The relative effectiveness of anterior night splints and a combination of anterior night splints and manipulation of the foot and ankle joints in the treatment of plantarfasciitis

BY

CHERYL ANNE VERONICA MORRIS

Dissertation submitted to the Faculty of Health in partial compliance with the requirements for the Master's Degree in Technology: Chiropractic at Technikon Natal.

I, Cheryl Morris, do hereby declare that this dissertation represents my own work in both conception and execution.

Cheryl Morris — Date: 1-6-2000

APPROVED FOR FINAL SUBMISSION BY:

SUPERVISOR:
Dr H. Kretzman
M. Dip Chiro (S.A.) — Date: 1-06-2000

DEDICATION

I would like to dedicate this work to

my parents Marion and Cliff,

to my husband Colin and

my daughter Dominique.

ACKNOWLEDGEMENTS

I would like to thank the following people for their assistance in the completion of this dissertation:

Dr James Brantingham, my mentor and initial supervisor, for his guidance, inspiration and expertise, without which I couldn't have reached the end of this project.

Dr H. Kretzman, for taking over supervisorship of this project at such a late stage

The staff at the Technikon Chiropractic Day Clinic.

Mr Chris Berresford from Mark Hancock Orthotists, for all your assistance in making sure each of my patients was timeously and well fitted with a night splint and for all your friendly encouragement.

Dr A.G.Till, and the Chiropractic Department at Technikon Natal.

Finally, to all those patients who participated in the study without whom the project would have been impossible.

Abstract

The purpose of this study was to test the effectiveness of anterior night splints alone compared to the combination of foot and ankle manipulation with anterior night splints, in terms of subjective and objective clinical findings, in the treatment of plantarfasciitis.

Plantarfasciitis is considered difficult to treat and is often resistant to most forms of treatment. The disorder presents a difficult problem for the patient, as well as their physician with regards to finding a suitable and successful form of treatment. Obesity and athletic over-training appear to be common denominators in the condition and more women seem to be afflicted than men are. The person's pain is most severe first thing in the morning, settling after a few steps, but returning to a severe level as the day wears on. This pain is often severe enough to be debilitating.

Via a random selection method 30 subjects were equally divided into Group 1 and Group 2. Group 1 received a combination of foot manipulation and the anterior night splint, while Group 2 used the night splint each night. A combination of objective and subjective tests were used in order to establish the correct diagnosis, the extent of biomechanical joint dysfunction, the degree of pain severity, disability and limitation to activities.

The treatment period was six weeks in total. Both groups were instructed to wear the night splint each night upon retiring to bed, and to remove it upon waking each morning. The first two weeks consisted of adjustments of the foot and ankle joint complex for group 1 and regular visits for group 2 in which several parameters were monitored, after which there was a one-month-follow-up period which culminated with a final visit for each group. Subjects in group 1 were adjusted at each visit while those in group 2 were examined and monitored at each visit. Readings were accurately recorded in the patients' files at each visit over the two week period and again after six weeks at the one month follow-up visit.

It was noted that in this study, 60% of the patients had heel spurs, there was a predominance of plantarfasciitis in the left heel, 17 of the 30 patients were overweight, 66,6% were female, 50% had a bilateral complaint, and the average age was 50.3 years.

The results indicated statistically significant improvement in both groups after the 6-week study period, although the group who received the adjustments as well as the night splint showed statistically improvement than the group who used the night splint only.

Statistical analysis revealed that the number of fixations decreased with statistical significance at each reading. This supports the chiropractic theory that adjusting fixated joint segments contributes to biomechanical normality and function of the segment.

This study indicate that although anterior night splints are therapeutic in the treatment of plantarfasciitis, chiropractic manipulation of the foot and ankle joint complex used

in conjunction with the splints, appears to contribute markedly to the improvement in perception of pain, functional gain, and to overall recovery of plantarfasciitis.

TABLE OF CONTENTS:

LIST OF TABLES:

Step 2: The Confidence Interval for Groups 1 & 2

LIST OF FIGURES

DEFINITION OF TERMS

ADJUSTMENT

A skillfully and speedily delivered articular manipulation, that is thrust-like in nature. The adjustment is administered by the hands of the Chiropractor in a particular direction with enough speed and force in order to create movement of a mis-aligned or subluxated vertebra, or extra-vertebral joint. (Scolfield 1968: 88)

ALGOMETER

A mechanical device capable of measuring the amount of pressure tolerated by a person on a painful spot. (Fisher 1986)

BIOMECHANICS

Application of mechanical laws to living structures. The study and knowledge of biological function from an application of mechanical principle. (Gatterman 1990:406)

CONTRAINDICATION

Any condition, especially any condition of disease, that renders one particular line of treatment improper or undesirable. (Gatterman 1990:407).

GONIOMETER

Instrument for measuring angles. (Gatterman 1990:410)

JOINT DYSFUNCTION

Joint mechanics showing area disturbances of function. (Gatterman 1990:409)

MANIPULATION

Passive manoeuvre in which specifically directed manual forces are applied to the vertebral and extravertabral articulations of the body, with the object of restoring mobility to restricted areas. (Gatterman 1990:410)

OBJECTIVE CLINICAL FINDINGS

For the purpose of this study this refers to the data obtained from algometer readings as a measure of pain threshold, and goniometer readings taken of degrees dorsiflexion at the ankle mortice joint.

SUBJECTIVE CLINICAL FINDINGS

For the purpose of this study this refers to the data obtained from the Numerical Rating Scale 101, Percentage Improvement and the Foot Function Index.

LIST OF APPENIDICES

CHAPTER 1: INTRODUCTION:

The purpose of this study was to compare the effectiveness of anterior night splints alone compared to the combination of foot and ankle manipulation with anterior night splints in terms of subjective and objective clinical findings, in the treatment of plantarfasciitis. It was the hypothesis of the author that there would be a statistically significant difference displayed by the group that was treated with the combination of the night splints with foot and ankle manipulation, when compared to the group that only received night splints in the treatment of plantarfasciits.

Plantarfasciitis has traditionally been considered a difficult condition to treat and has often shown itself to be resistant to many forms of treatment including stretching, strengthening, correction of training errors, administration of ultrasound, orthotics, surgical fascial release and corticosteroid injections (Ryan, 1995; Ambrosius and Kondraki, 1992). The disorder thus presents a difficult problem for the patient as well as their physician in regards to finding a suitable and successful form of treatment. When starting a therapy the conservative physician aims to choose one that is quick, cheap and least invasive as possible. Chiropractic adjusting techniques of the foot and ankle joint complex in combination with the anterior night splint may offer such and outcome.

The plantar fascia is a dense fibrous band of connective tissue that originates from the medial calcaneal tubercle (Viljoen, 1998). From its narrow origin it divides into five slips and fans out and inserts into the ball of the foot (Viljoen,1998; Ryan, 1995). The plantar fascia functions like a bowstring and supports the longitudinal arch of the foot during mid-stance, and reconstructing the arch by recoil when standing on the toes, by means of the "Windlass Effect" (Ryan, 1995; Brantingham, 1998).

Plantarfasciitis is usually considered an overuse injury, also known as "the painful heel syndrome", and is a frequent cause of heel pain in athletes as well as non sports persons (Ambrosius and Kondraki 1992; Viljoen 1998; Ryan 1995). In addition, plantarfasciitis, along with Achilles tendinitis, is the most frequent cause of heel pain in runners (Ryan, 1995).

Plantarfasciitis is an overuse injury resulting in microtears of the fascia at its origin. In the non-athlete the history will frequently reveal a sudden increase in the amount of standing, stair climbing or walking in the job environment. Excess weight has also been cited as a significant eitiological factor (Ryan, 1995).

In the athlete, the following have been isolated as precipitating factors for plantarfasciitis: a rapid increase in mileage, frequency and intensity of workouts and a change in terrain or running surface (Ryan, 1995; Brantingham, 1998). Plantarfasciitis, particularly bilateral, has been linked to sero-negative arthritides like ankylosing spondylitis and Reiter's syndrome (Ambrosius and Kondraki 1992).

Biomechanical factors that have been linked to plantarfasciitis are as follows:

- Pes cavus and pes planus malalignments (Brantingham 1992, Ambrosius and Kondraki 1992).
- An artificial biomechanical factor to be considered is the type of, and the state of, the patients shoes (Ryan, 1995).

Another reason that may impede healing in plantarfasciitis, is because the fascia is one of the few structures in the body that does not have a direct blood supply and therefore has to rely on absorption of nutrients from the tissues surrounding it (Moore:p500, 1994). It is like other ligaments in this regard and heals slowly as a result of this. At

night the plantar fascia contracts as the foot is held in the relaxed position during sleep and some healing begins to occur. Upon rising from bed in the morning, or during the night, the patient experiences severe pain because, not only is the tightened soft tissue stretched again to its maximum, but the person's entire body weight is placed on the fascia. Any healing that had begun in the area during the non weight-bearing state of sleep or rest, is reversed (Brantingham, 1998). This repetitive cycle of reinjury is one of the major contributing factors to lack of healing and development of chronicity. This cycle needs to be overcome in order to allow healing of the plantar fascia (Brantingham, 1998, Ryan, 1995).

Most authors report that plantarfasciitis is of insidious onset (Ambrosius and Kondraki, 1992). It is characterized by sharp pain localized to the anterior, medial and lateral borders of the calcaneus (Cailliet:p23-26, 1983). The pain may radiate into the medial arch (Polkinghorn, 1995; Ambrosius and Kondraki, 1992). Pain is present after prolonged rest and decreases with walking, but tends to worsen later in the day (Gorden, 1984). Athletes report that they can "run through the pain" only to find that it recurs with increased intensity after cessation of activity (Leach *et al.* 1986). Pain is lessened during sleep and is unlikely to wake the patient (Ryan, 1995). According to Leach *et al.* the pain is exaggerated by athletic activity. The pain is often severe enough to inhibit activities and cause gait and stride alterations (Ambrosius and Kondraki, 1992). The patient will sometimes hold the foot in a supinated position through the gait cycle in an attempt to minimize symptoms (Leach *et al*, 1986). In this study the author found that patients preferred to walk on the ball of the foot minimizing pressure on the painful heel.

On examination the patient may walk with a low gear toe off (that is toe off from the second through fifth metatarsophalangeal joints) to avoid the painful heel; which may also produce secondary foot pain due to compensation (Brantingham, 1998).

Examination of the plantar aspect of the foot reveals tenderness to firm, deep palpation over the medial calcaneal tubercle (Leach *et al.*1986, Ryan, 1995). Many authors agree that, in addition to the above palpation, passive dorsiflexion of the big toe and or toes greatly increases the pain, and is strongly indicative of plantarfasciitis (Ambrosius and Kondraki, 1992). According to Brantingham (1998) the "plantarfasciitis test" is currently accepted as dorsiflexion of the big toe, foot and ankle together with palpation of the anterior tubercle of the calcaneus and arch. A positive test is pain under the examiner's fingers.

A typical rehabilitation program followed by many therapists includes:

- Initial course of non-steroidal-anti-inflamatories to help control the initial inflammation (Ryan, 1995).
- Heel pads or heel cups (Brantingham, 1998).
- Taping the foot in a "Low-dye" style to prevent excessive pronation (Ryan, 1995, Brantingham, 1998).
- Correction of forefoot and hindfoot malalignment or abnormalities with orthotics (Ryan, 1995).
- Stretching followed by strengthening exercises for the Achilles and gastrocnemeus / soleus muscles as well as prescription of resisted isometric exercises for the arch of the foot are performed (Ryan, 1995).
- Balance and strength training to improve proprioception in the ankle joint.
- Graduated return to running program as soon as possible (Ryan, 1995).

Other treatments are corticosteroid injections or surgery. The spontaneous rupture of the plantar fascia has been reported as a sequel to corticosteroid injections by Leach *et al.* (1978). A possible mechanism to the rupture is that the injection provided relief

from symptoms allowing the athlete to train without pain before sufficient healing had taken place (Ambrosius and Kondraki, 1992).

Although there are no controlled trials, surgery is reported to have a very high success rate, but must be followed by a long recovery period and aggressive rehabilitation (Snider *et al.* 1983). Campbell & Inman (1974) believe the reason for the surgical procedures showing such a high success rate is due to the post-operative recovery techniques of casting and non-weightbearing. Thus the same results might be achieved with the use of an anterior or posterior night splint.

But before resorting to surgical correction or corticosteroid injections because of their obvious cost, trauma and invasive nature, the clinician should consider using splinting. The splints are designed to hold the foot in maximum dorsiflexion which the patient wears whilst asleep. Splinting maintains the length of the plantar fascia as the patient sleeps and prevents stiffening and contracture of the fascia that normally occurs during the night, helps alleviate morning pain, and prevents reinjury (Ryan, 1995). This has been suggested by several authors to break the cycle of contracture and reinjury in plantarfasciitis (Brantingham, 1998). Ryan(1995) expresses a view that in light of the low cost and low potential for complications, splinting seems to be a reasonable alternative to invasive procedures such as surgery or corticosteroid injections.

A placebo-controlled study performed here in South Africa by Viljoen (1998) appears to show impressive results with the use of an anterior night splint.

Chiropractors believe essentially that fixations/subluxations in the foot may decrease shock absorption, which may predispose the foot to more injury to the fascia, which increases stiffness or fixation in the foot, thus creating a viscous cycle. This is the

rationale behind adjusting the fixations in the foot in an attempt to correct the biomechanics and break the repetitive cycle (Brantingham, 1998).

Chiropractors have adjusted the foot for plantarfasciitis although most evidence for success in treating this condition chiropractically is anecdotal in nature (Brantingham, 1998). Polkinghorn published case reports in the Journal of Chiropractic Sports Medicine in 1995 in which he had treated 3 women who had heel pain from two months to four years duration. Their symptoms had not responded to any orthodox treatments. Polkinghorn delivered short lever mechanical adjustments to the foot, ankle and calcaneus. All patients had posterior subluxation of the calcaneus. All three patients tolerated the treatment well with complete resolution of symptoms, and had no recurrence of symptoms in follow up visits (Polkinghorn, 1995).

In a retrospective review of 29 cases Brantingham *et al.*(1992) utilized foot and ankle adjusting, taping or orthotics, ultrasound, ice or diathermy and claimed that 22 patients had a greater than 75% reduction in pain within eight treatments.

The disadvantage of the conservative treatment protocol that does not include the use of night splints is that it takes a long time and does not always deliver good results. Ambrosius and Kondraki (1992) state that a controlled study has not yet been published by a Chiropractor for the treatment of plantarfasciitis. Bearing in mind the belief by some that fixations may cause, predispose and delay healing in plantarfasciitis (Ambrosius and Kondraki 1992, Brantingham 1992 *et al.* & 1998), a study is needed to determine if manipulative treatment and night splints, compared to night splints alone, produces an earlier, higher level of relief for patients with plantarfasciitis.

Many of the abovementioned forms of treatment are costly, time consuming, may cause considerable pain and side effects to the patient, and cannot confidently claim a high success rate in treatment of this condition (Ambrosius and Kondraki 1992). Determining treatment modalities that are non-invasive, conservative in nature, that treat plantarfasciitis effectively by returning the tissues and joints to their normal state, and that are affordable and efficient are the primary motivation for this study. From reviewing the related literature, and in verbal consultation with Chiropractors and other professionals who have adjusted joints in the foot and ankle complex, and who have made use of the anterior night splints in the treatment of plantarfasciitis, it is the authors opinion that combining these treatment modalities may provide a better solution to the treatment problem of plantarfasciitis. The adjustments will also aid the restoration of normal joint and biomechanical function to the foot and ankle joint complex that result from the compensation made to the foot by the patient due to an antalgic gait and stance (Brantingham, 1998, Cailliet, 1993). The night splint breaks the repetitive cycle that is set in motion and allows healing of the plantar fascia to begin and continue.

Potential benefits of a success being shown by either treatment will provide effective treatment/s available for this previously stubborn condition. It will have financial implications as patients won't be subjected to the therapist jumping from one form of treatment to another in the hopes that something will work, whilst wasting the patient's time and money after which, their heel pain remains unchanged.

CHAPTER 2: REVIEW OF THE RELATED LITERATURE.

2.1. DEFINITION OF PLANTARFASCIITIS

Plantarfasciitis is an overuse injury, also known as "the painful heel syndrome", and is a frequent cause of heel pain in athletes as well as non-sports persons (Ambrosius and Kondraki 1992, Viljoen, 1998, Ryan, 1995). It is particularly common in people who take part in track athletic and aerobic type events (Leach *et al.* 1986). Plantarfasciitis, along with Achilles tendinitis, is the most frequent cause of heel pain in runners (Ryan, 1995).

2.2. ANATOMY

2.2.1 ANATOMY OF THE PLANTAR FASCIA, FOOT AND ANKLE.

The plantar fascia is a dense fibrous band of connective tissue that originates from the medial calcaneal tubercle (Viljoen, 1998). It has a strong, thick central part and weaker and thinner medial and lateral parts (Moore, 1984). From its narrow origin it divides into five slips and fans out, becoming thinner in the forefoot and inserting into the ball of the foot (Viljoen, 1998, Ryan, 1995). The superficial layer merges with and connects to the subcutaneous septa, providing additional support. The deep layer interconnects to the sagital septa and attaches to the proximal phalanges, thus helping to maintain the flexor tendons under the metatarsal heads (Viljoen, 1998). These bands split to enclose the digital tendons and are attached to the margins of the fibrous digital sheaths and to the sesamoids of the great toe (Moore, 1984). From the margins of the central part of the plantar fascia, vertical septa extend deeply to form the three compartments of the sole of the foot: the medial, lateral and central compartments (Moore, 1984).

Immediately deep to the plantar fascia is the flexor brevis muscle and it is in this

muscle, rather than in the plantar fascia, that a spur develops and is visible on a radiograph (Brown, 1996). The plantar fascia functions like a bowstring and supports the longitudinal arch of the foot during mid-stance and when standing on the toes by means of the "Windlass Effect" (Ryan, 1995; Brantingham, 1998). It is involved in the normal biomechanics of the foot and ankle joint complex as it is an impact absorbing structure that absorbs the shock from heel strike, mid-stance and toe off. The plantar fascia plays a pivotal role in stabilizing the medial longitudinal arch because as the toes hyperextend the plantar fascia tightens, and thus allows supination necessary for toe off. This action was thought, originally, to be achieved by muscle action. From a biomechanical point of view, any factor that causes tension on the plantar fascia could cause the micro tearing of the plantarfascial origin to occur (Brown, 1996).

2.2.2 INNERVATION OF THE PLANTAR FASCIA AND SURROUNDING STRUCTURES

The medial calcaneal nerve innervates the plantar fascia, which is a branch of the posterior tibial nerve (Ryan, 1995, Moore, 1984). The first branch of the lateral plantar nerve is a mixed nerve and passes deep to the medial calcaneal tubercle and partially innervates the perisotium and the calcaneus (Brown, 1996).

2.3. DISCUSSION OF THE SYNDROME AND ITS PRESENTING SYMPTOMS.

Plantarfasciitis presents in two rather distinct groups. The first group comprises of patients between 40 and 60 years of age and tends to be comprised mostly of women. Obesity is often present in this group. The second group is due to athletic over use and injuries are seen particularly in runners. (Brown, 1996.)

Plantarfasciitis is usually an overuse injury, resulting in microtears of the fascia at its origin. When it presents bilaterally, a sero-negative arthropathy should be suspected (Ambrosius and Kondraki, 1992). In a retrospective study performed by Wolgin *et al.* (1994) the presence of bilateral symptoms was significantly more common in patients who did poorly, and they fell into a category of patients who were more likely to have continued pain following treatment. When no systemic illness is suspected or diagnosed in patients with a bilateral presentation of the condition, they tended to be overweight. Of the 100 patients treated in this study, 55 were overweight, and of the 15 patients whose results were fair, 12 were overweight and 9 of them had bilateral symptoms.

Most authors report that plantarfasciitis is of insidious onset (Ambrosius and Kondraki, 1992, Brown, 1996). If the onset of the pain is sudden in the active person an acute rupture of the fascia must be suspected (Brown, 1996). If plantarfasciitis occurs in the non athlete patient he/she might recall a single precipitating period of prolonged standing or walking. Occupations that involve these activities might be of significance (Brown, 1996; Ryan, 1995).

The pain is most severe first thing in the morning, settling after the first few steps, but returning to a severe level gradually during the day (Tanner and Harvey, 1988; Brown, 1996). It is present after prolonged rest and decreases with normal walking, but tends to worsen during the day (Gorden, 1984). It has been described as burning or aching in nature (Tanner and Harvey, 1988; Brown, 1996). Athletes report that they can "run through the pain" only to find that it recurs with increased intensity after cessation of activity (Leach *et al.* 1986). Pain is lessened during sleep and is unlikely to wake the patient (Ryan, 1995). According to Leach

et al. the pain is exaggerated by athletic activity. It is often severe enough to inhibit activities and cause gait, and stride alterations (Ambrosius and Kondraki, 1992). The patient will sometimes hold the foot in a supinated position through the gait cycle in an attempt to minimize symptoms by decreasing pressure on the painful heel (Leach *et al.* 1986).

Plantarfasciitis is characterized by sharp nonradiating pain localized to the anterior, medial and lateral borders of the calcaneus, i.e.: the attachment of the plantar fascia (Cailliet, 1983). The pain can radiate into the medial arch and up towards the metatarsals (Polkinghorn, 1995; Ambrosius and Kondraki, 1992). It has also been known to radiate into the subtalar joint, ankle joint or up the heel into the region of the achilles tendon (Brantingham *et al.* 1992). The pain is attributed to degenerative and inflammatory changes in the plantar fascia with an associated periostitis. This finding has been histologically confirmed (Brown, 1996). The inflammation spreads to the adjacent nerves like the medial plantar nerve or the lateral plantar nerve which passes deep to the medial calcaneal tubercle and partially innervates the periostium and the calcaneus (Brown, 1996; Moore, 1985).

Heel spurs are often found on lateral radiographic views of the heel. They tend to project anteriorly from the calcaneus into the plantar aspect of the foot (Tanner and Harvey, 1988). The spurs originate from the medial calcaneal tubercle but grow into the belly of the flexor digitorum muscle rather than into the plantar fascia itself (Brown, 1996). They are considered to be stress related, caused by periosteal detachment which occurs as a result of repetitive microtrauma. This leads to hemorrhaging and chronic inflammation which inturn causes osteoblastic activity (Ambrosius and Kondraki, 1992). It is a misconception that the pain of

plantarfasciitis is caused by the spur. It is thought to be the result, not the cause, of the chronic fascial inflammation (Tanner and Harvey, 1988; Ambrosius and Kondraki, 1992). Brown (1996) believes they are probably only painful if projected plantarward or fractured. Many authors agree that there is a relationship between plantarfasciitis and heel spurs, although they are not the cause of the condition (Ambrosius and Kondraki, 1992)

Ambrosius and Kondraki (1992) cite cases where between 70 and 75% of patients with plantarfasciitis presented with heel spurs as compared to figures around 15% of assymptomatic people presenting with heel spurs.

2.4. AETIOLOGICAL FACTORS.

In the non-athlete the history will often reveal a sudden increase in the amount of standing, stair climbing or walking in the job or daily environment (Ryan, 1995).

In the athlete the microtears in the plantar fascia are often the result of a change made suddenly to the running program (Ryan, 1995). In the athlete the following have been isolated as precipitating factors: change in shoes or using worn shoes, rapid increase in mileage, increased frequency and intensity of workouts and a change in terrain or running surface (Ryan, 1995; Brantingham, 1998).

Biomechanical factors that have been linked to plantarfasciitis are as follows:

- Pes cavus and pes planus malalignments have been linked to an increased risk of injury to the plantar fascia due to decreased shock absorption and hypomobile joint dysfunction which shifts the shock absorption to the soft tissues (Brantingham *et al.*1992; Ambrosius and Kondraki 1992; Brown 1996).

  Ryan (1995) claims that pes planus with excessive pronation is more likely

to be found in examination of the patient with heel pain than a cavus deformity. Excessive pronation causes a decreased stability in the hindfoot. This places increased strain on the origin of the plantar fascia during stance and push off phases of running (Ryan 1995).

- Pes planus with excessive pronation can aggravate the entrapment of the above mentioned nerves and contribute to the heel pain in overweight patients who stand for long periods (Ryan, 1995). Pes planus may also cause the longitudinal arch to be excessively depressed during mid stance, which causes inefficient or strained supination at toe off. With reference to the aforementioned biomechanical function of the plantar fascia during supination, it is evident how tensile stress can be placed on it, which has been mentioned as a causative factor in the development of plantarfasciitis (Brown, 1996).

- Stiff subtalar joint (Brantingham *et al.* 1992; Brown 1996).

- Tight Achilles tendon can contribute by limiting ankle dorsiflexion which accentuates pronation and thereby stretches the plantar fascia excessively (Ryan, 1995, Brown, 1996, Brantingham *et al.* 1992).

- Hypomobile, dysfuntional foot and ankle joints may play a significant role in the pain and pathology of this condition. Hypomobile joints do not adequately absorb weight bearing stress and can shift this stress to the muscles and fascia on the plantar surface of the foot (Brantingham *et al.* 1992).

- An artificial biomechanical factor to be considered is the type of and the state of the patients shoes. Loose heel counters, poor arch support, a tight toe box, excessively high heels, or a worn out pair of shoes have all been linked to heel pain If the patient is a runner his running shoes should be evaluated. Excessive wear to the medial portion of the heel indicates excessive pronation (Ryan, 1995).

2.5. FINDINGS ON EXAMINATION:

On examination the patient may walk with a low gear toe off from the second through fifth metatarsophalangeal joints in order to avoid the painful heel and this may produce secondary pain due to compensation (Brantingham, 1998). Examination of the plantar aspect of the foot reveals tenderness to firm, deep palpation over the medial calcaneal tubercle. This tenderness might be accompanied by a nodule, or slight swelling over the area (Leach *et al.* 1986, Ryan, 1995). Many authors agree that passive dorsiflexion of the toes greatly increases the pain, and this sign is strongly indicative of plantarfasciitis (Ambrosius and Kondraki, 1992). According to Brantingham (1998) the "plantarfasciitis test" is currently accepted as dorsiflexion of the big toe, foot and ankle together with palpation of the anterior tubercle of the calcaneus and arch. A positive test is pain under the examiner's fingers.

2.6. DIFFERENTIAL DIAGNOSES:

2.6.1 TARSAL TUNNEL SYNDROME:

This involves entrapment of the Posterior tibial nerve or one of its three branches, under the lancinate ligament, in the tarsal tunnel posterior to the medial maleolus. This pain is characterized as a burning dysthesia in the distribution of the posterior tibial nerve that is exacerbated by exercise. Pain is worse at night time and better on rising. A Tinel's test is positive. It can be positively diagnosed with electromyography or nerve conduction diagnostic studies (Batt & Tanji, 1995; Ryan, 1995; Tanner and Harvey, 1988; Brantingham *et al.* 1992).

2.6.2. PARTIAL OR COMPLETE RUPTURE OF THE PLANTAR FASCIA:

Complete rupture of the plantar fascia is unusual. A complete rupture may be more likely to occur, following cortisone injections into the heel. The athlete may hear or feel a pop on the plantar aspect of the heel, often during running (Ambrosius & Kondraki, 1992; Tanner and Harvey, 1988; Ryan, 1995; Tanji & Batt, 1995). According to Tanner ruptured plantar fascia respond favorably to conservative treatment with only a small percentage of them requiring surgery (Tanner and Harvey, 1988). Leach confirms the finding that rupture of the plantar fascia, follows cortico-steriod injection. In a review of six athletes presenting with rupture of the plantar fascia, five out of the six had had previous injections. Five of them responded favorably to conservative treatment with 1 requiring surgery (Leach, 1978).

2.6.3. STRESS FRACTURE OF THE CALCANEUS:

Athletes who maintain a high weekly mileage or who suddenly increase their distance are susceptible to stress fractures of the calcaneus. Ryan states that there is usually a history of acute trauma associated with this type of bony injury (Ryan, 1995). The pain of a stress fracture increases with exercise or activity, unlike the pain of plantarfasciitis, which characteristically diminishes with activity (Batt & Tanji, 1995).

2.6.4. SYSTEMIC DISORDERS:

Plantarfasciitis, especially when presenting bilaterally, may be the presenting symptom of, or may co-exist with, a systemic disorder such as Rheumatoid Arthritis, Gout, or one of the sero-negative sponylo-arthropathies like Reiter's Syndrome,

Systemic Lupus Erythrematosis, Psoriatic Arthritis or Ankylosing Spondylitits. Nutritional osteomalacia is another systemic disorder that may present with plantarfasciitis (Batt & Tanji, 1995; Tanner and Harvey, 1988; Ryan, 1995; Ambrosius and Kondraki, 1992) Brown suggests that a systemic disorder, like one of the aforementioned, should be considered in young men presenting with bilateral plantarfasciitis (Brown, 1996). Blood tests for Erythrocyte Sedimentation Rate and Rheumatoid Factor should be performed to confirm these conditions (Tanner and Harvey, 1988; Ambrosius and Kondraki, 1992).

2.6.5. CALCANEAL APOPHOSITIS:

When plantarfasciitis develops in adolescents, this should be considered unusual. When heel pain is present in this section of the population then either calcaneal apophosytis or Sever's Disease should be considered as a diagnosis. Calcaneal Apophosytis is an overuse injury to the open epiphysis of the posterior calcaneus. The pain in this condition, unlike that of plantarfasciitis, progresses with activity and is much improved after rest (Ryan, 1995). According to Brantingham, (1997), it should be noted that some authors believe that plantar fasciitis, not apophysitis, is the more likely diagnosis in adolescents.

2.6.6. NERVE ENTRAPMENT:

Nerve entrapment of the medial calcaneal nerve by the adductor digiti minimi muscle may occur (Brown, 1996; Ambrosius and Kondraki, 1992). This entrapment can be differentiated from plantarfasciitis by their lack of tenderness over the medial calcaneal tubercle and a positive Tinel's test (Brantingham *et al.* 1992)

2.6.7. FAT PAD SYNDROME:

Calcaneal fat pad spread occurs from ages forty - sixty and up. The main function of the fat pad is that of shock absorption. It absorbs 20 - 25% of the body weight at heel strike. Its ability to function as such an efficient shock absorber is as a result of its unique design. U-shaped scepti/fat globules act as a hydraulic shock absorber. It has been histologically demonstrated that there are both free nerve endings and pacchionian corpuscles located in the fat pad itself. Any condition impairing, or damaging, the load carrying capacity of the septi in the fat pad can cause heel pain. Instead of at the anterior tubercle the pain is often localized to the central and posterior weight bearing aspect of the heel. A fat pad syndrome mimics the presentation of plantarfasciitis and can only be distinguished by examination of the fat pad where an atrophic, soft heel pad with poor rebound will be found (Brown, 1996).

Other differential diagnoses to be considered are:

- Calcaneal bursitis (Ambrosius and Kondraki, 1992, Brantingham *et al.* 1992).
- Degenerative changes like Osteo-arthritis (Brown, 1996).
- Tumors (Brown, 1996)
- Bone cyst, referred pain, Morton's neuroma - rare (Ambrosius and Kondraki, 1992)

2.7. TREATMENT CHOICES FOR PANTARFASCIITIS SUFFERERS:

A significant percentage of plantarfasciitis is traditionally resistant to many types of intervention including stretching, strengthening, correction of training errors, administration of ultrasound, orthotics, surgical fascial release and corticosteroid injections (Ryan, 1995, Ambrosius and Kondraki, 1992).

2.7.1 A TYPICAL REHABILITAION PROGRAM FOR PLANTARFASCIITIS:

In uncomplicated cases of plantarfasciitis, many therapists follow the following rehabilitation program:

Batt and Tanji (1995) suggest that treatment should address three areas namely the traction enthesitis and accompanying inflammation, the aetiological factors and thirdly the rehabilitation needs.

- Advice regarding weight loss can be given if appropriate (Brown, 1996).
- Treatment should begin once the initial inflammation and pain have begun to subside, which may take a few days to a few weeks (Batt and Tanji, 1995).
- A course of non-steroidal-anti-inflamatories to help control the initial inflammation (Ryan, 1995, Batt and Tanji, 1995).
- Relative rest from the aggravating factors - i.e.: continuing activities at reduced levels of intensity or duration, like prolonged walking, running or jogging (Batt and Tanji, 1995). Tanner (1988) suggests that runners decrease their mileage by 25% - 75% and avoid sprinting and running up hills. She also suggests that the patient be encouraged to participate in alternative forms of exercise to maintain conditioning. Good examples of this are swimming or cycling.
- Physical therapy modalities may be useful at this stage e.g.: ultrasound and ice therapy (Batt and Tanji, 1995).
- Heel cushions, pads or cups (Brantingham, 1998; Ryan, 1995; Batt and Tanji, 1995). Long-term use of heel raises or cups may be appropriate for patients who are overweight or older.
- Taping the foot in a "Low-dye" style to prevent excessive pronation (Ryan, 1995; Brantingham, 1998; Tanner and Harvey, 1988).

- Correction of forefoot and hindfoot abnormalities with orthotics. A survey of 46 runners using orthotics for the treatment of plantarfasciitis found that 74% reported a marked improvement of symptoms, and 90% continued to use the orthotics after cessation of the symptoms. Orthotics can be soft or rigid (Ryan, 1995; Brantingham, 1998; Batt and Tanji, 1995).

- The correct running shoe should be used, especially necessary is the correction of over pronation running styles (Ryan, 1995; Brantingham, 1998; Batt and Tanji, 1995).

- Stretching followed by strengthening exercises for the achilles and gastrocnemeus and soleus muscles, as well as prescription of resisted isometric exercises for the intrinsic muscles of the foot (Brown, 1996; Ryan, 1995; Batt and Tanji, 1995).

- Strength training normally follows to improve proprioception in the ankle joint. Functional rehabilitation should include the entire kinetic chain from the foot through the ankle and knee to the hip (Brown, 1996; Batt and Tanji, 1995).

- Return to running program as soon as possible (Ryan, 1995).

In 1994 Wolgin *et al.* performed an uncontrolled study where they evaluated the long-term results of conservative treatment of plantarfasciitis. Data was collected from 100 patients, 58 female and 42 male. The average age of the patients was 48 years old. The results were reported to be good for 82 patients, fair for 15 and poor for 3 patients. Those patients in the last group were all overweight and all had bilateral presentation of symptoms. The patients were entitled to choose their own treatment methods from the following list with the following results:

TABLE 1: Adapted from Table 2 taken from Conservative Treatment of Plantar Heel Pain: Long-Term Follow-Up. Foot and Ankle, volume 15, no. 3, March 1994, by Wolgin *et al.*

Treatment:	No. trying	No. successful.
Stretching	66	55 (83%)
Insert (cushioned)	64	53 (83%)
NSAID's	51	39 (76%)
Ice	33	21 (64%)
Injection	31	11 (35%)
Heat	27	16 (59%)
Heel Cup	9	8 (89%)
Night Splint	3	3 (100%)

2.7.2 CORTICOSTERIOD INJECTIONS:

This is an option exercised when conservative treatment has failed. Blockey administered corticosteroid injections into the heel on 19 plantarfasciitis patients in a controlled clinical trial in 1956. The result was symptomatic relief in 70% with the remaining 30% having persistent symptoms. If the injection didn't produce relief initially it was tried again. In the 1994 Wolgin *et al.* study they noted that when the corticosteroid injection was used it had the least successful rating of all the treatment options offered to the patients with plantarfasciitis. Gorden (1984) proposed no more than three corticosteroid injections per year, whereas Cailliet (1983) suggested three times in one week. The spontaneous rupture of the plantar fascia has been reported as a sequel to corticosteroid injections by Leach *et al.* (1978) who found that in six athletes with ruptured plantar fascia, five had had corticosteroid injections. A possible mechanism regarding rupture was that

the injection provided relief from symptoms allowing the athlete to train without pain before sufficient healing had taken place (Ambrosius and Kondraki, 1992).

Another complication from a corticosteroid injection into the heel pad, is that it frequently results in atrophy of the scepti in the heel pad leading to degeneration of the heel pad (Brown, 1996).

2.7.3 SURGICAL INTERVENTION:

Surgery has been used as a last resort in the treatment of plantarfasciitis when all other conservative measures have failed. The techniques described in the literature involve release of the plantar fascia, removal of granulomatous tissue and calcaneal spurs if present and symptom producing (Ambrosius and Kondraki, 1992, Snider *et al.* 1983). Surgery is reported to have a very high success rate of between 88% - 100%, but must be followed by a long recovery period and aggressive rehabilitation (Snider *et al.* 1983). Campbell & Inman (1974) believe the reason for the surgical procedures showing such a high success rate is due to post-operative recovery techniques of casting and non-weightbearing. The same results are achieved with the use of an anterior or posterior night splint (Campbell & Inman, 1974).

2.7.4 SPLINTING FOOT IN MAXIMUM DORSIFLEXION:

Before resorting to surgical correction or corticosteroid injections, the clinician should consider the use of splinting, due to its conservative nature. The splints are designed to hold the patients foot in maximum dorsiflexion. The patient is instructed to wear the splint upon retiring each night and to remove it in the mornings upon rising. Splinting maintains the length of the plantar fascia as the patient sleeps. This prevents the stiffening and contracture of the fascia that normally occurs during sleep (Ryan, 1995). This has been suggested by several authors to break

the cycle of the plantar-fasciitis (Brantingham, 1998). Ryan (1995) cites successfully treating 30 plantar fasciitis patients with posterior night splints who did not need corticosteroid injections. Ryan (1995) further cites another independent study in which 14 patients who had heel pain for longer that one year were treated with night splints. Treatment before the use of splints consisted of orthotics, stretching, strengthening and corticosteroid injections. In less than four months 11 of the 14 patients had relief of their symptoms. Ryan expresses a view that in light of the low cost and low potential for complications, splinting seems to be a reasonable alternative to invasive procedures such as surgery or corticosteroid injections.

The theory behind the night splint is that it maintains the tension in dorsiflexion on the plantar fascia during the night, which alleviates morning pain, prevents reinjury to the plantar fascia and assists in the healing process.

A placebo-controlled study, performed here in South Africa by Viljoen (1998), appears to show impressive results with the use of an anterior night splint. His study was designed to research the effect of maintaining dorsiflexion of the ankle during the night in plantar fasciitis. The results showed exceedingly good curative effects and led to the design of an anterior fitting night splint that is more comfortable to wear than the posterior fitting devices. He found that there was better patient compliance with the anterior fitting device as it was more comfortable to wear. This may incidentally be the reason for the improvement taking approximately four months in Ryan's study as opposed to the two weeks in Viljoen's study. Pilot studies that were aimed at finding the optimum angles of the device proved that a 20°dorsiflexion of the ankle with a 15° forefoot valgus seemed to deliver the best results.

Viljoen's study in 1998 included 56 symptomatic patients. They were randomly allocated into three groups:

Group A: Received an active NSAID plus a placebo orthotic device

Group B: Received both a placebo NSAID and placebo orthotic device

Group C: Received a placebo NSAID and an active orthotic device

The test period was two weeks. This design ensured that both the active NSAID and the active orthotic device were tested against placebo, and the results could be compared against each other.

Results showed that the patients in Group A had a total improvement in symptoms of 14,5%. The patients in Group B showed a total improvement of between 0%-3%. The patients in Group C had a total improvement of 80%.

Over the fourteen day period that the anterior night splint was worn there was an excess of 80% improvement. The healing rate seems impressive compared to that of accepted biokinetic and physiotherapeutic modalities. A fourteen day period for and overall 80% improvement using only the night splint is encouraging, when compared with the time period ranging from 8 - 36 months for many of the studies reviewed earlier in this literature review. Nevertheless, Viljoen's study must be interpreted with some caution as it has not been published or undergone review.

Wapner and Sharkey (1991) performed an uncontrolled study, where they used night splints to treat relcalitrant plantarfasciitis in 14 patients with a total of 18 symptomatic feet. All patients had the symptoms for greater than one year and had undergone a selection of treatments including non-steroidal-anti-

inflammatory drugs, cortisone injections, shoe modifications and physical therapies all without resolution. An interesting finding in these patients was that they were all an average of 20 pounds overweight. This confirms studies cited earlier that indicate that if patients are overweight, they have more of a chance of having persistent symptoms following treatment. Wapner *et al.* (1991) used custom fitted night splints that held the foot in 5° dorsiflexion. They continued using anti-inflammatory medication, Tuli cups and general stretching exercises and achieved a successful resolution of symptoms in 11 patients within 4 months. They had 3 failures. Their conclusion was that the night splints added a cost-effective, and useful adjunct to regular treatment options for plantarfasciitis.

The study performed by Wolgin *et al.* in March 1994 supported the use of night splints, as 3 of the patients who participated in the study chose to use the splint, and reported a 100% resolution of symptoms.

2.7.5 CHIROPRACTIC ADJUSTMENTS OF THE JOINTS IN THE FOOT AND ANKLE JOINT COMPLEX FOR TREATMENT IN PLANTARFASCIITIS:

Chiropractors have adjusted the foot for plantarfasciitis since the turn of the century. D.D. Palmer, the founder of chiropractic, suggested the importance and effectiveness of adjusting the tarsal joints to gain relief for pain experienced on the plantar surface of the foot. He encouraged chiropractors to treat patients with painful feet (Brantingham *et al.* 1992).

Kell treated 3 plantarfasciitis patients that the podiatrists had failed to help. His

claim for the success of his treatment was in re-aligning the calcaneus (the sub-talar joint) with an activator adjusting instrument, from posterior to anterior. He claimed complete success and resolution of symptoms. On x -ray showing a lateral view of the foot, he took a measurement, which he referred to as "Kell's line", which was a line drawn from the anterior-inferior aspect of the calcaneus to the most posterior aspect of the 5th metatarsal styloid. He took these measurements on both pre and post treatment radiographs. He claimed this showed an objective change (a decrease in length of the line) that would positively confirm the findings of full and complete resolution of symptoms in all 3 patients. This he had confirmed by podiatrists with whom he worked closely.(Brantingham *et al.* 1992)

Polkinghorn published case reports in which he had treated 3 women, aged 55 - 71 years of age, who had heel pain from 2 months to 4 years duration. All patients had calcaneal spurs which were demonstrated radiographically (Polkinghorn, 1995). He used the same methods of evaluating for the presence of a posterior calcaneus misalignment as Kell had in the previously mentioned study (Brantingham, 1998). The patients symptoms had not responded to any orthodox treatments, which included oral anti - inflammatories, corticosteroid injections, orthotics and physical therapy. Two of the patients had been diagnosed as candidates for surgical resection of the heel spurs. Polkinghorn delivered short lever mechanical adjustments to the foot, ankle and calcaneus by means of an activator adjusting instrument. All patients had posterior subluxation of the calcaneus. All three patients tolerated the treatment well with complete resolution of symptoms, and had no recurrence of symptoms in prolonged follow up visits. He concluded that plantarfasciitis may be efficiently managed with chiropractic care through specific adjusting techniques that correct the posteriority of the calcaneus, as he believes this is the common denominator in the subluxation complex of this condition (Polkinghorn, 1995).

In a retrospective review, Brantingham and Snyder, (Brantingham *et al.* 1992) managed 29 plantarfasciitis cases over a 3 year period. The diagnosis of the condition was made by the conventional methods in addition to the history. Examination included gait analysis for excessive pronation and non-weightbearing inspection of the subtalar, midtarsal and other joints. Treatment consisted of a combination of foot and ankle adjusting, taping or orthotics, ultrasound, ice or diathermy. The adjustive techniques that were performed on the ankle mortice, subtalar, midtarsal and intermetatarsal joints were according to the loss of motion on motion palpation examination. There were 16 women and 13 men with an average age of 36 years of age. There was evidence of foot dysfunction in all 29 patients. Twenty-two of them showed excessive pronation on gait analysis. All patients received foot and ankle joint manipulation, as well as some of the other treatment prescribed. The average number of treatments was 8 and the average length of the treatment period was 3.5 weeks. Three patients received little or no pain relief (less than 50% reduction in pain) and were referred for corticosteroid injections. Four patients reported between 50% - 75% reduction in pain. The rest reported a greater than 75% improvement in symptoms. They concluded that plantarfasciitis is a common condition that can be effectively treated by chiropractors. They also stated that adjusting the foot and ankle joint complex was beneficial 6 - 8 weeks after surgical intervention for plantarfasciitis that hadn't responded to conservative approaches, to restore normal joint motion (Brantingham *et al.* 1992).

By reviewing the related literature, it is a logical conclusion that manipulative techniques should be used as part of the treatment regimen. Because hypomobile or dysfunctional foot and ankle joints have been identified as contributing factors for the development of plantarfasciits, the correction of such biomechanical

limitations in the foot should be effective in treating plantarfasciitis.

2.7.6 THE NEED FOR AN EFFECTIVE, NON-INVASIVE, CONSERVATIVE TREATMENT FOR PLANTARFASCIITIS:

Ambrosius and Kondraki (1992) state that a controlled study has not yet been published by a Chiropractor for the treatment of plantar fasciitis. Bearing in mind the belief by some that fixations may cause, predispose and delay healing in plantar fasciitis (Ambrosius and Kondraki 1992; Brantingham 1992 *et al.* & 1998), a study is needed to determine the effectiveness of manipulative techniques in the treatment of plantarfasciitis. The other conservative treatment option that needs to be tested by a controlled study is that of the night splint. A combination treatment study was designed to compare the effectiveness of manipulative techniques on the foot and ankle joint complex together with a night splint, versus the effectiveness of the night splint alone in the treatment of plantarfasciitis.

CHAPTER 3: MATERIALS AND METHODS

Advertising was undertaken to acquire patients with plantarfasciits for this study. Adverts were placed in local newspapers, on air on the local radio station and as posters in sports gyms, running clubs and on general notice boards in supermarkets in the greater Durban area.

3.1. Inclusion Criteria:

All persons meeting the following criteria were accepted into this study:

- The plantarfasciitis was of a grade 3 - 4 severity. The grading system for severity of the condition was taken from Kellet (1986) (Appendix 1.).

- There was no age, sex or weight exclusion criteria, and no distinction made between athletes and non-athletes.

All patients were admitted into the study regardless of any other physical problems occurring elsewhere in their bodies, except for those with metabolic disorders such as Psoriatic Arthritis, Ankylosing Spondylitis, Reiter's Syndrome, or other metabolic arthritides. The study excluded patients with an obvious Fat Pad and Tarsal Tunnel Syndrome. Other exclusion criteria include: fixed foot deformities as in osseous coalition secondary to severe trauma, patients who have had a plantarfasciotomy, calcaneal bursitis, calcaneal stress fractures, severe osteoarthritis, referred pain, bone cyst, medial nerve root entrapment, neuromas and osteomalacia. The patients were not permitted to receive any other treatment for heel pain or take any form of analgesic or anti-inflammatory medication

during the trial period. The patients were also requested to rest from aggravating factors such as running uphill, or any other activity that might aggravate the condition, for the duration of the treatment to prevent confounding variables.

Before being accepted into the study, each patient signed a Patient Consent Form (Appendix 2). Each patient had the nature of the study explained to them by means of a Patient Information Sheet, which they took home with them (Appendix 3), as well as by verbal explanation by the examiner. It was imperative that each patient left the first consultation with a complete understanding of his/her condition, the possible mechanisms by which it arose, the reasons for the difficulty in treating it so far, and how they were to fit into the study.

3.2. Selection and allocation method.

Via the random allocation method a minimum of 30 subjects were equally divided into Group 1 and Group 2. Group 1 received a combination of foot manipulation and the anterior night splint, while Group 2 used the anterior night splint each night.

In the allocation method a dice was thrown with each number from 1 to 6 represented as follows:

1-TTtt, 2-TtTt, 3-TttT, 4-tTTt, 5-tTtT, 6-ttTT.

T = Group A, and t = Group B.

If the dice landed on 3 for the first throw, the first subject was placed in Group A, the second and third subjects in Group B and the fourth subject in Group A.

This procedure was repeated until Groups 1 and 2 had a minimum of 15 subjects each.

3.3. Method of examination and diagnosis:

The initial consultation with the patient included the case history, physical examination, and a specific foot regional examination as used by the Technikon Natal Chiropractic Clinic. (Appendix 4, 5 and 6 respectively.)

A combination of objective and subjective tests were used in order to establish the correct diagnosis, the extent of biomechanical joint dysfunction, the degree of pain severity, disability and limitation to activities.

A test referred to as the "plantarfasciitis test" which is considered to be diagnostic of the condition was used to diagnose the participants as positive for plantarfasciitis. It involves dorsiflexion of the big toe, foot and ankle together with palpation of the anterior calcaneal tubercle and medial arch. A positive test is denoted by pain experienced by the patient under the examiner's fingers (Brantingham, 1998).

X -rays were to be taken only if indicated i.e. a history of trauma to the foot or any indication of one of the aforementioned arthritides being present after the necessary examinations were performed.

3.4. Subjective and objective measures used:

3.4.1. Patients in both groups on four consultations filled out the Numerical Pain Rating Scale -101 used by Jensen *et al.* (1986). For the purpose of this study the patients were required, on one scale from 0 - 100, to use a line, as well as a percentage, across the scale to indicate their worst pain (0 indicating no pain and 100 pain as bad as it could be. This was followed by a second step on an identical scale, where they had to indicate, by the same method, their least pain anywhere on the same scale from 0 - 100. (Appendix 7.)

3.4.2. Patients in both groups at each of the four consultations completed the Foot Function Index (FFI). The FFI consists of 14 questions designed to gather subjective information from the patient in terms of their perception of pain, ability/disability and daily function. Four separate FFI forms were completed at four separate consultations so as to monitor and record any trend in perceptions of the pain, whether favourable or not. (Appendix 8.)

3.4.3. Motion palpation of the foot and ankle joint complex (Brantingham, 1997) of patients in Group 1 was performed by the examiner at the outset of each treatment day (and recorded before the 100 metre walk for the FFI). The motion palpation findings were noted each time the patients came into the clinic and the examiner was aware of a possible pattern of joint dysfunction that might present itself. This information could be helpful in understanding the way in which the foot

and ankle joint complex respond, by means of altered biomechanics and joint dysfunction, to the presence of plantarfasciitis and the concomitant nerve irritation. Any pattern that indicates fewer fixations found on motion palpation following treatment is believed to act as an indicator as to whether the treatment is clearing out the joint dysfunction and restoring correct mechanics to the area.

3.4.4. An algometer reading for pain was taken before the 100 m walk in case the walk aggravated the pain. The measurements was taken at the point of most tenderness, which was normally the medial calcaneal tubercle, or at the point of the calcaneal spur as patients with spurs were not excluded from the study as they frequently occur with plantarfacsiitis. There are two types of algometers, one that measures pain tolerance and one that measures pain threshold. The algometer measuring tolerance was used in this study. According to Fischer (1986) the algometer is reliable for quantifying tenderness and hypersensitive soft tissue. He also reports that an algometer with a larger pressure range can measure pain tolerance reliably. These hypersensitive spots can be due to pain originating in the ligaments, tendons, joint capsules or periostium according to Fischer (1987). These measurements were recorded and kept in the patient's file.

3.4.5. A goniometer reading was taken before the 100m walk in case the walk aggravated the pain. The measurement was taken at the talo-crural joint to assess any possible loss of ankle dorsiflexion. This measurement was taken to monitor talo-crural range of motion because it is generally believed that there is an associated tightness in the

4. The probable presence of a heel spur or not.
5. Whether the condition was unilateral or bilateral.
6. Athlete or non-athlete.
7. Was the patient overweight or not.
8. Duration of symptoms.

On each treatment day the fixations found by motion palpating the foot and ankle joints, of the symptomatic foot/feet of patients in group 1 were adjusted. No soft tissue treatment, mobilisation, stretching techniques, or physiotherapy modalities were used or allowed outside of the treatment for the duration of the study. Only the joint fixations found on motion palpation of the foot and ankle joint complex were adjusted.

3.5. The statistical method for analysis of data used is as follows:

3.5.1. The sample size of the study

An advertisement was made to invite patients to take part in the study. The first 30 patients to respond were taken into the study. They were randomly assigned into one of two groups using a fair die. Group 1 consisted of 15 patients making up the first experimental group and group 2 consisted of the remaining 15 patients who made up the second experimental group.

3.6. The following experiments were done:

* NRS 1 - four readings for worst pain out of 100.
* NRS 2 - four readings for least pain out of 100.
* ALGOMETER (ALG) - four readings taken.

achilles/gastrconemius/soleus muscle complex which affects the amount of dorsiflexion in the talo-crural joint, (Ambrosius and Kondraki, 1992). Kibler *et al.* (1991) conducted an uncontrolled study where they took measurements of the ankle in dorsiflexion in an effort to assess the affect on the flexibility and strength of the calf muscles in athletes with plantarfasciitis. They found strength, dorsiflexion and flexibility deficits in the supporting musculature of the posterior calf and foot affected by plantarfasciitis. They suggested that these anatomical and physiological alterations result in biomechanical deficits and should be considered when evaluating and treating plantarfasciitis.

Measurements of the ankle in dorsiflexion were taken with the foot in the relaxed position and then in forced dorsiflexion. The measurements were recorded in the patients' file.

* Both 3.4 and 3.5 to be performed before walking 100 metres, for the FFI, barefoot on flat ground. These measurements were taken in both groups at four intervals from the first consultation through to the follow-up consultation.

Other findings that were noted were as follows:

1. The percentage improvement perceived by the patient at each consultation from the start of the treatment up to and including that day. This percentage was recorded in their files
2. Age of patient.
3. Sex of the patient.

* GONIOMETER 1 (GON 1)- four readings of the degrees of plantarflexion with the foot in a relaxed position.

* GONIOMETER 2 (GON 2)- four readings of the degrees of forced dorsiflexion.

IMPROVEMENT (IMP)- subjective measurement by patient of a percentage improvement recorded at four consultations.

* FOOT FUNCTION INDEX (FFI1-19) - four sets of readings taken.

MOTION PALPATION FINDINGS (MPF)- four readings of the findings in the foot and ankle joint complex.

HEEL SPUR (HS)- present or not.

LR - left or right heel involved.

OW- whether or not the patient was overweight.

SEX - male or female.

AGE - in years.

BILATERAL (BIL)- whether the condition was bilateral or not.

NRS1, NRS2, ALG, IMP and AGE are continuous variables while the remaining variables are categorical. There were 4 readings taken over the six week study period for each variable with the * appearing before them from the first consultation to the follow-up. The variables with a # were recorded 3 times only, during the six week study period. MPF was taken only from group 1. The variables from HS to BIL each have only one reading and will be presented separately as frequencies, percentages and bar charts as a source of additional information regarding trends noticed in the patient group used for the study.

Non - parametric test (The Mann Whitney unpaired U test) was used to analyse categorical variables (variables measured in nominal or ordinal scales) irrespective of the sample size per group. Parametric test (The two-sampled t-test) was used to analyse continuous variables irrespective of the sample size per group.

3.7. The use of non - parametric tests to analyse categorical and continuous variables

3.7.1 Procedure 1: Comparison between 2 unpaired (independent) samples.

3.7.1.1. For categorical variables

The Mann - Whitney unpaired U test was used to compare independent samples with respect to each categorical variable. In each test, the null hypothesis states that there is no significant difference between groups 1 and 2 with respect to the variable in charge, at the $\alpha = 0.05$ level of significance. The alternative hypothesis states that there is a significant difference.

3.7.1.2. For continuous variables

The two-sample unpaired t-test was used to compare independent samples with respect to each continuous variable. In each test, the null hypothesis states that there is no significant difference between groups 1 and 2 with respect to the

variable in charge, at the $\alpha = 0.05$ level of significance. The alternative hypothesis states that there is a significant difference.

Decision Rule:

The null hypothesis is rejected at the α level of significance if $p < \alpha$ where p is the observed significance level or the P - value. Otherwise, the null hypothesis is accepted at the same level of significance.

3.7.2. Procedure 2: Comparison between two related samples within group 1.

3.7.2.1. For categorical variables

For each of the categorical variables, Wilcoxon's signed ranks test was used to compare results from related samples. In each test, the null hypothesis states that there is no significant improvement between the 2 related samples being compared, at the α level of significance. The alternative hypothesis states that there is a significant improvement.

3.7.2.2. For continuous variables

For each of the continuous variables, the two sample paired t-test was used to compare results from related samples. In each test, the null hypothesis states that there is no significant improvement between the 2 related samples being

compared, at the α level of significance. The alternative hypothesis states that there is a significant improvement.

Decision Rule:

The null hypothesis is rejected at the α level of significance if $p < \alpha$ where p is the observed significance level or the P - value. Otherwise, the null hypothesis is accepted at the same level of significance.

3.7.3. Procedure 3: Comparison between related samples within group 2.

Procedure 2 was repeated within Group 2.

3.7.3.1. For categorical variables

For each of the categorical variables, Wilcoxon's signed ranks test was used to compare results from related samples. In each test, the null hypothesis states that there is no significant improvement between the 2 related samples being compared, at the α level of significance. The alternative hypothesis states that there is a significant improvement.

3.7.3.2. For continuous variables

For each of the continuous variables, the two sample paired t-test was used to compare results from related samples. In each test, the null hypothesis states that there is no significant improvement between the 2 related samples being

compared, at the α level of significance. The alternative hypothesis states that there is a significant improvement.

Decision Rule:

The null hypothesis is rejected at the α level of significance if $p < \alpha$ where p is the observed significance level or the P - value. Otherwise, the null hypothesis is accepted at the same level of significance.

3.7.4. Procedure 4: Power analysis using means and variances for continuous variables only.

Averages and variances were computed for the continuous variables only, and were used for the power analysis and the construction of barcharts. Power analysis was done for continuous variables only.

The power of each two-sample unpaired t-test used in this study was computed using the following UCLA web site:
http:/www.edu/calculators/powercalc/normal.
Each test is two sided, and the variables involved are continuous. The purpose of the power analysis is to determine the power of a statistical test performed on raw data. A power analysis determines whether the test was a good or bad test. It does so by determining the probability of making a Type II error, which is falsely accepting the null hypothesis. The closer the value is to 1, the greater the power of the test. A power of 0.50 represents a good power and a reasonably high

protection against making a type II error. A power below 0.50 represents a poor power and a reasonably high chance of making a type II error.

3.7.5. Procedure 5: Additional analysis for HS, LR, OW, SEX, AGE, BIL.

3.7.5.1. Comparison with regards to HS, LR, OW, SEX,AGE and BIL

Frequencies, percentages and barcharts were obtained for each of these variables.

3.7.5.2. Comparison with regards to AGE.

Statistical package:

The statistical package SPSS Inc (1993)was used for data entry and analysis and was taken from:

Fischer, L.D. and van Belle, G. (1993). Bioistatistics: A Methodology for the Health Sciences. John Wiley and Sons: New York

CHAPTER 4: RESULTS

4.1 INTRODUCTION:

This chapter contains results obtained from the statistical analysis of the following:

Categorical variables:

GON 1: Degrees of plantarflexion measured with the foot in the relaxed position.

GON 2: Degrees of forced dorsiflexion performed by the examiner.

FFI 1 – 19: Foot Function Index, questions 1 – 19.

MPF: Motion Palpation Findings.

HS: Heel Spur. Was one present or not?

LR: Left or right foot involved?

OW: Was the person overweight or not?

SEX: Male or female?

BIL: Did the condition present bilaterally or not?

Continuous variables:

NRS 1: NRS 101 for worst pain out of 100.

NRS 2: NRS 101 for least pain out of 100.

ALG: Algometer readings.

IMP: Subjective perceived percentage improvement.

AGE: of the patient.

Tables displaying p values, means and power analysis results appear in this chapter, as do pie charts and graphs to visually display results.

4.2 INCLUSION & EXCLUSION CRITERIA

- There was no age, sex or weight exclusion.
- No distinction was made between athlete and non – athlete.
- The plantarfasciitis had to be of a grade 3 - 4 severity's. The grading system for severity of the condition was taken from Kellet (1986) (Appendix 1).
- Patients were admitted into the study regardless of other physical or musculoskeletal problems occurring elsewhere in their bodies.
- Patients with metabolic disorders such as Psoriatic Arthritis, Ankylosing Spondylitis, Reiter's Syndrome, or any other similar metabolic disorder were excluded from the study.
- Patients with fixed foot deformities (such as coalition causing gross hyperpronation secondary to severe trauma), calcaneal bursitis, calcaneal stress fractures, severe osteoarthritis, referred pain, bone cyst, medial nerve entrapment, neuromas and osteomalacia were all excluded from the study.
- Patients presenting with Fat Pad Syndrome or Tarsal Tunnel Syndrome were excluded from the study.
- Patients who had previously had a plantarfasciotomy were prohibited from taking part in the study.
- The patients were not allowed to receive any other form of treatment for heel pain or take any form of analgesic or anti-inflammatory medication during the trial period.
- The patients were requested to rest from any form of aggravating activity such as uphill running, known to aggravate their condition.

4.3. The inter-group Analysis using the Mann Whitney U test for the evaluation of 2 independent samples in terms of categorical Variables.

Note: In section 4.2 for the Mann Whitney U test, consultation 1 for groups 1 and 2 have been combined and compared, with the resulting variable e.g.: 1 denoting the first consultation for both group 1 and group 2.

4.3.1 Goniometer (GON 1 and GON 2):

GON 1: plantarflexion measured with the foot in the relaxed position.

GON 2: degrees of forced dorsiflexion performed by the examiner.

TABLE 2: GON 1: (Degrees of plantarflexion measured with the foot in the relaxed position)

Consultation	1	2	3	4
P – value	0.289	0.508	0.865	0.204

TABLE 3: GON 2: (Degrees of forced dorsiflexion - passive)

Consultation	1	2	3	4
P -value	0.461	1.000	0.983	0.423

The p values given indicate that there was no significant difference between the two groups. An $\alpha = 0.05$ level of significance was used , and since the null hypothesis states that the p value is greater than or equal to α, there is no statistically significant difference between the two groups.

A difference should not be found when comparing the above data for the first consultation, as there should be no difference if the demographic population samples are similar. Use of this data if demographically matched may indicate and equal base level between the two groups, and that neither group had an initial advantage over the other. The difference in the improvement in intragroup range of motion gained in the talo-crural joints, from the beginning of the treatment, through its steps, right up to the end, for each group, will be demonstrated in statistical section 2.1 for the Wilcoxon Signed Ranks test for intra-group evaluation.

4.3.2. Foot Function Index (FFI 1 -19) The Mann Whitney U test:

There were 14 questions in the FFI but 5 of them were repeated after walking 100m barefoot. This makes a total of 19 questions. (See chapter 3 for full description.) Again consultation 1 for groups 1 and 2 have been combined into one variable so that FFI 1 is for both groups.

The Foot Function Index questions were as follows: All scored out of 10 points.

FFI 1: Worst Pain.

FFI 2: Morning Pain

FFI 3: Pain walking barefoot

FFI 4: Pain walking with shoes.

FFI 5: Pain standing in shoes.

FFI 6: Can you walk in the house?

FFI 7: Can you walk outside?

FFI 8: Can you climb stairs?

FFI 9: Can you descend stairs?

FFI 10: Can you stand on tiptoe?

FFI 11: Can you get up from a chair?

FFI 12: Can you climb curbs?

FFI 13: Do you have to stay inside all day?

FFI 14: Do you have to stay in bed all day?

FFI 15: Worst pain

FFI 16: Pain walking barefoot?

FFI 17: Can you walk outside?

FFI 18: Can you stand on tiptoe

FFI 19: Can you get up from a chair?

TABLE: 4 FFI 1 –19 FOR CONSULTATIONS 1-4.

Consultation		1	2	3	4
FFI 1	P – value	0.6 24	0.950	0.768	0.900
FFI 2	P – value	0.274	0.850	0.271	0.983
FFI 3	P – value	0.654	0.543	0.834	0.916
FFI 4	P – value	0.867	0.834	0.658	0.557
FFI 5	P – value	0.850	0.412	0.899	0.690
FFI 6	P – value	0.315	0.324	0.600	0.949
FFI 7	P – value	0.818	0.597	0.660	0.605
FFI 8	P – value	0.081	0.377	0.768	0.487
FFI 9	P – value	0.049	0.294	0.544	0.485
FFI 10	P – value	0.585	0.374	0.383	0.966
FFI 11	P – value	0.916	0.802	0.751	0.721
FFI 12	P – value	0.599	0.295	0.833	0.735
FFI 13	P – value	0.150	1.000	1.000	1.000
FFI 14	P – value	0.317	1.000	1.000	1.000
FFI 15	P – value	0.884	0.753	0.785	0.912
FFI 16	P – value	0.490	0.886	0.661	0.567
FFI 17	P – value	0.490	0.737	0.542	0.416
FFI 18	P - value	0.599	0.983	0.931	0.766
FFI 19	P - value	0.413	0.426	0.640	0.798

The Mann Whitney U test requires comparisons of data from FFI 1 - 19 from both groups for all four consultations individually. There were 75 readings of no statistically significant improvement between groups with only one reading, (consultation 1 FFI 9: Can you descend stairs?), showing a statistically significant difference between the two groups.

This indicates that patients in both groups started at consultation one with no difference in the perception of their symptoms.

The null hypothesis is to be accepted for all comparisons except for the abovementioned variable.

4.4 The inter-group Analysis using the two sample unpaired t-test for the evaluation of 2 independent samples in terms of continuous variables.

This section contains examinations of the continuous variables, which are NRS 1, NRS 2, ALG and IMP, using the above test. Each of these variables were tested in the following steps under the t-test:

Step 1: The equality of variances

Step 2: The equality of means

Step 3: The equality of means: The 95% Confidence Interval.

Step 1: Equality of variances (t-test for continuous variables):

H_0: p is greater than or equal to α, then equal variances are assumed and there is no statistically significant difference between the two groups.

TABLE 5: Equality of variances (t-test for continuous variables):

NRS 1: NRS 101 readings for the worst pain for consultations 1-4.

CONSULTATION	P VALUE	ACCEPT/REJECT H_0	COMMENTS
1	0.001	Reject H_0	Equal variances not assumed
2	0.897	Accept H_0	Equal variances are assumed
3	0.917	Accept H_0	Equal variances are assumed
4	0.340	Accept H_0	Equal variances are assumed

For consultation 1, the p – value was: 0.001, and $p < \alpha$, $\therefore$ equal variances are not assumed.

There was a statistically significant difference between the NRS 1 readings for worst pain between the groups on the first consultation. All this indicates is that group 1, the adjusted group, perceived their pain to be worse than those in group 2 at the outset of the study.

After the second consultation there was no significant difference noted between the groups in terms of the worst pain reading for NRS 1.

TABLE 6: Equality of variances (Inter-group analysis: t-test for continuous variables):

NRS 2: NRS 101 readings for the least pain for consultations 1-4.

CONSULTATION	P VALUE	ACCEPT/REJECT H_0	COMMENTS
1	0.608	Accept H_0	Equal variances are assumed
2	0.658	Accept H_0	Equal variances are assumed
3	0.698	Accept H_0	Equal variances are assumed
4	0.617	Accept H_0	Equal variances are assumed

There was no significant difference between the groups as equal variances are assumed for NRS 2 for each consecutive consultation.

TABLE 7: Equality of variances (Inter-group analysis: t-test for continuous variables):

ALG: Algometer readings for consultations 1-4.

CONSULTATION	P VALUE	ACCEPT/REJECT H_0	COMMENTS
1	0.615	Accept H_0	Equal variances are assumed
2	0.759	Accept H_0	Equal variances are assumed
3	0.913	Accept H_0	Equal variances are assumed
4	0.970	Accept H_0	Equal variances are assumed

There was no significant difference between the groups as equal variances are assumed for ALG for each consecutive consultation.

TABLE 8: Equality of variances (Inter-group analysis: t-test for continuous variables):

IMP: Percentage improvement estimated by patient at consultations 2-4.

CONSULTATION	P VALUE	ACCEPT/REJECT H_0	COMMENTS
2	0.352	Accept H_0	Equal variances are assumed
3	0.444	Accept H_0	Equal variances are assumed
4	0.635	Accept H_0	Equal variances are assumed

There was no significant difference between the groups as equal variances are assumed for IMP for each consecutive consultation.

Step 2: Inter-group analysis: Test for equality of means:

H_0: p is greater than or equal to α, and therefore no statistically significant difference exists between the groups.

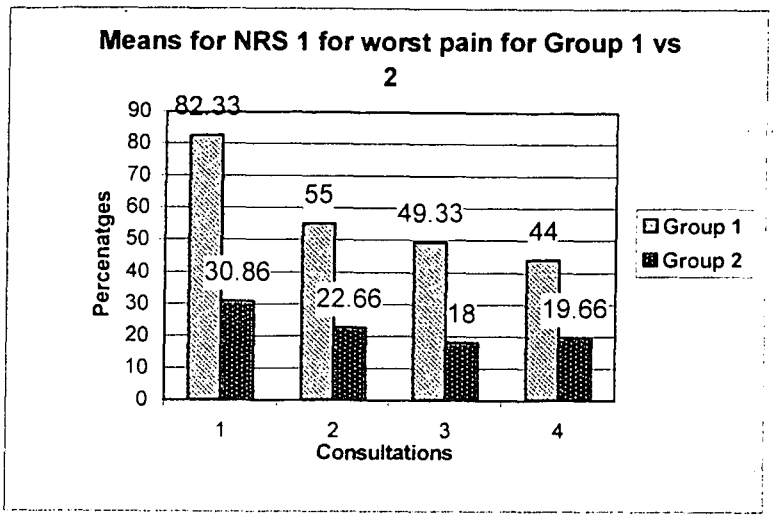
TABLE 9: Step 2: Inter-group analysis: Test for equality of means (part of t-test):

NRS 1: NRS 101 readings for the worst pain for consultations 1-4.

CONSULTATION	P VALUE	ACCEPT/REJECT H_0	COMMENTS
1	0.000	Reject H_0	The means differ significantly
2	0.000	Reject H_0	The means differ significantly
3	0.000	Reject H_0	The means differ significantly
4	0.018	Reject H_0	The means differ significantly

There is a statistically significant difference in p-values between group 1 and 2, in favour of group 1, the adjusted group, for the perception of a decrease in the worst pain for each of the four consultations in terms of the means.

FIGURE 1:



Group 1, the adjusted group, had a decrease of 62.67% in their overall perception of worst pain, from consultation 1 to consultation 4, compared with group 2 who perceived a decrease of only 11.2%. It is obvious that group 1 experienced a significant improvement compared with group 2.

TABLE 10: Inter-group analysis: Test for equality of means (part of t-test):

NRS 2: NRS 101 readings for the least pain for consultations 1-4.

CONSULTATION	P VALUE	ACCEPT/REJECT H_0	COMMENTS
1	0.271	Accept H_0	The means don't differ significantly
2	0.390	Accept H_0	The means don't differ significantly
3	0.277	Accept H_0	The means don't differ significantly
4	0.737	Accept H_0	The means don't differ significantly

There is no statistically significant difference between group 1 and 2 for the perception of the least pain for each of the four consultations in terms of the means.

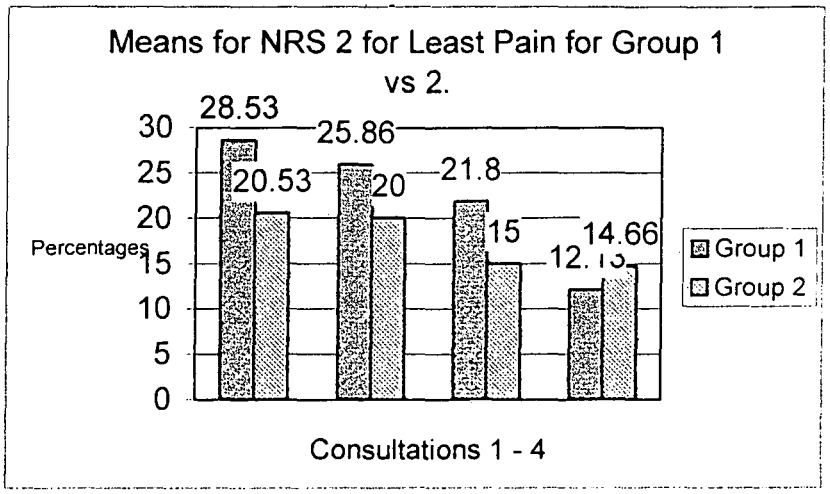


FIGURE 2:

The graph above clearly shows the remarkable decrease in the overall perception of least pain in group 1 with a decrease of 13.87 %, compared to the overall decrease in group 2 of 5.87 %, from consultation 1 to 4(one month follow-up). Group 1 displayed an improvement with respects to least pain when compared with group 2, although it was not statistically significant.

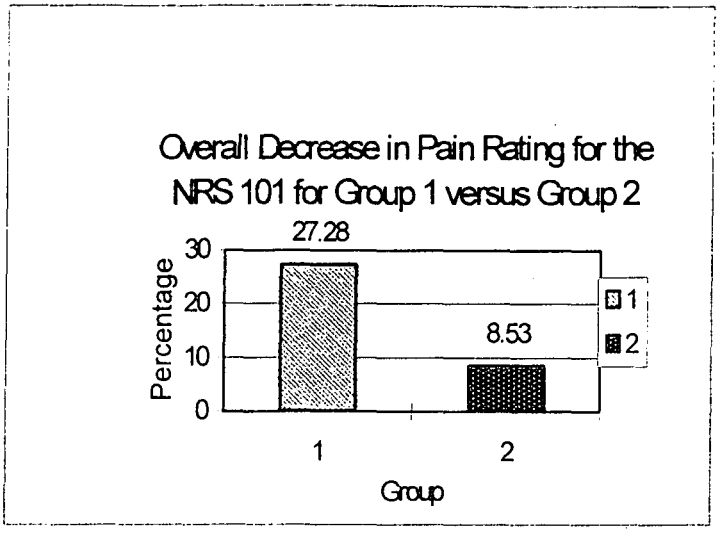


FIGURE 3:

The readings for the worst pain and the least pain have been combined for each group for the purposes of figure 3 and 4. These 2 graphs illustrate the statistically significant difference in the overall improvement in the combination of worst and least pain as measured by the NRS 101 scale between groups, in favour of group 1 over group 2.

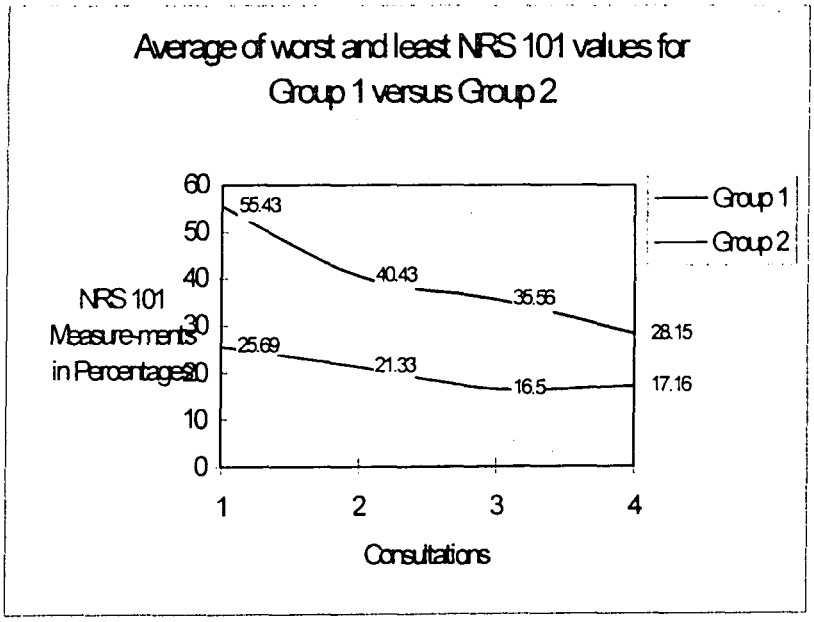


FIGURE 4:

The patients in group 1 perceived a far greater improvement in their perception of their pain as compared with group 2, thus indicating that the addition of the adjustments in this group's treatment protocol made the statistically significant difference.

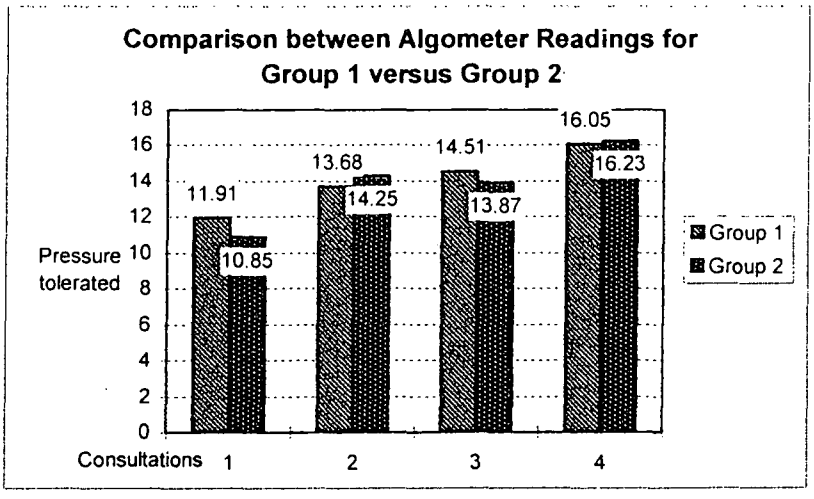
TABLE 11: Inter-group analysis: Test for equality of means (part of t-test):

ALG: Algometer readings for consultations 1-4.

CONSULTATION	P VALUE	ACCEPT/REJECT H_0	COMMENTS
1	0.473	Accept H_0	The means don't differ significantly
2	0.683	Accept H_0	The means don't differ significantly
3	0.658	Accept H_0	The means don't differ significantly
4	0.916	Accept H_0	The means don't differ significantly

There is no statistically significant difference between group 1 and 2 for the tolerance of pressure for each of the four consultations in terms of the means.

FIGURE: 5



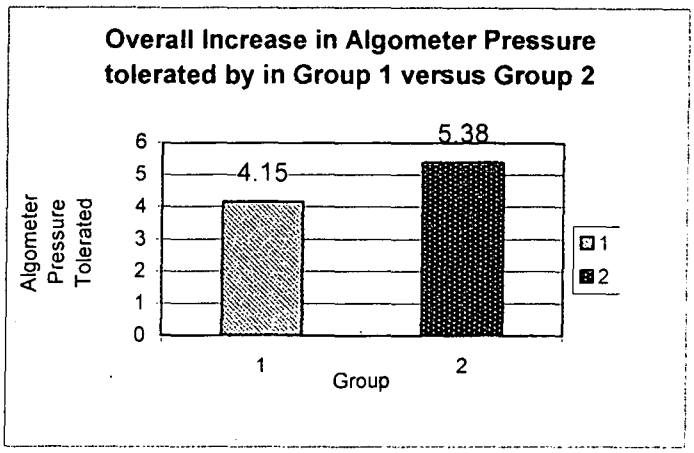


FIGURE: 6

The 2 graphs depict the results from table 10, which indicate that no statistical difference in averages exists between the two groups.

TABLE 12: Inter-group analysis: Test for equality of means (part of t-test):

IMP: Percentage improvement estimated by the patient at consultations 2-4.

CONSULTATION	P VALUE	ACCEPT/REJECT H_0	COMMENTS
2	0.000	Reject H_0	The means differ significantly
3	0.022	Reject H_0	The means differ significantly
4	0.163	Accept H_0	The means don't differ significantly

The patients were asked to estimate their improvement as a percentage at the second, third and fourth consultations. There is a statistically significant difference between groups in favour of group 1, for the perception of the percentage improvement between the first and second, and second and third consultation in terms of the means.

There is no significant difference between the third and fourth consultations for group 1 versus group 2 in terms of the means.

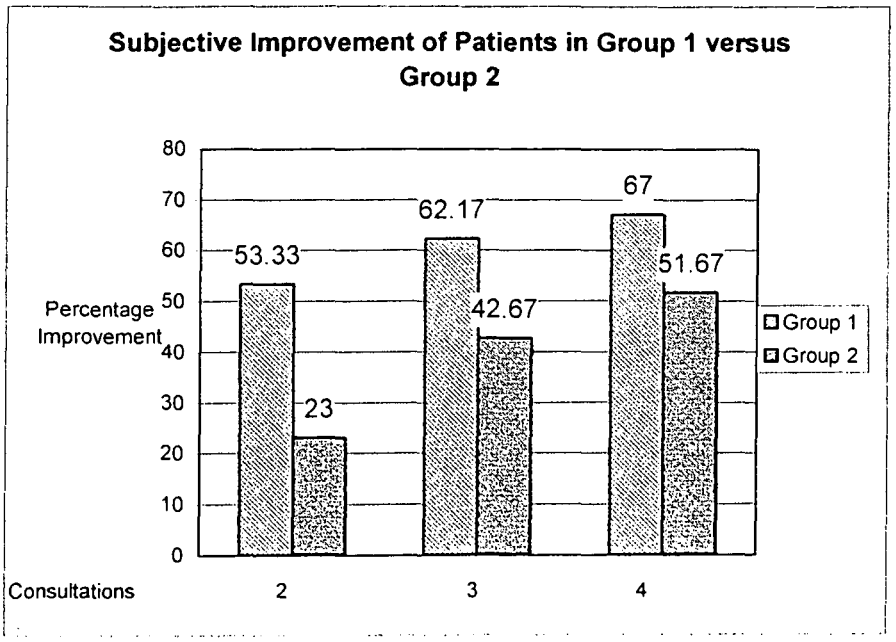


FIGURE: 7

The above graph indicates a striking difference in the initial improvement gained in group 1 compared with that of group 2. After the first treatment there was an impressive difference of 30.33% of improvement in group 1 as opposed to group 2. The overall trend of group 1's greater perceived improvement than group 2's is evident throughout the graph.

Step 3: Inter-group analysis: Test for equality of means: 95% Confidence Interval of the Difference.

H_0 states: 0 lies between the upper and lower limits and if so then no significant difference exists between the groups.

TABLE 13: Inter-group analysis: Test for equality of means: 95% Confidence Interval of the difference.

NRS 1: NRS 101 readings for the worst pain for consultations 1-4.

CONSULTATION	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
1	{35.3867;67.5466}	NO	Reject H_0
2	{17.2122;47.4544}	NO	Reject H_0
3	{16.7572;45.9094}	NO	Reject H_0
4	{4.5523; 44.1144}	NO	Reject H_0

A statistically significant difference exists in favour of Group 1, in terms of the means of the readings for NRS 1 in each of the 4 consecutive consultations.

TABLE 14: Inter-group analysis: Test for equality of means: 95% Confidence Interval of the difference.

NRS 2: NRS 2 readings for the least pain for consultations 1-4.

CONSULTATION	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
1	{-6.5817;2.5817}	YES	Accept H_0
2	{-7.8946;19.6279}	YES	Accept H_0
3	{-5.7641;19.3641}	YES	Accept H_0
4	{-17.835;12.7688}	YES	Accept H_0

A statistically significant difference does not exist between the 2 groups in terms of the means of the readings for NRS 2 in each of the 4 consecutive consultations.

TABLE 15: Inter-group analysis: Test for equality of means: 95% Confidence Interval of the difference.

ALG: Algometer readings for consultations 1-4.

CONSULTATION	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
1	{-1.9118;4.0185}	YES	Accept H_0
2	{-3.4149;2.2682}	YES	Accept H_0
3	{-2.2927;3.5727}	YES	Accept H_0
4	{-3.4959;3.1492}	YES	Accept H_0

TABLE 16: Inter-group analysis: Test for equality of means: 95% Confidence Interval of the difference.

IMP: Percentage improvement estimated by patient at consultations 2-4.

CONSULTATION	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
2	{19.4085;41.2582}	NO	Reject H_0
3	{3.0281; 35.9719}	NO	Reject H_0
4	{-6.5757;37.2424}	YES	Accept H_0

There was a statistically significant difference between first and second readings between groups 1 and 2. There was no significant difference between the third and fourth readings for either group.

In the inter-group analysis of the data, there was a difference of 7 statistically significant results between the groups, in favour of group 1. This indicates that the improvement in Group 1 was statistically significant compared to that in Group 2.

4.5. Intra group Analysis using the Wilcoxon's Signed Ranks Tests

A comparison of results between 2 related samples within group 1 followed by a comparison between 2 related samples within Group 2 to analyse the objective data (or categorical variables) collected between consultations

The comparison done in the following way:

For Group 1:	Followed by: For Group 2
Consultation 1 & consultation 2.	Consultation 1 & consultation 2.
Consultation 1 & consultation 3.	Consultation 1 & consultation 3.
Consultation 1 & consultation 4.	Consultation 1 & consultation 4.
Consultation 2 & consultation 3.	Consultation 2 & consultation 3.
Consultation 2 & consultation 4.	Consultation 2 & consultation 4.
Consultation 3 & consultation 4.	Consultation 3 & consultation 4.

TABLE 17: (The Wilcoxon Signed Ranks Test)

GON1: (Degrees of plantarflexion with the patient in the supine position and the foot in the relaxed position.)

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
p-value **Group 1**	0.017	0.005	0.007	0.034	0.067	0.306
p-value Group 2	0.017	0.034	0.005	0.347	0.007	0.017

In group 1 there was a statistically significant improvement between consultation 1 and 2,1 and 3, 2 and 3, 1 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2,1 and 3, 1 and 4, 2 and4, & 3 and 4.

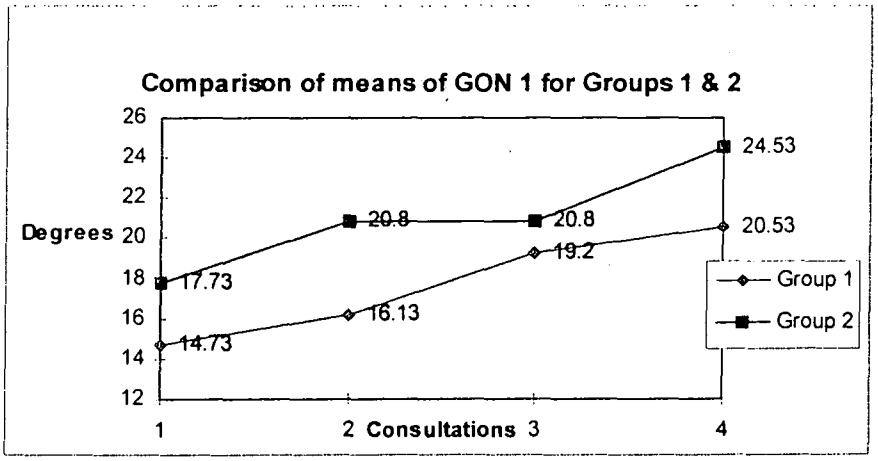


FIGURE : 8 Comparison of means of GON1 for Groups 1 and 2.

TABLE 18: (The Wilcoxon Signed Ranks Test)

GON 2: (Degrees of forced dorsiflexion – passive with patient supine)

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
p-value **Group 1**	0.046	0.003	0.007	0.064	0.061	0.306
p-value **Group 2**	0.102	0.102	0.102	1.000	1.000	1.000

In group 1 there was a statistically significant improvement between consultation 1 and 2,1 and 3, 1 and 4.

In group 2 no statistically significant improvement noted in the degree of forced dorsiflexion in any comparison between consultations.

TABLE 19: (The Wilcoxon Signed Ranks Test)

FF1 1: Worst pain out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.002	0.001	0.001	0.070	0.083	0.265
Group 2 p-value	0.001	0.001	0.001	0.111	0.053	0.142

In group 1there was a statistically significant improvement between consultation 1 and 2,1 and 3, 1 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 3,1 and 2, 1 and 4

TABLE 20: (The Wilcoxon Signed Ranks Test)

FFI 2: Morning pain out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.002	0.001	0.003	0.072	0.205	0.954
Group 2 p-value	0.039	0.002	0.003	0.180	0.094	0.836

In group 1 there was a statistically significant improvement between consultation 1 and 2,1 and 3, 1 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2,1 and 3,

1 and 4.

TABLE 21: (The Wilcoxon Signed Ranks Test)

FFI 3: Pain walking barefoot out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.062	0.049	0.003	0.641	0.105	0.096
Group 2 p-value	0.005	0.010	0.002	0.133	0.014	0.012

In group 1 there was a statistically significant improvement between consultation 1 and 3 and1 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2,1 and 3, 1 and 4, 2 and 4 & 3 and 4.

TABLE 22: (The Wilcoxon Signed Ranks Test)

FFI 4: Pain walking with shoes out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.016	0.063	0.016	0.963	0.296	0.030
Group 2 p-value	0.010	0.074	0.063	0.959	0.275	0.140

In group 1 there was a statistically significant improvement between consultation 1 and 2,1 and 4 & 3 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2.

TABLE 23: (The Wilcoxon Signed Ranks Test)

FFI 5: Pain standing in shoes out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.084	0.001	0.207	0.070	0.009	0.010
Group 2 p-value	0.004	0.010	0.004	0.718	0.137	0.078

In group 1 there was a statistically significant improvement between consultation 1 and 3 and 2 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2,1 and 3 & 1 and 4.

TABLE 24: (The Wilcoxon Signed Ranks Test)

FFI 6: Can you walk in the house ? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.030	0.084	0.001	0.207	0.070	0.009
Group 2 p-value	0.026	0.106	0.028	0.596	0.097	0.023

In group 1 there was a statistically significant improvement between consultation 1 and 2,1 and 4 & 3 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2,1 and 4 & 3 and 4.

TABLE 25: (The Wilcoxon Signed Ranks Test)

FFI 7: Can you walk outside? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.010	0.002	0.001	0.928	0.026	0.007
Group 2 p-value	0.005	0.023	0.010	0.528	0.106	0.030

In group 1 there was a statistically significant improvement between consultation 1 and 2,1 and 3, 1 and 4 & 3 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2,1 and 3, 1 and 4 & 3 and 4.

TABLE 26:_(The Wilcoxon Signed Ranks Test)

FFI 8: Can you climb stairs? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
p-value	0.098	0.407	0.020	0.670	0.036	0.002
p-value	0.089	0.005	0.027	0.370	0.031	0.096

In group 1there was a statistically significant improvement between consultation 1 and 4 & 3 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 3, 1 and 4 & 2 and 4.

TABLE 27: (The Wilcoxon Signed Ranks Test)

FFI 9: Can you descend stairs? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.041	0.237	0.005	0.571	0.005	0.001
Group 1 p-value	0.002	0.001	0.003	0.141	0.051	0.329

In group 1 there was a statistically significant improvement between consultation 1 and 2, 1 and 4, 2 and 4 & 3 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2,1 and 3 & 1 and 4.

TABLE 28: (The Wilcoxon Signed Ranks Test)

FFI 10: Can you stand on tiptoe? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.007	0.027	0.007	0.773	0.031	0.026
Group 2 p-value	0.009	0.005	0.020	0.367	0.503	0.697

In group 1there was a statistically significant improvement between consultation 1 and 2,1 and 3, 1 and 4, 2 and 4 & 3 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2,1 and 3 & 1 and 4.

TABLE 29: (The Wilcoxon Signed Ranks Test)

FFI 11: Can you get up from a chair? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.002	0.010	0.001	1.000	0.024	0.006
Group 2 p-value	0.001	0.001	0.010	0.227	0.231	0.149

In group 1 there was a statistically significant improvement between consultation 1 and 2,1 and 3, 1 and 4, 2 and 4, statistically significant & 3 and 4.

In group 2 there was a statistical improvement between consultation 1 and 2,1 and 3 & 1 and 4.

TABLE 30: (The Wilcoxon Signed Ranks Test)

FFI 12: Can you climb curbs? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.045	0.060	0.017	0.885	0.061	0.013
Group 2 p-value	0.405	0.004	0.027	0.106	0.040	0.243

In group 1 there was a statistically significant improvement between consultation 1 and 2, 2 and 4 & 3 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 3 & 2 and 4.

TABLE 31: (The Wilcoxon Signed Ranks Test)

FFI 13: Do you have to stay inside all day? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.157	0.157	1.000	1.000	1.000	0.005
Group 2 p-value	1.000	1.000	1.000	1.000	1.000	1.000

In group 1 there was a statistically significant improvement between consultation 3 and 4

In group 2 there was no statistically significant improvement between any comparisons within group 2 for FFI 13.

TABLE 32: (The Wilcoxon Signed Ranks Test)

FFI 14: Do you stay in bed all day? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.003	0.004	0.641	0.063	0.071	0.102
Group 2 p-value	1.000	1.000	1.000	1.000	1.000	1.000

In group 1 there was a statistically significant improvement between consultation 1 and 2 & 1 and 3.

In group 2 there was no statistically significant improvement between any comparisons within group 2 for FFI 14.

The following 5 questions were repeated immediately after walking 100m barefoot along a flat surface.

TABLE 33: (The Wilcoxon Signed Ranks Test)

FFI 15: Worst pain. Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.112	0.034	0.495	0.641	0.063	0.071
Group 2 p-value	0.078	0.068	0.035	0.105	0.057	0.053

In group 1 there was a statistically significant improvement between consultation 1 and 3.

In group 2 there was a statistically significant improvement between consultation 1 and 4.

TABLE 34: (The Wilcoxon Signed Ranks Test)

FFI 16: Pain walking barefoot. Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.102	0.112	0.034	0.495	0.107	0.296
Group 2 p-value	0.080	0.106	0.018	0.501	0.020	0.003

In group 1 there was a statistically significant improvement between consultation 1 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 4, 2 and 4 & 3 and 4.

TABLE 35: (The Wilcoxon Signed Ranks Test)

FFI 17: Can you walk outside? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.220	0.038	0.004	0.407	0.006	0.017
Group 2 p-value	0.051	0.003	0.021	0.030	0.030	0.284

In group 1 there was a statistically significant improvement between consultation 1 and 4, 2 and 4 & 3 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 3,1 and 4 , 2 and 3 & 2 and 4.

TABLE 36: (The Wilcoxon Signed Ranks Test)

FFI 18: Can you stand on tiptoe? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.058	0.028	0.024	0.090	0.090	0.572
Group 2 p-value	0.027	0.005	0.098	0.159	0.398	0.754

In group 1 there was a statistically significant improvement between consultation 1 and 3 & 1 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 2 & 1 and 3.

TABLE 37: (The Wilcoxon Signed Ranks Test)

FFI 19: Can you get up from a chair? Out of 10.

Consultation	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Group 1 p-value	0.089	0.063	0.025	0.526	0.152	0.471
Group 2 p-value	0.164	0.128	0.040	0.231	0.062	0.168

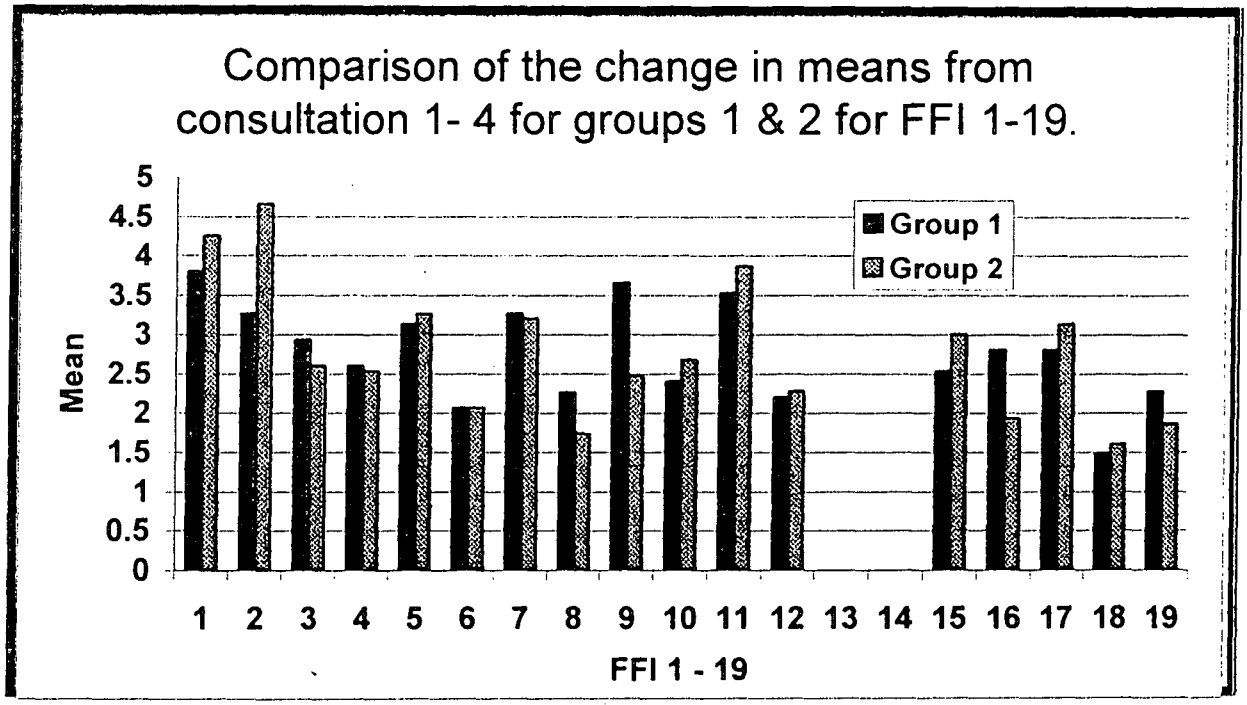
In group 1there was a statistically significant improvement between consultation 1 and 4.

In group 2 there was a statistically significant improvement between consultation 1 and 4.

The intra group analysis showed that, although both groups scored several statistically significant results, group 1 scored 57 statistically significant results to group 2's 50. This indicates that group 1 had a statistically significant advantage over group 2.

FIGURE : 9 (The Wilcoxon Signed Ranks Test for Intra-group Analysis)

The graph below shows the relationship between the average of the means of consultation 1 – 4 for groups 1 and 2. Questions 13 & 14 were excluded because they could only have a yes or no answer and distorted the graphic display. Only one person in each group answered yes to questions 13 & 14 on the first consultation.



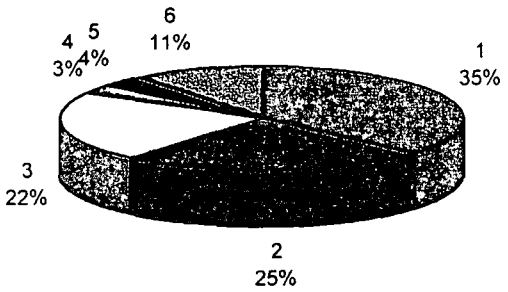
4.6. MPF: (Motion palpation findings): number of fixations found at the first, fourth and seventh consultation for Group 1 only.

Although the patient was examined at each consultation, the total number of fixations was recorded at the abovementioned consultations. The number of fixations was totalled and divided up into their respective percentages of the total number as seen below.

The fixations found were as follows:	Frequency of appearance:
1 - loss of dorsiflexion in the talo-crural joint	36.42 %
2 - loss of eversion in the sub-talar joint	24.88 %
3 - loss of dorsal to plantar, or plantar to dorsal glide in the mid tarsals	21.64 %
4 - loss of dorsal to plantar, or plantar to dorsal glide in the cuneiforms	2.76%
5 - loss of dorsal to plantar glide of the cuboid	3.70 %
6 - loss of dorsal to plantar glide of the First Ray	10.60 %

FIGURE: 10

Motion Palpation Findings for Group 1 during 6 week treatment period.



Consultation	1 & 2	1 & 3	2 & 3
p-value	0.015	0.001	0.002

The numbers 1-6 represent six types of fixations referred to in paragraph one of this section.

TABLE 38: Decrease in number of fixations found at each visit displayed as percentages.

The total number of fixations was recorded at three intervals during the six week study period and were statistically analysed and there was a significant improvement between consultation 1 and 2,1 and 3 & 2 and 3.

4.7 An intra-group comparison for groups 1 and 2 using the Two-sample t-test to analyse the results collected from the continuous variables.

There are 2 steps in this section for intra-group analysis of the continuous variables using the Two-sample t-test. They are:

Step 1: The means of the pairs of variables

Step 2: The 95% Confidence Interval.

4.7.1. Step 1: The means of the pairs of variables (Two-sample t-test)

Ho states that the means are equal and that no statistically significant difference exists between the groups.

TABLE 39: The means of the pairs of variables (Two-sample t-test)

NRS 1: NRS 101 Rating for worst pain for Group 1:

PAIR OF CONSULTATIONS	P VALUE	ACCEPT/REJECT Ho	COMMENTS
1 to 2	0.000	Reject Ho	The means differ significantly
1 to 3	0.000	Reject Ho	The means differ significantly
1 to 4	0.000	Reject Ho	The means differ significantly
2 to 3	0.236	Accept Ho	The means don't differ significantly
2 to 4	0.090	Accept Ho	The means don't differ significantly
3 to 4	0.357	Accept Ho	The means don't differ significantly

TABLE 40: The means of the pairs of variables (Two-sample t-test)

NRS 1: NRS 101 Rating for worst pain for Group 2:

PAIR OF CONSULTATIONS	P VALUE	ACCEPT/REJECT Ho	COMMENTS
1 to 2	0.306	Accept Ho	The means don't differ significantly
1 to 3	0.086	Accept Ho	The means don't differ significantly
1 to 4	0.189	Accept Ho	The means don't differ significantly
2 to 3	0.204	Accept Ho	The means don't differ significantly
2 to 4	0.711	Accept Ho	The means don't differ significantly
3 to 4	0.810	Accept Ho	The means don't differ significantly

There was a statistically significant difference in favour of group 1 versus group 2 with regards to the patient's perception of worst pain from consultation 1 and 2, 1 and 3 & 1 and 4. There was no other statistically significant result in this comparison.

TABLE 41: The means of the pairs of variables (Two-sample t-test)

NRS 2: NRS 101 Readings for least pain for Group 1:

PAIR OF CONSULTATIONS	P VALUE	ACCEPT/REJECT Ho	COMMENTS
1 to 2	0.553	Accept Ho	The means don't differ significantly
1 to 3	0.150	Accept Ho	The means don't differ significantly
1 to 4	0.016	Reject Ho	The means differ significantly
2 to 3	0.383	Accept Ho	The means don't differ significantly
2 to 4	0.011	Reject Ho	The means differ significantly
3 to 4	0.045	Reject Ho	The means differ significantly

TABLE 42: The means of the pairs of variables (Two-sample t-test)

NRS 2: NRS 101 Rating for least pain for Group 2:

PAIR OF CONSULTATIONS	P VALUE	ACCEPT/REJECT Ho	COMMENTS
1 to 2	0.920	Accept Ho	The means don't differ significantly
1 to 3	0.247	Accept Ho	The means don't differ significantly
1 to 4	0.405	Accept Ho	The means don't differ significantly
2 to 3	0.169	Accept Ho	The means don't differ significantly
2 to 4	0.508	Accept Ho	The means don't differ significantly
3 to 4	0.962	Accept Ho	The means don't differ significantly

There was only a statistically significant improvement in the patient's perception of their least pain in group 1 between consultation 1 and 4, 2 and 4, and 3 and 4. There was no statistically significant improvement at all in group 2.

TABLE 43: The means of the pairs of variables (Two-sample t-test)

ALG: Algometer readings for pain tolerance for Group 1:

PAIR OF CONSULTATIONS	P VALUE	ACCEPT/REJECT Ho	COMMENTS
1 to 2	0.030	Reject Ho	The means differ significantly
1 to 3	0.021	Reject Ho	The means differ significantly
1 to 4	0.011	Reject Ho	The means differ significantly
2 to 3	0.243	Accept Ho	The means don't differ significantly
2 to 4	0.066	Accept Ho	The means don't differ significantly
3 to 4	0.093	Accept Ho	The means don't differ significantly

TABLE 44: The means of the pairs of variables (Two-sample t-test)

ALG: Algometer readings for pain tolerance for Group 2:

PAIR OF CONSULTATIONS	P VALUE	ACCEPT/REJECT Ho	COMMENTS
1 to 2	0.001	Reject Ho	The means differ significantly
1 to 3	0.001	Reject Ho	The means differ significantly
1 to 4	0.000	Reject Ho	The means differ significantly
2 to 3	0.636	Accept Ho	The means don't differ significantly
2 to 4	0.082	Accept Ho	The means don't differ significantly
3 to 4	0.003	Reject Ho	The means differ significantly

Both groups displayed a statistically significant improvement between consultations 1 and 2, 1 and 3 & 1 and 4, with group 2 displaying a significant improvement between consultations 3 and 4. Group 2 had showed a statistically significant compared with group1.

TABLE 45: The means of the pairs of variables (Two-sample t-test)

IMP: Subjective percentage improvement for Group 1:

PAIR OF CONSULTATIONS	P VALUE	ACCEPT/REJECT Ho	COMMENTS
2 to 3	0.030	Reject Ho	The means differ significantly
2 to 4	0.062	Accept Ho	The means don't differ significantly
3 to 4	0.341	Accept Ho	The means don't differ significantly

TABLE 46: The means of the pairs of variables (Two-sample t-test)

IMP: Subjective percentage improvement for Group 2:

PAIR OF CONSULTATIONS	P VALUE	ACCEPT/REJECT Ho	COMMENTS
2 to 3	0.005	Reject Ho	The means differ significantly
2 to 4	0.001	Reject Ho	The means differ significantly
3 to 4	0.065	Accept Ho	The means don't differ significantly

There was a statistically significant improvement between consultations 1 & 2 in both groups, but group 2 also showed a statistically significant improvement between consultations 1 and 3. Group 2 therefore experienced more statistically significant improvement than group 1 with respect to subjective improvement.

4.7.2 Step 2: The Confidence Interval for Groups 1 & 2

If "0" lies between the upper and lower limits then Ho must be accepted and this indicates no significant difference between the groups. If "0" does not lie between the upper and lower limits then a significant difference exists between the two groups.

TABLE 47: The 95% Confidence Interval (Two-sample t-test)

NRS 1: NRS 101 Readings for worst pain readings for Group 1:

PAIR OF CONSULTATIONS	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
1 to 2	{17.6356;37.0311}	NO	Reject H_0
1 to 3	{23.4770;42.5230}	NO	Reject H_0
1 to 4	{23.8068;52.8599}	NO	Reject H_0
2 to 3	{-4.1434;15.4767}	YES	Accept H_0
2 to 4	{-.9536;23.9536}	YES	Accept H_0
3 to 4	{-6.6663;17.3329}	YES	Accept H_0

TABLE 48: The 95% Confidence Interval(Two-sample t-test)

NRS 1: NRS 101 Readings for worst pain readings for Group 2:

PAIR OF CONSULTATIONS	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
1 to 2	{ 8.341;24.7410}	NO	Reject H_0
1 to 3	{-2.0632;27.7966}	YES	Accept H_0
1 to 4	{23.8068;52.8599}	NO	Reject H_0
2 to 3	{-2.8413;12.1746}	YES	Accept H_0
2 to 4	{-13.9980;19.998}	YES	Accept H_0
3 to 4	{-16.2684;12.9351}	YES	Accept H_0

There was a statistically significant difference in the intra-group analysis between groups, in favour of group 1, with regards to the patients' perception of worst pain between consultation 1 and 2, 1 and 3 & 1 and 4. There was a statistically significant difference between group 2 and group 1 with respects to consultation 1 and 2 & 1 and 4. The advantage lies with group 1.

TABLE 49: The 95% Confidence Interval (Two-sample t-test)

NRS 2: NRS 101 Readings for least Pain readings for Group 1:

PAIR OF CONSULTATIONS	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
1 to 2	{-6.7445;12.0778}	YES	Accept H_0
1 to 3	{-2.7470;16.2136}	YES	Accept H_0
1 to 4	{3.5112;29.2888}	NO	Reject H_0
2 to 3	{-5.6103;13.7436}	YES	Accept H_0
2 to 4	{3.6203;23.8464}	NO	Reject H_0
3 to 4	{0.2462;19.0872}	NO	Reject H_0

TABLE 50: The 95% Confidence Interval (Two-sample t-test)

NRS 2: NRS 101 Readings for least Pain readings for Group 2:

PAIR OF CONSULTATIONS	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
1 to 2	{-10.6601;12.9351}	YES	Accept H_0
1 to 3	{-4.2839;11.7267}	YES	Accept H_0
1 to 4	{-8.7983;15.3505}	YES	Accept H_0
2 to 3	{-2.4002;20.5316}	YES	Accept H_0
2 to 4	{-11.5244;12.4002}	YES	Accept H_0
3 to 4	{-14.2984;14.9651}	YES	Accept H_0

The only statistically significant results exist between consultations 1 to 4, 2 to 4 and 3 to 4 in group 1 only with respects to the patients' perception of least pain.

TABLE 51: The 95% Confidence Interval (Two-sample t-test)

ALG readings for Pain Tolerance for Group 1:

PAIR OF CONSULTATIONS	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
1 to 2	{−3.3496;−0.1970}	NO	Reject H_0
1 to 3	{−4.7370;−0.4630}	NO	Reject H_0
1 to 4	{−7.1664;−1.1270}	NO	Reject H_0
2 to 3	{−2.2828;0.6294}	YES	Accept H_0
2 to 4	{− 4.9296;0.1829}	YES	Accept H_0
3 to 4	{−3.3864;0.2931}	YES	Accept H_0

TABLE 52: The 95% Confidence Interval (Two-sample t-test)

ALG readings for Pain Tolerance for Group 2:

PAIR OF CONSULTATIONS	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
1 to 2	{−5.0283;−1.7717}	NO	Reject H_0
1 to 3	{−4.5999;−1.4267}	NO	Reject H_0
1 to 4	{−7.5412;−3.2054}	NO	Reject H_0
2 to 3	{−1.3299;2.1032}	YES	Accept H_0
2 to 4	{−4.2362;0.2895}	YES	Accept H_0
3 to 4	{−3.9000;−0.9200}	NO	Reject H_0

A statistically significant difference exists in both groups between consultations 1 to 2, 1 to 3,1 to 4 and in group 2 between consultations 3 to 4. The advantage lies with group 2.

TABLE 53: The 95% Confidence Interval (Two-sample t-test)

IMP: Percentage Improvement for Group 1:

PAIR OF CONSULTATIONS	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
2 to 3	{-16.6801;-0.9865}	NO	Reject H_0
2 to 4	{-28.1101;0.7767}	YES	Accept H_0
3 to 4	{-15.3571;5.6904}	YES	Accept H_0

TABLE 54: The 95% Confidence Interval (Two-sample t-test)

IMP: Percentage Improvement for Group 2:

PAIR OF CONSULTATIONS	{UPPER LIMIT; LOWER LIMIT}	DOES 0 LIE BETWEEN { -;-} ?	ACCEPT/ REJECT H_0
2 to 3	{-32.289;-7.0443}	NO	Reject H_0
2 to 4	{-43.4844;-13.849}	NO	Reject H_0
3 to 4	{-18.6600;0.6600}	YES	Accept H_0

A statistically significant difference exists in both groups between consultations 1 to 2, and in group 2 between consultations 2 to 3.

In section 2.2 and 3.2 for the analysis of Continuous Variables by means of examination of the Means of the pairs of variances and of the 95% Confidence Interval, group 1 scored 26 statistically significant results as opposed to group 2, which scored 14.

TABLE 55: 4.8. Power Analysis for Continuous Variables only. (Those tests denoted by an * have a good power, as the result was greater than 50%).

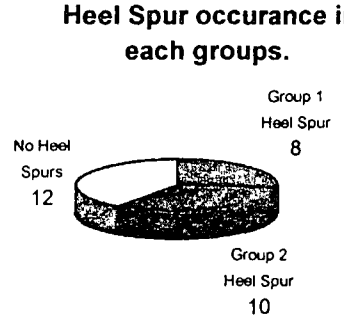
CONSULT-ATION	GROUP	MEANS (1 & 2)	P VALUE GROUP 1 VS 2	Accept/ Reject Ho	POWER OF THE TEST	GON 1
1	1	82.33	0.000	Reject Ho	1.0000>*	
1	2	30.86				
2	1	55.00	0.000	Reject Ho	0.9864>*	
2	2	22.66				
3	1	49.33	0.000	Reject Ho	0.9871>*	
3	2	18.00				
4	1	44.00	0.018	Reject Ho	0.6797>*	
4	2	19.66				
1	1	28.53	0.271	Accept Ho	0.1834>	GON 2
1	2	20.53				
2	1	28.86	0.390	Accept Ho	0.2369>	
2	2	20.00				
3	1	21.80	0.277	Accept Ho	0.1795>	
3	2	15.00				
4	1	12.13	0.737	Accept Ho	0.0612>	
4	2	14.66				
1	1	11.91	0.473	Accept Ho	0.1043>	ALGOMETER
1	2	10.85				
2	1	13.68	0.683	Accept Ho	0.0657>	
2	2	14.25				
3	1	14.51	0.658	Accept Ho	0.0696>	
3	2	13.87				
4	1	16.05	0.916	Accept Ho	0.0512>	
4	2	16.23				
2	1	16.17	0.000	Reject Ho	0.6680>*	% IMPROVEMENT
2	2	42.67				
3	1	62.17	0.022	Reject Ho	0.6455>*	
3	2	42.67				
4	1	67.00	0.163	Accept Ho	0.2718>	
4	2	51.67				

4.9 Demographic Analysis for Heel Spur, Left to Right, Overweight, SEX, AGE, and Bilaterality

A comparison with regards to categorical variables: HS, LR, OW, SEX and BIL using the Mann-Whitney U test for groups 1 and 2. Frequencies, percentages and pie charts for HS, LR, OW, SEX, AGE and BIL are also given here.

FIGURE : 11

HEEL SPUR OCCURRENCE:



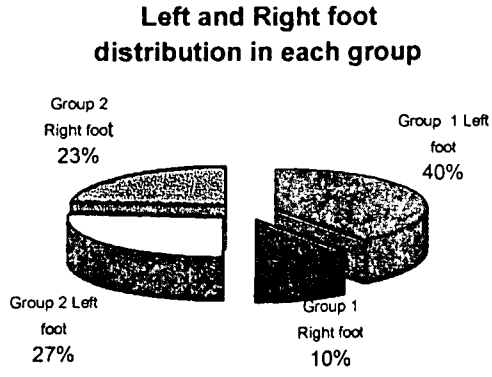
Total: 18 out of 30 patients had a heel spur. This information was gained from existing x – ray evidence as well as palpation of the spur.

Percentages: 60% yes

40% no

FIGURE: 12

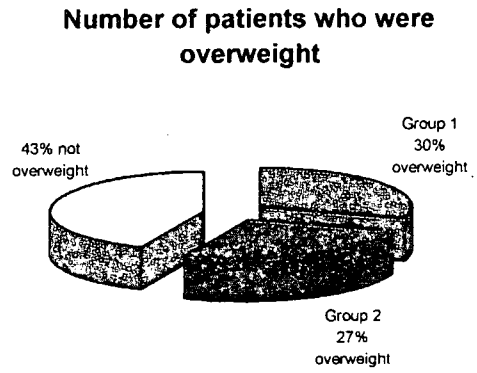
LEFT & RIGHT DISTRIBUTION OF SYMPTOMS:



Total: Plantarfasciitis occurred in the left heel in 20 out of 30, whilst 10 out of the 30 involved the right heel.

FIGURE : 13

NO. OF OVERWEIGHT PATIENTS:



Group 1:

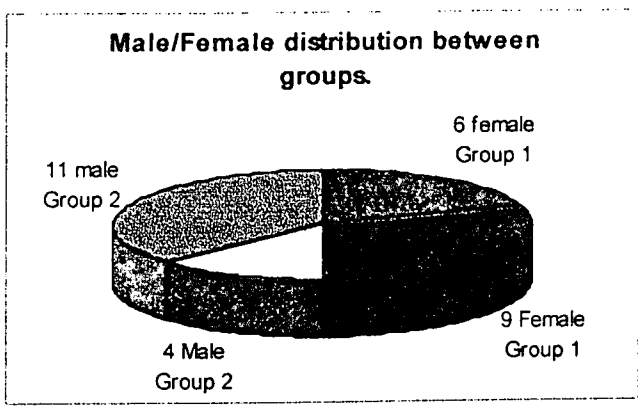
9 out of 15 patients were overweight

Group 2:

8 out of 15 patients were overweight

FIGURE : 14

SEX DISTRIBUTION WITHIN GROUPS.

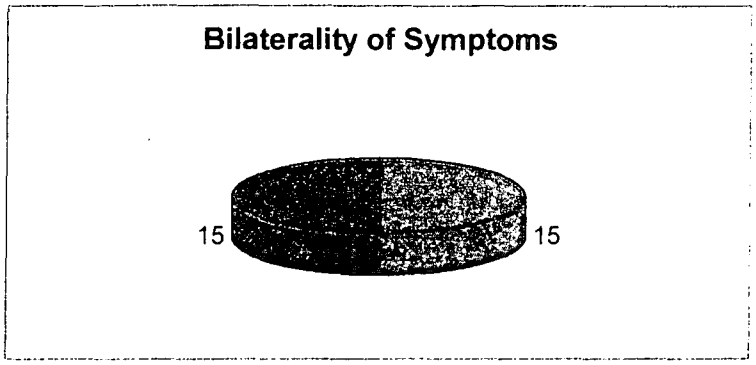


Percentages: 66.6% male

33.3% female

FIGURE : 15

BILATERALITY OF PRESENTATION.



Group 1: 8 out of 15 patients had bilateral symptoms
Group 2: 7 out of 15 patients had bilateral symptoms.

A total of 15 out of 30 patients had bilateral symptoms. (50 %)

4.10 Comparison with regards to Age. (T – test)

There was no significant difference between the two groups with regards to age. The average age in group 1 was 49.47 years and the limits were from 23 - 75. In group 2 the average age was 51.13 years and the limits were 25 - 75 years.

CHAPTER 5: DISCUSSION OF RESULTS.

5.1 Introduction

This chapter will discuss the results obtained from the subjective and objective statistical evaluation that is presented in chapter 4.

The data obtained from the inter-group evaluation with reference to the first, second, third and fourth (one month follow-up) consultation and treatment, gives the reader an indication of any statistically significant differences in the subjective and objective findings in terms of their initial presenting signs and symptoms, and their progress throughout the treatment period of 6 weeks. The assessment of results obtained at the fourth consultation gives an indication of the long-term effects of the treatment in both groups.

The data obtained from the intra-group evaluation with reference to the first, second, third and fourth consultation and treatment, gives the reader an indication of any statistically significant difference between treatments within each group.

5.2 Inter-Group Comparisons

5.2.1 The Subjective Data

The subjective data is comprised of the Numerical Rating Scale 101, the Foot Function Index and the Percentage Improvement estimated by the patient at each consultation date.

5.2.1.1 The Numerical Pain Rating Scale 101.

After statistical analysis of the worst pain readings for the NRS 101, a significant difference was found between the groups at presentation for the initial consultation.

The test for the equality of variances showed that group 1 perceived their worst pain to be far greater than group 2 at the outset of the treatment period.
The test for equality of means indicated that there was a significant difference between the 2 groups at each consultation with group 1 scoring a higher score for worst pain than group 2.

The interesting difference is the overall change in the perception of worst pain from the first consultation through to the third, and then the long-term results after a month of no adjustive treatment for group 1. Reminder: The one-month follow-up period consisted of no consultations for either group. Essentially the treatment for Group 2 didn't change at all, they continued to use the night splint, but Group 1 was no longer

being adjusted in this time. Group 1 showed a decrease in perception of worst pain of 33% from consultation 1 to 3, and an overall decrease of 38.33% from consultation 1 to 4. Whereas group 2 showed a decrease in worst pain perception of 12.86% between consultations 1 and 3, and an overall decrease of 11.14%. This is due to an increase in the perception of worst pain during the one-month follow-up period between consultations 3 and 4 of 1.66%.

Refer to chapter 4 for a graphical representation of the means for the worst pain readings for the 2 groups.

The statistical analysis of Least Pain readings from the NRS 101 showed no significant difference between the two groups in terms of equality of variances and means at each of the four consultations. The overall decrease in the perception of least pain for group 1 was 16.44% as opposed to 5.87% for group 2.

The decrease in the perception of worst and least pain for group 1 was greater than group 2. These readings indicate that adjustments augmented the treatment with the night splint, and with the improvement lasting over the one-month follow-up period clearly indicate a more significant improvement in group 1 than 2.

5.2.1.2 Estimated Percentage Improvement.

The patients were asked to report their estimated improvement in a percentage from the beginning of the treatment up to that point in time. They were asked this following the second through to the final consultation. Three of the total readings were taken spanning the entirety of the treatment period. On statistical analysis of the

percentage improvement a statistically significant difference was found between the two groups after the second and third consultations, in favour of Group 1 (adjustments + splint) i.e.: group 1 estimated their improvement to be greater than group 2 did. There was no significant difference found in the perceived improvement between the groups at the one-month follow-up.

5.2.1.2 Foot Function Index.

No significant difference in results was detected between the 2 groups, except for the reading at consultation 1 for FFI no: 9 Can you descend stairs? This result on its own is of no significance. This result indicates overall that both groups experienced similar results to their treatments in terms of function, pain and disability. This indicates that both treatments were effective in reducing the patients' pain and disability, and increasing their function.

5.2.2 The Objective Data.

The objective data is comprised of the results from the goniometer and algometer readings.

Statistical data and graphs can be found in tables and graphs in chapter 4.

5.2.2.1 Goniometer Readings.

Statistical analysis of the goniometer readings, for degrees of plantarflexion

measured with the foot in the relaxed position, and for degrees of forced dorsiflexion, did not reveal a statistically significant difference between groups after the 1st, 2nd, 3rd or 4th consultation. This suggests that changes in the ranges of motion in the ankle mortice joint were equally improved in both groups. Additional findings in the intra-group analysis will show the trends within each group.

5.2.2.2 Algometer Readings.

Statistical analysis of the algometer readings did not reveal a significant difference between the two groups at any point in time throughout the treatment period. This suggests that both groups experienced similar reduction in pain threshold.

5.3 Intra-Group Comparisons

5.3.1 The Subjective Data

The statistical data, tables and graphs can be found in chapter 4.

5.3.1.1 The Numerical Rating Scale 101

The statistical analysis of the data recorded for the worst pain showed that there was a statistically significant difference in a decrease in the perception of worst pain between consultations 1&2, 1&3 and 1&4 in group 1, and no significant difference was found in group 2.

The statistical analysis of the data recorded for the least pain showed that

there was a significant difference in a decrease in the perception of worst pain between consultations 1&4 in group 1, and no significant difference was found in group 2.

5.3.1.2 Percentage Improvement

Statistical analysis of the data showed a significant improvement between consultations 1&2 in both groups, and also between consultations 1&3 in group 2. This indicates that group 2 perceived their overall improvement to be greater than group 1 did.

5.3.1.3 The Foot Function Index

Statistical intra-group analysis of the data showed that there were statistically significant improvements and differences throughout the 19 questions in both groups. Because there were 19 x 4 questions to analyse, the number of results is to great to display again in this section, so referral to chapter 4 is necessary. Group 1 scored 57 statistically significant results, compared to Group 2 who scored 50.
This result indicates that more improvement was gained in Group 1 than in Group 2 in terms of pain, disability and function.

5.3.2 The Objective data

5.3.2.1 Goniometer Readings

Statistical intra-group analysis of the data for GON 1 (degrees of plantarflexion with

the foot in the relaxed position) showed that there was a statistically significant improvement, in the amount of plantarflexion at the ankle mortice joint, in Group 1 between consultations 1&2, 1&3 and 1&4. Group 2 experienced similar improvements in increased plantarflexion between consultations 1&2, 1&3, 1&4 and 2&4. This indicates that both group's experiences similar increases in degrees of plantarflexion throughout the treatment period. A graphical representation of this data appears in chapter 4.

Statistical intra-group analysis of the data for GON 2 (degrees of dorsiflexion) showed that there was a statistically significant result, in the amount of dorsiflexion at the ankle mortice joint, in Group 1 between consultations 1&2, 1&3 and 1&4. The increase in dorsiflexion within Group 1 was statistically significant. Group 2 experienced no statistically significant differences. Both groups, however, displayed a decrease in the measurement of degrees in the forced dorsiflexion position, and it is theorised that this is as a result of the shortening effect the night splint would have on the retinaculum of the ankle joint. A graphical representation of this data appears in chapter 4.

5.3.2.2 Algometer Readings

Statistical intra-group analysis of the data showed that there were statistically significant improvements and differences in both groups between consultations 1&2, 1&3 and 1&4. Neither group had more improvement than the other did and this indicates that both treatment options were equally efficacious in increasing pain threshold.

5.3.3 Analysis for Motion Palpation Findings

The patients in Group 1 were examined and adjusted 6 times in 2 weeks and again one month later at the final consultation. Readings were only taken at 3 intervals throughout the first two weeks and once again at the one-month follow-up consultation. The percentages and frequencies of each joint fixation, as well as a graphical representation of the percentages can be seen in chapter 4.

Statistical analysis of the data - the number of fixations at each visit – decreased with statistical significance at each reading. This supports the chiropractic principle that adjusting fixated joint segments contributes to biomechanical normality and function of the segment. A recommendation I would like to make at this stage to anyone wishing to do further research in this area would be to motion palpate the non-adjusting group to see if the night splint has any effect on the number of fixations.

5.3.4 Additional Analysis for:

Heel Spur, Left or Right Foot, Overweight, Sex, Age & Bilaterality.

5.3.4.1 Heel Spur

Group 1 had 8 out of 15 patients with a heel spur.

Group 2 had 10 out of 15 patients with a heel spur.

60% of all the patients had a heel spur.

Interesting note: Most of the women with heel spurs were also overweight.

5.3.4.2 Left or Right Foot Involved

The majority, 66%, of the plantarfasciitis occurred in the left foot.

5.3.4.3 Number of Overweight Patients

In Group1, 9 out of the 15 patients were overweight and in Group 2, 8 out of the 15 were overweight. 57% of the total 30 patients were overweight.

5.3.4.4 Male/Female Distribution

Group 1 had 6 men and 9 women, and Group 2 had 4 men and 11 women. 66.6% of the total were female and 33.3% were male.

5.3.4.5 Bilaterality of Symptoms

50% of the total 30 patients in the study had bilateral plantarfasciitis. This was higher than the literature quotes, which may have been coincidental, and most of these patients had been suffering from plantarfasciitis for a prolonged period of time.

5.3.4.5 Age of Patients

There was no difference in either group with regards to age distribution. The age range was 23 –75 years with the average age of patients in the study of 50.3 years.

5.4 Power Analysis

The purpose of the power analysis is to determine the power of a statistical test performed on raw data. A power analysis determines whether a test was a good or bad test. It does so by determining the probability of making a Type II error, which is falsely accepting the null hypothesis. This probability is denoted by beta (β). The closer the value of β is to 1, the greater the power of the test. A power of 0.90 represents a good power and a reasonably high protection against making a Type II error. A power value of 0.20 represents a reasonably high risk of making a type II error. It is common opinion that when the sample size of a study is small, the results of the power analysis be poor.

5.4.1 Inter-group Power Analysis of the Continuous Variables

5.4.1.1 GON 1: Degrees of Plantarflexion measured with the foot in the relaxed position.

The inter-group analysis of the goniometer readings for the foot in the relaxed, plantar-flexed position were good, and showed strong power analysis values, from the initial consultation right the way through to the final consultation.

5.4.1.2 GON 2: Degrees of Forced dorsiflexion

The inter-group analysis of the goniometer readings for the foot in the forced, dorsi-flexed position were poor, and showed weak power analysis values, from the initial consultation right the way through to the final consultation.

5.4.1.3 Algometer Readings

The inter-group analysis of the algometer readings in for pain threshold, and showed weak power analysis values, from the initial consultation right the way through to the final consultation.

5.4.1.4 Percentage Improvement

The inter-group analysis of the percentage improvement readings after each consultation were good, and showed strong power analysis values, after the first and second consultation, but the results for the final consultation were poor, indicating a weak power.

Although the sample size was small statistically significant differences were noted in the continuous variables tested above which were confirmed with a power analysis test. See table 72 in chapter 4.

5.5 Limitations of this study

5.5.1 Subjective Measurements

With regards to the Numerical Rating Scale 101 and the Foot Function Index, I would like to discuss a flaw I encountered with this method of data collection. It is usual not to let the patient see the previous score they gave for the scale or questionnaire, as this is thought to influence their answer. In the study when the patient reported feeling much better after a particular consultation, the examination would substantiate this statement. The problem arose when it came to filling in the scales and questionnaire on the day, because they couldn't remember what they'd scored the last time, they sometimes gave a higher score, which would indicate more pain and therefore a deterioration in the symptoms, when in fact they had improved. This situation occurred a number of times, especially with older patients. As one can see, the affect on the statistics is not favourable. My recommendation is that the patients be allowed to refer to their previous scores in order to get an accurate gauge, any influence this might have on their scoring would be less detrimental to the collection of data than the situation described above.

Occasionally patients admitted sheepishly that they didn't wear the night splint on occasion which can obviously affect the results.

The other limitation noted is that patient bias to please the clinician, might cause them to record scores lower than the true scores, which will indicate a positive change in their symptoms that does not really exist.

5.5.2.....Objective Measurements

There are two main areas with this method of measurement with the universal goniometer and they are:

- Examiner error
- Instrument error

5.5.3 Patient Selection

I found the patients with heel spurs were the ones who responded least well to the treatment and were the ones left with the most residual symptoms after the 6-week period was up. In my opinion, in future studies these patients should be excluded from the study or heel cups, or a similar orthotic device should be used as part of the treatment regimen for these patients.

5.5.4 Time Period of Study and Post-treatment Rehabilitation

The time period decided on for the study was 6 weeks, which included the one-month follow-up period. Most patients were left with some residual pain or symptoms at the end of the 6-week period. It is my opinion that the treatment period should be extended till they are symptom free, or no more improvement has been achieved for approximately 2 weeks.

Because of the loss of forced dorsiflexion in the goniometer measurement experienced

by both groups, my recommendation for anyone using the night splint for the treatment of plantarfasciitis, is to incorporate some rehabilitation for restoration of the end ranges of movement, once the splint is no longer needed. Group 1 experienced a significant decrease in degrees of dorsiflexion throughout the treatment period, while group 2 experienced a less significant loss of movement. This may indicate that a measurement of forced dorsiflexion might not be a good objective measurement to take, when monitoring the progress of plantarfasciitis treatment.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Recommendations

The author of this dissertation suggests the following changes to the treatment protocol for anyone wanting to repeat this study.

6.1.1 Time

The time period allocated for this study was 6 weeks, which included the one-month follow-up period. Most patients were left with some residual pain or symptoms at the end of the 6-week period. It is the author's opinion that, in the future, the treatment period should be extended until they are symptom free, or no more improvement has been achieved for a further 2 week period.

6.1.2 Patient Selection

Because of the increased residual symptoms in patients with heel spurs, it is the author's opinion that in future studies, these patients should either be excluded from the study, or an orthotic device such as a heel cup should be used as part of the treatment regimen.

The age of the patient needs to be considered if the study is to repeated, as the natural degeneration of the fat pad that occurs with age seems to intensify the symptoms of

plantarfasciitis. The older patients took longer to recover; this might be due to the degeneration already present in the plantar fascia, joints, ligaments and tendons of the foot.

6.1.3 Sample Size

A larger sample size would have strengthened and improved the results of the statistical analysis. This would then decrease the chance of making Type II errors. This would aid in improving the validity of the research.

6.1.4 Follow-up period

A further follow-up period 6 or even 12 months is recommended, as this would give a more accurate assessment of the long term benefits of the two different protocols tested in this study.

6.2 Conclusions

This clinically controlled trial consisted of a sample group of 30 patients. They were all diagnosed with a grade 3 or 4 severity plantarfasciitis. They were randomly allocated into either Group 1, which received the night splint as well as manipulative techniques to the foot and ankle joint complex, or into Group 2, which received the night splint only, for the six week period. Group 1 was seen 6 times in two weeks, and then received no other treatment until the one-month follow-up consultation. Group 2 was

seen 4 times in two weeks and then not again until the one-month follow-up consultation.

Statistically significant differences existed between the two groups, in favour of group 1, in terms of perception of worst and least pain, function and disability. There was a statistically significant improvement in favour of group 1, in terms of perceived percentage improvement between consultation 1 and 2, and 2 and 3. A statistically significant decrease was demonstrated in the analysis of the number of joint fixations detected in motion palpation examination of the patients in group 1 following each adjustment session.

Statistical analysis within group 1 showed a statistically significant improvement in terms of degrees plantarflexion measured with the foot in the relaxed position similar to those shown in the intra-group analysis of group 2. Analysis of the degrees of forced dorsiflexion for both groups showed a statistically significant decrease in measurements. This is assumed to be the result of restriction of movement induced in the anterior retinaculum and capsule of the talo-crural joint as a result of the position the night splint holds the foot in. Group 1, however, lost fewer degrees of forced dorsiflexion than group 2 and we can conclude that it was the addition of the manipulation received by group 1 that was responsible for this finding.

Statistically significant improvements to the answers to the Foot Function Index questionnaire were seen in both groups, but more were recorded in group 1, indicating that the group receiving the adjustments as well as the splint, perceived a greater improvement in terms of pain, disability and function.

A power analysis was performed to indicate the likely-hood of a type II error. It was performed on the continuous variables only. It indicated that the tests for the goniometer measurements of degrees of plantarflexion in the relaxed position and that perceived percentage improvement had a good power. The tests for degrees of forced dorsiflexion and the algometer readings had a poor power.

From the additional analysis it was noted that 60% of the patients in the study had heel spurs, 66% predominance in the left heel, 17 out of 30 patients were overweight, 66.6% were female, 50% had bilateral plantarfasciitis, and the average age was 50.3 years.

This study appears to indicate that although the anterior night splint is an effective therapeutic device for the treatment of plantarfasciitis, chiropractic manipulation of the foot and ankle joint complex, used in conjunction with the night splints, appears to contribute markedly to the improvement in the perception of pain, as well as functional improvement gained, and to the overall recovery from the plantarfasciitis.

When considering the well known, stubborn nature of plantarfasciitis, the results of this study appears to indicate that the chiropractic adjustment of the foot and ankle joint complex, in conjunction with the night splint, is a valuable adjunct to treat plantarfasciitis, as opposed to the night splint alone.

LIST OF REFERENCES

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

Astrom, M. and Arvidson, T. 1995. Alignment and Joint Motion in the Normal foot. JOSPT, 22(5):216-222.

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

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, August 1992.

Brantingham, J.W. 1997. March 1997. Fifth year lecture notes on Plantar fasciitis, Technikon Natal, Durban, South Africa.

Brantingham, J.W. 1998. Personal Communication. 18 May 1998. Technikon Natal, Durban, South Africa.

Brown, C. 1996. A review of subcalcaneal heel pain and plantar fasciitis. Australian Family Physician. 25(6): 875-885.

Budman-Mak, E, Conrad, K.J, Roach, K.E. 1991. The foot function index: A measure of foot pain and disability. Journal of Clinical Epidemiology. 44 (6):561-570.

Cailliet, R. 1983. Structural Anatomy. In: Foot and Ankle Pain, 2nd edition, Philadelphia, P A., F.A. Davis Company. p: 109:23-26.

Campbell, J.W. and Inman, V.T. 1974. Treatment of plantar fasciitis and calcaneal spurs with the UC-BL shoe insert. Orthopaedics and Related Research, 10:57-62.

Fischer, A.A. 1986. Pressure threshold meter. Its use for quantification of tender spots. Archives Physical Medicine Rehabilitation. 67:836-837.

Fischer, A.A. 1987. Pressure threshold measurement for diagnosis of myofascial pain and evaluation of treatment results. The Clinical Journal of Pain. 2:207-214.

Fischer, L.D. and van Belle,G. (1993). Biostatistics: A Methodology for the Health Sciences. John Wiley and Sons: New York.

Gatterman, M.I. 1990. Chiropractic Management of Spine Related Disoders. Maryland: Williams and Williams. 473p. ISBN 0-683-03438-3.

Gorden, G.M. 1984. Podiatric Sports Medicine: evaluation and prevention of disease. Clinical Podiatry, 1:401-416.

Jensen, M.P., Karol,P. and Barver,F. 1986. The measurement of clinical pain intensity: A comparison of six methods. Pain, 27:117-126.

Kellet,J. 1986. Grading system for plantar fasciitis. Medicine and Science in Sports and Exercise. 18 (5):189.

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

Leach, R.E., Jones, R. and Silvia, T. 1978. Rupture of the plantar fascia in athletes. Journal of Bone and Joint Surgery (America). 60:537-539.

Leach, R.E., Seavey, M.S. and Sulter, D.K. 1986. Results of surgery in athletes with plantar fasciits. Foot and Ankle. 7:156-161.

Magee, D.J., 1992. Orthopaedic physical assessment. 2nd ed. Philadelphia, Pennsylvania: Harcourt Brace Jovanovich, Inc. 655 p:568. ISBN 0-7216-4344-2.

Moore, K.L. 1984. Clinically oriented anatomy. Second Edition. Baltimore, USA, Williams and Wilkins. 1101p: 500. ISBN 0-683-06132-1.

Nield, S., Davis, K., Latimer, J., Maher, C. and Adams, R. 1993. The effect of manipulation on range of movement at the ankle joint. Scandinavian Journal of Rehablilitative Medicine, 25: 161-166.

Polkinghorn, B.S., 1995. Posterior calcaneal subluxation: An important consideration in chiropractic treatment of plantar fasciitis (heel spur syndrome). Chiropractic Sports Medicine, 9:44-51.

Power analysis website: UCLA :-
http:/www.edu/calculators/powercalc/normal.

Ryan, J. 1995. Use of posterior night splints in the treatment of plantar fasciitis. American Family Physician, 52:891-897.

Saag, K.G, Saltzman, C.L, Brown and C.K, Budman-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.

Scofield, A.G.Chiropractice: The science of specific spinal adjustment. London. Thorsons publishers Ltd. P222 (no ISBN number available)

Snider, M.P., Clancy, W.G. and McBeath, A.A. 1983. Plantar fascia release for chronic plantar facsiitis in runners. American Journal of Sports Medicine, 11:215-219.

Tanner, S.M. and Harvey, J.S. 1988. How We Manage Plantar Fasciitis. The Physician and Sportsmedicine, 16(8) 39-47.

Viljoen, D.A. [s.a.] 1998. The treatment of chronic plantar fasciitis and achilles tendinosis by maintaining dorsoflexion of the ankle with the use of a night splint. p:27. (Unpublished paper)

Wapner, K.L and Sharkey, P.F. 1991. The Use of Night Splints for Treatment of Recalcitrant Plantar Fasciitis. Foot and Ankle, 12(3):135-136.

Wolgin, M., Cook, C., Graham, C. and Mauldin, D.1994. Conservative Treatment of Plantar Heel Paon: Long-Term Follow-Up. Foot and Ankle, 15(3):97-102.

Youdas, J.W., Bogard, C.L. and Suman, V.J. 1993. Reliability of Goniometric Measurements and Visual Estimates of Ankle Joint Active Range of Motion Obtained in a Clinical Setting. Archives of Physical Medicine and Rehabilitation, 74: 1113-1118.

APPENDIX 1

Grading system for severity of Plantarfasciits:

1.) Grade 1

Mild pain in an area, especially when stress is applied. Local tenderness may or may not be present. Does not interfere with sports or other activities.

2.) Grade 2

Moderate pain, disappearing with exercise, not interfering with any activities.

3.) Grade 3

The person notices pain during activity and usually has to stop. Pain is present the whole time and is moderate to severe when the injury is stressed. The injury is associated with tenderness and swelling on palpation.

4.) Grade 4

Complete or near rupture or avulsion of at least a portion of a ligament or tendon. Severe to excruciating pain associated with swelling and tenderness on palpation and preventing participation in sports or other activities.

Kellet,J. 1986. Grading system for plantar fasciitis. Medicine and Science in Sports and Exercise,18(5):189.

APPENDIX 2: INFORMED CONSENT FORM

(To be completed in duplicate by patient/subject*) *Delete whichever is not applicable.

TITLE OF RESEARCH PROJECT:

The relative effectiveness of anterior night splints and a combination of anterior night splints and manipulation of the foot and ankle joints in the treatment of plantar fasciitis.

NAME OF SUPERVISOR:

Dr James Brantingham

NAME OF RESEARCH STUDENT:

Cheryl Morris

PLEASE CIRCLE THE APPROPRIATE ANSWER

1. Have you read the patient information sheet? YES / NO
2. Have you had an 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)

PARENT/GUARDIAN* Name _____ Signature _____
(in block letters)

WITNESS Name _____ Signature _____
(in block letters)

RESEARCH STUDENT Name_____ Signature _____
(in block letters)

APPENDIX 3: **Patient Information Sheet**

Dear Patient

Welcome to my Research Project. You have been selected to take part in this study as you have plantar fasciitis in your foot/feet.

As you are aware your treatment will be free of charge.

You will be randomly allocated to one of the two treatment groups by means of throwing a dice. Both groups will receive treatment for plantar fasciitis. There will be no placebo involved in either treatment.

Group A will wear the anterior night splint on the symptomatic foot upon retiring to bed each evening and will sleep in the device. The subjects in this group will have 6 consultations spanning two weeks for treatment and evaluation of the condition. After the two week period is up, a one month follow up visit will be scheduled to assess longterm results.

Group B will receive identical treatment to Group A with the exception of having their foot adjusted at each office visit.

You will not be allowed to receive any other form of treatment for your plantar fasciitis for the duration of your treatment at the chiropractic clinic, and this includes the administration of any analgesics or anti-inflammatory drugs. You are expected to rest from active sports activities during the treatment period so as not to injure yourself further and impede your healing.

There are no known risks to the treatment offered in this project but the benefits include a decrease in pain and discomfort in the foot and a return of normal mechanical functioning following treatment.

I ask you to be honest at this stage in the process in so far as your participation in this study as the night splints are very costly. If there is any reason you feel you are not suitable for this study please inform me now. If you drop out of the study before its completion, you will be required to return the night splint.

If you have any questions please do not hesitate to ask me for clarification.

Yours sincerely

Cheryl Morris (Chiropractic Resident)

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:_____ Date: _____
file #:_____ X-Ray#:_____
Age:_____ Sex:_____ Occupation:_____
Intern:_____ Signature:_____

FOR CLINICIAN'S USE ONLY
Initial visit clinician:_____Signature:_____

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

Case Status:

PTT: Conditional: Signed Off: Final Sign out:

Recommendations:

Intern's Case History

1. Source of History:

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

3. Present Illness:

- Location
- Onset
- Duration
- Frequency
- Pain (Character)
- Progression
- Aggravating Factors
- Relieving Factors
- Associated S & S
- Previous Occurrences
- Past Treatment and 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
- Environmental Hazards (Home, School, Work)
- Safety Measures (seat belts, condoms)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication
- 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

TECHNIKON NATAL

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:

TECHNIKON NATAL

Foot and ankle regional examination

Patient:_____File no:_____Date:_____
Intern:_____signature:_____
Clinician:_____signature:_____

Observation

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

_____

_____

Swelling_____
Heloma dura_____
Skin_____
Nails_____
Shoes_____

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*_____

Special tests

Anterior drawer test_____
Talar tilt_____
Thompson test_____
Homan sign_____
Tinel's sign_____
Subtalar neutral position_____
Balance/proprioception_____
Test for rigid/flexible flatfoot_____

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_____

APPENDIX 7

NRS 101 SCALE

Questionnaire to be filled out at home each morning upon rising from bed. This scale will measure the perceived pain on a scale of 1 - 10. Please complete this on each day for the duration of the treatment.

SCALE	SEVERITY
0	NO PAIN
1	-
2	SLIGHT PAIN
3	-
4	MILD PAIN
5	-
6	MODERATE PAIN
7	-
8	SEVERE PAIN
9	-
10	UNBEARABLE PAIN

Revised version of the NRS 101 SCALE used by D.A Viljoen.
Viljoen, D.A. [s.a.], The treatment of chronic Plantar Fasciitis and Achilles Tendinosis by maintaining dorsoflexion of the ankle with the use of a Night Splint. pp:27.

APPENDIX 8

FOOT FUNCTION INDEX

INSTRUCTIONS: Please fill in a value somewhere between 0 and 10 describing your pain.
0 indicates no pain and 10 indicates the worst pain.
If the question is not applicable then indicate this by writing N/A next to it.

Section A:

Worst pain	0 1 2 3 4 5 6 7 8 9 10
Morning pain	0 1 2 3 4 5 6 7 8 9 10
Pain walking barefoot	0 1 2 3 4 5 6 7 8 9 10
Pain walking with shoes	0 1 2 3 4 5 6 7 8 9 10
Pain standing with shoes	0 1 2 3 4 5 6 7 8 9 10

Section B: Can you:

Walk in the house	0 1 2 3 4 5 6 7 8 9 10
Walk outside	0 1 2 3 4 5 6 7 8 9 10
Climb stairs	0 1 2 3 4 5 6 7 8 9 10
Descend stairs	0 1 2 3 4 5 6 7 8 9 10
Stand on tip toe	0 1 2 3 4 5 6 7 8 9 10
Get up from a chair	0 1 2 3 4 5 6 7 8 9 10
Climb curbs	0 1 2 3 4 5 6 7 8 9 10

Section C: Do you have to:

Stay inside all day ?	Yes / No
Stay in bed all day ?	Yes / No

Budman-Mak,E, Conrad,K.L, Roach,K.E. 1991 The foot function index: A measure of foot pain and disability. Journal of Clinical Epidemiology. 44 (6):561-570.

APPENDIX 9 ALGOMETER & GONIOMETER READINGS.

PATIENT NAME:_____ FILE NO:_____

DAY	ALGOMETER READING	GONIOMETER READING
1		
DAY 7		
DAY 14		
1 MONTH FOLLOW UP		