THE RELATIVE EFFECTIVENESS OF PULSED ULTRASOUND AS AN ADJUNCT TO FOOT MANIPULATION IN THE TREATMENT OF PLANTAR FASCIITIS

By

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A dissertation submitted in partial compliance with the requirements for the Master's Degree in Technology in the department of Chiropractic at Durban Institute of Technology.

I, Juan du Plessis, do hereby declare that this dissertation is representative of my own work.

Date 10 October 2002

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Approved for final submission

Date 10 Octber 2002

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DEDICATION

I would like to dedicate this dissertation to my parents, Alf and Gloria. For all the support given and for always believing in me, not only during the course of my studies, but in life in general.

AKNOWLEDGEMENTS

I would like to thank Toby, Tazz, Cuddles and Captain 1, 2 and 3 for the pleasure they have given to me.

To my brother, Troy, and sister, Loren, thank you for all life's family experiences.

To my friends for being such a great group of people and for making life at Durban Institute of Technology so much easier.

To my supervisor, Dr Junaid Shaik for his guidance during the formulation of this project.

To Lauren Moulder for the special role she played in my life.

To my cousin Karen Kretzmann for always being a loyal friend.

To Pat, Linda and Mrs Ireland for all the help offered during the course of clinic duties and with the administrative aspects of this project.

ABSTRACT

Plantar fasciitis (PF) is a syndrome that causes pain at the insertion of the plantar fascia to the medial calcaneal tubercle of the calcaneous. This syndrome has been described as an overuse injury with subsequent inflammation at the insertion of the plantar fascia to the bone.

The literature describes inflammatory changes that occur within the body and attachment of the plantar fascia, together with biomechanical aberrances that may be the result of the PF. The purpose of this study was to determine the relative effectiveness of pulsed ultrasound as an adjunct to foot manipulation in the treatment of plantar fasciitis. The foot manipulations are used to correct the biomechanical abnormalities, while the pulsed ultrasound is used for its anti-inflammatory properties. The combination of pulsed ultrasound and foot manipulation was compared to foot manipulation alone to determine if this ultrasound manipulation combination had any beneficial effect over and above foot manipulation alone. Thus determining whether it is of importance to approach and treat both aspects of the syndrome described.

This was a prospective, randomised, comparative controlled trial. Forty subjects were diagnosed with plantar fasciitis and chosen to participate in the study. They were subsequently divided into two groups (Group A and Group B) of twenty. Group A was the experimental group receiving foot manipulation and ultrasound as treatment, and Group B, the control group received foot manipulation alone as treatment. Each subject received six treatments within a period of three weeks, with a seventh follow-up within one week of the sixth treatment. There was no treatment at the seventh consultation; this was used for obtaining subjective and objective readings.

Subjective assessment was by means of the Foot Function Index, and objective was by means of the manual algometer. Both the subjective and objective readings were taken prior to the first, sixth and at the seventh (final) consultations.

From the data obtained it can be concluded that both foot manipulation and pulsed ultrasound, and foot manipulation alone are equally effective in treating PF.

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DEFINITION OF TERMS

Chiropractic manipulation:

A method of manipulation utilizing specific short levers to which a high-velocity thrust of controlled amplitude is directed, with the aim of restoring mobility to individual articulations (Gatterman 1990:49).

CHAPTER ONE: INTRODUCTION

Plantar fasciitis (PF) is described as a syndrome that results from increased tension within the plantar fascia leading to microtears at the fascial insertion or within the body of the structure (Brown 1996, Ryan 1995, Young et al. 2001). Pollard and So (1999), Krivickas (1997), and Batt and Tanji (1995) describe PF as a overuse injury often occurring in athletes. The syndrome is characterised by pain at the medial calcaneal tubercle (Chandler and Kibler 1993) which is worse when first standing in the morning or for standing after being seated with the weight off the feet for a period of time (Young et al. 2001).

Pollard and So (1999), and Batt and Tanji (1995) state that plantar fasciitis is a common cause of heel pain, while Barrett and O'Malley (1999) state that it is the most common cause of heel pain with Ryan (1995) agreeing with that statement for the running population.

Hypomobile joints in the foot cause mechanical stress which lead to PF (Brown 1996, Polkinghorn 1995,and Brantingham et al.1992). This factor has lead the recommendation that manipulation of the hypomobile joints of the foot are indicated in the treatment of PF (Pollard and So 1999, Polkinghorn 1995, Brantingham et al. 1992, and Schafer and Faye 1989). Polkinghorn (1995) reviewed several cases of PF, concluding that PF can be effectively treated by foot manipulation.

The use of MT (manipulative therapy) is mainly aimed at correction of biomechanical components and not directly at the inflammatory component (Schafer and Faye 1989:6-7). For this reason the author has questioned whether a combination of MT and a modality with anti-inflammatory properties will be more beneficial in the treatment of PF.

Numerous studies have found that ultrasound accelerates the healing process and allows wounded tissue to move into the proliferative phase of repair (Fyfe

and Chahl 1985, Williams 1987, Young and Dyson 1990). Kahn (1994:53-63) stated that ultrasound increases cellular metabolism and reduces scar tissue.

After an extensive literature review performed by the researcher no studies were found that tested MT in combination with pulsed ultrasound in the treatment of PF. Therefore it is the purpose of this study to evaluate the relative effectiveness of pulsed ultrasound as an adjunct to MT of the foot in the treatment of plantar fasciitis.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

2.1 DEFINITION OF PLANTAR FASCIITIS (PF)

The Dorlands Medical Dictionary (1995) defines "plantar" as pertaining to the sole of the foot, and "fasciitis" as inflammation of the fascia.

Brantingham et al. 1992 describe PF as a common condition that usually presents as acute, localized plantar heel pain, and may be described by the patient as a "bone bruise".

Young et al. (2001) describes PF as heel pain which is caused by collagen degeneration associated with repetitive microtears of the plantar fascia while

Pollard and So (1999), Ryan (1995), and Chandler and Kibler (1993) all define PF as a repetitive microtrauma overload injury of the attachment of the plantar fascia at the inferior aspect of the calcaneous.

PF was first thought of as tuberculosis in 1812, and has more recently gained synonyms which include painful heel syndrome, painful heel spur, calcaneodynia, subcalcaneal pain, medial arch sprain, stone bruise and calcaneal periostitis (Batt and Tanji, 1995). Polkinghorn (1995) talks of similar synonyms; those being plantar fascial sprain, calcaneal exostosis, calcaneal spur, calcaneodynia and heel spur syndrome, which all represent different stages of the disorder in a progressive manner.

2.2 INCIDENCE, PREVALENCE AND ETIOLOGY

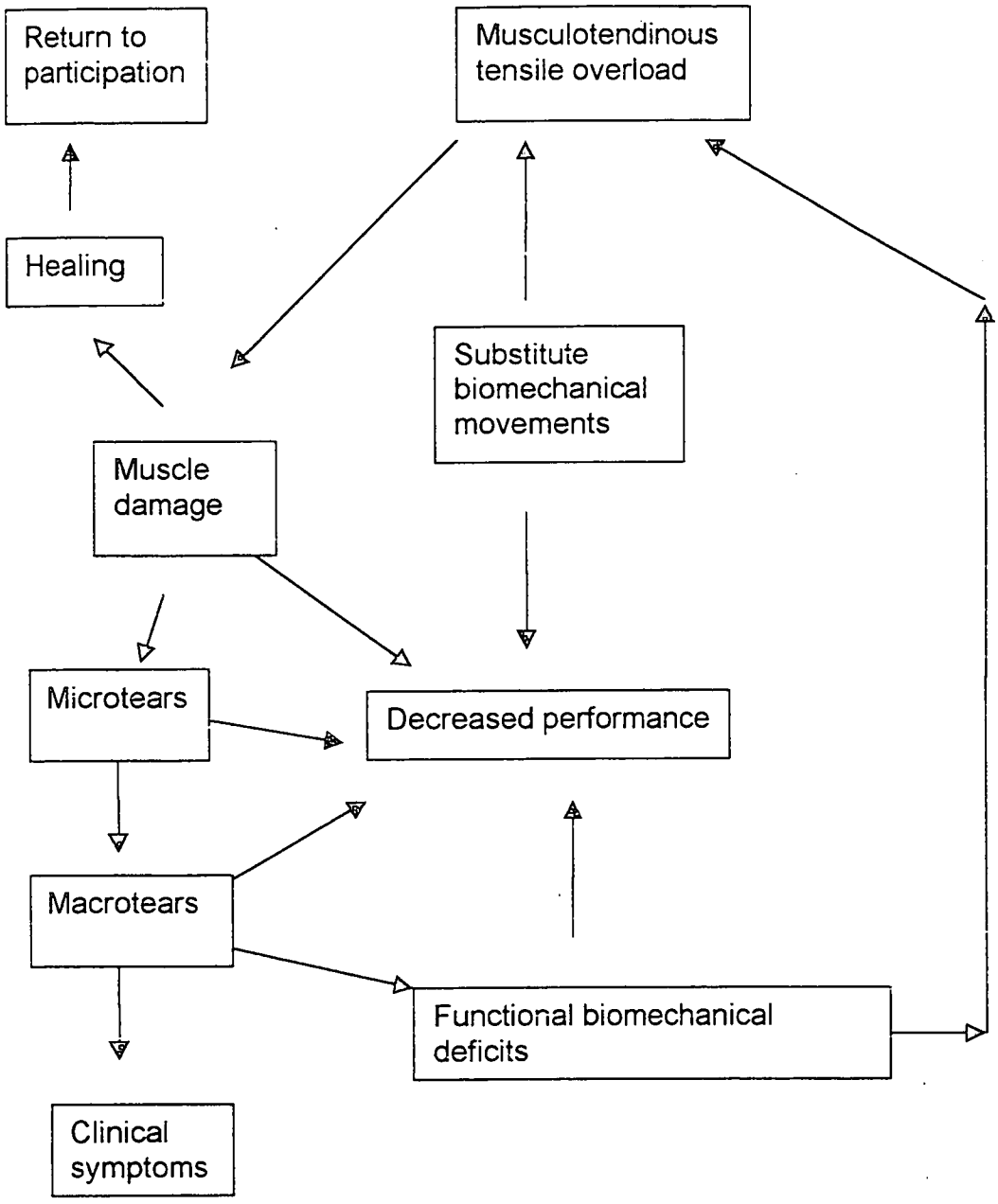
After an extensive literature search by the author, no statistics on global or South African incidence or prevalence could be found. Authors do however describe the condition based on clinical experience.

It is the opinion of Batt and Tanji (1995) and Kibler et al (1991) that PF constitutes about 10% of all running injuries. In two separate South African studies on PF (Morris 2000 and Hammond 2000), the authors found a slight predominance of females in the studies. Morris (2000) had a sample containing 66.7% female and 33.3% male, while Hammond (2000) had 56.7% female and 43.3% male. Both samples had a population sample of thirty patients, therefore these statistics are not representative of the demographics in the greater Durban area. It was also noted from these two studies that the average age of PF sufferers was between 44 and 52 years. This corresponds to the opinion of Reid (1992:196), who agrees that PF is more common after the age of forty. Calliet (1997: 181-187) noted that PF is more common in people whose occupation involves long periods of standing.

Barrett and O'Malley (1999) believe that most cases of PF are the result of a biomechanical fault that causes hyperpronation. Krivickas (1997) noted that excessive pronation causes an increase in the fascial tension during weight-bearing, which can be compounded by a leg length discrepancy which accentuates pronation on the side of the short leg. He goes on to say that a cavus foot causes decreased ability of the foot to absorb weight bearing loads and the ability to adapt to the ground orientation, thus increasing the tension and stress on the plantar fascia.

According to Polkinghorn (1995), Ryan (1995), and Batt and Tanji (1995) PF frequently occurs when there is a change in a runner's training routine, particularly excessive mileage or a sudden increase in volume according to Batt and Tanji (1995).

The overload viscious cycle: The result of overload injuries to the musculotendinous unit (Chandler and Kibler, 1993).



2.3 REVIEW OF ANATOMY

The plantar fascia is a multilayered fibrous aponeurosis which arises from the medial calcaneal tuberosity (Pollard and So 1999, Batt and Tanji 1995,and Moore 1992) and forms three slips that proceed forward toward the toes

where it eventually inserts on the base of the proximal phalanx of the toes (Pollard and So,1999). This structure forms three longitudinal bands of which the central is the is the largest; the medial and lateral bands are merely fascial coverings for the abductor muscles of the great and little toes respectively (Batt and Tanji 1995, Ambrosius and Kondracki 1992).

The central portion of the plantar fascia is known as the plantar aponeurosis, which consists of longitudinally arranged bands of dense fibrous connective tissue. This fans the entire sole of the foot, and divides distally into five bands which enclose the digital tendons and attach to the margins of the fibrous digital sheaths and to the sesamoids of the great toe (Moore 1992).

2.4 PATHOLOGY

The postulated lesion of PF is an enthesitis (inflammation at the bone-ligament interface) that results from tensile overload of the plantar fascia on the insertion at the medial calcaneal tuberosity (Pollard and So 1999, Batt and Tanji 1995, Brantingham et al. 1992). The lesion initially presents as acute inflammation, which results in a periostitis (Polkinghorn 1995 and Brantingham et al. 1992). With persistent overuse, the lesion is characterised by destructive collagen changes, which resemble a tendonosis (Polkinghorn 1995, Batt and Tanji 1995). Young (2001), however, is of the opinion that PF is the result of degeneration caused by repetitive microtears in the plantar fascia.

These postulations strengthen the hypothesis that PF begins as an inflammatory condition, which may progress, without treatment and continual overuse, to a degenerative condition similar to a tendonosis (Ryan 1995).

2.5 BIOMECHANICAL CHANGES

In a study by Kibler et al. (1991) it was found that at least 37 out of 43 subjects with symptomatic PF had dynamic and static range of motion deficits of the ankle range of motion. These deficits were compared to asymptomatic

feet or the uninvolved foot. These deficits according to Kibler et al. (1991) create an alteration in the normal biomechanics of the foot and decrease the efficiency of force absorption and propulsion. Kibler et al. (1991) go on to state that during continued running, this can cause a functional pronation and generate a greater tensile strain on the plantar fascia.

Brantingham et al. (1992), after reviewing 29 PF patient's files, concluded that the three factors involved in the etiology of PF are excessive pronation (either at the subtalar joint or due to a hypermobile first ray in dorsiflexion), joint dysfunction (involving the talocrural, subtalar or midtarsal joints) and myofascial strain (in the plantar muscles of the foot).

According to Schafer and Faye (1990:414) restricted joint motion in the foot causes mechanical stress which may lead to PF. Brown (1996) similarly states that PF is brought about by hypomobile joints in the foot which in turn cause reduced shock absorption and associated tissue damage at the site of attachment of the plantar fascia.

The injury in PF involves microtearing of fascial fibres that initiates an inflammatory response (Ryan 1995 and Kibler et al. 1991). This inflammatory response may be considered secondary to the primary biomechanical stress discussed above (Brown 1996). The use of MT is mainly aimed at correction of biomechanical components and not directly at the inflammatory component or the eventual degeneration of the tissue in the area (Schafer and Faye 1989:6-7). For this reason the author has questioned whether a combination of MT, which corrects the biomechanical aberrations, and a modality with healing properties, such as ultrasound, will be more beneficial in the treatment of PF.

2.6 SIGNS AND SYMPTOMS

PF is usually unilateral (Reid 1992:196). The pain, which is a sharp, piercing pain through the heel of the foot (Ryan 1995), is worst when getting out of bed and taking the first few steps in the morning (Young et al. 2001, Ryan 1995

and Reid 1992:196). The patient first notices pain at the beginning of an activity (e.g. walking), which decreases as the activity continues (Young et al. 2001).

On examination, the patient will have tenderness on the anteromedial aspect of the calcaneous and often the proximal portion of the plantar fascia. This pain may be exacerbated by passive dorsiflexion of the toes or by having the patient stand on the tips of the toes (Young et al. 2001). After reviewing the literature, the author has found no descriptions of neurological abnormalities causing or associated with PF.

2.7 DIFFERENTIAL DIAGNOSIS

PF should be differentiated from other conditions of the heel.

Neurological causes:

These syndromes are generally characterised by radiating burning pain, numbness and tingling, especially at night (Young et al. 2001). Heel pain caused by pressure on the L5-S1 nerve root presents as posterior heel pain, usually with shooting pain down the posterior aspect of the leg (Barrett and O'Malley, 1999). Clinically, these patients may present with a diminished ankle jerk reflex, power loss of foot plantar flexion, sensory loss of the plantar aspect of the foot and posterior leg, and may have a positive straight leg raising test (Magee 1997:382-403).

Tarsal tunnel syndrome causes pain and tingling over the medial and plantar aspect of the heel (Barret and O'Malley, 1999). This is due to entrapment of the posterior tibial nerve or one of its three branches in the fibro-osseus tunnel posterior to the medial malleolus (Batt and Tanji, 1995, Ryan 1995). The patients experience intense pain on standing and walking after long periods of rest, but do not experience the tenderness to palpation at the medial calcaneal tubercle. On palpation of the posterior tibial nerve the patient may experience pain radiating to the toes, known as Tinel's sign, or pain radiating

towards the calf, known as Valleix sign (Barrett and O'Malley 1999). Nocturnal pain is common (Batt and Tanji 1995).

Entrapment of the nerve to the abductor digiti minimi causes pain medial to the medial calcaneal tuberosity (Brown 1996). The entrapment usually occurs between the abductor hallicus muscle and the quadratus plantae muscle. These patients complain of a burning sensation on the plantar aspect of the heel, which may be present while resting and is aggravated by daily activities. Palpation of the plantar aspect of the heel is painful and causes a tingling sensation (Barrett and O'Malley, 1999).

Skeletal causes:

This type of pain is generally characterised by a history of trauma (Ryan 1995) and a bony point tenderness directly over the lesion (Young et al. 2001).

Calcaneal stress fractures are often evident with an increase in activity of the patient (Barrett and O'Malley, 1999, and Batt and Tanji, 1995). There is pain with weight-bearing, which increases with prolonged weight-bearing (Young et al. 2001) or increased activity (Batt and Tanji, 1995).

Calcaneal apophysitis (Sever's disease) generally causes posterior heel pain in adolescents, typically around the insertion of the Achilles to the calcaneous (Young 2001, Barrett and O'Malley 1999). This disorder is caused by an overuse injury to the open epiphysis of the calcaneous (Ryan 1995, Reid 1992). Clinically there is tenderness to palpation of the insertion of the Achilles tendon (Barrett and O'Malley 1999, and Reid 1992). The patients often have a tight Achilles tendon with limited ankle dorsiflexion. This causes them to walk on their toes, to decrease the tension of the Achilles tendon on the calcaneous, and hence reduce the pain (Barrett and O'Malley 1999).

A bone tumour may produce deep bone pain over the area of the tumour (Young et al. 2001). Patients with a calcaneal tumour (e.g. osteosarcoma)

may present with recent weight-loss, persistent pain over the area of the tumour, which is nocturnal. The main presenting symptom is painful swelling over the calcaneous (Yochum and Rowe 1996:1019-1020).

Soft tissue causes:

Fat pad syndrome is caused by atrophy of the heel pad (Young et al. 2001, Reid 1992). The fat pad within the heel degenerates with a thinning effect due to excessive weight-bearing on hard, uneven surfaces during training (Reid 1992). The pain is felt in the area of the heel pad which increases with activity (Reid 1992). Clinically, there is tenderness to palpation in the area of the heel pad (over the central aspect of the plantar surface of the heel) (Brown 1996).

Systemic disorders:

Certain systemic disorders such as gout, rheumatoid arthritis, or seronegative spondyloarthropathies (Reiter's syndrome and ankylosing spondylitis) may produce plantar heel pain, the pain of which is usually bilateral (Batt and Tanji, 1995, Ryan 1995). A detailed history and physical examination may lead the clinician to request radiographic and laboratory tests to determine the origin of the heel pain (Barrett and O'Malley 1999).

2.8 TREATMENT

The initial treatment for PF is as is used for a tendonitis, that being one of rest (Young 2001, Pollard and So 1999, Ryan 1995, and Ambrosius and Kondracki 1992,) and ice (Young 2001, Brown 1996, Batt and Tanji 1995, Ryan 1995, and Ambrosius and Kondracki 1992).

Pollard and So (1999), and Batt and Tanji (1995) recommend heel lifts or heel cups to diminish the pressure on the damaged plantar fascia (they also decrease the pressure on a heel spur when present). They also go on to state that the use of custom orthotics can help change the biomechanics of the foot, thus reducing abnormal pronation (a biomechanical change associated with

PF noted by Krivickas, 1997). Batt and Tanji (1995) also state that an arch support can help reduce the tensile strain on the plantar fascia. Barrett and O'Malley (1999) state that the use of a heel cup or heel pad can be used to correct a leg length inequality, thus reducing the chances of a functional hyperpronation, and hence the biomechanical predisposition to PF.

In a randomised prospective study, Lynch et al (1998) found that longitudinal foot arch taping and custom orthotics were significantly better than NSAIDs, cortisone injections or heel cups in the treatment of PF. One hundred and three subjects were allocated to three different groups. The first group (n=35) received anti-inflammatory therapy for three successive weeks. The anti-inflammatory was in the form of 0.5 ml dexamethasone sodium phosphate 4 mg/ml together with 0.5% bupivacaine hydrochloride injected into the area of maximal tenderness. The patients also consumed two 300mg capsules of etodolac per day. The second group (n=33) were required to wear a viscoelastic heel cup for three months. The third group (n=35) were given low-dye strapping together with a long metatarsal pad for 4 weeks, and then custom foot orthoses were used for the next two months. The final visual analog scale showed a significant difference between the groups ($p<0.01$). Group 3 showed significant improvement in comparison to the other two groups. In terms of the final outcome (no effect, minimal effect, occasional effect or constant effect according to leisure, work and exercise activities performed) reported by the patient, group 3 showed a significant improvement ($p= 0.005$). The study, however had many non-compliant patients, with only 85 of the 103 completing the study. At the end of the study Group 1 had 31 subjects, Group 2 had 26 subjects and Group 3 had 28 subjects.

Night splints and achilles stretching are advocated for PF. Night splints maintain the length of the plantar fascia as the patient sleeps. This prevents the contraction of the plantar fascia that would normally occur during sleep, thus reducing the tension on the insertion of the plantar fascia (Ryan, 1995). Achilles stretching also decreases the strain on the insertion of the plantar fascia, providing temporary relief of the painful symptoms (Ryan 1995).

Night splints and a shoe modification consisting of a steel shank and anterior rocker bottom according to Mizel et al. (1996) have been effective in the treatment of PF. They function by limiting plantar fascia contracture during sleep, and by decreasing the tension in the plantar fascia through the windlass mechanism during the toe off stage of the gait cycle, respectively. Seventy-one feet in 57 patients with PF were treated in this manner. No p-value was given for the outcome of the study. The author, however, based the conclusion on the fact that in 59% of the feet, symptoms were completely resolved, 18% improved, 15% found no change, and 7% worsened. The author chose to statistically analyse whether patient age, gender, duration of symptoms, and bilateral foot involvement influenced treatment outcome. This statistical analysis should rather have been on the final outcome of the treatment in terms of pain and disability to determine whether the treatment was successful.

Corticosteroid injections are used frequently with persistent pain (Ryan 1995) and provide a powerful anti-inflammatory effect to the specific target tissue (Pollard and So, 1999). Batt and Tanji (1995), and Ryan (1995) and are of the opinion that corticosteroids are often associated with fascia weakening and rupture, as well as atrophy of the fat pad beneath the calcaneous. This phenomenon could be due to the short term eburnation and osteopenia of the bone around the injection site (Pollard and So, 1999). Polard and So (1999) go on to state that due to this activity should be limited for the first 10 to 14 days postinjection. Young (2001), and Batt and Tanji (1995) believe that corticosteroid injections should only be reserved for recalcitrant cases of PF. Brown (1996) advocates the use of steroid injections only once conservative management has proven ineffective.

Sellman (1994) studied 37 patients with a history and physical findings of plantar fascia rupture. All the subjects had been diagnosed with PF prior to the rupture, which had been treated by corticosteroid injections into the base of the heel. In the majority of cases the injection was 20-40mg triamcinolone combined with 1.5 ml of lidocaine or bupivacaine. In all 37 patients there was

a palpable dimunition of the tension of the plantar fascia on the involved side, and footprints on a smooth Harris mat showed a flattening of the involved arch in 24 of the patients. Sellman (1994) concluded that corticosteroid injections, although helpful in the treatment of PF, appear to predispose to plantar fascial rupture (no p-value was given for this study). All the subjects were previous patients of the author. There are many factors that weaken this study. No randomised collection process was used. There were no limitations in terms of age, gender or duration of PF prior to the rupture.

2.9 MANIPULATION

Polkinghorn (1999) states that manipulative therapy represents an approach that can provide for both a conservative and an effective mode of therapeutic intervention.

Brantingham et al. (1992) performed a retrospective study on the outcome of treatment of 29 PF patients. No randomisation was used in the selection process. The subjects were all previous PF patients managed by the authors in the three years prior to the study. All the patients received foot manipulation as treatment. Some of the patients had additional treatment in the form of foot taping, orthotics, ice, ultrasound and diathermy. The results of the study showed that 3 patients (10%) received less than 50% reduction in symptoms. Four patients had 50% to 75% reduction in pain, while the remaining 22 patients (76%) had excellent results (more than 75% reduction in pain). The conclusion was that PF can be effectively treated using chiropractic foot care. This study unfortunately only demonstrates the effectiveness of combinations of various treatments, and does not illustrate how effective one treatment (ultrasound or manipulation) could be on its own. The patients did not receive a standardised treatment, but were exposed to different variations of a myriad of treatment modalities. This increased the variables of the study. The study does however show the need for more research into the treatment of PF, especially in terms of each different modality or treatment used.

Polkinghorn (1995) studied three patients with PF. All the patients were treated by foot manipulation only. The emphasis of the manipulations was on the foot, ankle and calcaneous. This study describes foot adjustments as being effective in the treatment of PF. No objective results were obtained, and the only subjective results obtained were in the form of oral questioning, in terms of pain levels and activity enhancement. Hence, no concrete analysis of the patient's pain or disability, subjectively or objectively, was performed. A statistical analysis needs to be performed with a larger sample size to make any conclusions. No randomisation has taken place either. The patients also received different protocols in terms of the treatment frequency and the number of treatments. A more conclusive study needs to be performed.

Hammond (2000) conducted a prospective, randomised, placebo-controlled study. The trial included two samples of 15 subjects, in which the efficacy of manipulative therapy (MT) was evaluated compared to placebo (which was in the form of detuned ultrasound) in terms of subjective and objective measures. The subjective measures were the short-form McGill Pain Questionnaire, the Numerical Pain Rating Scale-101 and the Foot Function Index. The objective measures were in terms of the algometer readings obtained. The manipulative group showed a statistically significant improvement ($p=0.05$) in terms of the short-form McGill Pain Questionnaire. No other significant differences were observed between the two groups. Placebo has proven equally effective as the experimental group in the treatment of PF in all the other subjective and the objective measurements involved in this study. This has lead to the need for a study of a combination of treatments to determine whether an adjunct (i.e. therapeutic ultrasound) to MT may enhance its effect. The study has shown the likelihood of a type-II error in the comparison of data relating to all the subjective and objective measurements. This indicates that the null hypothesis may have been falsely accepted. Hence the statistical conclusion may be incorrect. This was due to the variation, in terms of subjective and objective measurements, between the experimental and placebo group being too great at the initial consultation.

2.10 ULTRASOUND

Chuchuka et al. (1990) performed a study to determine the effect of low-intensity ultrasound on the healing strength of rabbit Achilles tendons. Twenty-four rabbits of similar size and weight were used. The rabbits had their right Achilles tendons ligated midway between the calcaneal insertion and the musculotendinous junction. The severed ends were then immediately sutured and placed in a fibreglass cast. Ten of the rabbits had their ligated tendons treated with ultrasound with a frequency of 1 MHz, at an intensity of 0.5 W/cm2 for 5 min every day for nine days. The other 14 rabbits formed the control group and received mock-ultrasound over the area as treatment. The tendons were put under strain until rupture, which was made possible by an Instron Materials Testing System. The load deformation curves were then plotted. The results after statistical analysis showed a significant difference in the experimental group compared to the control group in terms of tensile strength ($p< 0.02$), tensile stress ($p< 0.005$) and energy absorption capacity ($p< 0.001$) of the previously ligated Achilles tendons. The author concluded that daily application of therapeutic ultrasound enhances the healing processes in tendinous structures in rabbits. These processes may then also be enhanced in humans with the same treatment.

Kitchen and Bazin (1996:245-246) postulate that the thermal effects of ultrasound cause controlled heating within the target tissues. The desirable effects produced from this are pain relief, decreased joint stiffness and increased blood flow. The increase in the blood flow is especially favourable as this helps to restore the local blood flow in areas where injury may have enhanced the avascular nature of the the tissue; as seen in ligaments and tendons. Kitchen and Bazin (1996:246) postulate that the non-thermal effects of ultrasound produce certain phenomena. Cavitation occurs when ultrasound produces micron-sized gas bubbles within the tissues that vibrate, increasing the permeability of the cells to various ions, especially calcium, which

increases the activity of the cells. The other phenomenon is that the unidirectional activity of the ultrasound waves causes high velocity gradients next to boundaries between fluids and structures. This causes increased permeability of cell membranes, increased protein synthesis, increased uptake of calcium by the cells and increased production of growth factors by macrophages. All these effects account for the acceleration of repair following ultrasound therapy.

Reid (1992:46) states that due to the ease of application of therapeutic ultrasound together with its accessibility, it is used and will continue to be used by physical therapists, athletic therapists, podiatrists and chiropractors. The lack of adequate studies in this area has been a constant theme and is disappointing.

As was stated in the introduction:

The use of MT is mainly aimed at correction of biomechanical components and not directly at the inflammatory component (Schafer and Faye 1989:6-7). For this reason the author has questioned whether a combination of MT and a modality with anti-inflammatory properties will be more beneficial in the treatment of PF.

Numerous studies have found that ultrasound accelerates the healing process and allows wounded tissue to move into the proliferative phase of repair (Fyfe and Chahl 1985, Williams 1987, Young and Dyson 1990). Kahn (1994:53-63) stated that ultrasound increases cellular metabolism and reduces scar tissue.

After an extensive literature review performed by the researcher no studies were found that tested MT in combination with pulsed ultrasound in the treatment of PF. Therefore it is the purpose of this study to evaluate the relative effectiveness of pulsed ultrasound as an adjunct to CMT of the foot in the treatment of plantar fasciitis.
The author aims to determine that this approach of two modalities of treatment is more effective than foot manipulation alone.

CHAPTER THREE: MATERIALS AND METHODOLOGY

3.1 STUDY DESIGN AND PROTOCOL

A prospective randomised, comparative, controlled trial.

Sampling:

Advertisements (appendix D) were placed at local gyms, technikons, universities, newspapers, and radio stations. Convenience sampling was used to attract a minimum of forty subjects.

Applicants were screened at an initial consultation using a case history (appendix E), physical examination (appendix F) and regional foot examination (appendix G). During this process they were screened for compliance with the inclusion and exclusion criteria, which were as follows:

Inclusion criteria:

1. An age range of 18 to 70 years. This is similar to the age range used by Morris (2000) and Hammond (2000).

2. Morris (2000) and Hammond (2000) found approximate equal gender distribution. For this reason both males and females were included in this study.

3. In order to reduce complications associated with subjective interpretation of bilateral versus unilateral foot pain, only subjects with unilateral PF were incorporated into the study.

- 4. In order to have been diagnosed with PF, patients must have displayed all of the following: (Young et al. 2001)

- localised tenderness at the medial calcaneal tubercle
- increased pain at the insertion of the plantar fascia to passive dorsiflexion of the greater
- exacerbation of pain by standing or walking on the toes
- morning stiffness of the plantar aspect of the foot

5.All subjects accepted into the study were required to complete an informed consent form (appendix A) if a patient refused to sign this form; he/she was excluded from the study.

6. All subjects must have had foot fixation complexes identified using motion palpation techniques as described by Schaefer and Faye (1989:404-415).

Exclusion criteria:

1. Subjects with a history of fracture, dislocation, and peripheral neuropathy were not included in this study.

2. Subjects who had a history of more than one condition causing pain in their feet were not included in this study. However patients with myofascial pain of the intrinsic muscles of the foot were not excluded from the study.

3. Subjects were asked not to alter their lifestyle in terms of exercise, regular activities and medication use. Should they however have needed to do so, they would have been excluded from the study.

4. Subjects receiving any other form of manual or pharmacological treatment for their PF were excluded from the study.

5. Applicants in which foot X-rays were deemed clinically necessary were excluded from the study.

6. Any subjects that displayed any contra-indications to foot manipulation (Bergmann, Peterson and Lawrence 1993:132-134) in Group A were excluded from the study, and any patients that displayed any contra-indications to foot manipulation and/or ultrasound (Kitchen and Bazin 1996:261) in Group B were excluded from the study.

Randomisation:

Applicants were randomly allocated into 2 groups by asking them to draw papers out of a box. The box contained 20 pieces of paper stating Group A and 20 pieces stating Group B. Group A was the experimental group who received MT and pulsed ultrasound. Group B was the control group and received only MT.

Intervention:

Both groups were treated using a similar protocol to Hammond (2000), and Kirk, Lawrence and Valvo (1991).The protocol consisted of 6 chiropractic treatments over a three week period. The manipulative techniques used included those indicated by the principles of motion palpation (Schafer and Faye 1989:404-415). According to Morris (2000) the primary joint fixations in plantar fasciitis were in the talocrural, subtalar and midtarsal joints. These were the primary areas adjusted if fixations in these joints were encountered.

In addition, Group A received pulsed ultrasound applied to the plantar aspect of the foot, after being manipulated, over the area of the medial calcaneal tubercle. The unit intensity was set at 0.5 w/cm2 and applied through a coupling gel for a duration of five minutes per treatment (Kitchen and Bazin 1996, Kahn 1994).

Measurements:

Subjective data was gathered using the Foot Function Index (appendix C). This questionnaire has been found to be a reliable and valid scale for

measuring foot pain, disability and activity restriction (Saag, Saltzman, Brown and Budiman-mak 1996).

Objective data was obtained with use of the FDK 20 algometer (Wagner Instruments, supplied by Activator Methods Inc.). The procedure used was similar to that of Hammond (2000) whereby:

- the area of maximum tenderness around the medial calcaneal tubercle was located through palpation and marked with permanent ink
- the pain pressure threshold was then measured as described by Fischer (1987).

Measurements were recorded at the initial consultation, 6th consultation and at a follow-up 7th consultation. Measurements were taken before commencement of the treatment. The follow-up consultation was no longer than a week after the 6th treatment. No treatment was given to the patient during the 7th consultation.

3.2 STATISTICAL ANALYSIS

3.2.1 TREATMENT OF THE DATA

Subjective data:

The ratings for the Foot Function Index questions were all given a value out of 100. This data was then analysed for each question for both groups.

Objective data:

Three algometer readings were taken over the medial calcaneal tubercle. The data was then analysed.

3.2.2 STATISTICAL ANALYSIS OF THE DATA

Statistical analysis:

The statistical package SPSS Version 9.0 for Windows® was used for data analysis. The comparison of two samples of twenty subjects would allow analysis by non-parametric tests. Inter-group comparison was made using the Mann-Whitney u test, while intra-group comparison made use Friedman's t test coupled with the Dunn procedure. All data was analysed at the 5% level of significance and decisions were made using the appropriate p values. The results were displayed in table form for interpretation.

3.2.3 INTER-GROUP COMPARISON

The Mann-Whitney U test, a non-parametric test, was used to compare the manipulation and therapeutic ultrasound versus the manipulation groups with regard to the Foot Function Index and the algometer readings.

The Mann-Whitney U test was used to determine whether any significant difference existed between the foot manipulation and therapeutic ultrasound, and the foot manipulation group. This was analysed at the 1^{st}, 6^{th} and 7^{th} consultations for each of the variables at the $\alpha = 0.05$ level of significance.

Hypothesis Testing:

The null hypothesis stated that there was no difference in pain levels with regards to the Foot Function Index and the algometer readings between the two groups. The alternative hypothesis stated that there was a difference in pain levels, with regard to the Foot Function Index and the algometer readings between the two groups.

The Decision Rule:

The decision rule for all procedures:
The null hypothesis was rejected at the $\alpha = 0.05$ level of significance if $p < 0.05$ where p was the observed level or probability value. Otherwise, the null hypothesis was accepted at the α level of significance.

3.2.4 INTRA-GROUP COMPARISON

The Friedman's T test is a non-parametric test that compares three or more paired groups. If the p-value is small, one can conclude that at least one of the treatments differs from the rest. It is therefore necessary to look at post-hoc tests to determine which group differs from which other group (Instat 2001). In this study the post-hoc test used was a multiple comparison called the Dunn Procedure (Daniel 1978). The Friedman's T test was used within the foot manipulation and therapeutic ultrasound group, and the foot manipulation group to determine if there was any significant difference according to the Foot Function Index and the algometer readings between the 1^{st}, 6^{th} and 7^{th} consultations.

Hypothesis Testing:

The null hypothesis stated that there was no difference between consultations with regards to the Foot Function Index and the algometer readings. The alternative hypothesis stated that there was a difference between consultations with regards to the variable of interest.

The Decision Rule:

The decision rule for all procedures:
The null hypothesis was rejected at the $\alpha = 0.05$ level of significance if $p < 0.05$ where p was the observed level or probability value. Otherwise, the null hypothesis was accepted at the α level of significance.

The Dunn Procedure:

If the null hypothesis is rejected for Friedman's T test, then this multiple comparison test had to be applied to determine which of the treatments were significantly different (Daniel, 1978).

CHAPTER FOUR: THE RESULTS

4.1 INTRODUCTION

This chapter deals with the demographic data, and the results and interpretations obtained after statistically analysing the data from the measurement criteria utilised, namely:

- the Foot Function Index
- the algometer readings

4.2 CRITERIA GOVERNING THE ADMISIBILITY OF DATA

Only data from patients who met the criteria of the study was included. Only measurements of the algometer taken by the researcher were used. All responses to the Foot Function Index that were included, were completed under the researcher's supervision.

Patients who did not meet the inclusion and exclusion criteria were excluded from the study. Non–compliant patients were also excluded from the study.

Key for abbreviations used in the following tables:

Group A: Foot manipulation and ultrasound group
Group B: Foot manipulation group

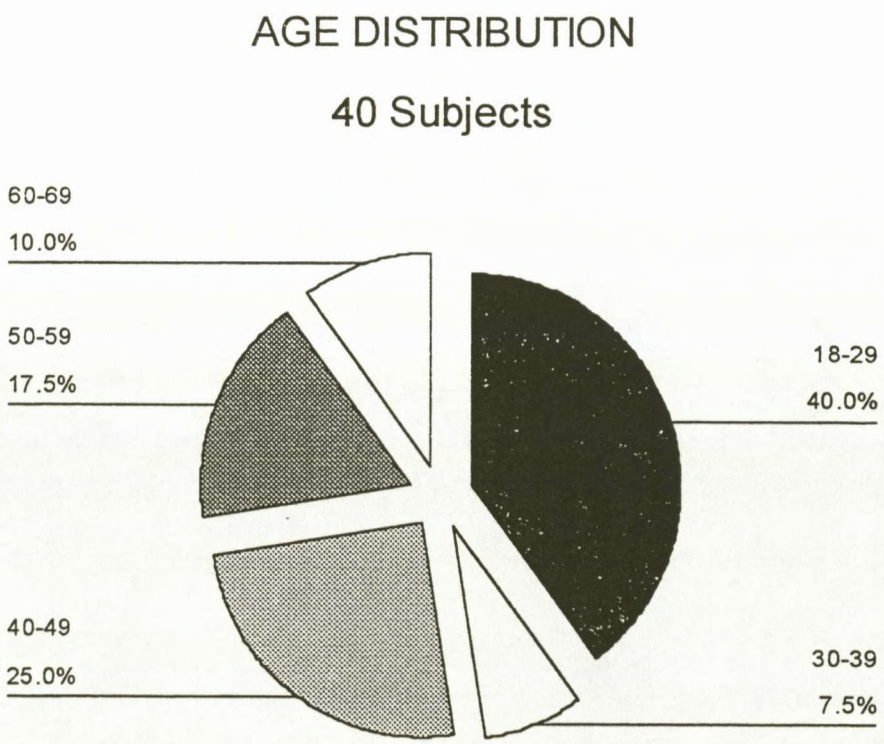
4.3 DEMOGRAPHIC DATA

4.3.1 AGE DISTRIBUTION

Table 1: Age distribution within the sample of 40 patients

AGE	GROUP A	GROUP B	TOTAL (N=40)
18-29	6	10	16(40%)
30-39	2	1	3(7.5%)
40-49	9	1	10(25%)
50-59	2	5	7(17.5%)
60-69	1	3	4(10%)

Graph1: An illustration of the age distribution within the sample of 40 patients.

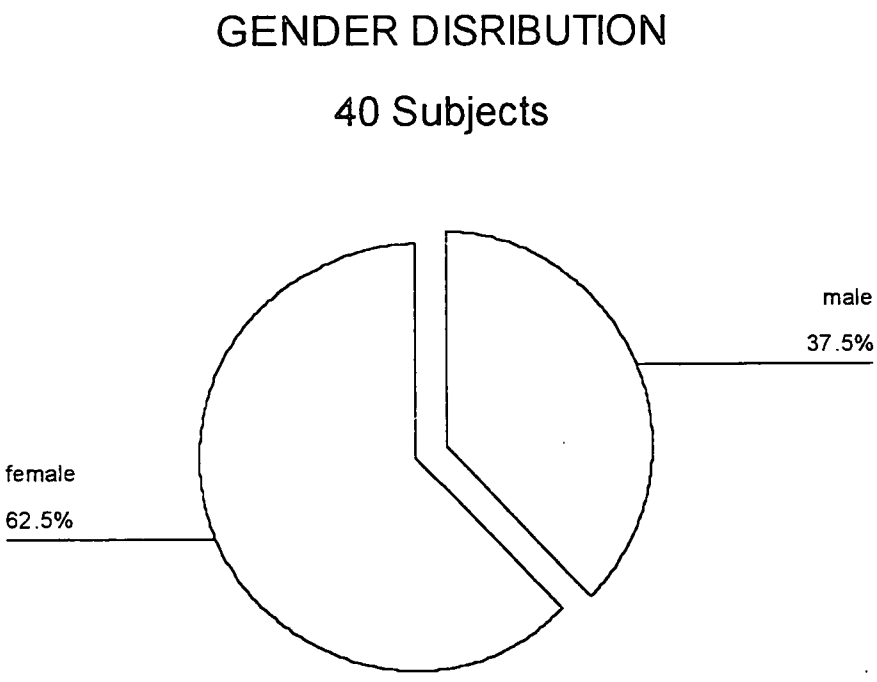


4.3.2 GENDER DISTRIBUTION

Table 2: Gender distribution within the sample of 40 patients

GENDER	GROUP A	GROUP B	TOTAL(N=40)
Male	10	5	15(37.5%)
Female	10	15	25(62.5%)

Graph 2: An illustration of the gender distribution within the sample of 40 patients.



4.3.3 RACE DISTRIBUTION

Table 3: Race distribution within the sample of 40 patients

RACE	GROUP A	GROUP B	TOTAL(N=40)
Indian	6	3	9(22.5%)
Black	1	1	2(5%)
Coloured	1	0	1(2.5%)
White	12	15	27(67.5%)
Oriental	0	1	1(2.5%)

4.3.4 PLANTAR FASCIITIS DISTRIBUTION

Table 4: PF distribution according to the side affected within the sample of 40 patients

SIDE AFFECTED	GROUP A	GROUP B	TOTAL(N=40)
Unilateral right	9	13	22(55%)
Unilateral left	11	7	18(45%)

4.4 RESULTS OF DATA ANALYSIS

4.4.1 INTER-GROUP COMPARISON (GROUP A VERSUS GROUP B)

4.4.1.1 SUBJECTIVE MEASUREMENTS

4.4.1.1.1 FOOT FUNCTION INDEX

RELEVANT QUESTION: WHAT WAS THE WORST LEVEL OF PAIN EXPERIENCED?

Table 5: Comparison of Group A and Group B using the Mann-Whitney U test to analyse results obtained from the Foot Function Index at visits 1, 6 and 7.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
Visit 1	24.50	0.028	16.50
Visit 6	20.88	0.838	20.13
Visit 7	20.75	0.892	20.25

The values that are shown for visit 1 are the values that were obtained before the first treatment. They indicate that there was a statistically significant difference between Group A and Group B before the treatments began ($p<0.05$). The null hypothesis was rejected and the alternative hypothesis accepted.

There was no statistically significant difference between the two groups for this question of the Foot Function Index following the 6^{th} and 7^{th} visits ($p\geq0.05$). The null hypothesis was accepted.

RELEVANT QUESTION: WHAT WAS THE LEVEL OF PAIN BEFORE GETTING OUT OF BED?

Table 6: Comparison of Group A and Group B using the Mann-Whitney U test to analyse results obtained from the Foot Function Index at visits 1, 6 and 7.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
Visit 1	21.30	0.664	19.70
Visit 6	19.40	0.544	21.60
Visit 7	18.75	0.334	22.25

There was no statistically significant difference between the two groups for this question of the Foot Function Index prior to the first visit ($p \geq 0.05$). The null hypothesis was accepted.

There was no statistically significant difference between the two groups for this question of the Foot Function Index following the 6^{th} and 7^{th} visits ($p \geq 0.05$). The null hypothesis was accepted.

RELEVANT QUESTION: WHAT WAS THE LEVEL OF PAIN WHEN WALKING BAREFOOT?

Table 7: Comparison of Group A and Group B using the Mann-Whitney U test to analyse results obtained from the Foot Function Index at visits 1, 6 and 7.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
Visit 1	23.05	0.163	17.95
Visit 6	20.88	0.838	20.13
Visit 7	20.27	0.902	20.73

There was no statistically significant difference between the two groups for this question of the Foot Function Index prior to the first visit ($p \geq 0.05$). The null hypothesis was accepted.

There was no statistically significant difference between the two groups for this question of the Foot Function Index following the 6th and 7th visits ($p \geq 0.05$). The null hypothesis was accepted.

RELEVANT QUESTION: WHAT WAS THE LEVEL OF PAIN WHEN STANDING BAREFOOT?

Table 8: Comparison of Group A and Group B using the Mann-Whitney U test to analyse results obtained from the Foot Function Index at visits 1, 6 and 7.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
Visit 1	22.35	0.312	18.65
Visit 6	20.52	0.989	20.48
Visit 7	19.23	0.482	21.77

There was no statistically significant difference between the two groups for this question of the Foot Function Index prior to the first visit ($p \geq 0.05$). The null hypothesis was accepted.

There was no statistically significant difference between the two groups for this question of the Foot Function Index following the 6th and 7th visits ($p \geq 0.05$). The null hypothesis was accepted.

RELEVANT QUESTION: WHAT WAS THE LEVEL OF PAIN WHEN WALKING WEARING SHOES?

Table 9: Comparison of Group A and Group B using the Mann-Whitney U test to analyse results obtained from the Foot Function Index at visits 1, 6 and 7.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
Visit 1	23.17	0.142	17.83
Visit 6	20.13	0.837	20.88
Visit 7	19.38	0.537	21.63

There was no statistically significant difference between the two groups for this question of the Foot Function Index prior to the first visit ($p \geq 0.05$). The null hypothesis was accepted.

There was no statistically significant difference between the two groups for this question of the Foot Function Index following the 6^{th} and 7^{th} visits ($p \geq 0.05$). The null hypothesis was accepted.

RELEVANT QUESTION: WHAT WAS THE LEVEL OF PAIN WHEN STANDING WEARING SHOES?

Table 10: Comparison of Group A and Group B using the Mann-Whitney U test to analyse results obtained from the Foot Function Index at visits 1, 6 and 7.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
Visit 1	21.42	0.611	19.58
Visit 6	19.60	0.618	21.40
Visit 7	18.52	0.275	22.48

There was no statistically significant difference between the two groups for this question of the Foot Function Index prior to the first visit ($p \geq 0.05$). The null hypothesis was accepted.

There was no statistically significant difference between the two groups for this question of the Foot Function Index following the 6th and 7th visits ($p \geq 0.05$). The null hypothesis was accepted.

RELEVANT QUESTION: WHAT WAS THE LEVEL OF PAIN AT THE END OF THE DAY?

Table 11: Comparison of Group A and Group B using the Mann-Whitney U test to analyse results obtained from the Foot Function Index at visits 1, 6 and 7.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
Visit 1	20.80	0.870	20.20
Visit 6	20.38	0.946	20.63
Visit 7	19.65	0.641	21.35

There was no statistically significant difference between the two groups for this question of the Foot Function Index prior to the first visit ($p \geq 0.05$). The null hypothesis was accepted.

There was no statistically significant difference between the two groups for this question of the Foot Function Index following the 6th and 7th visits ($p \geq 0.05$). The null hypothesis was accepted.

For the questions about levels of pain when wearing orthotics: not enough of the patients wore orthotics to run any statistical analysis. Hence none of the tests were performed and no conclusions drawn.

4.4.1.2 OBJECTIVE MEASUREMENTS

4.4.1.2.1 ALGOMETER READINGS

Table12: Comparison of Group A and Group B using the Mann-Whitney U test to analyse results obtained from the algometer readings at visits 1, 6 and 7.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
Visit 1	18.35	0.244	22.65
Visit 6	22.45	0.291	18.55
Visit 7	23.88	0.068	17.13

There was no statistically significant difference between the two groups for the algometer readings prior to the first visit ($p \geq 0.05$). The null hypothesis was accepted.

There was no statistically significant difference between the two groups for the algometer readings following the 6^{th} and 7^{th} visits ($p \geq 0.05$). The null hypothesis was accepted.

4.4.2 INTRA-GROUP COMPARISON

4.4.2.1 SUBJECTIVE MEASUREMENTS

4.4.2.1.1 FOOT FUNCTION INDEX

Graph 3: Comparison of Group A and B for the Foot Function Index question; what was the worst level of pain experienced? This was at treatments 1, 6 and 7.

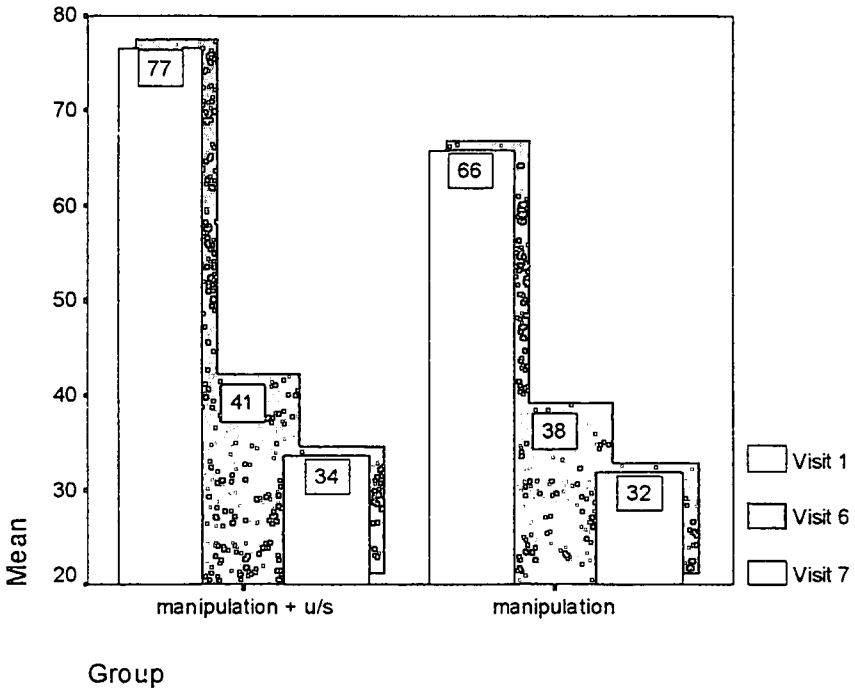


Table 13: Comparison of Group A and Group B using Friedman's T test to analyse results obtained within the groups for the worst pain levels. The Foot Function Index results were used.

	Group A			Group B		
	Visit 1	Visit 6	Visit 7	Visit 1	Visit 6	Visit 7
Mean	76.50	41.25	33.50	65.75	38.25	31.75
p-value	0.000 (<0.001)			0.000 (<0.001)		

For both groups A and B the null hypothesis is rejected for this particular question of the Foot Function Index. This indicates that at the α=0.05 level of significance, there was a statistically significant improvement in pain perception between the three consultations in each group.

Graph 4: Comparison of Group A and B for the Foot Function Index question; what was the level of pain before getting up in the morning? This was at treatments 1, 6 and 7.

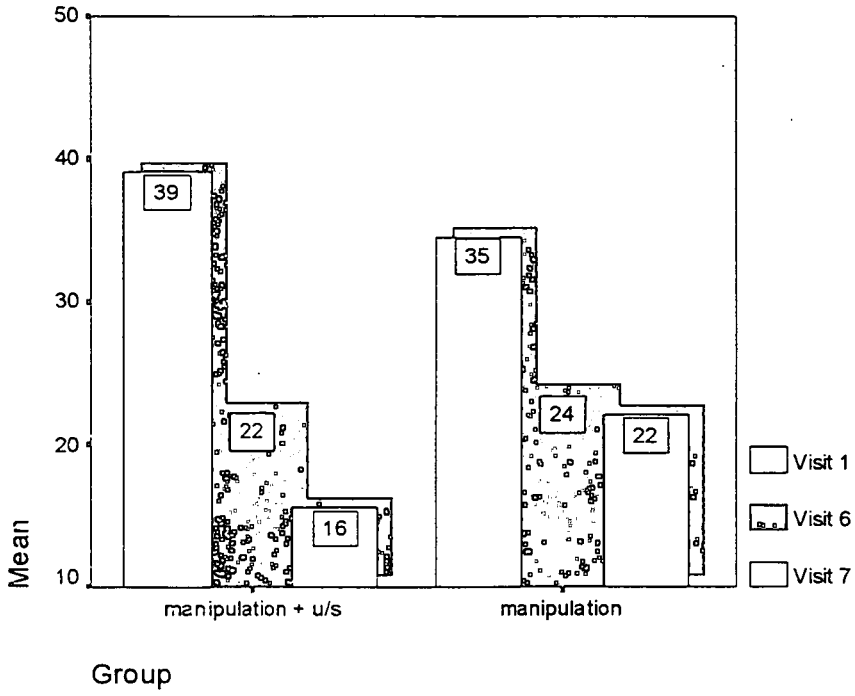


Table 14: Comparison of Group A and Group B using Friedman's T test to analyse results obtained within the groups for the level of pain before getting up in the morning. The Foot Function Index results were used.

	Group A			Group B		
	Visit 1	Visit 6	Visit 7	Visit 1	Visit 6	Visit 7
Mean	39.00	22.25	15.50	34.50	24.00	22.00
p-value	0.000 (<0.001)			0.001		

For both groups A and B the null hypothesis is rejected for this particular question of the Foot Function Index. This indicates that at the α=0.05 level of significance, there was a statistically significant improvement in pain perception between the three consultations in each group.

Graph 5: Comparison of Group A and B for the Foot Function Index question; what was the level of pain when walking barefoot? This was at treatments 1, 6 and 7.

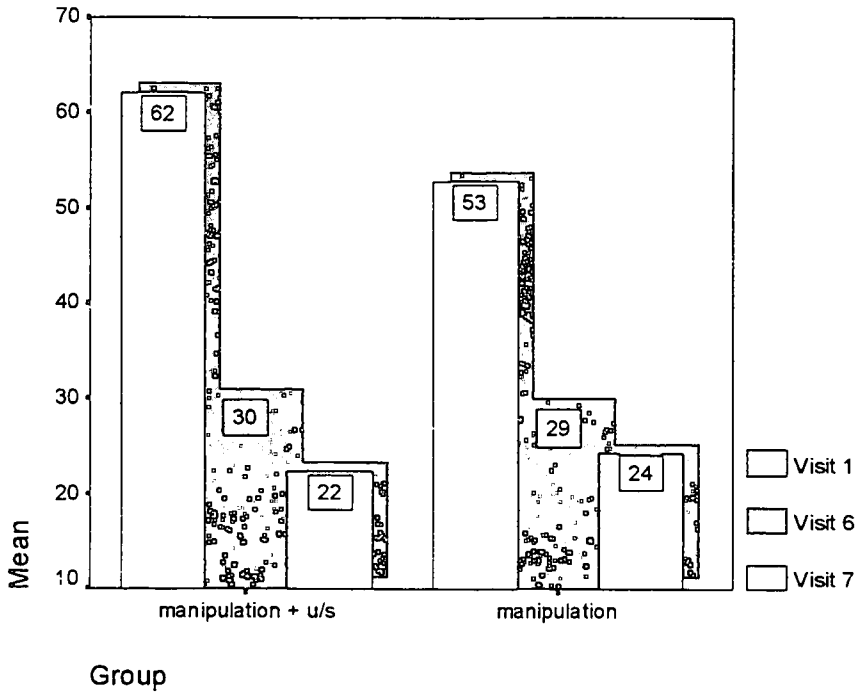


Table 15: Comparison of Group A and Group B using Friedman's T test to analyse results obtained within the groups for the level of pain when walking barefoot. The Foot Function Index results were used.

	Group A			Group B		
	Visit 1	Visit 6	Visit 7	Visit 1	Visit 6	Visit 7
Mean	62.00	30.00	22.25	52.75	29.00	24.25
p-value	0.000 (<0.001)			0.000 (<0.001)		

For both groups A and B the null hypothesis is rejected for this particular question of the Foot Function Index. This indicates that at the α=0.05 level of significance, there was a statistically significant improvement in pain perception between the three consultations in each group.

Graph 6: Comparison of Group A and B for the Foot Function Index question; what was the level of pain when standing barefoot? This was at treatments 1, 6 and 7.

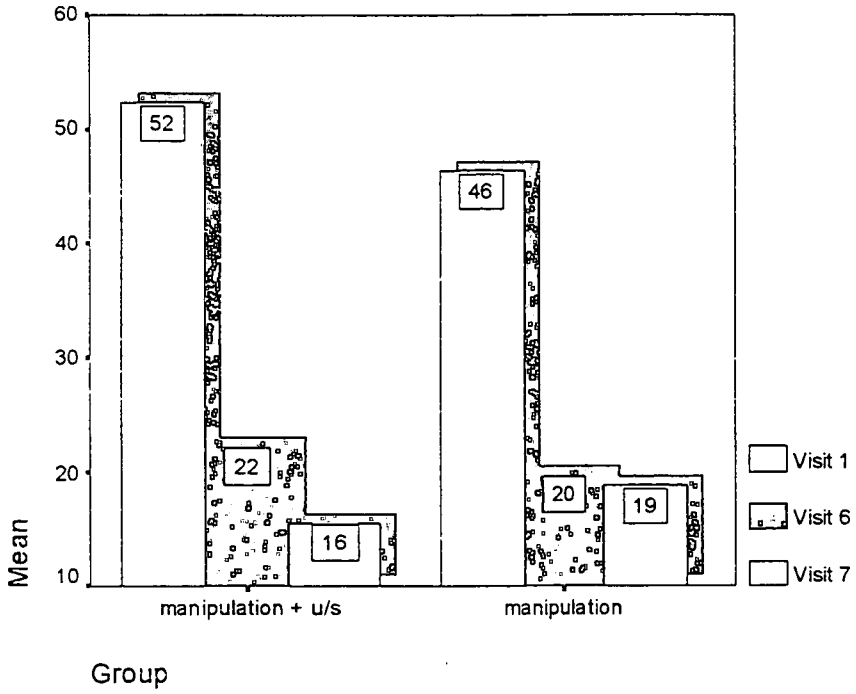


Table 16: Comparison of Group A and Group B using Friedman's T test to analyse results obtained within the groups for the level of pain when standing barefoot. The Foot Function Index results were used.

	Group A			Group B		
	Visit 1	Visit 6	Visit 7	Visit 1	Visit 6	Visit 7
Mean	52.25	22.25	15.5	46.25	19.75	18.75
p-value	0.000 (<0.001)			0.000 (<0.001)		

For both groups A and B the null hypothesis is rejected for this particular question of the Foot Function Index. This indicates that at the α=0.05 level of significance, there was a statistically significant improvement in pain perception between the three consultations in each group.

Graph 7: Comparison of Group A and B for the Foot Function Index question; what was the level of pain when walking wearing shoes? This was at treatments 1, 6 and 7.

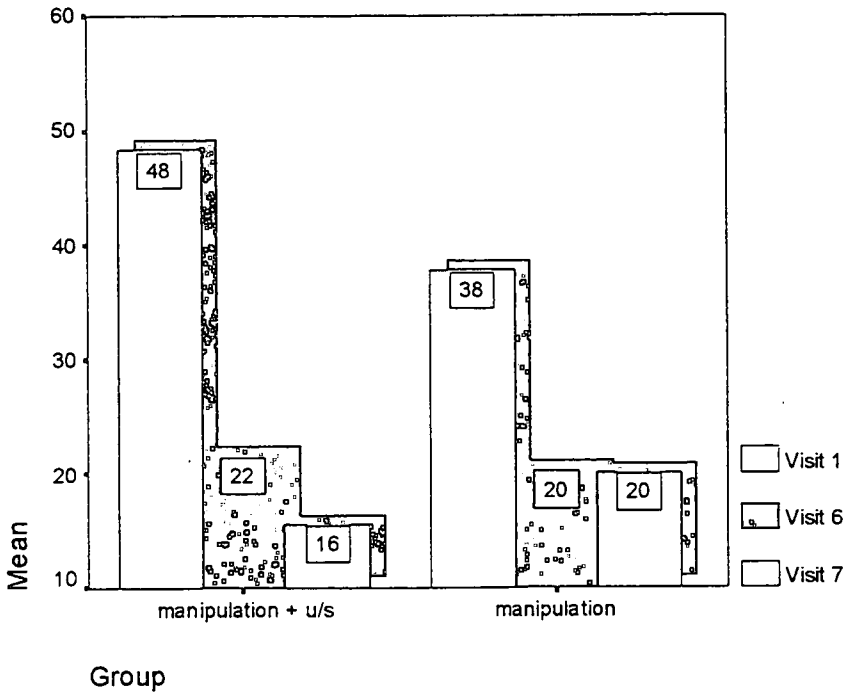


Table 17: Comparison of Group A and Group B using Friedman's T test to analyse results obtained within the groups when walking wearing shoes. The Foot Function Index results were used.

	Group A			Group B		
	Visit 1	Visit 6	Visit 7	Visit 1	Visit 6	Visit 7
Mean	48.25	21.5	15.5	37.75	20.25	20.00
p-value	0.000 (<0.001)			0.000 (<0.001)		

For both groups A and B the null hypothesis is rejected for this particular question of the Foot Function Index. This indicates that at the α=0.05 level of significance, there was a statistically significant improvement in pain perception between the three consultations in each group.

Graph 8: Comparison of Group A and B for the Foot Function Index question; what was the level of pain when standing wearing shoes? This was at treatments 1, 6 and 7.

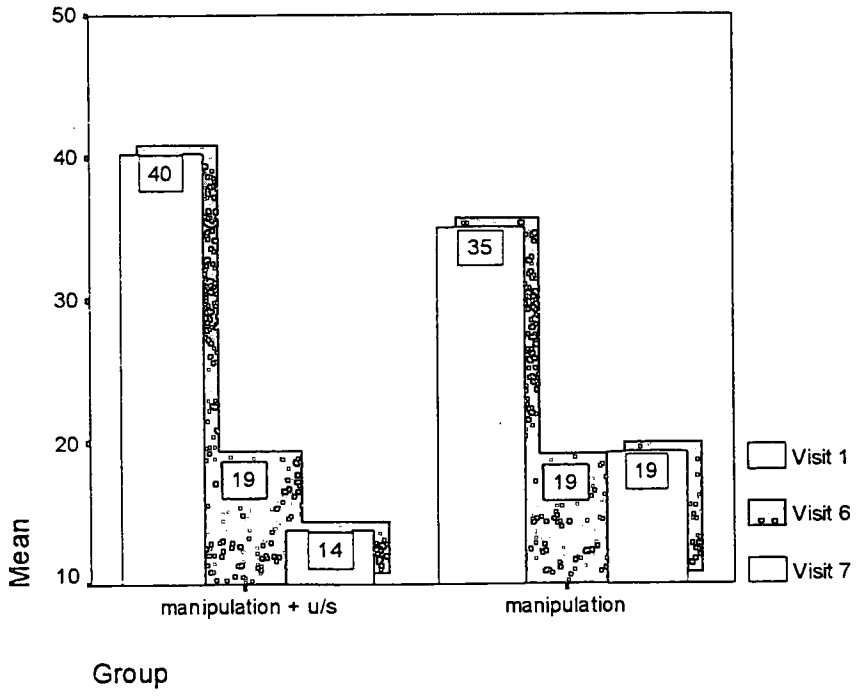


Table 18: Comparison of Group A and Group B using Friedman's T test to analyse results obtained within the groups for the level of pain when standing wearing shoes. The Foot Function Index results were used.

	Group A			Group B		
	Visit 1	Visit 6	Visit 7	Visit 1	Visit 6	Visit 7
Mean	40.25	18.75	13.75	35.00	18.50	19.25
p-value	0.000 (<0.001)			0.001		

For both groups A and B the null hypothesis is rejected for this particular question of the Foot Function Index. This indicates that at the α=0.05 level of

significance, there was a statistically significant improvement in pain perception between the three consultations in each group.

Graph 9: Comparison of Group A and B for the Foot Function Index question; what was the level of pain at the end of the day? This was at treatments 1, 6 and 7.

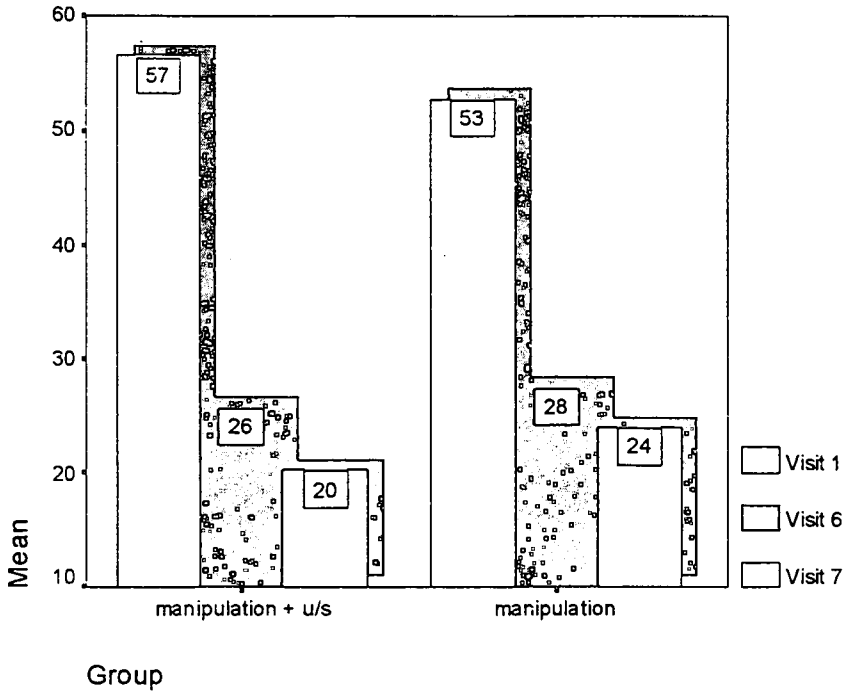


Table 19: Comparison of Group A and Group B using Friedman's T test to analyse results obtained within the groups for the level of pain at the end of the day. The Foot Function Index results were used.

	Group A			Group B		
	Visit 1	Visit 6	Visit 7	Visit 1	Visit 6	Visit 7
Mean	56.50	25.75	20.25	52.75	27.50	24.00
p-value	0.000 (<0.001)			0.000 (<0.001)		

For both groups A and B the null hypothesis is rejected for this particular question of the Foot Function Index. This indicates that at the α=0.05 level of

significance, there was a statistically significant improvement in pain perception between the three consultations in each group.

4.4.2.2 OBJECTIVE MEASUREMENTS

4.4.2.2.1 ALGOMETER READINGS

Graph 10: Comparison of Group A and B for the algometer readings at treatments 1, 6 and 7.

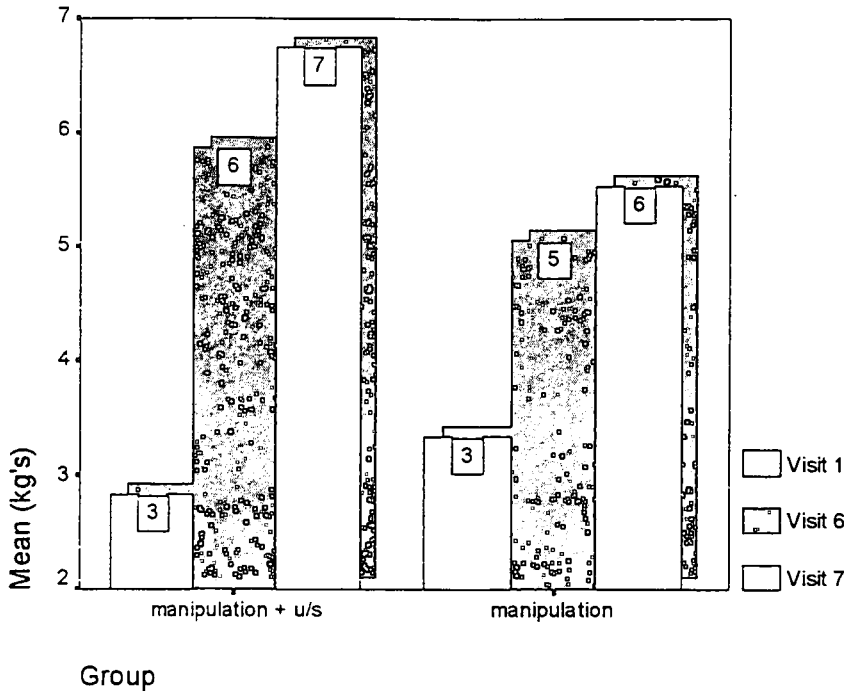


Table 20: Comparison of Group A and Group B using Friedman's T test to analyse results obtained within the groups for the algometer readings.

	Group A			Group B		
	Visit 1	Visit 6	Visit 7	Visit 1	Visit 6	Visit 7
Mean	2.83	5.865	6.75	3.335	5.055	5.53
p-value	0.000 (<0.001)			0.000 (<0.001)		

For both groups A and B the null hypothesis is rejected for the algometer readings. This indicates that at the α=0.05 level of significance, there was a statistically significant improvement in tenderness between the three consultations in each group.

4.4.2.3 THE DUNN'S PROCEDURE (MULTIPLE COMPARISON TEST)

If the null hypothesis is rejected for Friedmann's T test, then this multiple comparison procedure is applied to determine between which treatments a significant improvement occurred (Daniel 1978).

When the null hypothesis is rejected for the objective or subjective findings of Group A and B, it is necessary to apply the Dunn's procedure to the Foot Function Index questionnaire and the algometer readings. This is to determine which of the treatments are significantly different.

Let Vj and Vj' be the jth and j'th treatment rank totals.
Let α be the experiment-wise error rate. Usually α=0.10

If $|Vj-Vj'| \geq z\sqrt{\frac{bk(k+1)}{6}}$, then Vj and Vj' are declared insignificant.

In the above formula: b= the number of blocks
k= the number of readings
z= value in inverse normal distribution corresponding to (1-[α/k(k-1)])

In this case, k=3, b=20, α=0.10 and z=2.12
i.e. If the difference of rank totals $\geq$ 13.408, then Vj and Vj' are declared insignificant.

For the purposes of this study, V1 is the first visit, V6 is the sixth visit and V7 is the seventh visit.

4.4.2.3.1 SUBJECTIVE MEASUREMENTS

4.4.2.3.1.1 FOOT FUNCTION INDEX IN GROUP A

Table 21: Dunn's procedure for the question: what was the worst level of pain experienced?

	Rank total	Difference	Rank total	
Visit 1	76.50	35.25	41.25	Visit 6
Visit 1	76.50	43.00	33.50	Visit 7
Visit 6	41.25	7.75	33.50	Visit 7

V1 – V6 =35.25 $\geq$ 13.408, therefore between consultations 1 and 6 , the result is declared statistically significant.

V1 – V7 =43.00 $\geq$ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 =7.75 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 22: Dunn's procedure for the question: what was the level of pain before getting up in the morning?

	Rank total	Difference	Rank total	
Visit 1	39.00	16.75	22.25	Visit 6
Visit 1	39.00	23.50	15.50	Visit 7
Visit 6	22.25	6.75	15.50	Visit 7

V1 – V6 = 16.75 $\geq$ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 23.50 $\geq$ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 6.75 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 23: Dunn's procedure for the question: what was the level of pain when walking barefoot?

	Rank total	Difference	Rank total	
Visit 1	62.00	32.00	30.00	Visit 6
Visit 1	62.00	39.75	22.25	Visit 7
Visit 6	30.00	7.75	22.25	Visit 7

V1 – V6 = 32.00 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 39.75 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 7.75 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index.

Table 24: Dunn's procedure for the question: what was the level of pain when standing barefoot?

	Rank total	Difference	Rank total	
Visit 1	52.25	30.00	22.25	Visit 6
Visit 1	52.25	36.75	15.50	Visit 7
Visit 6	22.25	6.75	15.50	Visit 7

V1 – V6 = 30.00 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 36.75 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 6.75 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7

with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 25: Dunn's procedure for the question: what was the level of pain when walking wearing shoes?

	Rank total	Difference	Rank total	
Visit 1	48.25	26.75	21.50	Visit 6
Visit 1	48.25	32.75	15.50	Visit 7
Visit 6	21.50	6.00	15.50	Visit 7

V1 – V6 = 26.75 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 32.75 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 6.00 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 26: Dunn's procedure for the question: what was the level of pain when standing wearing shoes?

	Rank total	Difference	Rank total	
Visit 1	40.25	21.50	18.75	Visit 6
Visit 1	40.25	26.5	13.75	Visit 7
Visit 6	18.75	5.00	13.75	Visit 7

V1 – V6 = 21.50 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 26.50 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 5.00 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 27: Dunn's procedure for the question: what was the level of pain at the end of the day?

	Rank total	Difference	Rank total	
Visit 1	50.50	24.75	25.75	Visit 6
Visit 1	50.50	30.25	20.25	Visit 7
Visit 6	25.75	5.50	20.25	Visit 7

V1 – V6 = 24.75 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 30.25 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 5.50 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

4.4.2.3.1.2 FOOT FUNCTION INDEX IN GROUP B

Table 28: Dunn's procedure for the question: what was the worst level of pain experienced?

	Rank total	Difference	Rank total	
Visit 1	65.75	27.50	38.25	Visit 6
Visit 1	65.75	34.00	31.75	Visit 7
Visit 6	38.25	6.50	31.75	Visit 7

V1 – V6 = 27.50 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 34.00 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 6.50 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 29: Dunn's procedure for the question: what was the level of pain before getting up in the morning?

	Rank total	Difference	Rank total	
Visit 1	34.50	10.50	24.00	Visit 6
Visit 1	34.50	12.50	22.00	Visit 7
Visit 6	24.00	2.00	22.00	Visit 7

V1 – V6 = 10.50 < 13.408, therefore between consultations 1 and 6, the result is declared statistically insignificant.

V1 – V7 = 12.50 < 13.408, therefore between consultations 1 and 7, the result is declared statistically insignificant.

V6 – V7 = 2.00 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that no significant improvement exists between visits 1 and 6, 1 and 7, and 6 and 7, with regard to the subjective data on pain for this particular question of the Foot Function index.

Table 30: Dunn's procedure for the question: what was the level of pain when walking barefoot?

	Rank total	Difference	Rank total	
Visit 1	52.75	23.75	29.00	Visit 6
Visit 1	52.75	28.50	24.25	Visit 7
Visit 6	29.00	4.75	24.25	Visit 7

V1 – V6 = 23.75 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 28.50 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 4.75 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 31: Dunn's procedure for the question: what was the level of pain when standing barefoot?

	Rank total	Difference	Rank total	
Visit 1	46.25	26.50	19.75	Visit 6
Visit 1	46.25	27.50	18.75	Visit 7
Visit 6	19.75	1.00	18.75	Visit 7

V1 – V6 = 26.50 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 27.50 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 1.00 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 32: Dunn's procedure for the question: what was the level of pain when walking wearing shoes?

	Rank total	Difference	Rank total	
Visit 1	37.75	17.50	20.25	Visit 6
Visit 1	37.75	17.75	20.00	Visit 7
Visit 6	20.25	0.25	20.00	Visit 7

V1 – V6 = 17.50 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 17.75 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 0.25 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 33: Dunn's procedure for the question: what was the level of pain when standing wearing shoes?

	Rank total	Difference	Rank total	
Visit 1	35.00	16.50	18.50	Visit 6
Visit 1	35.00	15.75	19.25	Visit 7
Visit 6	18.50	0.75	19.25	Visit 7

V1 – V6 = 16.50 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 15.75 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 0.75 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

Table 34: Dunn's procedure for the question: what was the level of pain at the end of the day?

	Rank total	Difference	Rank total	
Visit 1	52.75	25.25	27.50	Visit 6
Visit 1	52.75	28.75	24.00	Visit 7
Visit 6	27.50	3.50	24.00	Visit 7

V1 – V6 = 25.25 ≥ 13.408, therefore between consultations 1 and 6, the result is declared statistically significant.

V1 – V7 = 28.75 ≥ 13.408, therefore between consultations 1 and 7, the result is declared statistically significant.

V6 – V7 = 3.50 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that a significant improvement exists between visits 1 and 6, and 1 and 7, but no improvement can be demonstrated between visits 6 and 7 with regard to the subjective data on pain for this particular question of the Foot Function index. There was overall improvement, but no further improvement occurred once treatment was stopped at the 6th consultation.

4.4.2.3.2 OBJECTIVE MEASUREMENTS

4.4.2.3.2.1 ALGOMETER READINGS IN GROUP A

Table 35: Dunn's procedure for the algometer readings.

	Rank total	Difference	Rank total	
Visit 1	2.83	3.04	5.87	Visit 6
Visit 1	2.83	3.92	6.75	Visit 7
Visit 6	5.87	0.88	6.75	Visit 7

V1 – V6 = 3.04 < 13.408, therefore between consultations 1 and 6, the result is declared statistically insignificant.

V1 – V7 = 3.92 < 13.408, therefore between consultations 1 and 7, the result is declared statistically insignificant.

V6 – V7 = 0.88 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that no significant improvement exists between visits 1 and 6, 1 and 7, and 6 and 7, with regard to the subjective data on pain for this particular question of the Foot Function index.

4.4.2.3.2.1 ALGOMETER READINGS IN GROUP B

Table 36: Dunn's procedure for the algometer readings.

	Rank total	Difference	Rank total	
Visit 1	3.335	1.72	5.055	Visit 6
Visit 1	3.335	2.195	5.53	Visit 7
Visit 6	5.055	0.475	5.53	Visit 7

V1 – V6 = 1.72 < 13.408, therefore between consultations 1 and 6, the result is declared statistically insignificant.

V1 – V7 = 2.195 < 13.408, therefore between consultations 1 and 7, the result is declared statistically insignificant.

V6 – V7 = 0.475 < 13.408, therefore between consultations 6 and 7, the result is declared statistically insignificant.

This implies that no significant improvement exists between visits 1 and 6, 1 and 7, and 6 and 7, with regard to the subjective data on pain for this particular question of the Foot Function index.

CHAPTER 5: DISCUSSION

5.1 INTRODUCTION

This chapter deals with the discussion of the results, presented in chapter four, after statistical analysis of the data obtained. The results are discussed in two parts, namely: inter-group and intra-group comparisons.

5.2 INTER-GROUP COMPARISON

5.2.1 SUBJECTIVE DATA

The statistical data is located in tables 5 to 11.

Statistical analysis of the Foot Function Index revealed a statistically significant difference between Group A and Group B before the first consultation, for the worst level of pain question of the Foot Function Index. There was no statistically significant difference found for any other question of the Foot Function Index at the first, sixth or seventh consultations. Thus, foot manipulation with pulsed ultrasound, statistically, was no more effective than foot manipulation alone in the treatment of PF.

The Foot Function Index:

Relevant question: What was the worst level of pain experienced? (Table 5)

A comparison of the first consultation of both groups revealed a statistically significant difference ($p=0.028$). The null hypothesis, which states that there is no significant difference between the two groups, was rejected and an alternative hypothesis was accepted. This resulted in a type I error occurring. This meant that both groups did not start off in a similar position in terms of pain perception.

A comparison of the sixth and seventh consultations revealed no statistically significant difference between the two groups (p=0.838 and p=0.892 respectively). The null hypothesis was accepted for both groups at these consultations. Both groups were therefore equally effective in reducing the patient's perception of pain. A type I error may have resulted in the null hypothesis being rejected when it should have been accepted.

This only occurred in this question, together with the Foot Function Index being a subjective measurement, this result has very little effect on the Foot Function Index results as a whole.

Analysis of all questions of the Foot Function Index except for the 1st question: (Table 6-11)

A comparison of the first consultation indicated no statistically significant differences, meaning that both groups started off at a similar position in terms of pain perception for these questions of the Foot Function Index. A comparison of the sixth and seventh consultations indicated no statistically significant difference between the two groups ($p \geq 0.05$ for both groups). The null hypothesis is therefore accepted. This indicates that both foot manipulation and foot manipulation in conjunction with pulsed ultrasound are equally effective in reducing the patient's perception of pain for all aspects of the pain questioned by the Foot Function Index.

5.2.2 OBJECTIVE DATA

Algometer readings:

(Table 12)

A comparison of the first consultation indicated no statistically significant difference (p=0.244), meaning that both groups started off at a similar position in terms of there tenderness. A comparison of the sixth and seventh consultations indicated no statistically significant difference between the two

groups (p=0.291 and 0.068 respectively). The null hypothesis is therefore accepted. This indicates that both foot manipulation and foot manipulation in conjunction with pulsed ultrasound are equally effective in reducing the patient's tenderness.

5.3 INTRA-GROUP COMPARISON

It was hypothesized that there would be a difference between consultations with regards to the variable of interest in Group A, showing that foot manipulation in conjunction with pulsed ultrasound was more effective than foot manipulation alone in the treatment of PF.

5.3.1 SUBJECTIVE DATA

The statistical data is located in tables 13 to 19 and 21 to 34.

The Foot Function Index:

An analysis of consultations one, six and seven revealed a statistically significant difference in Group A and Group B ($p<0.05$ for both groups), indicating a decrease in the level of pain perception. A multiple comparison procedure, namely, the Dunn's procedure was used to determine at which point the treatment made a significant difference.

In Group A, a significant improvement was noted between consultations 1 and 6, and 1 and 7, but no significant improvement was demonstrated between consultations 6 and 7.

In Group B, a significant improvement was noted between consultations 1 and 6, and 1 and 7 but no significant improvement was demonstrated between consultations 6 and 7.

These results indicate that both foot manipulation with pulsed ultrasound, and foot manipulation alone showed a significant improvement during the course

of the treatment. However, once the treatments ended, both groups did not show any further improvement.

Relevant question: What was the level of pain before getting up in the morning?

Statistical analysis of this particular question showed a variation to the other questions of the Foot Function Index.

An analysis of consultations one, six and seven using Friedman's T test revealed a statistically significant difference in Group A and Group B ($p<0.05$ for both groups), indicating a decrease in the level of pain perception (table 14). A multiple comparison procedure, namely, the Dunn's procedure was used to determine at which point the treatment made a significant difference.

In Group A, a significant improvement was noted between consultations 1 and 6, and 1 and 7 but no significant improvement was demonstrated between consultations 6 and 7 (table 22). Thus, the treatment was effective in reducing the patients' pain perception during the course of the treatment. Once treatment was abandoned, the patients did not improve.

In Group B, no significant improvement was demonstrated between any consultations (table 29). Thus, no particular stage of the treatment was more effective than any other. The patients improved at a steady rate with no isolated treatments or periods during the entire treatment process being of greater statistical significance in terms of improvement as indicated by pain perception.

Friedman's T test showed an statistically significant improvement in both groups for this question, thus the Dunn procedure's results showing Group A to have a statistically significant improvement between consultations, which did not occur in group B has no bearing on the overall statistical analysis. The Dunn's procedure was merely used to determine at what stage of treatment the group showed improvement.

5.3.2 OBJECTIVE DATA

The statistical data is located in tables 20, 35 and 36.

Algometer readings:

An analysis of consultations one, six and seven revealed a statistically significant difference in Group A and Group B ($p<0.05$ for both groups), indicating a decrease in the level of tenderness (table 20). A multiple comparison procedure, namely, the Dunn's procedure was used to determine at which point the treatment made a significant difference.

In Group A, no significant improvement was demonstrated between any of the consultations (table 35).

In Group B, no significant improvement was demonstrated between any of the consultations (table 36).

The results show that both groups, statistically, showed no period of treatment or any particular consultation that may have enhanced the healing process more than the rest of the treatment. The patients improved at a steady, uniform rate.

5.4 CONCLUSIONS

From the data obtained it can be concluded that both foot manipulation and pulsed ultrasound, and foot manipulation alone are equally effective in treating PF. Inter-group comparisons showed that both treatments improved the subjects' pain perceptions in terms of the Foot Function Index and the algometer readings taken. Intra-group analysis revealed that both treatment groups showed significant improvement, subjectively and objectively, between consultations.

5.5 COMPARISON OF THE RESULTS WITH OTHER STUDIES

Crawford and Snaith (1996) performed a prospective, randomised placebo-controlled study to determine the effectiveness of pulsed ultrasound in the treatment of plantar heel pain in twenty-six cases. The patients in this study received eight treatments twice weekly for four weeks instead of the six treatments over a three week period. There was an independent observer to make the setting of the ultrasound unit a double-blind procedure. The settings of the ultrasound unit were not exactly the same. Crawford and Snaith (1996) used a machine delivering a dose of pulsed ultrasound at 3 MHz, 0.5 w/cm2. The current study used pulsed ultrasound of 1 MHz also at 0.5 w/cm2. In both studies, all treatments were performed by the same operator. Neither the Foot Function Index for subjective measurements nor the algometer for objective data were used. The method of pain measurement was done in the form of a linear analogue scale before the commencement of the eight treatments, and then after the course of treatments was over. The results were analysed using the Wilcoxin Signed-Ranks test. Thus, only an intra-group analysis (no inter-group analysis) was performed. The results showed no significant difference between the placebo and pulsed ultrasound groups. These results are similar to this study, in that both found pulsed ultrasound to be of no significant value in the treatment of the condition studied. This study needs a more conclusive statistical analysis to show at what stages of the treatments there were significant changes in pain perception, if any. The examiner should also include an objective measurement together with the measurements to be taken during the course of the study and not just at the beginning and end.

In another trial, Gudeman et al. (1998) performed a randomised, double-blind, placebo-controlled trial to determine whether iontophoresis of dexamethasone and traditional therapy provides better relief from symptoms of PF than traditional therapy alone. The traditional therapy was in the form of ice therapy, stretching, strengthening, home exercises and the use of a viscoelastic heel orthosis. Gudeman et al. (1996) made use of the same sample size as was used in this study ie. forty patients divided equally into two groups. A six-treatment protocol was used. Their treatments, however,

were spread over a period of two weeks, not three. The measurements used were only that of the subjective Maryland Foot Score, which was performed after each treatment. No objective measurements were performed. They also performed a one-month follow-up to determine whether the treatment was long lasting, which was not performed in this study. This research showed a significant improvement in the experimental group compared to the control group in the initial stages of treatment. There was, however, no improvement after the one-month follow-up between the two groups. This is important as it helps to strengthen the hypothesis that PF has an inflammatory component shown by the relief obtained by using the corticosteroids. The one-month follow-up showed no significant difference between the two groups, this supports the hypothesis that there is a biomechanical abnormality associated with this condition, which if not addressed would hinder any further healing.

Brantingham et al. (1992) in a retrospective review of twenty nine patient's files found 33.3% of patients to be under the age of thirty, 10% between the age of thirty and forty and the rest to be over the age of forty. This correlates with this study, which has 40% of patients under the age of thirty, 7.5% between thirty and forty, and the rest being over the age of forty. Morris (2000) and Hammond (2000) found most the majority of PF patients in their studies to be in the 44 to 52 year range. These studies correspond with Reid (1992) who states that PF is most predominant over the age of forty. In the researcher's opinion, weight is a factor. The majority of patients in the older age groups were overweight. Thus the prevalence of PF in the 40 to 60 year age group age groups is affected, and increased due to most of the patients being overweight.

The gender distribution in this study shows women to be more affected with 62.5% of the sample being women and 37.5% being men. This correlates with Morris (2000), Hammond (2000) and Brantingham et al. (1992) who all show a predominance of PF in women. In the researchers opinion, this is again a result of patients being overweight. The majority of the women in this study were overweight. PF was more severe and debilitating in the women seen in this study, all of who were overweight. This may be due to the nature of the

occupations of women in the greater Durban area. Occupations as seen with the women in this study involve long periods of standing, but not much involvement in physical activity.

In terms of race distribution, only Hammond (2000) analysed this particular of the study. The results of her study were similar to this study showing a predominance of white sufferers with indian patients being the second most common. This is probably more an indication of the demographics of patients at the Durban Institute of Technology Chiropractic Day Clinic rather than the distribution of PF as a whole. The clinic is located in an area that is easily accessible for white and Indian patients because of the predominance of white and Indian residents in this area. The other race groups because of location and transport difficulties, may find it difficult to access the clinic on successive occasions as was needed for this study.

The results from the current study do not display any enhanced relief found from the addition of pulsed ultrasound to the foot manipulation. There was a significant improvement in both groups but no additional relief by attacking the hypothesised inflammatory component of PF. This study shows that there is a biomechanical component that must be addressed, due to the relief obtained by the foot manipulation. The inflammatory component may exist, but may be in the form of degenerative changes that occur at the medial calcaneal tubercle. Corticosteroids, according to Reid (1992:45) are prescribed for degenerative musculoskeletal conditions. The results from Gudeman et al. (1996), showing improvement with corticosteroids during the treatment period, together with the results obtained in this study support the hypothesis that PF is a condition in which there is a degenerative process underway. This is also the opinion of Young (2001) who states that PF is the degeneration caused by repetitive microtears that overcome the body's ability to repair itself.

CHAPTER SIX: RECOMMENDATIONS AND CONCLUSIONS

6.1 RECOMMENDATIONS

There are certain limitations that may be improved on if this study is to be repeated.

Randomisation:

Patients included in the study should be screened by the researcher and allocated into the two groups. The aim of this being that the patients in each group should not differ in weight, height or severity of their complaint. These are factors that may influence the outcome of a patient's response to treatment (Gudeman et al. 1998). PF is more common in overweight persons and the chronicity and severity of their complaint is often more debilitating than in average weight individuals. The screening of the patients would spread this the sample evenly, avoiding the possibility of one group containing more severe cases which may need a lengthier protocol to provide sufficient results.

A double-blind study:

A suitable placebo (e.g. Detuned ultrasound) in the control group would make the study more accurate. The patients in the control group would have a placebo together with their foot manipulations as treatment. This would result in the patients perceiving themselves to be receiving the same treatment as all the subjects in the experimental group. Both groups would then have the same expectation of the treatment, not knowing which group is in fact benefiting more.

Accuracy of measurements:

The examiner used one of three analogue algometers available. One or more of these instruments were not available at certain stages, due to many other

students having to use them in similar studies. Thus, the same algometer may not have been used for particular patients on certain occasions. This may have lead to inaccurate measurements. One algometer should be assigned to an examiner for their particular study and should not be shared.

The algometer could also be improved on by using the more accurate digital algometer instead.

Sample diversity:

The sample used was not representative of the population. The advertising was aimed at certain populations because of the ease of access to the facilities available for those prospective subjects. In future the trial should be mobile, thus informing and treating people of other areas who lack access to the current stationary clinic.

Another proposition is that advertising is broadened to incorporate those areas not informed about the treatment.

Most people are of the opinion that chiropractic only deals with spinal complaints. The result is difficulty in obtaining patients for an extremity research program. Presentations need to be performed to inform prospective subjects of the benefits that may be obtained by using a chiropractor. This broadening of the knowledge base of chiropractic would also result in a larger sample to choose from, limiting the chances of the same groups of people being involved in the research studies performed at this college.

Age range:

The age range of this study was too broad. The older patients took longer to recover; this may be due to degeneration already present in the plantar fascia, joints and ligaments of the foot. In future a stratified age range should be used whereby subjects of the same ages can be compared with each other.

6.2 CONCLUSION:

This was a prospective, randomised, comparative, controlled trial. All the subjects were diagnosed with PF according to the inclusion and exclusion criteria. Forty subjects were chosen and randomly assigned to two groups of twenty.

Group A was the experimental group and received foot manipulation, and pulsed ultrasound to the plantar fascia as treatment. Group B received only foot manipulation as treatment. Both groups received six treatments over a three week period, with a seventh consultation within a week of the final treatment as a follow-up for obtaining results. No treatment was given at this final consultation.

Intra-group analysis showed that in each treatment protocol, the subjects showed significant improvement in both the subjective (Foot Function Index) and objective measurements (algometer readings at the medial calcaneal tubercle).

Inter-group analysis revealed that both treatments were equally effective in the management of PF.

The aim of the study was to determine whether pulsed ultrasound would have made any difference to the treatment outcomes if applied with foot manipulations, as opposed to foot manipulation as the sole treatment.

This study shows that both pulsed ultrasound as an adjunct to foot manipulation, and foot manipulation alone are effective in the treatment of PF. This indeed shows that ultrasound need not be used as an adjunct to foot manipulation for the treatment of PF.

The results of this study show that conservative treatment limits the condition to a period less than the natural history, which is a resolution of symptoms after six months as described by Wolgin et al. (1994).

REFERENCES:

Ambrosius, H and Kondracki, M.P. 1992. Plantar Fasciitis. European Journal of Chiropractic. 40:29-40.

Barrett, S.L. and O'Malley, R. 1999. Plantar Fasciitis and other causes of Heel Pain. American Family Physician. 59(8):2200-2206.

Batt, M.E. and Tanji, J.L. 1995. Management Options for Plantar Fasciitis. The physician and Sports Medicine. 23(6):77-86.

Bergmann,T.F. , Peterson,D.H. and Lawrence,D.J. 1993. Chiropractic Technique: Principles and Procedures. New York:Churchill Livingstone Inc. 756p.

Brantingham, J.W. , Snyder, W.R. , Dishman, R.W. , Hubka, M.J. , Brown, R.A. , Brantingham, C.R. , and markham, D.J. 1992. Plantar fasciitis. Chiropractic Technique. 4(3):75-82.

Brown, C. 1996. A Review of Subcalcaneal Heel Pain and Plantar Fasciitis. Australian Family Physician. 25(6):875-885.

Calliet, R. 1997. Foot and Ankle Pain. 3rd ed. Philadelphia:F.A. Davis Company. 287p. ISBN 0-8036-0216-2.

Chandler, T.J. and Kibler, W.B. 1993. A Biomechanical Approach to the Prevention, Treatment and Rehabilitation of Plantar Fasciitis. Sports Medicine. 15(5)344-352.

Chukuka, E.S. , Rodriguez, O. and Mendosa, S. 1990. The Biomechanical Effect of Low-Intensity Ultrasound on Healing Tendons. Ultrasound in Medicine and Biology. 16(8):801-807.

Crawford, F and Snaith, M. 1996. How Effective is Therapeutic Ultrasound in the Treatment of Heel Pain? Annals of the Rheumatic Diseases. 55:265-267.

Daniel, W.W. 1978. Applied Nonparametric Statistics. 231p. Houghton Mifflin Company. USA. ISBN 0-395-25795-6.

Dorland's Pocket Medical Dictionary. Edition Twenty Five. 1995. W.B. Saunders Company. Philadelphia. 904p. ISBN 0-7216-5738-9

Fischer, A.A. 1987. Pressure Threshold Meter: It's use for Quantification of Tender Spots. Archives of Physical and Rehabilitative Medicine. 67:836-838.

Fyfe, M.C. and Chahl, L.A. 1985. The effect of single or repeated applications of "therapeutic" ultrasound on plasma extravasations during silver nitrate induced inflammation of the rat hindpaw ankle joint in vivo. Ultrasound Med Biol 2:273-283.

Gatterman, M.I. 1990. Chiropractic Management of Spine Related Disorders. Williams and Wilkens. Baltimore. 437p. ISBN 0-683-03438-3

Gudeman, S.D. , Eiscle, S.A. , Heidt, R.S. Jr. , Colosimo, A.J., and Stroupe, A.L. 1998. Iontophoresis of 0.4% Dexamethasone for Plantar Fasciitis. Clinical Journal of Sports Medicine. 8(1):68.

Hammond, S.L. 2000. The Relative Efficacy of Chiropractic Manipulative Therapy compared to Placebo in Patients with Plantar Fasciitis. A dissertation submitted to the Faculty of Health in partial compliance with the requirements for a Master's Degree in Technology: Chiropractic at the Technikon Natal. 86p.

Kahn, J. 1994. Principles and Practice of Electrotherapy. 3rd ed. New York: Churchill Livingstone Inc. 194p.

Kibler, W.B., Goldberg, C. and Chandler, T.J. 1991. Functional Biomechanics of Athletes with Plantar Fasciitis. The American Journal of Sports Medicine. 19(1):66-71.

Kirk, C.R., Lawrence,D.J. and Valvo,N.L. 1991. States Manual of Spinal, Pelvic and Extravertebral Technic. 2nd edition. Baltimore:Waverly Press, Inc. 245p.

Kitchen, S. and Bazin, S. 1996. Clayton's Electrotherapy. 10th ed. London:WB Saunders Co. Ltd. 373p. ISBN 0-7020-1762-0.

Krivickas, L.S. 1997. Anatomical Factors Associated with Overuse Sports Injuries. Sports Medicine. 24(2):132-146.

Lynch, D. , Goforth, W.P. , Martin, J.E. , Odom, R.D. , Preece, C.K. and Kotter, M.W. 1998. Conservative Treatment of Plantar Fasciitis: A prospective study. Journal of the American Podiatric Medical Association. 88(8):375-380.

Magee, D.J. 1997. Orthopaedic Physical Assessment. Third Edition. W.B. Saunders Company. Philadelphia. 805p. ISBN 0-7216-6290-0

Mizel, M.S. , Marymont, J.V. and Trepman, E. 1996. Treatment of Plantar fasciitis with a Night Splint and Shoe Modification Consisting of a Steel Shank and Anterior Rocker Bottom. Foot and Ankle International. 17(12):732-735.

Moore, K.L. 1992. Clinically Oriented Anatomy. Edition Three. Williams and Wilkins. Baltimore. 917p. ISBN 0-683-06133-X

Morris, C.A.V. 2000. The Relative Effectiveness of Anterior Night Splints and a combination of Anterior Night Splints and Manipulation of the Foot and Ankle in the Treatment of Plantar Fasciitis. A dissertation submitted to the Faculty of Health in partial compliance with the requirements for a Master's Degree in Technology: Chiropractic at the Technikon Natal. 118p.

Polkinghorn, B.S. 1995. Posterior Calcaneal Subluxation: An important consideration in Chiropractic treatment of plantar fasciitis (Heel Spur Syndrome). Chiropractic Sports Medicine. 9(2):44-51.

Pollard, H. and So, V. 1999. Management of Plantar Fasciitis: A case report. Sports Chiropractic and Rehabilitation. 13(3):93-97.

Reid, D.C. 1992. Sports Injury Assessment and Rehabilitation. Churchill Livingstone. 1269p. ISBN 0-443-08662-1.

Ryan, J. 1995. Use of Posterior Night Splints in the treatment of Plantar Fasciitis. American Family Physician. 52(3):891-897.

Saag, K.G. , Saltzman, C.L. , Brown, C.K. and Budiman-mak, E. 1996. The Foot Function Index for Measuring Rheumatoid Arthritis Pain: Evaluating Side-to-Side Reliability. Foot and Ankle International. 17(8):506-510.

Schafer, R.C. and Faye, L.J. 1989. Motion Palpation and Chiropractic technic: Principles of Dynamic Chiropractic. California: The motion palpation institute. 426p. ISBN 0-924889-00-4.

Sellman, J.R. 1994. Plantar Fascia Rupture Associated with Corticosteroid Injection. Foot and Ankle International. 15(7):376-381.

Williams, A.R. 1987. Production and Transmission of Therapeutic Ultrasound. Physiotherapy. 73(3):113-116.

Wolgin, M. , Cook, C. , Graham, C. and Mauldin, D. Conservative treatment of plantar heel pain: Long-term follow-up. Foot and Ankle International. 15(3)97-102.

Yochum, T.R. and Rowe, L.J. 1996. Essentials of Skeletal Radiography. Volume Two. Second Edition. Williams and Wilkins. Baltimore. 795-1526. ISBN 0-683-09330-4

Young, C.C. , Rutherford, D.S. and Niedfeldt, M.W. 2001. Treatment of Plantar Fasciitis. American Family Physician. 63(3):467-474.

Young, S.R. and Dyson, M. 1990. Macrophage responsiveness to Therapeutic Ultrasound. Ultrasound Med Biol. 16:809-816.

APPENDIX A

(To be completed in duplicate by patient/subject)

Informed Consent Form

Date.....

Title of research project: The relative effectiveness of pulsed ultrasound as an adjunct to foot manipulation in the treatment of plantar fasciitis.

Name of supervisor: Dr J Shaik (031) 204 2588

Name of research student: Juan du Plessis (031) 204 2512

Name of institution: Durban Institute of Technology

This study involves research on 60 patients testing whether it is more effective to use foot manipulation combined with therapeutic ultrasound than manipulation only in the treatment of plantar fasciitis.

Please circle the appropriate answer

1. Have you read the patient information sheet? YES / NO
2. Have you had opportunity to ask questions regarding this study? YES / NO
3. Have you received satisfactory answers to your questions? YES / NO
4. Have you had an opportunity to discuss this study? YES / NO
5. Have you received enough information about this study? YES / NO
6. Who have you spoken to?_____
7. Do you understand the implications of your involvement in this study? YES / NO
8. Do you understand that you are free to withdraw from this study? YES / NO
   a) at any time?
   b) Without having to give a reason for withdrawing, and
   c) Without affecting your future health care.
9. Do you agree to voluntarily participate in this study? YES / NO

PATIENT/SUBJECT* Name_____ Signature_____
(in block letters)

WITNESS Name_____ Signature_____
(in block letters)

RESEARCH STUDENT Name_____ Signature_____
(in block letters)

If you have answered NO to any of the above questions, please do not hesitate to contact my supervisor who will be able to assist you.

APPENDIX B

Letter of information

Dear Patient

Title of research project: The relative effectiveness of pulsed ultrasound as an adjunct to foot manipulation in the treatment of plantar fasciitis.

Name of supervisor: Dr J Shaik (031) 204 2588

Name of research student: Juan du Plessis (031) 2042512

Name of institution: Durban Institute of Technology

Welcome to this study.
This study involves research on 60 patients testing whether it is more effective to use foot manipulation combined with therapeutic ultrasound than manipulation only in the treatment of plantar fasciitis.

You are required to undergo 6 treatment sessions with a 7^{th} consultation for data collection within a period of 3 weeks. The first appointment will take approximately 2 hours with the following appointments taking approximately half an hour. You will undergo a history taking, physical examination and foot regional examination during your first consultation. This will be followed by either a treatment comprised of either foot manipulation combined with pulsed ultrasound, or manipulation alone, depending on which treatment group you are assigned to. Both these types of treatment have a relatively low risk of any discomfort which may include mild tenderness, joint pain and stiffness over the area which should be mild and short-lived.

You are asked not to change any lifestyle habits or take any medication for the treatment period as this may affect the results of the research. Any lifestyle changes must be made known to the researcher immediately.

All patient information is confidential and the results will be used for research purposes only, although authorities may require to inspect the records. You have the right to be informed of any new findings which are made. Your treatment in this clinical trial is free of charge and your participation is voluntary. You may drop out at any stage without any adverse consequences and, if required, the researcher is entitled to end your participation in this trial at any stage. You have the right to access a knowledgeable person (my supervisor on the above number, or any other authority in this field: phone numbers of such authorities will be available through the researcher or the supervisor) other than the researcher and if required you may make a complaint to the Durban Institute of Technology Research Ethics Committee.

Thank you for participating.

Yours faithfully
Juan du Plessis(Chiropractic intern)

APPENDIX C

Foot Function index Pain Subscale

INSTRUCTIONS: The line next to each question represents the amount of pain you typically had in each situation. On the far left is "No pain" and on the far right is "The worst pain imaginable". Place a mark on the line to indicate how bad your foot pain was in each of the following situations. If you were not involved in one or more of these situations, mark that item N/A.

How severe was your foot pain:

No pain **Worst pain**

1. At it's worst? _____

2. Before you get up in the morning? _____

3. When you walked barefoot? _____

4. When you stood barefoot? _____

5. When you walked wearing shoes? _____

6. When you stood wearing shoes? _____

7. When you walked wearing orthotics? _____

8. When you stood wearing orthotics? _____

9. At the end of the day? _____

Saag,K.G. , Saltzman,C.L. , Brown,C.K. and Budiman-mak, E. 1996. The foot Function Index for Measuring Rheumatoid Arthritis Pain: Evaluating side-to-side Reliability. Foot and Ankle International. 17(8): 506-510.

APPENDIX D

Do You Suffer From

Pain in the soles of your feet

You may have

PLANTAR FASCIITIS

You may qualify for the Chiropractic research being conducted with respect to this condition

For further information about the

FREE TREATMENT

for this condition contact:

Juan

031-2042205 or **031-2042512**

at the Chiropractic Day Clinic At Durban Institute of Technology

APPENDIX E

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:..... Date: .....

File # :..... Age : .....

Sex :..... Occupation:.....

Intern :.....Signature:.....

FOR CLINICIANS USE ONLY:

Initial visit

Clinician:..... Signature :.....

Case History:

Examination:

Previous: Current:

X-Ray Studies:

Previous: Current:

Clinical Path. lab:

Previous: Current:

Case Status:

PTT:.....

Signature:..... **Date:**.....

Conditional:

Reason for Conditional:.....

Signature: ..... **Date:** .....

All Conditions met in Visit No.:.....

To be signed into PTT:.....

Signature:..... **Date:** .....

Signed off:.....

Intern's Case History:

1. **Source of History:**

2. **Chief Complaint : (patient's own words):**

3. **Present Illness:**

	Complaint 1	Complaint 2
▸ Location		
▸ Onset : Initial:		
Recent:		
▸ Cause:		
▸ Duration		
▸ Frequency		
▸ Pain (Character)		
▸ Progression		
▸ Aggravating Factors		
▸ Relieving Factors		
▸ Associated S & S		
▸ Previous Occurrences		
▸ Past Treatment		
▸ **Outcome:**		

4. **Other Complaints:**

5. **Past Medical History:**

- General Health Status
- Childhood Illnesses
- Adult Illnesses

- Psychiatric Illnesses
- Accidents/Injuries
- Surgery
- Hospitalizations

6. Current health status and life-style:

- Allergies
- Immunizations
- Screening Tests incl. xrays

- Environmental Hazards (Home, School, Work)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication
  Analgesics/week:

- Tobacco
- Alcohol
- Social Drugs

7. Immediate Family Medical History:

- Age
- Health
- Cause of Death
- DM
- Heart Disease
- TB
- Stroke
- Kidney Disease
- CA
- Arthritis
- Anaemia
- Headaches
- Thyroid Disease
- Epilepsy
- Mental Illness
- Alcoholism
- Drug Addiction
- Other

8. **Psychosocial history:**

- Home Situation and daily life
- Important experiences
- Religious Beliefs

9. **Review of Systems:**

- General
- Skin
- Head
- Eyes
- Ears
- Nose/Sinuses
- Mouth/Throat
- Neck
- Breasts
- Respiratory
- Cardiac
- Gastro-intestinal
- Urinary
- Genital
- Vascular
- Musculoskeletal
- Neurologic
- Haematologic
- Endocrine
- Psychiatric

APPENDIX F

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

Patient:_____File#: _____Date:_____
Clinician:_____Signature:_____
Intern:_____Signature:_____

1. VITALS

Pulse rate:
Respiratory rate:
Blood pressure: R L
Temperature:
Height:
Weight:

2. GENERAL EXAMINATION

General Impression:
Skin:
Jaundice:
Pallor:
Clubbing:
Cyanosis (Central/Peripheral):
Oedema:
Lymph nodes - Head and neck:
- Axillary:
- Epitrochlear:
- Inguinal:

Urinalysis:

3. CARDIOVASCULAR EXAMINATION

1) Is this patient in **Cardiac Failure** ?
2) Does this patient have signs of **Infective Endocarditis** ?
3) Does this patient have **Rheumatic Heart Disease ?**

Inspection - Scars
- Chest deformity:
- Precordial bulge:
- Neck -JVP:

Palpation: - Apex Beat (character + location):
- Right or left ventricular heave:
- Epigastric Pulsations:
- Palpable P2:
- Palpable A2:

Pulses:
- General Impression:
- Radio-femoral delay:
- Carotid:
- Radial:
- Dorsalis pedis:
- Posterior tibial:
- Popliteal:
- Femoral:

Percussion: - borders of heart

Auscultation: - heart valves (mitral, aortic, tricuspid, pulmonary)
- Murmurs (timing,systolic/diastolic, site, radiation, grade).

4. RESPIRATORY EXAMINATION

1) Is this patient in **Respiratory Distress** ?

Inspection
- Barrel chest:
- Pectus carinatum/cavinatum:
- Left precordial bulge:
- Symmetry of movement:
- Scars:

Palpation
- Tracheal symmetry:
- Tracheal tug:
- Thyroid Gland:
- Symmetry of movement (ant + post)
- Tactile fremitus:

Percussion
- Percussion note:
- Cardiac dullness:
- Liver dullness:

Auscultation
- Normal breath sounds bilat.:
- Adventitious sounds (crackles, wheezes, crepitations)
- Pleural frictional rub:
- Vocal resonance
  - Whispering pectoriloquy:
  - Bronchophony:
  - Egophony:

5. ABDOMINAL EXAMINATION

1) Is this patient in **Liver Failure** ?

Inspection
- Shape:
- Scars:
- Hernias:

Palpation
- Superficial:
- Deep = Organomegally:

- Masses (intra- or extramural)
- Aorta:

Percussion - Rebound tenderness:
- Ascites:
- Masses:

Auscultation - Bowel sounds:
- Arteries (aortic, renal, iliac, femoral, hepatic)

Rectal Examination
- Perianal skin:
- Sphincter tone & S4 Dermatome:
- Obvious masses:
- Prostate:
- Appendix:

6. G.U.T EXAMINATION

External genitalia:
Hernias:
Masses:
Discharges:

7. NEUROLOGICAL EXAMINATION

Gait and Posture
- Abnormalities in gait:
- Walking on heels (L4-L5):
- Walking on toes (S1-S2):
- Rombergs test (Pronator Drift):

Higher Mental Function
- Information and Vocabulary:
- Calculating ability:
- Abstract Thinking:

G.C.S.:
- Eyes:
- Motor:
- Verbal:

Evidence of head trauma:

Evidence of Meningism:
- Neck mobility and Brudzinski's sign:
- Kernigs sign:

Cranial Nerves:

I Any loss of smell/taste:
Nose examination:

II External examination of eye:
- Visual Acuity:
- Visual fields by confrontation:

- Pupillary light reflexes = Direct:
  = Consensual:
- Fundoscopy findings:

III Ocular Muscles:
Eye opening strength:

IV Inferior and Medial movement of eye:

V a. Sensory - Ophthalmic:
- Maxillary:
- Mandibular:

b. Motor - Masseter:
- Jaw lateral movement:

c. Reflexes - Corneal reflex
- Jaw jerk

VI Lateral movement of eyes

VII a. Motor - Raise eyebrows:
- Frown:
- Close eyes against resistance:
- Show teeth:
- Blow out cheeks:

b. Taste - Anterior two-thirds of tongue:

VIII General Hearing:
Rinnes = L: R:
Webers lateralisation:
Vestibular function - Nystagmus:
- Rombergs:
- Wallenbergs:
Otoscope examination:

IX & X Gag reflex:
Uvula deviation:
Speech quality:

XI Shoulder lift:
S.C.M. strength:

XII Inspection of tongue (deviation):

Motor System:

a. Power
- Shoulder = Abduction & Adduction:
  = Flexion & Extension:
- Elbow = Flexion & Extension:
- Wrist = Flexion & Extension:

- Forearm = Supination & Pronation:
- Fingers = Extension (Interphalangeals & M.C.P's):
- Thumb = Opposition:
- Hip = Flexion & Extension:
  = Adduction & Abduction:
- Knee = Flexion & Extension:
- Foot = Dorsiflexion & Plantar flexion:
  = Inversion & Eversion:
  = Toe (Plantarflexion & Dorsiflexion):

b. Tone
- Shoulder:
- Elbow:
- Wrist:
- Lower limb - Int. & Ext. rotation:
- Knee clonus:
- ankle clonus:

c. Reflexes
- Biceps:
- Triceps:
- Supinator:
- Knee:
- Ankle:
- Abdominal:
- Plantar:

Sensory System:

a. Dermatomes
- Light touch:
- Crude touch:
- Pain:
- Temperature:
- Two point discrimination:

b. Joint position sense
- Finger:
- Toe:

c. Vibration:
- Big toe:
- Tibial tuberosity:
- ASIS:
- Interphalangeal Joint:
- Sternum:

Cerebellar function:

Obvious signs of cerebellar dysfunction:
= Intention Tremor:
= Nystagmus:
= Truncal Ataxia:

Finger-nose test (Dysmetria):
Rapid alternating movements (Dysdiadochokinesia):
Heel-shin test:
Heel-toe gait:
Reflexes:
Signs of Parkinsons:

8. **SPINAL EXAMINATION:**(See Regional examination)

Obvious Abnormalities:
Spinous Percussion:
R.O.M:
Other:

9. **BREAST EXAMINATION:**

Summon female chaperon.

Inspection
- Hands rested in lap:
- Hands pressed on hips:
- Arms above head:
- Leaning forward:

Palpation
- masses:
- tenderness:
- axillary tail:
- nipple:
- regional lymph nodes:

APPENDIX G

Foot and ankle regional examination

Patient:_____ File no:_____ Date:_____
Intern / Resident_____ Signature:_____
Clinician:_____ Signature:_____

Observation

Gait analysis (antalgic limp,toe off, arch, foot alignment, tibial alignment).

_____

_____

Swelling_____
Heloma dura / molle_____
Skin_____
Nails_____
Shoes_____
Contours (achilles tendon, bony prominences)_____

Active movements

weight bearing:	*Non weight bearing:*
Plantar flexion_____	50°_____
Dorsiflexion_____	20°_____
Supination_____	
Pronation_____	
Toe dorsiflexion_____	40°(mtp)_____
Toe plantar flexion_____	40° (mtp)_____
	Big toe dorsiflexion (mtp) (65-70°)_____
	Big toe plantar flexion (mtp) 45°_____
	Toe abduction + adduction_____
	5° first ray dorsiflexion_____
	5° first ray plantar flexion_____

Resisted Isometric movements:

Knee flexion_____
Plantar flexion_____
Dorsiflexion_____
Supination (inversion)_____
Pronation (eversion)_____
Toe extension (dorsiflexion)_____
Toe flexion (plantar flexion)_____

Passive movement motion palpation
(Passive ROM quality, ROM overpressure, joint play)

Ankle joint: *Plantarflexion*_____ *Dorsiflexion*_____
Talocrural: *Long axis distraction*_____
Subtalar joint: *Varus*_____ *Valgus*_____
First ray: *Dorsiflexion*_____ *Plantarflexion*_____
Circumduction of forefoot on fixed rearfoot:_____
Midtarsal: *A-P glide*_____ *P-A glide*_____ *rotation*_____
Tarso metatarsal joints: *A-P*_____

Intermetatarsal glide:_____
Metatarsophalangeal dorsiflexion (with associated plantar flexion of each toe)_____
_____
Interphalangeal joints: *long axis distraction*_____*A-P glide*_____
*lat and med glide*_____*rotation*_____

Neurological: Dermatomes_____

Reflexes_____

Special tests

Anterior drawer test_____
Talar tilt_____
Thompson test_____
Homan sign_____
Tinel's sign_____
Subtalar neutral position_____
Balance/proprioception_____
Test for rigid/flexible flatfoot_____
Kleiger test (med. deltoid)_____

Alignment

Heel to ground_____
Feiss line_____
Tibial torsion_____
Heel to leg (subtalar neutral)_____
Forefoot to heel (subtalar & Midtarsal neutral)_____
First ray alignment_____
Digital deformities_____
Digital deformity flexible_____

Palpation

Anteriorly
Medial maleoli_____
Med tarsal bones, tibial (post) artery_____
Lat.malleolous, calcaneus, sinus tarsi, and cuboid bones_____
Inferior tib/fib joint, tibia, mm of leg_____
Anterior tibia, neck of talus, dorsalis pedis artery_____

Posteriorly
Calcaneus_____
Achilles tendon_____
Musculotendinous junction_____

Plantarily
Plantar muscles and fascia_____
Sesamoids_____