

THE EFFECTIVENESS OF ULTRASOUND  
THERAPY AS AN ADJUNCT TO THE TREATMENT  
OF MEDIAL TIBIAL STRESS SYNDROME TYPE II  
(SHIN SPLINTS).

by

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Technology: Chiropractic, at Technikon Natal.

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## DEDICATION

This dissertation is dedicated to my mother Patricia van Lingen  
and my parents Michael and Elza van Lingen.

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## ABSTRACT

Very few studies of medial tibial stress syndrome type II address the treatment of the condition. There is a need to find a method of hastening the recovery of the condition. Therefore the objective of this study was to determine whether application of ultrasound therapy to medial tibial stress syndrome type II would influence the recovery of this condition.

It was hypothesised that application of ultrasound would hasten the recovery of medial tibial stress syndrome type II.

This randomised clinical trial consisted of an experiment group of fifteen patients. Treatment consisted of reducing the aggravating and perpetuating factors and ten treatments of ultrasound therapy. The fifteen control patients received the same care but the ultrasound unit was not active.

The subjective results were assessed using the Numerical Pain Rating Scale, a Pain Disability Index and a McGill Short Form Pain Questionnaire. The objective results were obtained from pressure algometer readings. Data was collected at the initial treatment, the final treatment and a follow up treatment one month after the last treatment.

The results were analysed statistically within each group using the non-parametric Wilcoxin signed rank test and between the two groups using the Mann Whitney U-test.

Patients in both groups improved through the treatment. Subjectively the patients in the control group improved more between the final and follow up treatments. Objectively however there was no statistical difference between the two groups. All tests were done at the  $\alpha = 0.05$  level of significance

The results rejected the hypothesis that the group receiving ultrasound therapy would recover faster. The conclusion is that ultrasound therapy is not an effective adjunct for the treatment of medial tibial stress syndrome type II.

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## **GLOSSARY**

### **Shin Splints:**

Any exercise related lower limb pain.

### **Medial Tibial Stress Syndrome Type II:**

Pain or discomfort along the distal two thirds of the medial tibia as a result of inflammatory periostitis or chronic periostalgia. The pain is present only during activity and may be reproduced clinically as localised palpatory tenderness along the posteromedial edge of the distal one third of the tibia. (Michael and Holder, 1985)

### **Placebo:**

Any sham medical treatment having no specific pharmacological or physical effect against the patient's illness or complaint given solely for the psychophysiological effects of the treatment so that the specific and non-specific effects of the experiment may be distinguished.

### **Subjective Changes:**

Those changes personally perceived by the patient and reported to the practitioner and noted in the Numerical Pain Rating Scale, the McGill Short Form Pain Questionnaire and the Pain Disability Index.

**Objective Changes:**

Those changes observed in the level of tenderness experienced by the patient as measured by the algometer and noted by the practitioner.

**Algometer:**

An instrument used to determine pain threshold. It is calibrated in kilograms per square centimetre. The instrument and its use will be described later (Appendix D).

**Patient Education:**

These are specific instructions given to the patient to modify his or her lifestyle and or the perpetuating factors of the condition.

## *Chapter One*

### INTRODUCTION

This study deals with medial tibial stress syndrome type II or periostitis of the medial tibial insertion of the soleus muscle. The aim of this study is to determine whether ultrasound therapy is an effective adjunctive therapy to hasten recovery of this condition.

“Shin splints” is a vague term that has been used to describe any form of exercise-induced lower leg pain. It commonly affects runners, aerobic dancers and military recruits. The type of shin pain or “shin splints” dealt with in this study was described by Mubarak *et al.* (1982) as medial tibial stress syndrome. Dettmer (1986) further classified medial tibial stress syndrome into three components according to the tissue involved:

- Type 1: Bone: stress reactions and stress fractures.
- Type 2: Periosteal – fascial junction: Periostitis.
- Type 3: Muscular tissue and its compartments.

Medial tibial stress syndrome type II has also been referred to as soleus syndrome, as the resultant periostitis has been localised to the medial insertion of the soleus muscle (Michael and Holder, *et al.* 1985).

The condition often affects men and women who are active athletically. Studies have shown that six percent of all running injuries occur in the tibial region (Marti *et al.* 1988). Medial tibial stress syndrome commonly affects athletes

participating in strenuous and repetitive activities such as tennis, running, volleyball, basketball and long jumping (Mubarak et al. 1982).

The condition responds poorly to treatment and the treatment of choice seems to be rest with a gradual return to sporting activities (Detmer 1986). Taping, arch supports and changing shoes also seem to help (Mubarak et al. 1982). Conservative care is successful in approximately 90 % of the cases although surgery is indicated if there is failure of conservative care with a rest period of two months (Detmer 1986). A cost-effective method of hastening recovery during this period of diminished activity is therefore desirable. Elite athletes will also benefit immensely from a hastened treatment protocol as they often develop shin splints during the increased training load associated with pre-race peaking when they can least afford to reduce their training. (Noakes 1992: 458)

There is a need for studies that will shed some light on whether ultrasound therapy can supplement exercise therapy (Gam and Johannsen 1995). Ultrasound is used to stimulate repair of soft tissues and has been used to hasten bone healing particularly in the early inflammatory stages (Dyson and Brookes 1983 and Hasson et al. 1990). This study aims to determine whether or not ultrasound is a useful clinical adjunct in hastening recovery from medial tibial stress syndrome type II.

## LITERATURE REVIEW

### 2.1 Introduction

The purpose of this literature review is to:

- Summarise the current facts and theories on medial tibial stress syndrome type II.
- Outline the current treatment and management thereof.
- Elucidate the need for a treatment modality to hasten the healing process.
- Demonstrate the possible value of therapeutic ultrasound in hastening the recovery of the condition.

### 2.2 Terminology

"Shin splints" has been commonly used as a description of exercise-induced lower limb pain during the last two decades. The term "shin splints" is however only a description and not a diagnosis, as it is broadly used to describe any leg pain associated with exercise. The term "shin splints" encompasses several separate clinical entities each affecting different structures and each with a different mechanism of injury, treatment and management. These include compartment syndromes, tendonitis, myositis, stress fractures, periostitis (Michael and Holder 1985), venous disease, obliterative arterial disease and neurological pain (Styf 1988).

Slocum (1966) suggested that this had happened because a lay term was accepted into medical literature and has assumed medical diagnostic

significance. He therefore suggested removing the term “shin splints” from generalised use as a catchall phrase. This was done by providing a definition of the term as a “sterile mechanical inflammation of the muscle-tendon unit brought about by overexertion of the muscles of the lower part of the leg during weight bearing”. This was important in order to differentiate shin splints from conditions that may simulate it in order to allow empiric methods of treatment. He also suggested that the terminology was confusing as the term “shin” was vague and could be used to describe any area between the knee and ankle (Slocum 1966). Slocum however did not suggest a more appropriate name or an improvement to the classification of lower leg pain.

Further studies have focused on the clarification of this misleading terminology. There have been a number of recent studies on shin splints emphasising the diagnosis, cause and classification (Mubarak et al. 1982, Michael and Holder 1985, Detmer 1986 and Styf 1988). These studies have either been very specific, focusing on one cause of lower limb pain e.g. Michael and Holder’s study of the soleus syndrome (1985), or more generally in an attempt to provide clarity of all types of exercise induced lower limb pain (Mubarak et al. 1982, Detmer 1986 and Styf 1988).

The term medial tibial stress syndrome was first used in 1982 by Mubarak et al. to describe an exercise induced periostial reaction of the distal posterior-medial aspect of the tibia.

In order to aid the diagnosis, Styf (1988) suggests classifying exercise induced lower limb pain as either anterolateral or posteromedial according to the location of the symptoms. Styf (1988) recognises the term medial tibial stress



syndrome and classifies it under posteromedial lower leg pain; he does not provide a further classification.

Detmer (1986) provides a useful method of classification by dividing posteromedial tibial pain into three types depending upon the primary structures involved:

- Type I: bony injury including local stress reactions and stress fractures:
  - Type I-A or a discrete cortical stress fracture.
  - Type I-B a stress microfracture or stress reaction of varying length along the tibia.
- Type II: periostalgia at the periostial-fascial junction posterior to the tibial edge.
- Type III: posterior compartment syndromes of the distal deep compartment.

Medial tibial stress syndrome type II or periostalgia from chronic avulsion of the periosteum at the periostial-fascial junction has also been termed the soleus syndrome as the site of the injury corresponds to the medial origin of the soleus muscle (Michael and Holder, et al. 1985).

## **2.3 Pathology**

### **2.3.1 Site**

The injury typically occurs at the posterior medial border of the tibia at the medial origin of the soleus muscle and its fascial attachments. Radionuclide bone scans of patients with medial tibial stress syndrome revealed long, linear radiotracer uptake along one third of the medial posterior border of the tibia which corresponds to the medial origin of the soleus muscle. The tibialis posterior muscle was shown not to be implicated as was previously thought,

thus ruling this muscle out as a possible cause of medial tibial stress syndrome (Michael and Holder, et al. 1985)

### **2.3.2 Mechanism**

Detmer (1986) proposes the mechanism of injury to be as a result of the periosteum becoming traumatically disengaged from the bone. This is either a result of ballistic avulsion of the periosteum from the bone or less frequently due to subperiosteal bone stress on the tibial edge resulting in subperiosteal bone haemorrhage that causes the periosteum to be lifted away from the bone. (Detmer 1986)

This periosteal avulsion is thought to be as a result of the powerful contractions of the soleus muscle at the site of the medial insertion of the soleus muscle (Michael and Holder, et al. 1985). In electromyographic studies the medial soleus muscle has been shown to be a plantar flexor and heel inverter and thus resisting heel pronation would result in traction stress at the medial origin of the soleus. (Detmer 1986, Michael and Holder, et al. 1985)

Histologically it has been shown that there is increased inflammatory change in the fascia and underlying bone. Bone biopsies from the medial edge of the tibia of patients suffering from medial tibial syndrome revealed that there was increased tissue metabolic activity in 22 of 35 biopsies, this was evident as increased osteoblast activity, vascular ingrowth and an increased osteoid area. Inflammatory changes were also noted in 13 of 33 soft tissue biopsies with one biopsy revealing periosteal involvement. This was evident as focal aggregation of lymphocytes, histocyte and mast cell infiltration of small arteries. (Johnell, et al. 1982)

Other studies have also revealed inflammation and vasculitis (Mubarak *et al.* 1982) periostitis and new bone formation (Michael and Holder, *et al.* 1985).

Detmer (1986) however found arterial hypertrophy in only one case out of ten biopsies and saw no evidence of inflammation or vasculitis; he did however note adipose tissue between the periosteum and underlying bone. He suggests that this represents periostalgia as a result of stretched and avulsed periosteal fibres causing periosteal elevation rather than periostitis. (Detmer, 1986)

## **2.4 Aetiology**

The soleus inserts on the posterior aspect of the calcaneus via the tendo calcaneus (Moore 1985). Studies have shown that the medial soleus inserts on the medial aspect of the calcaneus. This results in an elongation of the muscle when the heel is pronated. Electromyographic studies have shown that the medial half of the soleus muscle acts as a plantar flexor and a heel inverter (Michael and Holder, *et al.* 1985). Viitasalo and Kvist (1983) showed that the achilles tendon angle is greater and there is increased pronation in the subtalar joint in patients with "shin splints" than in patients without "shin splints". Their conclusion was that the excess pronation resulted in an eccentric contraction of the soleus muscle, stressing the insertion on the medial tibial border.

Individual active and passive testing of the tibialis posterior, flexor hallucis longus and flexor digitorum longus muscles, the other muscles possibly implicated in medial tibial stress syndrome type II, was pain free for normal and symptomatic patients. Standing on tiptoes to test the soleus muscle

resulted in the symptomatic patients suffering varying degrees of pain. (Michael et al. 1985)

That the soleus muscle is the major contributor toward medial tibial stress syndrome and that the tibialis posterior can be excluded as a cause of medial tibial stress syndrome, is supported by a study completed on 50 cadavers. On dissection it was determined that the muscle attachments that coincided with medial tibial stress syndrome were:

- The soleus.
- The flexor digitorum longus.
- The deep crural fascia.

(Beck and Ostering, 1994)

Rearfoot pronation results in an increased traction of the soleus muscle as the soleus resists heel pronation. This results in increased traction on the soleus muscle and it's insertion and possible eccentric contraction during activity. The net result being a traction avulsion of the periosteum along the posterior medial tibial border at the site of the origin of the soleus muscle. (Detmer 1983, Viitasalo and Kvist, 1983)

#### **2.4.1 Overpronation:**

In a study of 25 dancers suffering from medial tibial stress syndrome, it was found that there was a higher incidence of forefoot and hindfoot varus amongst the symptomatic subjects. The researchers concluded that hyperpronation of the subtalar joint might be the most important factor in patient's suffering medial tibial stress syndromes. (Sommer and Vallentyne, 1995)

A comparative study involving long distance runners and orienteers showed that injured athletes had greater passive mobility with respect to inversion, eversion and their sum when compared to uninjured runners. The study also indicated that there may be an elongated pronation time in injured runners. (Viitasalo and Kvist, 1983)

Factors that may influence overpronation include:

- An externally rotated hip.  
Causes the lower limb to be externally rotated and therefore prevents proper toe off, and as a result, the foot overpronates during stance phase when the foot is weight bearing.
- Adduction of the lower limb across the midline.  
Causes a functional overpronation.
- Camber of the training surface.  
Causes a functional overpronation of the elevated foot.
- Leaning associated with track running.  
Causes a functional overpronation of the inside foot.
- Collapsed soles of training shoes.  
Results in decreased support and possible medial compression of the sole. The shoe then loses support and results in overpronation.
- Hypermobile feet.  
Excessive mobility in the subtalar and talar joints are associated with lower limb injuries and can cause overpronation.

(Noakes, 1992: 457-458; Reid, 1992 276-277,)

#### **2.4.2 Associated Factors**

In a study by Myburgh et al. (1988) several factors were found to be associated with shin soreness in athletes:

- Inadequate calcium uptake.
- Excessive subtalar and talar joint mobility.
- Sudden increase in training intensity.
- Exercising in worn shoes.

(Myburgh et al. 1988)

Factors that were not associated with injury include:

- Exercising on hard surfaces.
- Tight calf muscles.
- Increased body mass.
- Menstrual Irregularity.
- The number of months of weight bearing exercise.

(Myburgh et al. 1988)

The study focussed on all types of shin pain and was not specific to medial tibial stress syndrome type II. It did however, support the notion that the biomechanics of the subtalar and talar joints and factors that influence such biomechanics are implicated in lower limb injuries.

#### **2.5 Incidence and Prevalence**

People involved in ballistic sports i.e. jumping or powerful contraction of the soleus muscle are most likely to be afflicted (Michael and Holder, et al. 1985, Viitasalo and Kvist 1983, Detmer 1986). This includes runners, sprinters, hurdlers, gymnasts, dancers, basketball players, aerobic dancers, tennis players,

volleyball players and long jumpers (Michael and Holder et al. 1985, Viitasalo and Kvist 1983, Detmer 1986). In a study of over 4000 runners, 20 % had sustained running injuries severe enough to terminate training and 6% of those reported an injury to the medial tibial region (Marti et al. 1988).

## **2.6 Diagnosis**

According to Detmer (1986), medial tibial stress syndrome type II is a chronic condition. The condition is termed chronic if the symptoms reappear after the patient has undergone sufficient rest to completely resolve the symptoms and if the symptoms persist despite conservative treatment.

### **2.6.1 Symptoms**

The pain and tenderness is localised to the distal two thirds of the medial border of the tibia at the junction of the periosteum and fascia (Detmer 1986, Mubarak et al. 1982).

### **2.6.2 Signs**

The pain is exacerbated by weight bearing or physical activity and relieved by rest and may be severe enough to prevent the patient from continuing exercise (Detmer 1986). The pain may recur promptly after periods of rest and is described as a dull ache or persistent pain (Detmer 1986, Mubarak et al. 1982).

### **2.6.3 Physical Findings**

Palpation along the distal medial two thirds of the tibia just posterior to the bone at the junction of the periosteum and fascia produces maximum tenderness (Detmer, 1986). The tenderness is well localised and is often more pronounced if examined immediately after exercise (Mubarak et al. 1982). Contracting the soleus muscle by having the patient stand on tiptoes may cause

discomfort (Michael and Holder, 1985). There are no sensory, motor or circulatory changes (Mubarak et al. 1982). Excess pronation or excess subtalar and talar joint motion are often associated with the condition (Mubarak et al. 1982, and Sommer and Vallentyne 1995).

#### **2.6.4 Special Investigations**

Plain film X-rays may or may not reveal anything. The condition is evident as diffuse cortical thickening and periosteal thickening over the medial tibia. Bone scans may reveal no abnormalities especially in the early stages though diffuse uptake may be evident a few weeks after the patient is symptomatic. Plain film X-ray and bone scans may be utilized to exclude stress fractures and the presence of tumours. (Detmer, 1986, Mubarak et al. 1982)

Three – phase radionuclide bone scanning does show linear radiotracer uptake along the posterior medial tibial border in the delayed phase (Michael and Holder, 1985).

Intramuscular compartment pressures of the posterior compartments are normal and are not required to diagnose medial tibial stress syndrome type II (Mubarak et al. 1982).

### **2.7 Management**

A conservative approach of rest and correcting training and equipment errors is usually successful in treating the condition in the early stages (Detmer, 1986). After the condition becomes more established i.e. after repetitive episodes or when the symptoms become severe, it may respond poorly to treatment (Detmer, 1986 and Mubarak, 1982). Medial tibial stress syndrome type II may respond poorly to the following forms of treatment:



- Aspirin, phenylbutazone and non-steroidal anti-inflammatories (NSAIDS) (Detmer, 1986 and Mubarak, 1982).
- Xylocaine or steroid injections (Detmer, 1986 and Mubarak, 1982).
- Orthotics, arch supports and heel pads (Detmer, 1986 and Mubarak, 1982).
- Stretching (Detmer, 1986 and Mubarak, 1982).
- Immobilisation and taping (Mubarak, 1982).

Detmer (1986) reports that treatment of medial tibial stress syndrome type II once it has become well established includes:

- Rest (helpful in 90 % of cases).
- Orthotics (helpful in 25 % of cases).
- Taping (helpful in 40 % of cases).
- NSAIDS (helpful in 50 % of cases).

Arch supports and a change of shoes are helpful (Mubarak et al. 1982). Patients also respond very well to deep posterior fasciotomy (Detmer, 1986, Mubarak et al. 1982). Ninety three percent of the patients that underwent surgery were functioning better than their preoperative status, three months following surgery (Detmer, 1986). In one study two patients were reluctant to have this procedure repeated on the contralateral side even after successful treatment of the contralateral limb (Mubarak et al. 1982). This was not reflected in Detmer's (1986) study where two patients returned for surgery when the contralateral limb developed symptoms.

### **2.7.1 Medication:**

The use of nonsteroidal anti-inflammatory drugs (NSAIDS) may be beneficial in reducing the pain and inflammation, but it is recommended that the full course and dosage be taken and that the treatment not be given for longer than

six weeks. NSAIDS should also not be used as the sole source of treatment unless in very mild cases (Reid, 1992: 278).

### **2.7.2 Correction of Aetiological Factors:**

Once the major causes resulting in an increased stress load and thus the symptomatology of medial tibial stress syndrome have been isolated, (see 2.3.2 Increased stress) steps may be taken to reduce the effect of these causes. Increased training loads can be reduced in frequency, intensity and duration until the patient recovers and then a more gradual and controlled increase in training may commence. Noakes (1992: 459-460) advises that beginning runners incorporate a program of alternate running and walking in order to adapt to the initial stress that running places on the bones. He also suggests that novices be advised to avoid overstriding and pushing off with their toes. Activities such as jumping in volleyball, dancing and gymnastics should be reduced to minimum and running may also be substituted with cycling or running in the pool (Reid, 1992: 279).

Downhill running is a possible cause for medial tibial stress syndrome. Examining athletes' shoes is recommended. Worn out or collapsed shoes should be replaced and track runners might have to substitute spikes for softer soled shoes initially. New shoes should be examined for compatibility with the runners' biomechanics. It is particularly important that overpronators wear shoes that resist pronation. Hard unyielding training surfaces may be modified by encouraging training on grass or trails. Running on the opposite side of the road or running in the opposite direction on a track may also reduce training stress. (Noakes 1992: 459-460)

### **2.7.3 Orthosis:**

Orthosis helps prevent overpronation and reduce stress of the tibia, particularly in patients with more severe pronation. Often using a softer-soled shoe with an arch support will help runners with mild pronation (Noakes, 1992: 459), but Reid (1992: 279) warns against unnecessary permanent orthoses where a temporary orthosis will suffice.

### **2.7.4 Physical Modalities:**

The use of ice is widely employed as a treatment modality for all sports injuries following the guideline of Rest, Ice, Compression and Elevation (R.I.C.E.). Treatment should be administered for a duration of at least twenty minutes up to three times a day. Ice therapy or cryotherapy may include ethyl chloride spray, ice packs, direct ice massage or immersion in ice water. (Reid, 1992: 278-279)

No studies exist demonstrating the effects of ultrasound on medial tibial stress syndrome type II. As well there is disagreement over the use of ultrasound as a therapeutic modality for this condition. Allen (1990: 148-150) suggests that ultrasound is unhelpful and may even aggravate the condition. Reid (1992: 279) however suggests its use.

Two studies examining the literature on therapeutic ultrasound in the treatment of musculoskeletal conditions have shown that there is a need for well conducted clinical trials of ultrasound therapy. The studies show that the use of ultrasound therapy is based largely on empirical evidence and not on clinically controlled trials. (Falconer et al. 1990 and Gam and Johannsen 1995)

Dyson and Brookes (1982) found that ultrasound therapy stimulated bone regrowth of fractured femurs in adult female Wistar rats. The treatment was most effective in the early inflammatory and proliferative stages of bone regrowth. They also found that treatment at 1.5 MHz is more effective than at 3.0 MHz all other parameters being the same.

Ultrasound therapy has also been shown to accelerate the restoration of normal muscle performance after exercise thus reducing the amount of delayed onset muscle soreness (Hasson et al. 1990).

The therapeutic effects of ultrasound are attributed to thermal or heating effects and mechanical effects. These effects are said to reduce inflammation, accelerate haematoma resorption, reduce muscle pain and spasm, promote healing and increase the extensibility of scars and musculoskeletal conditions such as athletic injuries. The heating effect of ultrasound may also block or slow down the conduction of sensory nerves particularly the small nerve fibres resulting in pain relief (Burns and McDiarmid, 1987; Falconer et al. 1990; Kahn 1994; Reid, 1992: 37-40).

The recommended dose to maximally reduce inflammation and promote healing is to use pulsed ultrasound of two milliseconds on, eight milliseconds off, at 0.5 watts cm<sup>2</sup> giving a spatial average intensity of 0.1 watts cm<sup>2</sup>. For acute and sub-acute conditions treatment of three or more times a week for 10 minutes is recommended (Burns and McDiarmid, 1987; Kahn 1994; Reid, 1992: 42-44, 278).

Ultrasound therapy is contraindicated in the following instances:

- Over gonads or a pregnant uterus

- On malignancies, precancerous lesions or tissues damaged by radiation therapy
- Vascular diseases: deep vein thrombosis and atherosclerosis
- Haemophiliacs
- Cardiac area in advanced heart disease
- Near pacemakers
- Acute infections
- Fluid filled cavities or the eyes
- Subcutaneous major nerves and cranium
- Prolonged treatment of the epiphyseal plates
- Around metal and plastic implants
- Spinal cord after laminectomy
- Anaesthetised areas or when the patient is unable to feel heat (the development of pain during treatment is strongly contraindicated).

(Dyson, 1985 and Kahn, 1994)

Other treatment modalities that may be of benefit in the treatment of medial tibial stress syndrome type II include interferential therapy and short wave diathermy (Reid, 1992: 278-279, Allen, 1990: 148-150).

#### **2.7.5 Summary:**

Rest has been shown as the most effective form of treatment of medial tibial stress syndrome type II (Detmer, 1986). Active measures in treating medial tibial stress syndrome type II include isolating the causative factors and then modifying their influence on the patient and in so doing, reduce their effect (Detmer, 1986). Once the patient has recovered, caution should be exercised to avoid a recurrence of the condition. Treatment for medial tibial stress syndrome type II is to primarily reduce the pain and inflammation by use of ice or NSAIDS (Detmer, 1986). Ultrasound therapy may accelerate the recovery process by reducing inflammation, increasing haematoma reabsorption and promoting healing (Burns and McDiarmid, 1987; Falconer et al. 1990; Kahn

1994; Reid, 1992: 37-40). This would then provide the therapist with a tool to hasten the recovery of this condition.

## MATERIALS AND METHODS

### **3.1 The Objective**

This placebo controlled study proposed to investigate the effects of ultrasound therapy on patients presenting with medial tibial stress syndrome type II. This will be done in terms of the patients' subjective response to the treatment as well as the measurable physical findings in order to establish efficacy of ultrasound therapy as an adjunct in the management of medial tibial stress syndrome type II.

### **3.2 The Research Methodology**

#### **3.2.1 Subjects**

A sample of thirty patients diagnosed with medial tibial stress syndrome type II was accepted into the study.

The sample group was obtained by advertising in local newspapers and on the local radio station. Pamphlets and flyers were used at local gyms and sports clubs and distributed through local running club's newsletters. Patients were also obtained via referral and word-of-mouth from other patients.

Approximately 60 subjects were interviewed by telephone prior to and during the project with respect to receiving treatment for medial tibial stress syndrome type II. Appointments were made for 39 of the subjects that seemed likely



candidates for research, and of these, 34 were admitted into the study. Three subjects did not complete the scheduled 10 treatments and one subject was non compliant due to illness. The remaining thirty subjects completed the research protocol satisfactorily.

### **3.2.2 Allocation of the Subjects**

The subjects admitted to the study were randomly assigned to one of two groups. The randomisation took place by placing thirty cards into a hat, 15 marked "experimental" and 15 marked "placebo". Before the study commenced all the cards were drawn and the order in which they were drawn determined which group the subjects were assigned to.

### **3.2.3 Standards of Acceptance**

At the initial consultation all the subjects underwent a detailed case history (Appendix H), a general physical examination (Appendix I) and a regional examination (Appendix J). Patients exhibiting the following contra-indications to ultrasound were excluded from the study (Burns and McDiamid 1987):

- Malignancies, precancerous lesions or tissue damaged by radiation therapy.
- Vascular disease: deep venous thrombosis and atherosclerosis.
- Haemophiliacs
- Acute infections
- Fluid-filled cavities
- Metal or plastic implants
- Anaesthetised areas or when the patient was unable to feel heat



The patients then underwent a regional foot examination (Appendix J) and were examined for the signs and symptoms of medial tibial stress syndrome type II. Patients that were diagnosed with medial tibial stress syndrome type II were accepted into the study.

Patients that fell within the research parameters were then informed as to the nature of the study and were told that they might receive a simulated form of treatment. The subjects then signed a written consent form (Appendix B) before taking part in the study.

#### **3.2.4 Interventions**

The subjects accepted into the study completed the numerical pain rating scale (Appendix F), the McGill Short Form Pain Questionnaire (Appendix G) and the pain disability index (Appendix E) under the researcher's supervision. An algometer reading (Appendix C) was taken from the subject. The first part of the study commenced where the patient was treated according to the treatment group to which the subject had been assigned. The patient was treated for five treatments, on the sixth visit the patient was reassessed using the numerical pain rating scale, the McGill short form pain questionnaire, the pain disability index and algometer readings. If the patient made a full recovery within the first five treatments the results were noted and the patient then underwent a four week, no treatment period before the patient was reassessed according to the method described above and then released from the study.

After 10 treatments i.e. at the 11th visit the patients were reassessed according to the numerical pain rating scale, pain disability index, McGill short form pain questionnaire and algometer readings.

This was followed by a four week no treatment period, after which the patient was again reassessed according to the method described above at which stage the patients were released from the study.

The treatment for the experimental group consisted of application of ultrasound therapy and reducing perpetuating factors through patient education. Ultrasound therapy was administered by a Sonoplus 436 made by Enraf Nonius (E.N.G. 12 Pb, ERA 5 cm<sup>2</sup>, BMR max 6 watts/cm<sup>2</sup>). The subjects each received 10 treatments. The treatment time was five minutes per affected limb. A one MHz applicator head set at 0.5 watts cm<sup>2</sup> and pulsed at two milliseconds on and eight milliseconds off was used. Ultrasound gel was used as a coupling agent.

The placebo group consisted of fifteen subjects. The subjects also received patient education regarding perpetuating factors. The placebo consisted of a simulated therapy for five minutes with the ultrasound machine rendered inoperative (the timer was set but the ultrasound machine was switched off before the treatment commenced). The placebo patient also received 10 sham treatments.

### **3.3 Measurement and Observations**

#### **3.3.1 The Data**

The data was in two forms, primary data and secondary data.

### *3.3.1.2 The Primary Data*

Four types of primary data:

- The patients' response to the numerical pain rating scale (Appendix F).
- The patients' response to the pain disability index (Appendix E).
- The patients' response to the algometer reading (Appendix C) at the region of tenderness on the medial tibial border.
- The patients' response to the McGill Short Form Pain Questionnaire (Appendix G).

### *3.3.1.3 The Secondary Data*

The published documentation and accepted theories on medial tibial stress syndrome and ultrasound therapy.

## **3.3.2 Method of Measurement**

### *3.3.2.1 Subjective Measurement*

#### *A. Pain Disability Index (Appendix E)*

The pain disability index was used to give the researcher an indication of how the pain was affecting the patient's lifestyle. The patient's response was noted at the initial visit, after five and 10 treatments and at the one month follow up. The questionnaire comprised five questions. The patient was required to respond to the question on a scale of one to 10. A score of one meant no disability at all and 10 meant the pain completely prevented the patient from that activity. The result was the sum of the scores expressed as a percentage of the total of 50.

### *B. Numerical Pain Rating Scale (NRS 101) (Appendix F)*

The questionnaire was used to determine the subjective pain intensity experienced by the patient. The patient's response was noted at the initial visit, after five and 10 treatments and at the one month follow up. The patient was asked to note down their perceived level of pain on a numerical scale of zero to 100, with zero representing no pain at all and 100 representing pain at its worst. The number noted represented the patient's level of pain intensity.

The Numerical Pain Rating Scale (NRS – 101) has been shown to be simple, effective and the recommended choice in a study comparing six methods of measuring clinical pain intensity (Jenson et al. 1986).

### *C. McGill Short Form Pain Questionnaire (Appendix G)*

The questionnaire assesses the sensory dimension of the pain experienced by the patient (Melzack and Katz 1992). The questionnaire was derived from the McGill long form pain questionnaire and consisted of a list of 15 words that describe pain. Each description was ranked on an intensity scale: 0 = none, 1 = mild, 2 = moderate, 3 = severe (Melzack and Katz 1992).

The short form pain questionnaire compares closely to the long form of the questionnaire and is considered to be a reliable and consistent subjective measuring device (Melzack and Katz 1992).

### *3.3.2.2 Objective Measurement*

#### *A. Algometer Readings*

In order to measure the tenderness at the medial tibial border, a pressure algometer was used. The algometer was used to quantify palpatory pain findings over bone and consists of a force dial, which reads in kilograms and a

one-centimetre diameter rubber-tipped stylus. Pain threshold was determined by the amount of force per square centimetre required for a person to first perceive pain. (Fischer, 1986)

### **3.4 Statistical Analysis**

#### **3.4.1 The Sub problems**

##### *3.4.1.1 The First Sub problem*

The first sub problem is to evaluate the effects of ultrasound therapy of medial tibial stress syndrome type II, with respect to the patient's subjective response to the treatment in order to establish the subjective effectiveness of ultrasound therapy.

##### *3.4.1.2 The Second Sub problem*

The second sub problem is to evaluate the effects of ultrasound therapy of medial tibial stress syndrome type II with respect to the measurable physical changes that may or may not occur, in order to determine the objective effectiveness of ultrasound therapy.

##### *3.4.1.3 The Third Sub problem*

The third sub problem is to integrate the subjective and objective data generated in order to determine the viability of ultrasound therapy as an adjunct to the treatment of medial tibial stress syndrome type II.

### **3.4.2 Treatment of the Data**

#### *3.4.2.1 Treatment of the Subjective Data*

The questionnaires were examined to assess whether they had been correctly completed and then the results transferred to a spreadsheet. These results then underwent statistical analysis.

#### *3.4.2.2 Treatment of the Objective Data*

The algometer readings were transferred to a spreadsheet and then underwent statistical analysis.

### **3.4.3 Statistical Analysis of the Data**

The data was analysed statistically using Statgraphics Plus Version 6. The following tests were used:

- The Mann-Whitney U tests between the experimental and control groups.
- The Wilcoxon's signed rank test within the experimental group and within the control group.
- Summary statistics and bar charts.

#### *3.4.3.1 Non-Parametric Unpaired Tests*

##### *The Subjective Data*

The Mann-Whitney U-Test was used to analyse the data obtained from the questionnaires of the control and experimental groups. Data from the initial consultation, the final consultation and the follow up consultation was used. The level of significance was determined by analysing the results from the control and the experimental group.

##### *The Objective Data*

The Mann-Whitney U-Test was used to analyse data obtained from the algometer readings of the control and experimental groups. Data from the

initial consultation, the final consultation and the follow up consultation was used. The level of significance was determined by analysing the results from the control and the experimental group.

#### *3.4.3.2 Non-Parametric Paired Tests*

##### *The Subjective Data*

The Wilcoxon's signed rank test was used to analyse data within the control and experimental groups. Data from the questionnaires taken at the initial consultation, the final consultation and the follow up consultation was used. The level of significance was determined by analysing the results of these consultations as follows:

- The initial consultation and the final consultation;
- The initial consultation and the follow up consultation;
- The final consultation and the follow up consultation.

##### *The Objective Data*

The Wilcoxon's signed rank test was used to analyse data within the control and experimental groups. Data from the algometer readings taken at the initial consultation, the final consultation and the follow up consultation was used. The level of significance was determined by analysing the results of these consultations as follows:

- The initial consultation and the final consultation;
- The initial consultation and the follow up consultation;
- The final consultation and the follow up consultation.

## *Chapter Four*

### THE RESULTS

This chapter deals with the results and statistical analysis of the data obtained from the:

- Numerical Pain Rating Scale 101
- The McGill Short Form Pain Questionnaire
- The Pain Disability Index
- The Algometer Readings

#### **4.1 The Criteria for the Admissibility of the Data**

- Data was only collected from compliant patients.
- All questionnaires were completed under the supervision of the researcher.
- The algometer readings were measured and recorded by the researcher.
- All treatment was done by the researcher.

#### **4.2 Demographic Data Obtained from the Patients' Files**

Table 4.1: Age Distribution

	<b>Control</b>	<b>Experiment</b>	<b>Total</b>
<b>15-19</b>	1	0	1
<b>20-24</b>	6	6	12
<b>25-29</b>	3	5	8
<b>30-34</b>	0	3	3
<b>35-39</b>	2	0	2
<b>40-44</b>	1	0	1
<b>45-49</b>	0	0	0
<b>50-55</b>	2	1	3



Table 4.2: Gender Distribution

	Control	Experiment	Total
Male	7	7	14
Female	8	8	16

Table 4.3: Race Distribution

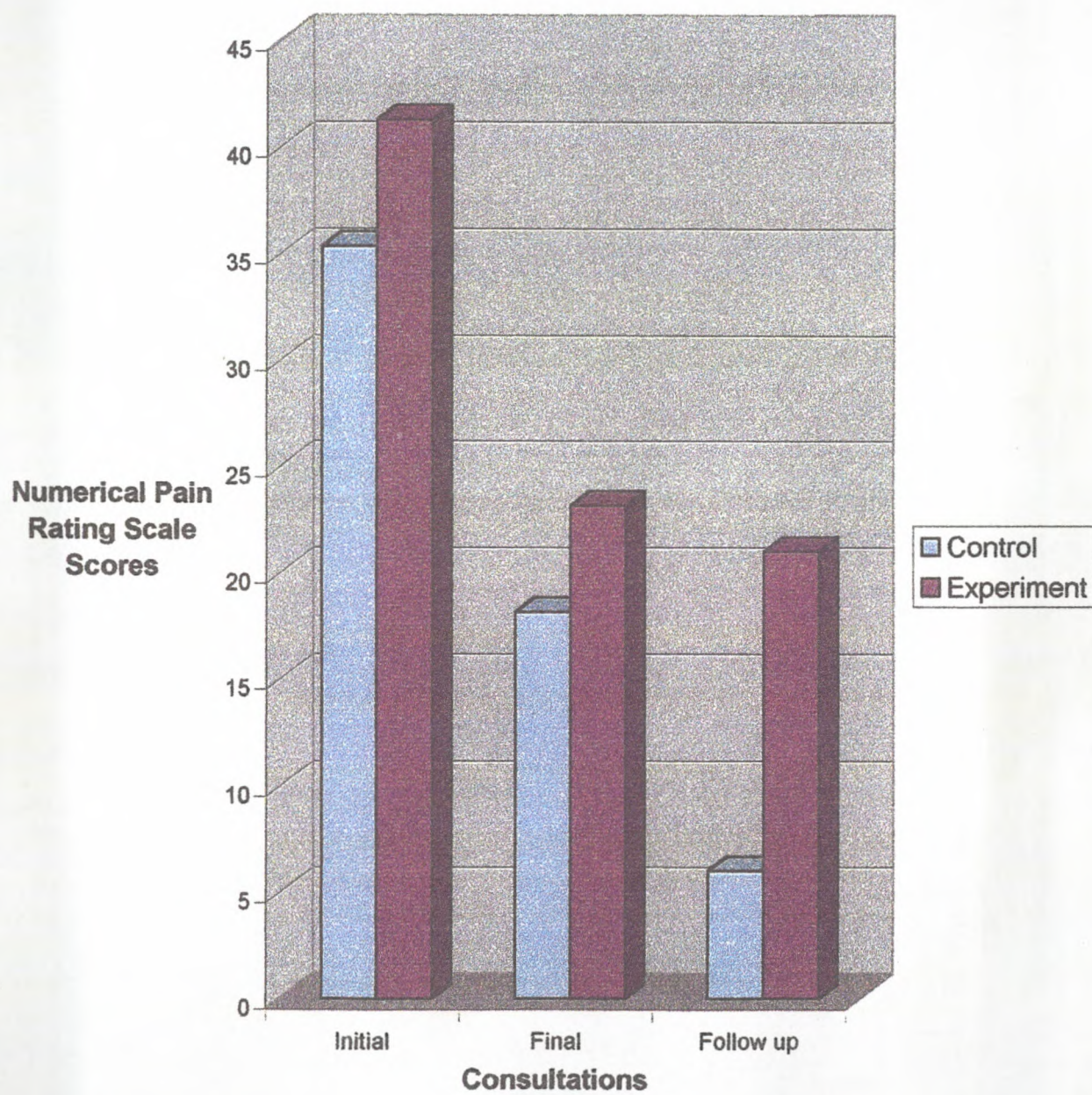
	Control	Experimental	Total
Black	1	0	1
Indian	0	1	1
White	14	14	28

Table 4.4: Sport Distribution

	Control	Experiment	Total
Aerobics	1	1	2
Cricket	0	1	1
Runner	9	11	20
Sedentary	3	1	4
Walker	2	1	3

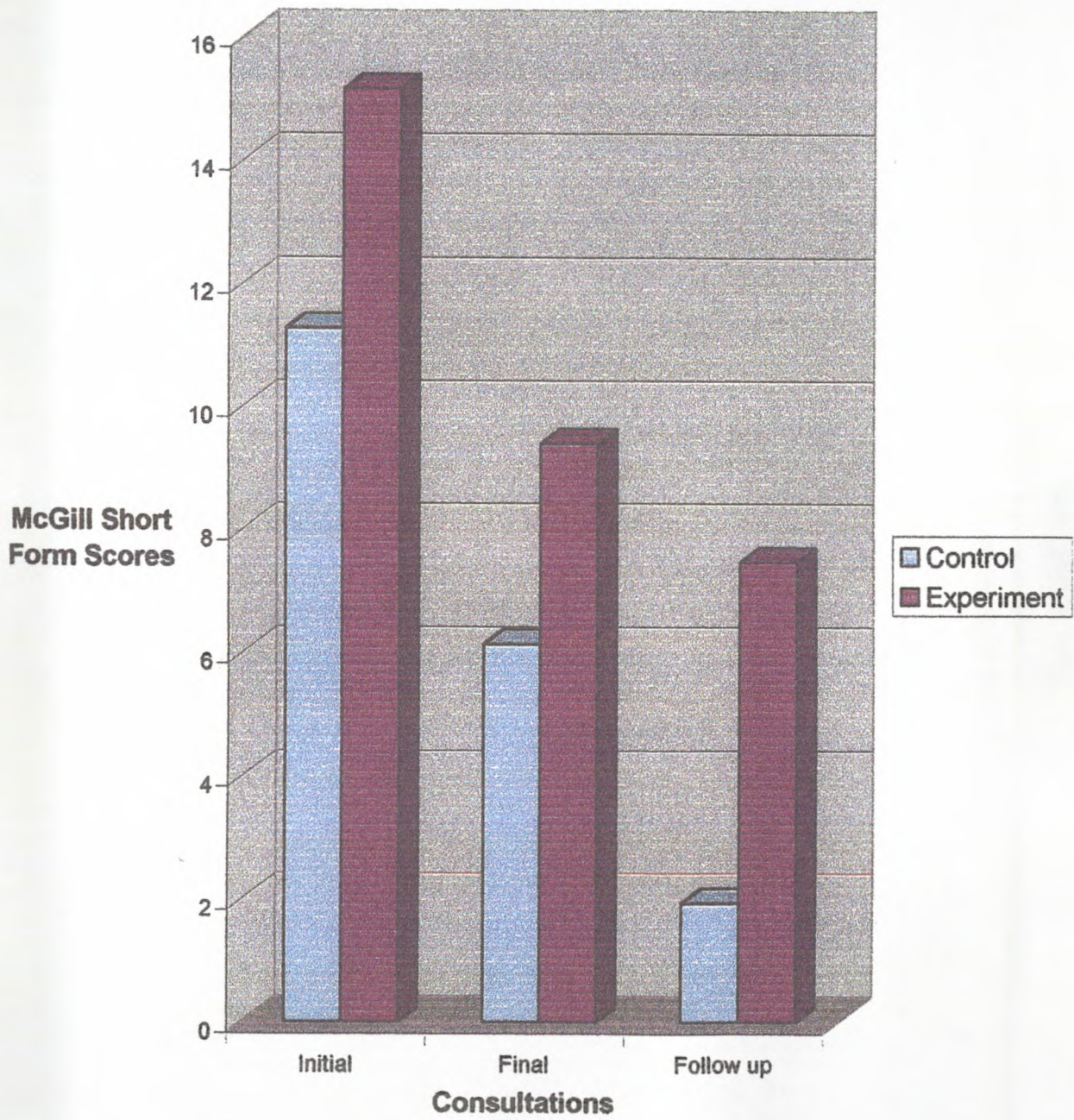
Some other patients used in studies of lower limb exercise-induced leg pain include aerobic dancers, ballet dancers, racquetball players, field hockey players and basketball players (Myburgh *et al.* 1988), folk dancers (Sommer and Vallentyne, 1995), swimmers, runners and physical labourers (Styf, 1988).

**Table 4.5 Numerical Pain Rating Scale**



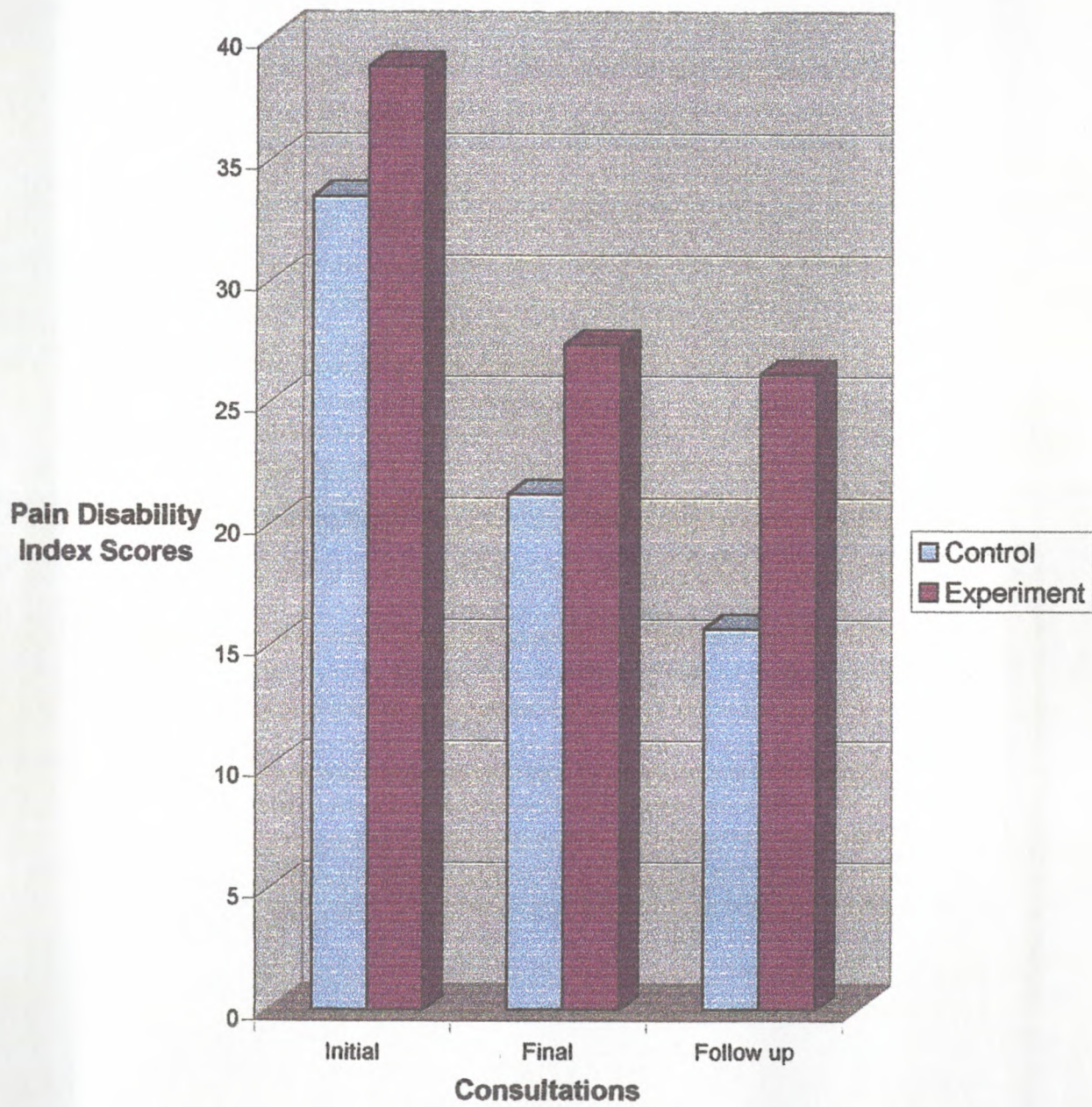


**Table 4.6: McGill Short Form Pain Questionnaire**



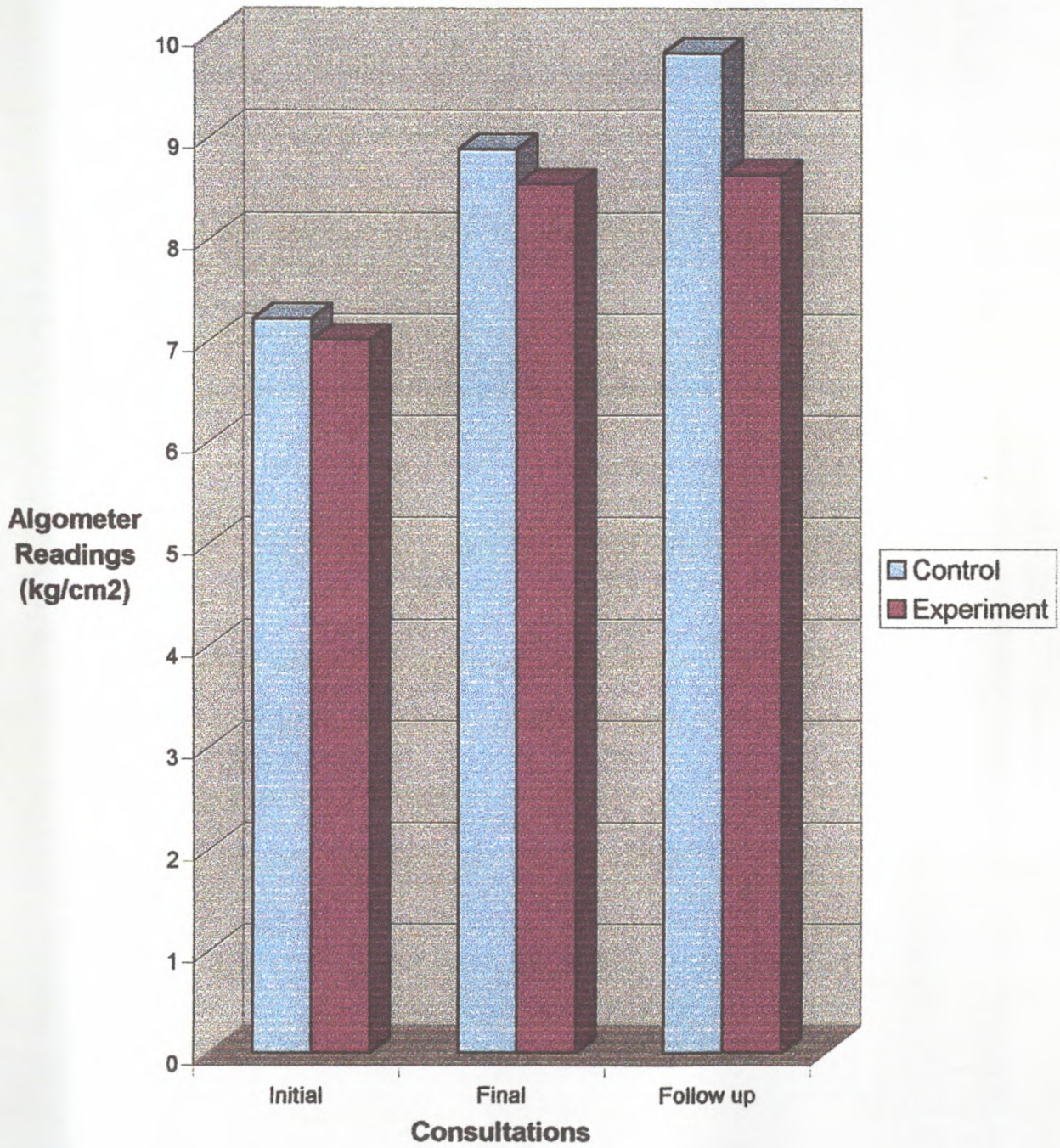


**Table 4.7: Pain Disability Index**





**Table 4.8: Algometer Readings**



### 4.3 Tabulation of Results

#### 4.3.1 Comparison of Control and Experimental Group

The hypotheses were as follows:

$H_0$ : There is no significant difference between the control and experimental group.

$H_1$ : There is a significant difference between the control and experimental group.

$\alpha = 0.05$  or a 5% level of significance

The  $H_0$  was rejected if  $P \leq \alpha$

The  $H_0$  was accepted if  $P > \alpha$

##### 4.3.1.1 Numerical Pain Rating Scale

The Mann-Whitney Unpaired test was used to assess the mean values of the Numerical Pain Rating Scale between the control and experimental groups. The initial treatments, the final treatments and the follow up consultations were compared.

Table 4.9 Inter-treatment Analysis Numerical Pain Rating Scale

	Control	Experiment	P-value	Statistical Significance
<b>Initial</b>	13.6 (13.4)	17.4 (10.3)	0.1210515	No Significance
<b>Final</b>	14.17 (12.5)	16.8333 (15.5)	0.207953	No Significance
<b>Follow up</b>	11.57 (9.5)	19.4333 (16.9)	0.0051655	Significant Difference

Standard Deviation in Brackets

The  $H_0$  hypothesis was accepted for the initial and final consultation, indicating that there was no statistical significance between the results of the Numerical Pain Rating Scale for the control and experimental groups during the initial and final consultation.

The  $H_0$  hypothesis was rejected for the follow up consultation, indicating that there was a statistical significance between the results of the Numerical Pain Rating Scale for the control and experimental groups at the follow up consultation.

The standard deviation for the experimental group shows a tendency to increase through the treatments indicating a wider range of scores. The opposite occurs for the control group, indicating that the readings for the control group may be less influenced by very high or low scores.

#### *4.3.1.2 The McGill Short Form Pain Questionnaire*

The Mann-Whitney Unpaired test was used to assess the mean values of the McGill Short Form Pain Questionnaire between the control and experimental groups. The initial treatments, the final treatments and the follow up consultations were compared.

Table 4.10 Inter-treatment Analysis McGill Short Form Pain Questionnaire

	<b>Control</b>	<b>Experiment</b>	<b>P-value</b>	<b>Statistical Significance</b>
<b>Initial</b>	12.8 (4.6)	18.2 (5.7)	0.0479502	Significant Difference
<b>Final</b>	13.9333 (4.98)	17.0667 (7.5)	0.168283	No Significance
<b>Follow up</b>	11.4667 (3.5)	19.5333 (7.3)	0.0046726	Significant Difference

Standard Deviation in Brackets

The  $H_0$  hypothesis was accepted for the final consultation, indicating that there was no statistical significance between the results of the McGill Short Form

Pain Questionnaire for the control and experimental groups during the final consultation.

The  $H_0$  hypothesis was rejected for the initial and follow up consultation, indicating that there was a statistical significance between the results of the McGill Short Form Pain Questionnaire for the control and experimental groups at the initial and follow up consultations.

The standard deviation again shows a tendency to increase from the initial to the final treatment for the experimental group and a decrease between the initial and follow up for the control group although the standard deviation is low, indicating a low range of scores.

#### *4.3.1.3 The Pain Disability Index*

The Mann-Whitney Unpaired test was used to assess the mean values of the Pain Disability Index between the control and experimental groups. The initial treatments, the final treatments and the follow up consultations were compared.

Table 4.11 Inter-treatment Analysis Pain Disability Index

	Control	Experiment	P-value	Statistical Significance
<b>Initial</b>	14.1 (1.4)	16.9 (2)	0.1967865	No Significance
<b>Final</b>	14.1 (2)	16.9 (2.2)	0.1956145	No Significance
<b>Follow up</b>	11.7667 (1.9)	19.2333 (2.1)	0.0092813	Significant Difference

Standard Deviation in Brackets

The  $H_0$  hypothesis was accepted for the initial and final consultation, indicating that there was no statistical significance between the results of the Pain Disability Index for the control and experimental groups during the initial and final consultation.



The  $H_0$  hypothesis was rejected for the follow up consultation, indicating that there was a statistical significance between the results of the Pain Disability Index for the control and experimental groups at the follow up consultation.

The standard deviation in both cases is very low indicating a very close range for the Pain Disability Index scores and shows little change through the treatments thus emphasising the difference in pain disability of the two groups at the follow up treatment.

#### 4.3.1.4 The Algometer Readings

The Mann-Whitney Unpaired test was used to assess the mean values of the Algometer Readings between the control and experimental groups. The initial treatments, the final treatments and the follow up consultations were compared.

Table 4.12 Inter-treatment Analysis Algometer Readings

	Control	Experiment	P-value	Statistical Significance
<b>Initial</b>	16.8 (13.3)	14.2 (14.4)	0.2151435	No Significance
<b>Final</b>	15.9667 (12.4)	15.0333 (16.6)	0.3935555	No Significance
<b>Follow up</b>	17.8333 (9.1)	13.1667 (14.3)	0.0761475	No Significance

Standard Deviation in Brackets

The  $H_0$  hypothesis was accepted for the initial, final and follow up consultation, indicating that there was no statistical significance between the results of the Algometer Readings for the control and experimental groups during the initial, final and follow up consultation.

The experimental group shows no real change as far as standard deviation is concerned, while the control group shows a general decrease of the standard deviation, indicating a closer range of scores towards the end of the study.

#### 4.3.2 Comparison of treatments within the Control Group

The hypothesis were as follows:

$H_0$ : There is no significant difference between the treatments within the control group.

$H_1$ : There is a significant difference between the treatments within the control group.

$\alpha = 0.05$  or a 5% level of significance

The  $H_0$  was rejected if  $P \leq \alpha$

The  $H_0$  was accepted if  $P > \alpha$

##### 4.3.2.1 Numerical Pain Rating Scale

The Wilcoxon's signed rank test was used to assess the mean values of the Numerical Pain Rating Scale to compare treatments within the control group. The initial and final treatments, the initial and follow up treatments and the final and follow up treatments were compared.

Table 4.13 Intra-treatment Analysis Numerical Pain Rating Scale

	P-value	Statistical Significance
Initial and final	0.000512	Significant Difference
Initial and Follow Up	0.0001503	Significant Difference
Final and Follow Up	0.000437	Significant Difference

The  $H_0$  hypothesis was rejected for the comparison between the initial and final, the initial and follow up and the final and follow up consultations, indicating that there was a statistical significance between the results of the treatments for the Numerical Pain Rating Scale.

#### *4.3.2.2 McGill Short Form Pain Questionnaire*

The Wilcoxon's signed rank test was used to assess the mean values of the McGill Short Form Pain Questionnaire to compare treatments within the control group. The initial and final treatments, the initial and follow up treatments and the final and follow up treatments were compared.

Table 4.14 Intra-treatment Analysis McGill Short Form Pain Questionnaire

	<b>P-value</b>	<b>Statistical Significance</b>
<b>Initial and final</b>	0.0009729	Significant Difference
<b>Initial and Follow Up</b>	0.0001503	Significant Difference
<b>Final and Follow Up</b>	0.0007481	Significant Difference

The  $H_0$  hypothesis was rejected for the comparison between the initial and final, the initial and follow up and the final and follow up consultations indicating that there was a statistical significance between the results of the treatments for the McGill Short Form Pain Questionnaire.

#### *4.3.2.3 Pain Disability Index*

The Wilcoxon's signed rank test was used to assess the mean values of the Pain Disability Index to compare treatments within the control group. The initial and final treatments, the initial and follow up treatments and the final and follow up treatments were compared.

Table 4.15 Intra-treatment Analysis Pain Disability Index

	<b>P-value</b>	<b>Statistical Significance</b>
<b>Initial and final</b>	0.0016417	Significant Difference
<b>Initial and Follow Up</b>	0.000256	Significant Difference
<b>Final and Follow Up</b>	0.03522	Significant Difference

The  $H_0$  hypothesis was rejected for the comparison between the initial and final, the initial and follow up and the final and follow up consultations, indicating that there was a statistical significance between the results of the treatments for the Pain Disability Index.

#### *4.3.2.4 Algometer Readings*

The Wilcoxon's signed rank test was used to assess the mean values of the Algometer Readings to compare treatments within the control group. The initial and final treatments, the initial and follow up treatments and the final and follow up treatments were compared.

Table 4.16 Intra-treatment Analysis Algometer Readings

	<b>P-value</b>	<b>Statistical Significance</b>
<b>Initial and final</b>	0.0194334	Significant Difference
<b>Initial and Follow Up</b>	0.0009729	Significant Difference
<b>Final and Follow Up</b>	0.150849	No Significance

The  $H_0$  hypothesis was rejected for the comparison between the initial and final and the initial and follow up consultations, indicating that there was a statistical significance between the results of the treatments for the Algometer Readings.

The  $H_0$  hypothesis was accepted for the comparison between the final and follow up consultations indicating that there was no statistical significance between the results of the treatments for the Algometer Readings.

#### 4.3.3 Comparison of treatments within the Experimental Group

The hypothesis were as follows:

$H_0$ : There is no significant difference between the treatments within the experimental group.

$H_1$ : There is a significant difference between the treatments within the experimental group.

$\alpha = 0.05$  or a 5% level of significance

The  $H_0$  was rejected if  $P \leq \alpha$

The  $H_0$  was accepted if  $P > \alpha$

##### 4.3.3.1 Numerical Pain Rating Scale

The Wilcoxon's signed rank test was used to assess the mean values of the Numerical Pain Rating Scale to compare treatments within the experimental group. The initial and final treatments, the initial and follow up treatments and the final and follow up treatments were compared.

Table 4.17 Intra-treatment Analysis Numerical Pain Rating Scale

	P-value	Statistical Significance
Initial and final	0.0027728	Significant Difference
Initial and Follow Up	0.000256	Significant Difference
Final and Follow Up	0.133628	No Significance

The  $H_0$  hypothesis was rejected for the comparison between the initial and final and the initial and follow up consultations indicating that there was a statistical significance between the results of the treatments for the Numerical Pain Rating Scale.

The  $H_0$  hypothesis was accepted for the comparison between the final and follow up consultations indicating that there was no statistical significance between the results of the treatments for the Numerical Pain Rating Scale.

#### 4.3.3.2 McGill Short Form Pain Questionnaire

The Wilcoxon's signed rank test was used to assess the mean values of the McGill Short Form Pain Questionnaire to compare treatments within the experimental group. The initial and final treatments, the initial and follow up treatments and the final and follow up treatments were compared.

Table 4.18 Intra-treatment Analysis McGill Short Form Pain Questionnaire

	<b>P-value</b>	<b>Statistical Significance</b>
<b>Initial and final</b>	0.0009729	Significant Difference
<b>Initial and Follow Up</b>	0.0016417	Significant Difference
<b>Final and Follow Up</b>	0.150849	No Significance

The  $H_0$  hypothesis was rejected for the comparison between the initial and final and the initial and follow up consultations indicating that there was a statistical significance between the results of the treatments for the McGill Short Form Pain Questionnaire.

The  $H_0$  hypothesis was accepted for the comparison between the final and follow up consultations, indicating that there was no statistical significance between the results of the treatments for the McGill Short Form Pain Questionnaire.

#### 4.3.3.3 Pain Disability Index

The Wilcoxon's signed rank test was used to assess the mean values of the Pain Disability Index to compare treatments within the experimental group. The initial and final treatments, the initial and follow up treatments and the final and follow up treatments were compared.

Table 4.19 Intra-treatment Analysis Pain Disability Index

	<b>P-value</b>	<b>Statistical Significance</b>
<b>Initial and final</b>	0.0049116	Significant Difference
<b>Initial and Follow Up</b>	0.0907245	No Significance
<b>Final and Follow Up</b>	0.386413	No Significance

The  $H_0$  hypothesis was rejected for the comparison between the initial and final consultations, indicating that there was a statistical significance between the results of the treatments for the Pain Disability Index.

The  $H_0$  hypothesis was accepted for the comparison between the initial and follow up and the final and follow up consultations, indicating that there was no statistical significance between the results of the treatments for the Pain Disability Index.

#### 4.3.3.4 Algometer Readings

The Wilcoxon's signed rank test was used to assess the mean values of the Algometer Readings to compare treatments within the experimental group. The initial and final treatments, the initial and follow up treatments and the final and follow up treatments were compared.

Table 4.20 Intra-treatment Analysis Algometer Readings

	<b>P-value</b>	<b>Statistical Significance</b>
<b>Initial and final</b>	0.0194334	Significant Difference

<b>Initial and Follow Up</b>	0.0049116	Significant Difference
<b>Final and Follow Up</b>	0.150849	No Significance

The  $H_0$  hypothesis was rejected for the comparison between the initial and final and the initial and follow up consultations, indicating that there was a statistical significance between the results of the treatments for the Pain Disability Index.

The  $H_0$  hypothesis was accepted for the comparison between the final and follow up consultations, indicating that there was no statistical significance between the results of the treatments for the Pain Disability Index.



## DISCUSSION

### **5.1 Introduction**

This chapter will discuss the results of the subjective and objective data obtained from the questionnaires and the algometer readings. The subjective data is discussed in terms of intra- and inter-treatment analysis in order to determine the subjective efficacy of the ultrasound therapy. The objective data is then discussed according to the results of the intra- and inter-treatment analysis in order to evaluate the objective efficacy of ultrasound therapy as an adjunct to medial tibial stress syndrome type II. The limitations and recommendations of the study are then discussed.

The mean age for this study was 29 in comparison with other studies of exercise induced lower limb pain: 20.5 (Detmer, 1986), 27 (Styf, 1988), 24.6 (Mubarak et al. 1982) and (Myburgh et al. 1988). The youngest patient was 19 in comparison with 15 (Detmer 1986), and 16 (Styf, 1988) and (Mubarak et al. 1982). The oldest patient was 52 compared with, 52 (Detmer 1986), 55 (Styf, 1988), and 42 (Mubarak et al. 1982).

## 5.2 Subjective Data

### 5.2.1 Numerical Pain Rating Scale

#### *A. Intra-treatment Analysis*

Analysis of the data obtained from the mean results of the Numerical Pain Rating Scale showed that there was a significant improvement in the control group for all the groups (initial and final, initial and follow up and final and follow up). In the experimental group, however, there was no significant improvement from the last treatment to the follow up treatment indicating that once the treatment stopped, the patient stopped improving.

#### *B. Inter-treatment Analysis*

The inter-treatment analysis showed that there was a significant statistical difference between the results of the follow up treatments. The control group perceived less pain than the experimental group after treatment had ceased. This indicates that the ultrasound therapy did not help the recovery of the patients.

The standard deviation for the experimental group is greater than the control group and shows a greater increase, indicating that there is a greater range of values for the experimental group and that this range increases through the treatments. This indicates that the experimental group was under a greater influence by scores that deviated from the median. The relatively large scores (severe cases) or small scores (relatively symptom-free patients) may have swayed the results of the experimental group.

### **5.2.2 The McGill Short Form Pain Questionnaire**

#### *A. Intra-treatment Analysis*

Analysis of the data obtained from the mean results of the McGill Short Form Pain Questionnaire showed that there was a significant improvement in the control group for all the treatments (initial and final, initial and follow up and final and follow up). In the experimental group, however, there was no significant improvement from the last treatment to the follow up treatment indicating that once the treatment stopped, the patient stopped improving.

#### *A. Inter-treatment Analysis*

The inter-treatment analysis showed that there was a significant difference between the results of the initial visit and the follow up treatments. The control group again perceived less pain than the experimental group. This indicates that the average pain perception of the experimental group was higher than that of the control group at the onset of the study and again after treatment had ceased. The difference initially is probably due to the relatively small sample size (15 patients). This difference in results before the treatment de-emphasises the difference in results after the treatment as the experimental group clearly suffered more in terms of pain perception than the control group. In order to overcome this problem the sample size should have been larger in order to produce two similar treatment groups.

The standard deviation is again larger in the experimental group and again shows a tendency to increase through the treatments indicating that there were differences in the way that the patients responded to the treatment and that these differences increased through the treatment and were greater in the experimental group. This was due to a small number of patients in the

experimental group that did not respond to the treatment in the same manner as the rest of the experimental group and thus swayed the results.

### **5.2.3 The Pain Disability Index**

#### *A. Intra-treatment Analysis*

Analysis of the data obtained from the mean results of the Pain Disability Index showed that there was a significant improvement in the control group for all the treatments (initial and final, initial and follow up and final and follow up). In the experimental group, however, there was only significant improvement between the initial treatments and final treatments for pain disability, indicating that the experimental group did not improve from the initial visit to the follow up visit and between the final and follow up treatment.

#### *B. Inter-treatment Analysis*

The inter-treatment analysis showed that there was a significant difference between the results of the follow up treatments. Statistically the control group was less disabled by pain than the experimental group after treatment had ceased. Either the experimental group re-injured themselves to a greater extent than the control group or ultrasound therapy did not help their recovery. This difference is more significant in light of the low standard deviations for the scores used in the in disability index.

## **5.3 Objective Data**

### **5.3.1 Algometer Readings**

#### *A. Intra-treatment Analysis*

Both control and experimental groups showed significant improvement with regard to tenderness when compared between the initial and final treatments and between the initial and follow up treatments. However neither group showed any improvement with regard to tenderness once the treatment had ceased between the final and follow up treatment.

#### *B. Inter-treatment Analysis*

There was no significant difference between the two groups with regard to the amount of tenderness either group perceived. The relatively similar standard deviations obtained emphasise that objectively, both groups performed similarly.

## **5.4 Discussion of the Subjective and Objective Data**

### **5.4.1 The Solving of the Sub Problems**

#### *5.4.1.1 The First Sub Problem*

The McGill Short Form Pain Questionnaire revealed that the experimental group experienced more pain than the control group before the study commenced. There was however no difference between the two groups at the final treatment. Subjectively the control group fared better in their follow up treatments with regard to the scores obtained from the Numerical Pain Rating Scale, the McGill Short Form Pain Questionnaire and the Pain Disability Index, thus indicating that the control group subjectively improved more than the experimental group.

Therefore the first hypothesis, the evaluation of the effects of ultrasound therapy of medial tibial stress syndrome type II, with regard to the patients subjective response, is rejected.

#### *5.4.1.2 The Second Sub Problem*

Objectively however, the two groups performed similarly. Both groups improved from the initial treatment to the final and follow up treatment and neither group showed a significant improvement between the final and follow up treatments. There was also no objective significant difference between the two treatments. Both groups also showed similar standard deviation patterns.

The second hypothesis, the evaluation of ultrasound therapy of medial tibial stress syndrome type II with regard to the measurable physical changes that may or may not occur, in order to determine the objective effectiveness of ultrasound therapy, is rejected.

#### *5.4.1.3 The Third Sub problem*

Neither the subjective nor the objective results showed any benefit of using ultrasound therapy as an adjunctive therapy for medial tibial stress syndrome type II. The third hypothesis, the evaluation of the subjective and objective data generated in order to determine the viability of ultrasound therapy as an adjunct to the treatment of medial tibial stress syndrome type II, is rejected.

This is supported by studies of the literature that have shown negative results for the use of ultrasound in the treatment of musculoskeletal disorders. Empirical evidence does however support the use of ultrasound therapy and there have been studies showing that ultrasound is effective for these same conditions. (Gam and Johannsen 1995 and Falconer et al. 1990)

The findings of this study show that the use of ultrasound therapy does not help the recovery of patients subjectively and that there is no benefit in using ultrasound therapy as an adjunctive therapy in the treatment of medial tibial stress syndrome type II. The results may vary with different dosages and or different frequencies of treatment.

The fact that the patients ceased to improve subjectively after treatment had ceased may mean that ultrasound does not help the improvement of medial tibial stress syndrome type II of patients, or that the experimental group was closer to recovery and therefore less improvement could be expected. Another possibility is that the patients returned to their athletic activity after treatment and re-injured themselves. The researcher may also have unintentionally influenced the patients that were receiving the placebo treatment, thus resulting in a higher patient compliance.

### **5.5 Limitations of the Study**

The small sample size and the varying activities of the patients may have compromised the results of the study. The make up of the two groups differed with regard to the activities of the patients. The placebo group had fewer sedentary patients and these patients may not respond as well to treatment due to the difficulty in getting them to reduce aggravating and perpetuating factors i.e. walking. The placebo group also had more runners, which may swing the balance as these patients often respond well to limiting their training, or pronation correction. Two elite runners that developed symptoms halfway through the hillwork phase of their training were part of the placebo group. Both athletes became symptom free as soon as the hillwork phase ended. This occurred during the study and they therefore responded very well.

The placebo group also contained a cricket player that ceased playing altogether during the study with subsequent rapid improvement.



## CONCLUSIONS

### **6.1 Recommendations**

A larger sample size would increase the validity of the study and a more significant reflection of the results. The study should only use one type of patient i.e. only recreational joggers or only marathon runners doing similar training, as the recovery period differs according to activity and how that activity is modified.

Including an assessment of the lower limb with respect to range of motion especially of the subtalar and talar joints and the amount of forefoot varus or valgus would be easy to incorporate into the study at very little cost of time or money and would greatly enhance the study. The results of the treatment could then be correlated with the results of the biomechanical assessment.

Using separate examiners and therapists that were blinded to whether the patients were part of the experimental group or control group and were unaware what type of treatment they administered would also increase the significance of the study.

Further studies using ultrasound would do well to examine the effect of different dosages in terms of intensity and duration and also the size of the area treated.

## 6.2 Conclusion

Subjectively the patients in this study did not benefit from the application of ultrasound as an adjunctive therapy in the treatment of medial tibial stress syndrome type II. Indeed the recovery of the patients was limited and it would seem that the patient's recovery was limited after cessation of the treatment. This may not be an accurate reflection of the treatment as the patients may have re-injured themselves and the experimental group did contain more sedentary patients who did not respond very well to the treatment. Objectively however, there was no difference between the two treatment groups. It is important to note however that this is only applicable for the ultrasound dosage given (1MHz head, pulsed at 2/8 milliseconds at 0.5 watts/cm<sup>2</sup> for five minutes). This may differ with different doses, treatment duration and frequencies. The results of the study are therefore inconclusive but would suggest that using ultrasound for the treatment of medial tibial stress syndrome type II is not as important as correcting the aggravating and perpetuating factors. This highlights the need for further studies comparing ultrasound doses and treatment frequencies.

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## APPENDICES

### **Appendix A: Introductory Letter**

Dear Patient

Welcome to the Chiropractic Day Clinic. I am currently investigating ultrasound treatment of medial tibial stress syndrome Type II or "shin splints". At this stage it is not really known how well ultrasound treatment of shin splints actually works so your assistance will be of great value. All information in this study is strictly confidential and will not be included in the results. Please be as accurate or as correct as possible when answering any questions or filling out any forms.

Your co-operation is greatly appreciated.

Yours sincerely

Lawrence van Lingen.

## Appendix B: Patient Consent Form

Patient name:

File no.:

Date:

This is a research program comparing the effectiveness of two different treatments for medial tibial stress syndrome (shin splints). The results of this research depend almost entirely on you the patient and so your fullest co-operation would be appreciated.

This is to confirm that I ..... am willing to participate in the research being conducted by Lawrence van Lingen.

I undertake to the best of my ability to adhere to the designed program and to comply with the requests of the researcher. I also understand that all personal information is strictly confidential.

I may withdraw from the study any time I wish by notifying Lawrence van Lingen in writing.

(signed)

(witness)

(witness)

(date)



## **Appendix C: Algometer Readings**

Patient Name:

File no.:

Date:

**Initial Treatment:**

**After 10 Treatments:**

**Follow Up:**

## **Appendix D: Algometer Instructions**

(Adapted from the Activator Methods, inc. algometer instructions)

Using an algometer, pressure pain threshold is used to quantify palpatory pain findings for myofascial trigger points and pain over bone. The pressure algometer consists of a force dial which reads in kilograms and a 1 centimetre diameter rubber tipped stylus. Pain threshold is determined by the amount of force per square centimetre required for a person to first perceive pain.

The procedure and use of the algometer is first demonstrated and explained to the patient. The meter must be reset before taking the reading. The area you to be measured is then localised by palpation. The rubber tipped stylus is then placed over the tender area with the dial perpendicular to the skin surface. Steady, gentle pressure is then applied at the rate of 1 kilogram per square centimetre per second until the patient first perceives pain and responds by saying now. The stylus is then removed and the recorded value noted. (Fischer 1987)

## Appendix E: Pain Disability Index

Patient name:

File no.

Date:

The rating scales below are designed to measure the degree to which several aspects of your life are presently disrupted by pain. In other words how much your pain is preventing you from doing what you normally do, or from doing it as well as you normally would. Please respond to each question by indicating the overall impact of the pain in your life and not just when it is at its worst.

For each of the categories of activities listed, please circle the number on the scale that describes the level of disability you typically experience. A score of one (1) means no disability at all and a score of ten (10) signifies that all of the activities in which you normally be involved have been totally disrupted or prevented by your pain.

1. Family and home responsibilities. This category refers to activities related to the home and f

1 2 3 4 5 6 7 8 9 10

2. Recreation. This category includes hobbies, sports and other similar leisure time activities.

1 2 3 4 5 6 7 8 9 10

3.Social activity. This category refers to activities which involve participation with friends and ;

1 2 3 4 5 6 7 8 9 10

4.Occupation. This category refers to activities that are part of or directly related to one's job. '

1 2 3 4 5 6 7 8 9 10

5.Self care. This category includes activities which involve personal maintenance and independ

1 2 3 4 5 6 7 8 9 10

## **Appendix F: Numerical Pain Rating Scale**

Patient name:

File no.:

Date:

Please indicate on the line below the number between 0 and 10 that best describes the pain of your shin splints while exercising when it is at it's worst. A one (1) would mean "no pain at all" and ten (10) would mean "pain as bad as it could be". Please write only one number.

1.....10

## Appendix G: McGill Short Form Pain Questionnaire

Patient name:

File no.:

Date:

	NONE	MILD	MODERATE	SEVERE
1 Throbbing	0)....	1)....	2)....	3)....
2. Shooting	0)....	1)....	2)....	3)....
3. Stabbing	0)....	1)....	2)....	3)....
4. Sharp	0)....	1)....	2)....	3)....
5. Cramping	0)....	1)....	2)....	3)....
6. Gnawing	0)....	1)....	2)....	3)....
7. Hot-burning	0)....	1)....	2)....	3)....
8. Aching	0)....	1)....	2)....	3)....
9. Heavy	0)....	1)....	2)....	3)....

10. Tender	0)....	1)....	2)....	3)....
11. Splitting	0)....	1)....	2)....	3)....
12. Tiring-exhausting	0)....	1)....	2)....	3)....
13. Sickening	0)....	1)....	2)....	3)....
14. Fearful	0)....	1)....	2)....	3)....
15. Punishing-cruel	0)....	1)....	2)....	3)....

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC

Appendix H: Case History

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: TN  
Other

Current: TN  
Other

X-ray Studies:

Previous: TN  
Other

Current: TN  
Other

Clinical path. lab.:

Previous: TN  
Other

Current: TN  
Other

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 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. Family history:

Immediate family:

Age

Health

Cause of death

DM

Heart disease

TB

HBP

Stroke

Kidney disease

CA

Arthritis

Anemia

Headaches

Thyroid disease

Epilepsy

Mental illness

Alcoholism

Drug addiction

Other

8. Psychosocial history:

Home situation

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 CHIROPRACTIC DAY CLINIC**

**Appendix I: Physical Exam**

**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:	- Dorsalis pedis:
- Radio-femoral delay:	- Posterior tibial:
- Carotid:	- Popliteal:
- Radial:	- 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 & Gag reflex:
- X 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:

## FOOT REGIONAL

### History:

Appendix J: Regional Exam of shoes worn  
Effect of walking on different territories

### Observation:

- Weight bearing
- Non-weight bearing
- Standing
- Walking (Gait Analysis with and without shoes)
- Shoes

### Active movements:

Weight bearing: plantar flexion  
dorsi flexion  
supination  
pronation  
toe extension  
toe flexion

Non-weight bearing: plantar flexion  
dorsi flexion  
supination  
pronation  
toe extension  
toe flexion  
toe abduction  
toe abduction

### Passive movements:

plantarflexion talocrural joint  
dorsiflexion talocrural joint  
inversion subtalar joint  
eversion subtalar joint  
adduction of mid tarsal joint  
abduction of mid tarsal joint  
toe flexion  
toe extension  
toe adduction  
toe abduction  
Circumduction of forefoot on fixed rearfoot  
dorsiflexion of first ray  
plantarflexion of first ray  
hallux dorsiflexion  
hallux plantarflexion

### Resisted Isometric movements:

knee flexion  
plantar flexion  
dorsi flexion  
supination  
pronation  
toe extension  
toe flexion<sup>83</sup>

Functional activities:

- squatting
- standing on toes
- squat and bounce at end of squat
- standing on one foot at a time
- standing on toes of 1 foot at a time
- up and down stairs
- walk on toes
- run straight ahead
- run and twist
- jumping
- jump into a full squat

Special tests:

Alignment:

- |  |  |
|--|--|
| Anterior drawer sign                                   | - heel to leg (Subtalar Neutral)       |
| Talar tilt   | - forefoot to heel (Midtarsal Neutral) |
| Thompson test  | - Feiss line                           |
| Swing test   | - tibial torsion                       |
| Homan's sign   |  |
| Kleiger test   |  |
| Tinel's sign   |  |
| Ankle neutral position (weight and non-weight bearing) |  |
| Joint Play   |  |
| - Talocrural joint                                     | - extension                            |
|  | - A-P glide                            |
| - Subtalar joint                                       | - Talar rock                           |
|  | - side tilt - medial                   |
|  | - laterally                            |
| - Midtarsal joints                                     | - A - P glide                          |
|  | - P - A glide                          |
|  | - rotation                             |
| - Tarso-metatarsal joints                              | - A - P glide                          |
|  | - rotation                             |
| - Metatarsophalangeal and interphalangeal joints:      |  |
|  | - long axis traction                   |
|  | - A - P glide                          |
|  | - lat/side glide                       |
|  | - rotation                             |

Palpation:

- Anteriorly +
- = Ant. med:
    - med. maleoli
    - med. tarsal bones, tibial (post) artery.
  - = Anterior and Anterior laterally -
    - lat. malleolus, calcaneus, sinus tarsi and cuboid bones.
  - = Inferior Tib/fib joint, tibia, mm of the leg
  - = Ant. tibia, neck of talus, dorsalis pedis artery.

Posteriorly:

- calcaneus
- achilles tendon