	75	50	28	37
Posttreatment	72.5*	81.2*	60	100	77.8	100	75	8	12*
Follow-Up	100*	100*	85*	100	100	100	75	0	0*

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

During the interview, Allen described himself as an educator who would be on his feet approximately 3-5 hours a day. He described his previous CPHP as making it difficult to walk more than ½ a block, and standing on his feet for long periods of time. “I found that I would shift my weight to my other foot a lot, and so you are just off balance all the time, and I realized I would do it without thinking about it. Just because when you have a pain, you try to do things subconsciously to get rid of the pain, and then that would just make me uncomfortable overall I think.”

After the Graston Technique, Allen described his foot as much better, but some pain was still evident. Allen elaborates how the pain eventually went away:

> I can’t pinpoint when this happened, it was a few months afterwards. I remember talking to my wife and I said, ‘You know, my heel doesn’t hurt anymore,’ and I couldn’t tell you when that happened, I think it was a gradual, the pain went away. Because it was not an issue of; ‘oh I woke up one day and it didn’t hurt.’ I just noticed that it hadn’t hurt for a long time (laughs) and this is several months after the last treatment.

Allen discusses walking after the treatment ended. “My wife and I would walk a lot in the summer. Um, and I found I could go for walks, after the treatment was done, and I really didn’t notice any kind of issue.”

Participant "Trudy"

Trudy had suffered from CPHP for approximately two years before participating in the previous study. She was age 55 at the time her treatment completed, with a BMI of 37.6. Trudy's self-reported pre, post, and follow-up scores are reported in Table 3.

Table 3: Quantitative scores for participant "Trudy."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	31.3	43.8	0	100	55.6	62.5	50	44	35
Posttreatment	78.1*	81.3*	60*	100	77.8	100	56.3	8	0*
Follow-Up	87.5	93.8*	72.5*	90	77.8	87.5	81.3	11	8

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

Working as a nurse for 8 hours a day used to be excruciating for Trudy. She states: "Work was very bad because I'm on my feet all day, and it was just painful I can't even explain." Once the initial treatment ended, she recalls: "You still knew it was there, but it was so much better, oh yeah, so much better, I didn't have half the pain I had before that." Regarding her current status: "right now, today I have no pain." When asked about her physical activity before the study compared to now, she responded: "Oh my goodness, it is so much nicer to go to work and know that I am moving better than a 20 year old, you know? Then at the end of the day they will say: 'Oh I hurt, or I am tired' and I say: 'Oh my gosh you're half my age.' I can get home from work now, and I don't have to just sit and put my foot up, or soak it or whatever I was doing, I can still keep moving."

She was asked how she felt she tolerated the Graston Technique, especially the first few sessions. “The first couple, yes, yes, I’m not ticklish or anything, but yeah, you did tell that after the first two, it may be even a little bruised or felt really sore after and so I did have a little tenderness after the first couple. It always felt good, I was very happy to come back.”

Participant “Bonnie”

Before participating in the previous study, Bonnie had some of the worst pain with the first steps in the morning. “I was having problems just actually when I first got up in the morning, walking like, just like to the kitchen or the bathroom. It would, that would last for 40 minutes or so, then it would kind of go away and then depended on how much walking or standing I did throughout the day. It would come was just really sharp pains on the bottom of my foot made it difficult to get around.” She also discussed getting cortisone shots: “I was getting cortisone shots on the bottom of my foot, and that would help, but soon it kind of wore off and it was back to the same old.”

Bonnie had right foot CPHP for approximately 18 months before participating in the previous study at age 47, with a BMI 32.3. Bonnie’s quantitative statistics are shown in Table 4, delineating the pre, post, and follow-up scores.

Table 4: Quantitative scores for participant "Bonnie."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	66.3	68.8	60	90	94.4	75	50	22	40
Posttreatment	78.1	93.8*	85*	90	94.4	100	56.3	10	21*
Follow-Up	100	100	100*	100	100	100	75	0	0*

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

Bonnie describes how her foot felt after the initial treatment:

> Well, I think I felt pretty good, cause that was the beginning of school, and I would've had then… I would've jumped right into all of the work that, all of the sporting events, and going to even my daughter's sporting events, so I would've been active, really active in September and October, and I didn't have any problems. Because if I would've, I would've probably gone back in to the foot doctor again, cause, I wouldn't of been able to go through another fall like I had previously.

When asked about looking back on her entire health care experience with CPHP, she added:

> I didn't even know that you could do anything besides just go to the podiatrist and have them look at your foot, so maybe I wish I would've known that I had options? That would of negated having to get cortisone shots which are really painful and not fun. And uh, it would have been nice to that [Graston Technique] because I felt like the cortisone shots were temporary, and then realizing that after x amount you might have to have surgery, that was kind of like, that was kind of a bummer.

Bonnie concludes: "I know for a fact, and you can ask my husband, I have not had any foot problems, which is weird. I just got back from a European trip and probably was walking 10 hours a day. Not an issue. I wouldn't of been able to do that two years ago, not at all, there's no way possible. And I didn't have to have surgery, and no more shots, so hopefully it will stay good."

Participant "Kelly"

Kelly was 57 years old (BMI 30.5) when she participated in the previous study, and she reported that she suffered from CPHP for over 4.5 years beforehand. After her treatment ended in November of 2012, she reported continuing Graston Technique treatments with a local chiropractor for two more months, until January 2013. Unfortunately, Kelly reports that her CPHP returned the fall of 2014:

> It seems from 1-10 on a pain scale, it's probably a three all the time, two to three, you know, it's there, I can feel it, but it's not deterring…doing anything to stop me from doing anything. Before the study, I couldn't hardly walk on it, I mean the getting out of bed it hurt tremendously. Now after the study, if I stretch my heel, I can get out of bed, and it's not deterred me from getting out of bed at all and walking right away on it in the morning.

Kelly described the first few treatments as "hurtful."

> It was hurting, and I'm thinking I'm not going to do this anymore. It was that hurtful, but I thought: 'no you got to keep doing it just to get it better,' and it did get better and easier, other than it tickled sometimes. Maybe you were just hitting the spot, and I guess, it's no pain, no gain, is what I think. The scar tissue or whatever it is that is in there, that you have to break that down. I kind of understand the whole concept that if you don't break it down, and get it dissolved out of your body, then it's not going…I guess that's what I was thinking but, yeah the first couple times it was difficult, it hurt, but after it was fine.

The quantitative scores for Kelly are displayed in Table 5, she reports that the reoccurrence of CPHP in the fall of 2014 still affects her during the follow up.

Table 5: Quantitative scores for participant "Kelly."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	29.4	37.5	72.5	100	44.4	87.5	37.5	34	78
Posttreatment	71.9*	100*	85*	100	77.8	100	68.8	7	19*
Follow-Up	78.1	81.3	85	90	94.4	100	68.8	4	17

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

Participant “Melissa”

Melissa had suffered from CPHP for about nine months before participating in the previous study. She was 70 years old at the time with a BMI of 21.3. Quantitative scores for the survey instruments are presented in Table 6 at pre, post, and follow-up.

Table 6: Quantitative scores for participant "Melissa."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	35.6	68.8	25	60	88.9	100	62.5	41	74
Posttreatment	72.5*	100*	42.5*	60	94.4	87.5	81.3	19	20*
Follow-Up	93.8*	100	60*	60	100	100	75	10	1*

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

In the interview, Melissa described how she had morning pain, but it didn’t affect her physical activity:

> Well it would take a while in the morning when I would get out of bed it was really, really, sore. It would take a while before I walk normally, and then periodically during the day it would be sore as well, so it was just kind of an inconvenience and just an irritant. I’m so compulsive, I went ahead and did it anyway. I like to walk and sometimes jog a little bit, and I went and did that, but it was sore sometimes.

She also explains how her symptoms decreased after the treatment protocol ended:

> Well I have to say it was still sore, it was not as sore, but it was still sore. I could tell there was some improvement, but then gradually it just went away after that, it seemed like you know, it progressively got a little better as time went on…I think it was a little bit later that I really noticed an improvement. I noticed a slight improvement right when you got done, but then, just a short time later it seemed like it just started progressively getting better…I would say in a couple of months it was completely, the pain was completely gone.

Melissa concluded with her thoughts regarding the Graston Technique: “I don’t remember that I thought it was very painful. Once in a while you would hit a pain spot that was painful. But that was just so brief and you know it didn’t last very long. So I guess I didn’t view it as a painful process, just once in a while you would hit a spot that was sore.”

<u>Participant “Susana”</u>

Susana was 47 years old when she participated in the initial study. She estimates she had CPHP for 12 years previously, and her BMI was 27.6. She explained how the condition affected her before the treatment:

> When I would get up in the morning, the pain would be immediate and constant throughout the day. It affected my work, it affected what I did, and what I didn’t do. I used to walk quite a bit, I had to curtail that because the pain was too much. The pain was pretty much constant throughout the day, and I do have job where I am on my feet all day. In that respect it affected my work, it affected my concentration, because all I could think about was how much pain I was in.

Susana discussed how her foot felt and the end of the 12 session treatment protocol:

> I felt better. I wasn’t completely out of pain which surprised me a little bit, because you know, I was hoping this was a miracle thing. So right after the study, I felt more positive. I felt that it had worked for me to a certain extent. I was

> interested in continuing, you know, finding a place in the area where I could continue receiving the technique…What I found interesting, one of the reasons why I came back to do this part of it, is that I wasn't completely out of pain right after, but I'm pain free right now. What I find interesting is that over time, I became less and less aware of the pain, the pain went away, over time.

She shared her general thoughts regarding receiving the Graston Technique:

> I had some reservations when you first showed me the instrument, and I saw that they were super hard metal, and that was one of my concerns was that, wow that's going to hurt. And it did, it did, it felt like, I mean the manipulation felt like a bunch of marbles in there getting moved around and bashed around, the funny thing was that, I had been hurting for so long, it was painful but it was different kind of pain. And in some respects I sort of welcomed it, because I thought perhaps, that this feels different, and the not necessarily in a good way, but it was, it was good that it was different. I can't really put it into words, but after the first couple of times, and walking around on a now twice sore foot, was a little intense, but even from, after the first couple of times, I was already noticing improvement. Like I said the pain was different but the different the other kind of pain was a whole lot easier to deal with, cause it wasn't the achy, toothache, 'oh my God,' 'I can't stand this' kind of thing. It was more a matter of, oh well, you know, this I can deal with.

When asked about her foot function and physical activity level, she responded: "I can pretty much do anything I want. I'm not as active as I could be, I'm getting older, I'm a little more sedentary in my ways, just because. But if I decided that I wanted to do something, I don't have any compunction about just 'jetting off' and doing it."

The quantitative scores for the survey instruments of Susana are presented in Table 7.

Table 7: Quantitative scores for participant "Susana."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	35.6	50	72.5	60	77.8	100	31.3	26	57
Posttreatment	78.1*	87.5*	72.5	60	88.9	100	62.5	14	2*
Follow-Up	72.5	93.8	100*	90	83.3	100	68.8	9	5

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

Participant "Stan"

Stan was 28 years old with a BMI of 42.5 when he received the Graston Technique in the previous study, and he had symptoms for nine months. Quantitative scores for the pre, post, and follow-up scores are listed in Table 8.

Stan describes how CPHP affected him before the treatment: "It really hurt in the morning…first step out of bed, it almost brought me to the floor. It's real shooting pain in my heel, really, really, sensitive in the morning and then I would have to limp around a little bit. Eventually it would work itself out a little bit, but it would hurt for walking, just general walking throughout the day would just hurt.

Table 8: Quantitative scores for participant "Stan."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	35.6	100	42.5	90	100	100	81.3	20	38
Posttreatment	78.1*	100	100*	100	100	100	56.3	11	15*
Follow-Up	87.5	100	85	80	83.3	100	68.8	0	0*

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

When asked if he CPHP limits him in any way, Stan responded: "Not in any way, nope. I'm doing stuff…I'm active. As much as I can do with work, and you know, with everything like that, so, it’s not even a factor.” He sums his function with: “When I move my body, like walking around, and again like active, playing aspect with my kids, or for general exercise, I didn’t want to do that as much before, and now, it’s not a barrier at all.”

Stan describes how he felt after the treatment sessions ended:

> It was a little sore afterwards, but then it eventually went away and I haven’t had problems really, since I’d say probably January (2-3 months later) by the latest. I probably stopped noticing it. It doesn’t hurt anymore. So I did keep up with some of the stretches, that seemed to keep it loose enough. I don’t know if that did anything or not. It felt better and then I just kind of stopped doing it because it didn’t hurt anymore…I really didn’t feel the morning pain…I would feel a little ache every now and then, but eventually, it just disappeared.

Stan provided insight on his opinion of the Graston Technique:

> I don’t remember being sore, it was sore already. I think it helped more than it hurt anything, my foot was sore for those afterwards, and my foot hurt so bad that I couldn’t even tell the difference at first maybe, I don’t know. I remember, towards the end, that it felt better that you were just like jamming it, and you were like “You sure you want me to keep pushing this hard?’ you were asking, and I was like ‘Yeah, get in there, get after it.’ It felt better, using those tools, I don’t think it was bothersome, but I see how it could be if your feet are more sensitive, maybe my feet aren’t sensitive as other people maybe...It felt a little bit better when I was doing the placebo portion of the study, then we started using those metal tools, then it was like ‘oh wow, this is immediately better,’ I could just feel it loosening up, I would absolutely recommend it.

Participant “Stella”

Stella was 55 years old when she participated in the previous study. Her BMI was 26.6 and self-reported that she suffered from CPHP for six years beforehand. The quantitative scores of the survey instruments at pre, post, and follow-up is disseminated in Table 9.

Table 9: Quantitative scores for participant "Stella."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	54.4	75	72.5	90	77.8	100	31.3	15	40
Posttreatment	84.4*	100*	85*	100	100	87.5	43.8	9	4*
Follow-Up	100*	100	85	100	88.9	87.5	43.8	1	1

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

Stella described how the CPHP affected her physical activity before the study:

> It impacted how I would exercise whether I felt like I could walk or run, or even just do a class or aerobic exercise, so there were times I choose not to do exercise because I knew it was going to hurt, or it was going to hurt after it was over…I don't think it would make me sit down, or not walk around, but I would know it was there. The hard part would be just walking across campus. But I think with what the pain would do is keep me from doing anything extended. So if I had to stand for a few hours, that wasn't a big deal to me, I mean it would be painful, or I would just forget about it while I was working, I mean, I would know it was there, but it wouldn't impair my work, but it would just be a nuisance.

Stella continues after the treatment protocol completed:

> It was much better. I felt like I could exercise, it wasn't going to cause me pain afterwards, I didn't think about it all the time, like I did before." When asked about her current status, she responded: "It's still good! I haven't had any pain. I probably don't work out as hard as I used to, I don't run as much as I used to, just because of getting old, but I haven't thought about it. In fact, when you called me, I thought 'Wow, I haven't had any pain since then, I really haven't and I have been hiking and walking.

When asked about her perceptions of the Graston Technique, she responded: "I don't remember it ever being something I couldn't handle. If there was a little, little discomfort as you were working through it. I don't ever think I ever got to the point where I said 'Not so hard.'"

Participant "Lonnie"

Lonnie was 53 years old with a BMI of 28.2, when she consented to take part in the previous study. She had experienced CPHP previously for one year, and had numerous doctor visits:

> When I got out of bed, I went to step down on the floor, and I didn't know what was going on, and I couldn't even walk, there was so much pain. So then went to XXXXXXX to see Dr. XXXXX, to see if he could help me, and he gave me cortisone shots, to get me by and I think it was maybe 3 or 4. It helped, but then it came back again, and so he gave me the envelope to see you guys and I said, 'I don't want to have surgery, if I could go somewhere to have some help, I would like that.'

The pre, post, and follow-up scores for Lonnie's CPHP are displayed in Table 10. She describes how her foot felt when the previous study ended: "I was very, very, happy. Back, like I said, when I got out of bed there was so much pain, and it's just an absolute turn around. I was so excited that you guys could help me out."

Table 10: Quantitative scores for participant "Lonnie."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	6.3	12.5	0	100	0	100	37.5	10	71
Posttreatment	100*	100*	100*	100	100	100	50	3	0*
Follow-Up	100	100	100	60	100	100	18.8	6	0

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

Lonnie continues about the current status of her foot: "I'm doing really good, no pain, I'm not having any troubles with my foot, not even a little bit of pain or anything, I'm just doing my normal, and walking the nature trail now, and I want to get up to the fitness center, and get back on the treadmill and do some things and stuff like that. My foot is doing very, very good, very good, this is the best I've ever felt."

Participant "Kendra"

Kendra was 40 years old with a BMI of 27.2, and had suffered from CPHP for six years before taking part in the initial study. Her survey instrument scores are in Table 11. She described herself as an active runner who was always in pain.

> Before the study I woke up with daily pain. I would have to stretch the moment I got out of bed just to be able to walk on my foot. And for a while, I would usually walk on the outside of my foot or adjust my gait, until it was stretched and warmed up, and then I could go through my day. I would run through the pain, I think it probably made it worse. But when I was running, it wasn't hurting as much, it would just hurt after, once it tightened up again. So I was trying to stay active, but it was harder.

Table 11: Quantitative scores for participant "Kendra."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	72.5	62.5	25	90	94.4	100	68.8	33	21
Posttreatment	72.5	93.8*	60*	100	100	100	75	9	15
Follow-Up	100*	100	85*	100	100	100	75	1	1*

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

"When the study ended, it was a lot better, I remember our last appointment, since I knew it was my last appointment, I told you to really work it. I do remember it hurting for a little while after, and I thought 'Oh no, I shouldn't have done that" but within a couple weeks it was so much better. That initial pain of really working it was gone, it's a lot better.

Kendra discusses if her foot currently affects her activity: “It really isn’t. I still run, I’m running a ton.” In regards to the Graston Technique, she adds: “I remember asking for it to be a little more aggressive because I really wanted something to work. So while I could definitely feel it, it was worth it.” On recommending Graston Technique to someone with CPHP: “Absolutely, yes. Because it worked, it helped me, and it was the only thing that really helped me move past it.”

Participant “Marge”

Marge was 53 years old when she participated in the previous study, while having a BMI of 27.4 and CPHP for 10 years. Her self-reported survey scores on the Foot Health Status Questionnaire, McGill Pain Questionnaire, and Visual Analog Score for pretreatment, posttreatment, and follow-up are disseminated in Table 12.

Table 12: Quantitative scores for participant "Marge.”

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	78.2	75	42.5	50	72.2	87.5	68.8	5	16
Posttreatment	100*	93.8*	92.5*	100	88.9	100	75	2	3*
Follow-Up	100	100	85	100	100	100	62.5	1	4

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

Marge described having a lot of pain, “I had been in pain for years, and it was a lot of limping around, and trying different things, wearing arch supports, and I had cortisone injections and tried wearing a boot in bed…It just affected my life, it was hard walking, I’d be in pain after I walked, and it was definitely affecting my quality of life.” When asked about what aspects of quality of life, Marge continued: “If I was on my feet all day, with my job there were times where I would be out all day long on locations and walking and constantly on my feet; that was a guarantee for having a lot of pain at night or the next morning when I got up."

When asked if she recalled how her foot felt when the treatment ended, she reminiscences: "I really can't remember if it was like, feeling a lot better at that time…but I know that since then, I don't have, I hardly have any pain at all." Marge responded about her current quality of life:

> Even when I would sit on my desk at work, and I'd stand up, and initially the first few steps would hurt. That doesn't happen anymore, so I can go out and do exercise and go for a long walk and not have to worry about the fact that my heel is gonna hurt by the time I get to the end of it. When I get up in the middle of the night, I don't, my first thought isn't oh yeah I have to slip in these shoes I wear for comfort, I can actually make a short walk down the hall and not be in pain. So I would just I guess the quality of life is that I don't worry about it anymore.

Marge expressed her thoughts on receiving the Graston Technique:

> I mean it hurt a little bit, I could feel the grinding, but it wasn't a pain that was uncom-unbearable by any means. It was kind of a, one of those it hurt so good kind of things like I knew that it would be good for me (laughs). But it wasn't at all, uncomfortable to a point where I didn't, would of considered not continuing with the treatment.

She would recommend Graston Technique to a friend: "It was simple, non-invasive, it doesn't involve drugs."

<u>Participant "Ned"</u>

Ned was a very active physical educator when he took part in the previous study. He was 41 years old, having symptoms for six months, with a BMI of 32. Ned's quantitative scores are in Table 13.

Ned was still able to be active, but he was in a lot of pain:

> Well, it limited me, as far as the training and exercise, I still did the exercise bit I was in quite a bit of pain. Quality of life was probably down a little bit because I'm on my feet all day for a career, so standing on your feet is what I do, and I was dealing with pain all day long…I used orthotics, I've had cortisone shorts, massage a little bit with physical therapy, a little bit of treatment ionotophoresis, pretty much with PT and podiatrists.

Ned described how his foot felt when the Graston Technique therapy ended:

"Much better, it was pretty much cleared up. I felt and if it was on a scale of 1-10, maybe a 2 at that point and time, when we wrapped up."

Table 13: Quantitative scores for participant "Ned."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	29.4	25	0	100	38.9	75	62.5	51	61
Posttreatment	78.1*	93.8*	42.5*	90	72.2	87.5	68.8	5	9*
Follow-Up	100*	100	100*	70	100	100	93.8	0	0*

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

When asked about his current foot status, Ned brought up that he does his own preventative massage treatment, something that no other participant mentions:

> From what I learned from the study, is, you can put this in there, but I learned how to scrape it myself, and I went to Taiwan and bought those gua-sha tools. I'm doing preventative maintenance, every morning I probably spend about three/four minutes scraping each foot. It's not come back, I just will do it every morning except for weekends I don't, but five days a week I work on it. There's no pain, and there hasn't been any pain, I just go over nice and easy, maybe three minutes a foot, and that's it. Spend six minutes a day on it and no pain.

Ned says he would recommend the Graston Technique to people with CPHP, and describes the first few sessions:

> Yeah, I remember the first session was probably the most tender, and it got a little bit easier and a little bit easier, right now, it's very easy with the gua-sha. I'm

> probably applying more pressure, I am applying more pressure with any of the pain. You know, once it gets so severe and chronic, it is a little tougher to start, but I don't remember planning on being there again (laughs), where it's all bunched up like that.

Participant "Nellie"

Nellie had suffered from CPHP for 3 months before participating in the previous study, she was 51 years old with a BMI of 37.9. Self-reported survey instrument scores for Nellie are in Table 14. She described herself as someone who wanted to be active, since she spends most of her day sitting at a desk. She describes: "It was affecting my workouts, because it's like I couldn't…I couldn't do the push-ups and the planks, and all that, because it was so painful. I did the burpees, and if did the burpees I would just be in pain for day…It would affect my walking, I would have to kind of almost limp."

Table 14: Quantitative scores for participant "Nellie."

	FP	**FF**	**GFH**	**GH**	**PA**	**SC**	**Vig**	**MPQ**	**VAS**
Pretreatment	12.5	68.8	85	70	72.2	100	75	37	72
Posttreatment	78.1*	93.8*	60	70	88.9	100	68.8	0	0*
Follow-Up	93.8	100	100*	90	77.8	100	75	0	0

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

When asked about how her CPHP affected her after the treatment regimen ended, Nellie responded: "Actually there was little if any effect, it was almost completely gone, if not completely gone. I was kind of cautious about doing some things, but then after a while it was okay, I didn't have any pain." She reports her current status as: "It does not affect anything, there is no pain."

Nellie brought up how the CPHP affected her quality of life. Before the study, she describes: “It was disappointing you know, I’ve been trying to work out, I was doing a kickboxing workout, and I really enjoyed it, and I was doing it a lot for the enjoyment cause I was trying to tone up and lose weight…If I couldn’t work out to the, up to the standards that everybody else was, I felt like, I was, failing. I just felt I wasn’t…wasn’t giving enough effort.” When asked about her current quality or outlook on life, she responded: “It’s a lot better, because I don’t have to face pain everyday.” She was asked specifically about kickboxing: “Yeah, I’ve quit that, but I joined a different gym, it doesn’t affect anything that I want to do.”

When asked about her perception of the Graston Technique the first few sessions, she replied:

> Well, I think, I felt some relief while he (investigator) was doing it. I mean it did help a lot, it wasn’t really painful, any more painful that what it was. But I could tell that there was something that was working because I was able to walk a little bit better gradually, over time and then the pain kept going after I repeated sessions, the pain you know subsided quite a bit. Like I said, by the end it was either gone, or almost gone.

Participant “Sandy”

Sandy was 60 years old with a BMI of 32.8 when she participated in the previous study, she self-reported that she suffered from CPHP for approximately four months in her left foot before receiving the treatment. Quantitative results for the survey instruments are in Table 15 for pretreatment, posttreatment, and follow-up.

Table 15: Quantitative scores for participant "Sandy."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	66.3	43.8	42.5	80	50	75	37.5	27	56
Posttreatment	78.8	87.5*	60*	40	83.3	100	56.3	10	12*
Follow-Up	100*	100*	85*	90	88.9	100	81.3	0	0*

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

Before the study, Sandy had CPHP in her contralateral (right) foot for years, as she described:

> I just had what I would call trouble getting up after sitting, some severe pain in my left foot. I'd had it in my right foot years before and knew what it was, felt, yeah, it's back in my left foot now. It just made it hard to, to want to walk, move, get from place to place, because your foot hurt so bad…I had been walking at the Arena, and I was walking two to three miles probably three to four times a week, and that had to come to an abrupt stop because of the plantar fasciitis.

Not being able to walk affected her outlook: It was disappointing yeah, because the walking actually made me feel better. Made me feel more fit, and I'm not into real strenuous exercise, so you know everybody says, 'well you can get good exercise just walking,' well when you can't even walk the yeah that's pretty discouraging."

Sandy describes how her foot felt after the Graston Techique® treatment: "I was able to do a lot more. Exercise and not feel badly. Pain had subsided, and I could have a more normal life. While we were going through the treatment I was in the process of moving from one house to another, so I was doing a lot of work and it helped me get through all that because of the treatment I got."

Sandy continues about the current status of her foot:

> I haven't had any severe problems with it to date. I did start walking a little bit at the Arena, and anytime I get any kind of a twinge that I think that, it hurts a little

> bit or it's acting up a little bit, I stop. So I haven't really done a lot of walking for exercise. I did this last summer, a little bit, we have a track behind my house and since that's not cement, I thought that would be appropriate for me to walk on so I've tried to do that…I'd say my outlook on life is better not that I can walk and move without pain. I've never been a real unhappy person, so I guess I'm just going to say that I'm pretty much back to normal!

Sandy provided interesting feedback about her thoughts with her experience with receiving the Graston Technique treatment, "I had something similar done at XXXX Hospital Occupational Health, and that was, at that time, very difficult to tolerate. But I found with you guys did not so, not so bad. From what I can recall, it's maybe a little uncomfortable, but I'm not gonna say it was really painful." She states that she did not recall exactly what IASTM technique was performed on her at XXXX Hospital Occupational Health.

Participant "Cindy"

Not all participants had mostly positive results with the Graston Technique. Cindy, a 60 year old with a body mass index of 35.4, had suffered from not just CPHP for nine years, but chronic lower extremity pain in her knees and feet most of her adult life. The results of Cindy's pretreatment, posttreatment, and follow-up scores are in Table 16. She reported some improvement near the end of treatment, but the pain has returned during the follow-up.

Table 16: Quantitative scores for participant "Cindy."

	FP	FF	GFH	GH	PA	SC	Vig	MPQ	VAS
Pretreatment	12.5	0	0	30	5.6	0	31.3	46	87
Posttreatment	54.4*	25*	42.5*	40	22.2	50	50	15	47*
Follow-Up	12.5	6.3	0	20	16.7	50	50	29	71

FHSQ: FP=Foot Pain, FF=Foot Function, GFH=General Foot Health, PA=Physical Activity, SC=Social Capacity, Vig=Vigour. Higher scores on the FHSQ signify optimal health. MPQ=McGill Pain Questionnaire, VAS=Visual Analog Scale. Low scores describe less pain, with zero being no pain. * indicates surpassed Minimum Clinical Important Difference: FP>14, FF>7, GFH>9, VAS>9.

Cindy describes her pain issues: “Well I had had plantar fasciitis for almost 15 years, and I have arthritis really bad, but I actually got that from being on my feet I think a lot on tile floors, cement floors, and you actually get it from overusing your feet, so. Then it just continually got worse and my knees are bad because I have an arthritis condition to begin with.”

She continued with her pain before taking part in the study:

> Well I got so bad that I could hardly walk because I just kept working and I should have taken some time off, which you need to take some time off if you get really bad and anyway, I got to where I couldn’t hardly walk, so then I had surgery on my feet and I ended up not going back to work. So I taught for 35 years and then I only had six month more to get my, well I had enough time thank God, to retire, but I didn’t really recover from that. It was kind of a new surgery and then I don’t think they are even using it, it was called the Topaz where they put steel wires, like electrical units in the back of your heels and shock it to get your…I guess to help your circulation and things like that, but it didn’t work with me and it actually made things worse, so.

She had some relief after the Graston Technique regimen was completed:

> I really thought it helped me deal with some of the pain and it seemed like it wasn’t quite as think in there. I thought that it really kind of helped, but I have, you know, I’m not the normal person, because I had all this knee trouble, I need both my knees replaced, so my walking isn’t…I don’t dispense my weight correctly when I walk either, cause I have a really bad right knee and I’m just chicken to get my knees done. But anyway, that’s kind of my situation, so, but I did feel some relief with the pain from the process.

When asked to describe her situation, she responded: “Oh yes, see I have bone spurs, and I have a lot of calcium deposits in there, so, and I have a lot of irregular bone growths. Actually, I have like three on one foot, and I don’t know, a couple on the other foot, I guess.”

She discusses the current status of her foot:

> Well, I didn’t keep up with any kind of treatments so I’m kind of, I think some days are a little bit better, but usually I can walk for, be on my feet for about 10 or 15 minutes and then it’s still really hot, feels tingly, but I think if a person didn’t have all my situational problems, I think it would work a lot better for them, so, I mean, I’m, I really haven’t done anything to keep up with that treatment, so, it’s kind of just diminished in my opinion.

In regards to how she felt she tolerated the treatment, she continued: “Well, I’m always in pain so it didn’t bother me that much, it wasn’t painful to me at all, so. I have such a high tolerance to pain from being in pain all the time. But I thought it felt good, and that seemed to help my walking, you know, it helped my dexterity a little bit.” When asked if she would recommend Graston Technique to someone with CPHP, she concluded: “I think that you know, I think it’s helpful I just don’t know that much really about it, if you continue doing it on a long term basis. I’m really not sure would it completely heal that, I don’t know, because I want to give you honest answers from what I knew, for me I thought it helped a little bit, so.”

Qualitative Themes

Many themes emerged from the qualitative interviews. Most participants described decreased levels of pain, and increased levels of physical activity since the Graston Technique treatment ended, which were compatible with the quantitative scores of the three survey instruments. One unexpected theme that surfaced involved participants describing decreased pain, but still apparent, foot pain at the end of the six week treatment period, then the pain completely subsided a few months later. Participants also described the desire to avoid surgery as a treatment option, and many thought that Graston Technique was a favorable treatment. Finally, most participants had not sought healthcare or treatment for their CPHP, as the reduction of symptoms and increase of function made it unnecessary.

Summary of Results

Current Pain Level

The pain results had 14 of 15 participants report decreased pain from pre testing to two year follow up. Also, 13 out of 15 maintained or reported decreased pain for two out of the three outcome instruments from posttest to the follow-up. Mean group scores presented a trend of decreased pain from pre, post, and follow-up with the FHSQ, MPQ, and VAS. From the qualitative interviews, there were 11 out of 15 participants who described being “pain free” at the follow up. Of the 15 participants, 13 described overall satisfaction with the decrease in pain, as one participant suffered a re-injury, and one felt that they improved at posttest but regressed to the pretest levels during the follow up. With the results, it appears that for the majority of the participants, the answer to the research question is that decreased pain levels were maintained longitudinally from the posttest, and the pain levels continued to slightly decrease during the two year follow up.

With the qualitative interviews, 11/15 reported that with the longitudinal follow up, they ‘had no pain’ or were ‘pain free,’ but only four reported a 100 on the Foot Pain score of the FHSQ, a zero on the MPQ, and a zero on the VAS at the same time.

However, participants “Kendra” and “Stella” both reported their pain as a FHSQ of 100, MPQ as one, and VAS of one, indicating a very low level of pain. “Lonnie” rated her pain as a FHSQ of 100, MPQ of six, and VAS of zero, also indicating a very low level of pain. “Marge” had similar scores of FHSO at 100, MPQ as one, and VAS of four. “Nellie” on the other hand, rated her MPQ and VAS score as zero, but scored her FHSQ foot pain as 93.8. Two participants described themselves as significantly better, but suffering from occasional minor pain. One subject was doing well, but suffered a relapse of CPHP, while one improved at the end of the Graston Technique, but regressed to pretreatment levels longitudinally.

Minimal Important Difference

Landorf and Radford[120] describe the minimal important difference as what is clinically significant, or the minimal score of an instrument where the participants sense the treatment is beneficial, rather than statistically significant. For the FHSQ, the minimal important difference scores are Foot Pain > 14, Foot Function >7, and >9 for General Foot Health. The Visual Analog Scale was any score greater than nine.[120]

From pretest to posttest of the four variables, eight out of 15 increased in all four, while six out of 15 increased in three out of the four variables, leaving one participant increasing in two out of the four. From posttest to follow-up, 11/15 produced a minimal important difference in at least one variable. Of that 11, two reached with all four variables, three in three of the variables, two with two of the variables, and four with one variable, leaving four with no increase.

Physical Activity Level

As previously reported, with the qualitative interviews,10/15 participants reported being more physically active during the follow-up than before starting the study, with 3/15 stating their activity level stayed the same. This is reflected in the survey instruments, as 13/15 reported higher “Physical Activity” scores on the FHSQ at follow-up than pretreatment. Nobody scored exactly the same “Physical Activity” score on pretreatment and follow-up, but three participants had a score within six points on a one hundred point scale.

Qualitatively, at the posttest or cessation of the Graston Technique treatment 5/15 responded that they became more physically active, while 8/15 were the same physical activity, with less pain. When comparing from pretest to follow up, 10/15 described being more physically active, with three staying the same. One participant went back to pretesting levels, and one is more active, but has to stop after 1.5 miles of walking due to a “twinge” on the plantar surface on the bottom of her foot.

There were three suppositions that emerged regarding the physical activity level of the participants at the posttest, or time of the cessation of the Graston Technique treatment. The leading theme by 8/15 participants of their recollection of that time was the physical activity stayed the same, but with less pain. There were comments of: “I was no longer consciously thinking about it,” “walking felt better,” and “no more pain at work.” Five out of the 15 described as immediately becoming more active at the end of the treatment protocol, with reports of: “my activity improved significantly,” and “I was doing more walking.” Lastly, there were two who had no recollection.

Pain at Cessation of Treatment

One unexpected theme that emerged involved participants in the interview reporting that their pain had diminished during the Graston Technique, but there was still minor pain at the cessation of treatment. However, an undetermined amount of time later (some describe three to six months) 10/15 participants described their pain as decreasing to where many described to the point of negligible, even though treatment had been discontinued months before. From the survey instruments, this trend of a consistent decrease in pain scores from pretreatment, to posttreatment, to follow-up, was reflected in 10/15 participants.

Follow-up Care and Self-treatment

After the cessation of treatment, nine of the 15 participants had not performed any follow-up self-treatments, while five continued to stretch on their own, and one subject was both stretching on their own and had purchased their own IASTM device to perform plantar massage every day. The vast majority of participants (13/15) had not engaged in formal follow-up healthcare. However, one subject continued Graston Technique with a local chiropractor, and one continues to visit her podiatrist.

Attitude Towards Surgery

Many (11/15) voiced their hesitation to undergo plantar fascia release surgery, with two that seriously considered surgery, and two that had no opinion. As previously mentioned, the plantar fascia provides structural integrity to the foot,[24,25,30-33,37,42,44,46,47] with any amount of release or resection of it leading to a change in foot mechanics.[34-39, 43] Therefore, undergoing plantar fascia release surgery has become controversial.[37]

Attitude Towards Graston Technique

All of the participants had a favorable attitude toward the Graston Technique received. Some stated that the first few sessions were initially uncomfortable, but tolerable. It is important to note that in the previous study before this follow-up that four participants dropped out because of hypersensitivity to the treatment on the plantar surface of the foot or for excessive pain. The Graston Technique is not tolerated by everyone suffering from CPHP, as patients with pain from nerve entrapment, an inflammation specifically of the plantar nerves, or a pathological exototic calcaneal heel spur may feel an increase in pain and discomfort from the treatment. IASTM may be more prudent for CPHP patients with pathology of chronic degenerative plantar fasciosis, due to the aforementioned increased thickness of the plantar fascia.

CHAPTER 5

DISCUSSION

The purpose of this study was to examine the longitudinal outcomes of chronic plantar heel pain participants for approximately 24 months after the completion of a six week Graston Technique regimen. Specifically, data was collected using a mixed methods approach of convergent parallel design,[7] where quantitative and qualitative data were collected simultaneously, and analyzed independently. There were three research questions addressed by this dissertation. The first question is “Will participants treated with Graston Technique for CPHP report a maintenance of pain levels two years posttreatment?” This study used three quantitative survey instruments the FHSQ, MPQ, and VAS to measure pain, which were completed pretreatment, posttreatment, and approximately two years longitudinally posttreatment. Also, participants were asked to qualitatively report their pain during a two year follow-up interview. The second research question was “Will participants treated with Graston Technique for CPHP report a maintenance of functional outcomes two years posttreatment?” The FHSQ has a sub sections of “Foot Function” and “Physical Activity” to answer the research question, as well as a specific question about function and physical activity in the qualitative interview. The third and final research question is “What are the lived experiences of participants treated with Graston Technique for CPHP?” The results were presented as a case series, where the qualitative data of narrative interviews provided more depth to the quantitative data from the foot health and pain instruments.[7]

In this study, 13 out of 15 participants maintained or decreased their foot pain, and 13 out of 15 maintained or increased their physical activity from posttest over the two year longitudinal span. All 15 participants were patients of podiatrists, whom many had received the typical treatment plan of rest, activity modification, orthotics, and some a corticosteroid injection or multiple injections over time. While this common protocol temporary relief, this practice often leads to a return of symptoms, with sometimes a rupture of the plantar fascia due to multiple corticosteroid injections.[3] The results of this study produce a trend of the majority of participants maintaining or having positive longitudinal gains to their foot pain and function. Therefore, IASTM may be a treatment modality that for many with CPHP could be a viable therapeutic option, and provide long term relief.

One major finding from the qualitative aspect of this study is that 10 out of 15 participants reported foot pain continuing to decrease after the treatment had ended. It is curious to determine why these participants had decreasing levels of pain for CPHP, even though they were not receiving treatment. One possible theory comes from the mechanical changes that Graston Technique can make to soft tissue, including the plantar fascia. Many postulate that CPHP is a degeneration of the plantar fascia,[3,4,13,49,54,55,69,70,130] causing thickening to abnormal levels, therefore causing pain and loss of function.[13,14] Hammer[83] proposes that mechanical treatment of Graston Technique creates a “controlled inflammatory process” that promotes the healing process. While authors have not hypothesized how Graston Technique effects degenerated tissue specifically, it is possible that it has a dual effect on CPHP. First, the mechanical effects of Graston

Technique may literally “break up” the degenerated tissue, therefore decreasing the plantar fascia thickness. Secondly, the “controlled inflammatory process” can recruit fibroblasts cells to the area, and allow the collagen and elastin fibers to form in the tissue in more of a parallel and organized manner, as described in laboratory rats.[2,81] In humans, this maturation or “remodeling” phase of tissue can take up to 12 months to finalize.[53] Therefore, this may be reason that participants felt as if their foot pain continued to improve even after the treatment.

The results of the initial study of this dissertation are consistent with previous studies[83-111] that demonstrate the possible benefits of IASTM for treating soft tissue pain and dysfunction of various pathologies. Specifically, this study results are similar to the case series by Looney et al[87] in 2011, who had 10 CPHP participants receive Graston Technique, with nine reporting improvement and one not describing improvement to the treatment. One major difference between Looney and this study was this study was more consistent with Graston Technique treatment sessions, as participants were treated twice a week for six weeks per the Graston Technique Instruction Manual guidelines.[1] The Looney et al[87] study had participants receive treatment an average of 6.9 times once or twice a week for a range of six to eight weeks, due to the availability of the participants. Whereas both studies had similar outcome results, this study also disclosed that the majority of participants maintained or increased upon the positive outcomes for an average of two years from the posttest.

Currently in the literature there are four IASTM published studies that provide longitudinal follow-up from the cessation of Graston Technique treatment, three for tennis elbow (lateral epicondylitis), and one for carpal tunnel syndrome. Sevier et al[85] described significant results with outcome measures for Graston Technique treatment for lateral epicondylitis compared to conventional physical therapy at 1, 4, 8 and 12 weeks from the start of treatment. Blanchette and Normand[99] also found no difference for lateral epicondylitis with three month follow-up between Graston Technique and ergonomic training, however, both had positive outcomes from pretesting. Similar results were discovered in a pilot study by Burke et al[98] during a three month follow-up where there was no difference in the improvement between manual therapy and Graston Technique for carpal tunnel syndrome. The longest longitudinal follow-up for an IASTM study was Sevier and Stegnik-Jansen[87] in 2015, with lateral epicondylitis patients at six months and 12 months. The participants were separated into an ASTYM group and eccentric exercise group, with the ASTYM group having greater gains in the disabilities of the arm, shoulder, and hand (DASH) outcome measure, VAS, and grip strength. The gains were maintained at the six and 12 months marks.

Whereas, the previous IASTM literature regarding longitudinal outcomes is for upper extremity conditions and has a duration of either three months or one year, this is the first longitudinal study specifically for CPHP, and has a duration of two years. This longer longitudinal duration suggests that IASTM provides a more permanent change to the tissues that otherwise may not occur with conventional treatment modalities, such as rest and corticosteroid injection.[3]

Limitations

A limitation of this study is the length of months it takes for CPHP to become a chronic condition. In 2012, DiGiovanni et al[11] describes recalcitrant “plantar fasciitis” as lasting longer than ten months. The previous study for this dissertation used inclusion criteria of onset of symptoms of greater than three months, consequently, 6/15 (40%) participants had less than ten month onset of symptoms with a range of 3-9 months. While these participants had symptoms for less than ten months, the inclusion criteria also had a physician’s or podiatrist formal diagnosis of CPHP, rather than the judgement of the researchers. It is unknown if these participants would have spontaneously improved by the 10 month mark, however the participants went to a formal physician evaluation for the condition, therefore the symptoms were severe enough for further assessment.

Another limitation was the ability to control any treatments of the participants during the two year follow-up time period. While it was reported in this study, one subject continued Graston Technique with a local chiropractor, and one participant bought his own IASTM instrument and performs the technique on himself. Other participants reported performing their own plantar fascia specific stretching, or gastrocnemius/soleus stretching on their own. However, none of the participants sought formal health care from a physician, podiatrist, or physical therapist during the two year follow-up.

Implications for Professional Practice

With CPHP affecting over one million patients a year[63-64] it is a condition that can be often encountered at the rehabilitation setting. This case series demonstrates that IASTM may be an option as a beneficial treatment for patients suffering from CPHP. However, from the previous study, there were four out of 28 participants who dropped out of the randomized control trial due to pain from Graston Technique. It was hypothesized that two of the participants had a neuropathy due to their response to the treatment, with the other two suffering from hypersensitivity to the treatment. Therefore, due to the differential diagnosis, IASTM may not be for every case of CPHP, but for 13/15 participants in this study, they had healthier pain and function outcomes as compared to pretesting. Also, the participants showed a trend of improved pain outcomes and maintaining functional activity, at the two year follow-up than the posttest. This is important, as some CPHP patients have the symptoms return with conservative treatments such as rest and a cortisone shot.[3]

Whereas there are contraindications for the Graston Technique,[1] for most, it is a safe, non-invasive treatment for CPHP. Many of the participants of this study described that the first or second treatment sessions were uncomfortable, but they later described that they were able to get accustomed to it. As previously mentioned, IASTM may not be for all CPHP sufferers, as it may not be a plantar fasciopathy specifically, and quite possibly other differential diagnoses,[22] such as neuropathy or nerve impingement syndrome, which IASTM may exacerbate symptoms. If the cause of the CPHP is a true plantar fasciopathy, this study agrees with the theory that IASTM may cause a controlled inflammatory response.[83,84] It may take up to 12 months for the plantar fascia to remold and completely remodel the collagen in the tissue,[53] which was indicated by a majority of participant's mild pain reported at posttest, and less pain at the two year follow-up.

Future Directions of Research

With the increasing influence of evidence based practice[6] for healthcare providers, it would be appropriate to recommend more randomized controlled trials utilizing IASTM. This would involve participants with the same condition being randomized into a treatment group, sham group, or control, and measuring the outcomes between groups. The results of the randomized controlled trials would be higher on the levels of evidence as compared to other studies.

While it is known that the plantar fascia thickens with CPHP,[13,14] future research could utilize diagnostic ultrasound to measure plantar fascia thickness before and after an IASTM treatment regimen. This would truly measure if IASTM is effective in decreasing plantar fascia thickness from a pathological plantar fasciopathy to a functional and asymptomatic connective tissue.

Similarly, it has been previously mentioned of studies[49,54,55] taking tissue biopsies of pathological plantar fascia tissue, and describing the degenerative changes to the tissue. Future research should examine biopsies of plantar fascias before IASTM treatment compared to after IASTM, along with symptoms and function. This could give a more conclusive sense of how degenerated tissue reacts to an IASTM regimen.

Conclusions

For some people, Chronic Plantar Heel Pain can be a very painful and debilitating condition that can persist for years. The results of this study suggest that Graston Technique treatment for CPHP provides for most, decreased pain and increased function not only at the end of a six week therapy protocol, but maintains the decreased pain and increased function over a two year longitudinal span. This study also suggests that with CPHP as a chronic fasciosis, the Graston Technique may possibly create a controlled inflammatory response in the degenerated tissue, which allow for proper tissue remodeling and remolding after cessation of treatment.

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APPENDIX A: THE FOOT HEALTH STATUS QUESTIONNAIRE

The Foot Health Status Questionnaire

INSTRUCTIONS

- This questionnaire asks for your views about your foot health.
- All you need to do is circle your answer to each question.
- If you are unsure about how to answer a question, please give the best answer you can.

The following questions are about the foot pain you have had during the past week.

1. What level of foot pain have you had during the past week ?

(circle number)

None..1

Very Mild.................................. 2

Mild... 3

Moderate.................................. 4

Severe...................................... 5

(circle a number for each question below)

DURING THE LAST WEEK...	Never	Occasionally	Fairly Many Times	Very Often	Always
2. How often have you had foot pain ?	1	2	3	4	5
3. How often did your feet ache?	1	2	3	4	5
4. How often did you get sharp pains in your feet ?	1	2	3	4	5

These questions are about how much your <u>feet</u> interfere with activities you might do during a typical day.

(circle a number for each question below)

<u>DURING THE LAST WEEK</u>.......

	Not at All	Slightly	Moderately	Quite a bit	Extremely
5. Have your feet caused you to have difficulties in your work or activities ?	1	2	3	4	5
6. Were you limited in the kind of work you could do because of your feet ?	1	2	3	4	5

<u>DURING THE LAST WEEK</u>...

	Not at All	Slightly	Moderately	Quite a bit	Extremely
7. How much does your foot health limit you walking ?	1	2	3	4	5
8. How much does your foot health limit you climbing stairs ?	1	2	3	4	5

9. How would you rate your overall foot health ? (circle number)

Excellent................................ 1
Very Good............................... 2
Good.................................... 3
Fair..................................... 4
Poor..................................... 5

Please turn to the next page

The following questions are about the shoes that you wear. Please circle the response which best describes your situation.

		Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
10.	It is hard to find shoes that do not hurt my feet.	1	2	3	4	5
11.	I have difficulty in finding shoes that fit my feet.	1	2	3	4	5
12.	I am limited in the number of shoes I can wear.	1	2	3	4	5

13. In general, what condition would you say your feet are in ?

(circle number)

Excellent........................... 1

Very Good......................... 2

Good................................ 3

Fair.................................. 4

Poor................................. 5

Please write some comments about the current state of your feet:

....

....

....

....

....

14. In general, how would you rate your health :

(circle number)

Very Good.. 1
Fair.. 2
Poor.. 3

15. The following questions ask about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

(circle a number on each line)

ACTIVITIES	Yes, Limited A Lot	Yes, Limited A Little	No, Not Limited At All
a. **Vigorous activities**, such as running, lifting heavy objects, or (if you wanted to) your ability to participate in strenuous sports	1	2	3
b. **Moderate activities**, such as cleaning the house, lifting a chair, playing golf or swimming	1	2	3
c. Lifting or carrying bags of shopping	1	2	3
d. Climbing a steep hill	1	2	3
e. Climbing **one** flight of stairs	1	2	3
f. Getting up from a sitting position	1	2	3
g. Walking **more than a kilometre**	1	2	3
h. Walking **one hundred meters**	1	2	3
i. Showering or dressing yourself	1	2	3

16. This next question asks to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours or social groups?

(circle number)

Not at all.. 1
Slightly.. 2
Moderately.. 3
Quite a bit.. 4
Extremely.. 5

Please turn to the next page

17. These questions are about how you "feel" and how things have been with you during the past month. For each question, please give the one answer that comes closest to the way you have been "feeling". How much of the time during the past 4 weeks:

	All of the time	**Most of the Time**	**Some of the Time**	**A little of the Time**	**None of the Time**
a. Did you feel tired?	1	2	3	4	5
b. Did you have a lot of energy?	1	2	3	4	5
c. Did you feel worn out?	1	2	3	4	5
d. Did you feel full of life?	1	2	3	4	5

18. During the past 4 weeks, how much of the time has your emotional problems or physical health interfered with your social activities (like visiting with friends, relatives, etc.)?

(circle number)

No time at all.. 1

A small amount of time.. 2

Moderate amount of time... 3

Quite a bit of the time.. 4

All of the time.. 5

19. How TRUE or FALSE is each of the following statements for you?

(circle a number on each line)

	True or Mostly True	**Don't Know**	**False or Mostly False**
a. I seem to get sick a little easier than other people	1	2	3
b. I am as healthy as anybody I know	1	2	3
c. I expect my health to get worse	1	2	3
d. My health is excellent	1	2	3

This questionnaire is designed to be analysed by:
The Foot Health Status Questionnaire
Data Analysis Software © (Version 1.03) and is
supported by Microsoft Windows™ 3.11. 95 and 98.

APPENDIX B: THE MCGILL PAIN QUESTIONNAIRE

The McGill Pain Questionnaire: Some of the words below describe your present sensations. Circle ONLY those words that best describe it. Leave out any category that is not suitable. Use only a single word in each appropriate category - the one that best applies.

1

Flickering
Quivering
Pulsing
Throbbing
Beating
Pounding

2

Jumping
Flashing
Shooting

3

Pricking
Boring
Drilling
Stabbing

4

Sharp
Cutting
Lacerating

5

Pinching
Pressing
Gnawing
Cramping
Crushing

6

Tugging
Pulling
Wrenching

7

Hot
Burning
Scalding
Searing

8

Tingling
Itchy
Smarting
Stinging

9

Dull
Sore
Hurting
Aching
Heavy

10

Tender
Taut
Rasping

11

Tiring
Exhausting

12

Sickening
Suffocating

13

Fearful
Frightful
Terrifying

14

Punishing
Grueling
Cruel
Vicious
Killing

15

Wretched
Blinding

16

Annoying
Troublesome
Miserable
Intense
Unbearable

17

Spreading
Radiating
Penetrating
Piercing

18

Tight
Numb
Drawing
Squeezing
Tearing

19

Cool
Cold
Freezing

20

Nagging
Nauseating
Agonizing
Dreadful
Torturing

APPENDIX C: VISUAL ANALOG SCALE

How severe is your plantar fasciitis pain today? Place a vertical mark on the line below to indicate how bad you feel your plantar fasciitis pain has been in the last 24 hours.

No Pain Worst Pain Imaginable

APPENDIX D: QUALITATIVE SCRIPT

Explain how your chronic plantar heel pain affected your life before you started the study…

-Pain -Function -Participation -Activities of Daily Living

When the study ended for you, how did the chronic plantar heel pain affect you?

-Pain -Function -Participation -Activities of Daily Living

Does your chronic plantar heel pain affect your life?

-Pain -Function -Participation -Activities of Daily Living

Explain things you couldn't do before the study (because of your foot), that you can do now?

Have you sought formal health care for your foot since the study ended? Type of Provider, diagnostic eval, therapy?

Are you currently performing any self-treatment to your feet? Stretching, icing, massage, night splint, NSAIDs, etc?

Any major life changes since the study that may affect your feet?

Would you recommend the Graston Technique to a friend with the same condition?

Looking back on your chronic plantar heel pain experience, what overall advice would you have for someone with the condition?