

**THE RELATIVE EFFECTIVENESS OF PERIOSTEAL PECKING COMBINED
WITH THERAPEUTIC ULTRASOUND COMPARED TO THERAPEUTIC
ULTRASOUND IN THE TREATMENT OF MEDIAL TIBIAL STRESS
SYNDROME TYPE II.**

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Institute of Technology in partial compliance with the requirements for the
Master's Degree in Technology : Chiropractic**

I *Moira Eleanora Robertson* do declare that this dissertation is representative of
my own work.

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Signed: _____ Date: _____

DEDICATION

I dedicate my research to my family for all their constant support, love, motivation and for helping me become the person I am today. I would never have got this far without you.

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ABSTRACT

Medial Tibial Stress Syndrome Type II (MTSS), otherwise known as shin splints, accounts for approximately 13% of injuries in American runners. Van Mechelen (1992) reported that 37-57% of recreational runners experience an injury over the course of a year, from which 54-75% of all injuries are caused by overuse.

The American Medical Association defines shin splints as “pain and discomfort in the leg from repetitive activity on hard surfaces, or due to forceful, excessive use of foot flexors. The diagnosis should be limited to musculoskeletal inflammations excluding stress fractures and ischemic disorders.” (Thacker et al., 2002)

Treatment protocols vary from biomechanical interventions (orthotics), to non-steroidal anti-inflammatory drugs and modalities such as ultrasound all with varying degrees of success (Noakes, 2001). Apart from therapeutic interventions it is the overriding symptom of pain, which patients are left with (Noakes, 2001).

A therapeutic intervention called periosteal pecking has received increased interest with regards to symptomatic treatment of shin splints. Periosteal pecking is a form of *dry needling in which the tip of the needle contacts the periosteum (Raso,1997).

The aim of this study is to establish the effect of periosteal pecking in the clinical setting with and against that of an established intervention, namely therapeutic ultrasound.

This prospective randomised clinical trial consisted of two equal groups of 22 patients. Group A received periosteal pecking and ultrasound and was treated four times over the period of two weeks. Group B received ultrasound alone for four treatments over the period of two weeks.

* Dry Needling- is the insertion of an empty hypodermic needle to stimulate relative areas. (Birch et al.,1999).

The subjective results were assessed using the Short-form McGill Pain Questionnaire, Numerical Pain Rating Scale and the Pain Disability Scale. The objective results were obtained from the pressure algometer readings. Data was collected at the initial and final treatments.

The results were analysed statistically using the SPSS package. Within each group the non-parametric Wilcoxon Signed Rank Test was used and between the two groups the Mann-Whitney U-Test was used.

Patients in both groups improved through the treatments. Subjectively both groups improved from the initial to the final treatment. Objectively both groups improved but Group A improved significantly faster than Group B. All tests were done at the $\alpha= 0.05$ level of significance.

The results accepted the hypothesis that the group receiving periosteal pecking and ultrasound would recover faster. The conclusion is that periosteal and pecking when combined with ultrasound is more effective than ultrasound alone for the treatment for Medial Tibial Stress Syndrome Type II.

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DEFINITION OF TERMS

Shin Splints

Shin splints is a non specific term that has been applied to a variety of disorders causing pain in the lower leg.

Medial Tibial Stress Syndrome Type II

Medial Tibial Stress Syndrome Type II (MTSS), otherwise known as shin splints according to the American Medical Association is defined as “pain and discomfort in the leg from repetitive activity on hard surfaces, or due to forceful, excessive use of foot flexors. The diagnosis should be limited to musculoskeletal inflammations excluding stress fractures and ischemic disorders.” (Thacker et al. 2002).

Periosteal Pecking

Periosteal pecking is a form of *dry needling in which the tip of the needle contacts the periosteum (Raso,1997).

Contra-indication

The counterbalancing of a defect in structure or function (Redwood, 1997).

Algometer

An instrument used to determine pain threshold. It is calibrated in kilograms per square centimetre. The instrument and its use will be described in chapter 3 (Appendix K).

* Dry Needling- is the insertion of an empty hypodermic needle to stimulate relative areas (Birch et al.1999).

Subjective changes

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

Objective changes

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

MTSS Type I (Detmer, 1986)

The primary problem is the bone itself.

MTSS Type II (Detmer, 1986)

The symptoms are typically noted just adjacent to the bone at the periosteal-fascial junction.

MTSS Type III (Detmer, 1986)

The symptoms are localized over the distal, deep posterior compartment musculature.

CHAPTER ONE

1.1 INTRODUCTION

With an increase in sporting activities over the last decade there has been an increase in sports injuries, both from acute and from overuse trauma (Kannus, 1992). Stress related bone injuries are common in athletes and account for up to 10% of cases in sports medicine practice. Pain in the lower leg brought on by exercise but relieved by rest is a common complaint in athletes. Stress injuries involving the tibia account for up to 75% of exertional leg pain and encompass several clinical symptoms such as shin splints, medial tibial stress syndrome (MTSS), chronic compartment syndrome, soleus syndrome and stress fractures (Bhatt et al., 2000).

Medial Tibial Stress Syndrome Type II (MTSS), otherwise known as shin splints according to the American Medical Association is defined as “pain and discomfort in the leg from repetitive activity on hard surfaces, or due to forceful, excessive use of foot flexors. The diagnosis should be limited to musculoskeletal inflammations excluding stress fractures and ischemic disorders” (Thacker et al., 2002).

According to Bhatt et al. (2000) MTSS is characterised by exertional pain along the posteromedial border of the middle and distal thirds of the tibia. Pain is typically felt over a much more diffuse area than in stress fractures, it becomes more apparent during activity, and disappears after a variable period of rest. On clinical examination, there is diffuse extreme tenderness along the posteromedial border of the tibia, peripheral pulses are normal and no neurological changes are apparent.

MTSS Type II is described by Bennet et al. (2001) as a “periostitis at the posterior medial border of the distal tibia”. Periostitis has been defined as tearing away of the muscle fibers at the muscle-bone interface causing inflammation and pain. Therapeutic approaches have so far had little focus on resolving the periosteal component of this condition, but have rather targeted the symptomatic pain aspect of the condition. Treatment protocols vary from biomechanical interventions (orthotics), to non-steroidal anti-inflammatory drugs and modalities such as ultrasound all with varying degrees of success (Noakes, 2001). Apart from these therapeutic interventions it is the overriding symptom of pain, which patients are left with.

A therapeutic intervention called periosteal pecking has received increased interest with regards to symptomatic treatment of shin splints. Periosteal pecking is a form of *dry needling in which the tip of the needle contacts the periosteum (Raso,1997).

Multifaceted, conservative, preventative treatment protocols have focused on decreasing pain, modification of activity, the effectiveness of training surfaces, orthotics and medication in the association with the condition, but have yielded poor results. The success of periosteal pecking, in comparison to other modalities, warrants further investigation into this form of treatment, as well as investigating its effect when combined with another established treatment modality, like therapeutic ultrasound, in order to investigate a more effective treatment protocol.

The aim of this study is to establish the effect of periosteal pecking in the clinical setting with and against that of an established intervention, namely therapeutic ultrasound.

* Dry Needling- is the insertion of an empty hypodermic needle to stimulate relative areas (Birch et al. 1999).

1.2 THE PROBLEM AND IT'S SETTINGS

1.2.1 The problem statement

The purpose of this investigation is to evaluate the relative effectiveness of periosteal pecking combined with therapeutic ultrasound, compared to therapeutic ultrasound alone in the treatment of MTSS Type II.

1.2.2 The objectives

The first objective was to investigate the relative effectiveness of periosteal pecking combined with therapeutic ultrasound, compared to therapeutic ultrasound alone in terms of objective clinical findings in the treatment of MTSS Type II.

The second objective was to investigate the relative effectiveness of periosteal pecking combined with therapeutic ultrasound, compared to therapeutic ultrasound alone in terms of subjective clinical findings in the treatment of MTSS Type II.

CHAPTER TWO

2. REVIEW OF THE RELATED LITERATURE

2.1 Introduction

Shin splints is a non specific term that has been applied to a variety of disorders causing pain in the lower leg. Shin splints is a descriptive rather than a diagnostic term that encompasses exertional shin pain. Due to the multifaceted aetiology of shin splints, there is widespread controversy regarding treatment protocols for this condition.

According to the 1966 American Medical Association, shin splints is defined as “ pain and discomfort in the leg from repetitive running on hard surfaces or forcible, excessive use of foot flexors; diagnosis should be limited to the musculotendinous inflammations excluding fracture and ischeamic disorders.” According to Moore (1988) clinical evidence suggests that exertional shin pain represents a spectrum of syndromes. The terms “Medial Tibial Stress Syndrome (MTSS),” “posterior tibial tendonitis,” and “anterior shin splints” have evolved out of the effort to describe exertional shin pain more precisely.

2.2 Incidence and Prevalence

Pain in the lower leg brought on by exercise but relieved by rest is a common complaint amongst athletes, particularly after an unaccustomed increase in activity or a start of a season. Exercised-induced pain in the leg is a frequent complaint of athletes along with shin splints which is common and harmful problem among athletes who train by running hundreds of kilometers per week.

MTSS Type II^{*}, otherwise known as shin splints, accounts for approximately 13% of injuries in American runners (Drez, 1994), while Marti (1984) suggests that 6% of all running injuries occur in the tibial region. Bennett et al. (2001) found that tibial stress syndrome accounted to 10.7% of injuries in men and 16.8% in women.

A further study by Drez (1994) and Marti (1984) revealed a 4.07% incidence of shin splints in naval recruits. In runners, 70% experience injuries severe enough to keep them from running for 7 to 10 days (Reber et al., 1993). Van Mechelen (1992) reported that 37-57% of recreational runners experience an injury over the course of a year, from which 54-75% of all injuries are caused by overuse.

Thacker et al. (2002) presented a systematic review of literature into the prevention of shin splints in sports and found that shin splints accounts for 6-16% of injuries in runners and considered shin splints to be the most common cause of disabling leg pain in young competitive athletes.

2.3 Anatomy

Fatigue failure and overload can cause cellular damage in muscles and the majority of the injuries below the knee are related directly or indirectly to muscle dysfunction (Reber, 1993). The repetitive forces exerted during endurance-type activities, when combined with such other variables as inadequate recovery, biomechanical abnormalities, muscle imbalance or impaired flexibility, can exceed the capability of the muscle-tendon units of the deep posterior compartment, resulting in symptomatic injury (Moore, 1988).

-
- Type I – The primary problem is the bone itself.
 - Type II – The symptoms are typically noted just adjacent to the bone at the periosteal-fascial junction.
 - Type III – The symptoms are localised over the distal, deep posterior compartment musculature.

Bone is a living, constant changing, mineralised connective tissue which is highly vascular. It has a remarkable hardness, resilience and regenerative capacity (Matin, 1988). The entire external surface of long bones is covered by a fibrous sheet called the periosteum. The outside layer of the periosteum is fibrous and appears to be purely supportive in function. The innermost layer of the periosteum is the cambium layer, like the endosteum, it contains osteogenic cells (Oloff, 1994). It contains the ability to produce skeletal tissue (Matin, 1988).

Muscles and tendons attach to the bone by fibres of collagen known as Sharpey's fibres. These fibres are actually microscopic extensions of fibrocartilage which extend into the skeletal matrix prior to the mineralization of bone (Matin, 1988). Matin (1988) also postulated that the Sharpey's fibres extend through the periosteum into the mineralised matrix and with increased forces from the muscle or connective tissue could eventually cause local changes which result in increased bone metabolism.

According to Moore (1988) shin splints is believed to be a stress or overuse related injury to the muscle- tendon units of the deep posterior compartment or the anterior tibial compartment.

2.3.1 Compartments of the leg

The leg has four fascial compartments (Moore, 1988):

1. Anterior tibial compartment – The tibialis anterior functions as a dorsiflexor and inverter of the foot. The extensor digitorum longus and extensor hallucis longus extend the toes and assist in dorsiflexion and eversion of the forefoot.
2. Deep posterior compartment – The tibialis posterior functions as a primary plantar flexor and inverter of the foot. The flexor digitorum longus and flexor hallucis longus flex the toes and assist the primary plantar flexors.

3. Lateral compartment – The peroneus longus and peroneus brevis evert the foot and assist in plantar flexion.
4. Superficial posterior compartment – According to Hyde and Gengenbach (1996) the posterior crural compartment is divided into two groups of structures by the transverse crural intermuscular septum and functionally acts as two distinct compartments. The large soleus and the two heads of the gastrocnemius function as the primary plantar flexors of the foot.

According to Nicholas et al. (1995) the posterior calf muscles are active for about the first 80% of the stance phase. Reber et al. (1993) proposed that the posterior muscles act together in an eccentric contraction that may provide dynamic stability to the ankle joint as the centre of gravity passes over the foot. The activity begins in the last 25% of the swing phase. The muscle activity seems to control or modulate the rapid dorsiflexion activity. Nicholas et al. (1995) stated that during midstance the foot is pronated and the tibia internally rotated. As the posterior musculature is firing, the tendon may be abnormally stressed as a result of a hypermobile, pronated foot or increased heel eversion and due to weakness of the posterior muscles may contribute to inflammation.

There has been much controversy about which muscles are involved in causing MTSS. Michael and Holder (1985) and Detmer (1986) both proposed that MTSS is a consequence of traction stress on the periosteum applied by the medial arising fibres of the soleus muscle. Garth and Miller (1989) implicated the flexor digitorum longus and Saxena et al. (1990) performed a dissection study to support the theory of involvement of the tibialis posterior whereby they concluded that due to the attachment of the tibialis posterior on the distal third of the tibia it therefore was a potential contributor to MTSS. It was also suggested that the deep crural fascia, which attaches along the length of the medial border of the tibia, may produce a traction stress at the site of the symptoms of MTSS when the posterior compartments become tight with exercise (Beck, 1994).

2.3.2 Soleus

According to Travell and Simon's (1999) the soleus acts across the talocrural and the talocalcaneal (subtalar) joints. It attaches proximally to the posterior surface of the head of the fibula and to the middle third of the medial border of the tibia and to the tendinous arch between the proximal tibia and fibula. Distally it attaches to the underside of the aponeurosis, which forms part of the Achilles tendon, which in turn attaches to the posterior part of the calcaneus.

According to Michael and Holder (1985) the soleus bridge is a tough layer of investing fascia that inserts on the tibial periosteum and traction at this site may produce a periostitis, which has been demonstrated on bone biopsy.

James (1988) illustrated an aponeurosis which connects the medial aspect of the soleus muscle belly to the medial border of the tibia at a site inferior to the attachment of its muscle fibers could be a cause of symptoms of MTSS. He explained that this aponeurosis has the potential to transfer traction stress to its attachment on the medial border of the tibia during contraction or stretching of the soleus muscle.

The Functions of the soleus:

- Contributes to knee stability during gait.
- Provides ankle stability.
- Restrains forward rotation of the tibia over the fixed foot.
- It is the main dynamic and static controller of ankle plantar flexion.
- Inverts the calcaneus.
- Contracts eccentrically to limit pronation, in other words, excessive pronation increases the eccentric work of the soleus.

Innervation of the soleus muscle is the tibial nerve (S1 and S2). Symptoms caused by soleus trigger points are referred heel pain, tenderness and restricted dorsiflexion at the ankle. Referred pain primarily occurs in the posterior aspect and plantar surface of the heel and often distal to the Achilles.

2.3.3 Tibialis Posterior

According to Travell and Simon's (1999) the tibialis posterior is the most deeply located muscle in the calf. It lies between the interosseus membrane anteriorly and the soleus muscle posteriorly. Proximally it attaches primarily to the interosseous membrane and the medial surface of the fibula; it also attaches to the posterior surface of the body of the tibia, the deep transverse fascia and to intermuscular septa of the adjacent muscles. Beck et al. (1994) explains that it is easy to mistake the inferior attaching muscle fibers as originating on the tibia rather than on the interosseous membrane.

The tibial attachment of the muscle commonly continues into the distal third of the leg as far as the crossing of the tibialis posterior tendon with that of the flexor digitorum longus. The two tendons pass behind the medial malleolus together but in separate sheaths.

Distally it anchors to the plantar surface of most of the bones that form the arch of the foot, primarily the navicular but also to the calcaneus, each cuneiform, the cuboids and the base of the 2nd, 3rd, 4th metatarsals.

The Functions of the tibialis posterior:

- Prevents excessive pronation of the foot in midstance.
- Prevents excessive weight bearing on the medial side of the foot.
- Distributes weight among the heads of the metatarsals.
- Supinator of the foot.
- Assists in plantar flexion of the foot.

Innervation of the tibialis posterior muscle is the tibial nerve (L5 and S1). Symptoms caused by active trigger points of the tibialis posterior include pain on the sole of the foot when running or walking. Pain is felt in the arch of the foot, Achilles tendon and the heels, toes and calf.

2.3.4 Flexor Digitorum Longus

According to Travell and Simon's (1999) the flexor digitorum longus muscle lies on the back of the tibia deep to the soleus and gastrocnemius and medial to the tibialis posterior. The proximal attachment is to the posterior surface to the middle two-quarters of the tibia, beginning distal to the soleus attachment and including the intermuscular septum that is shared with the tibialis posterior muscle. The tendon passes behind the medial malleolus in a groove shared with the tibialis posterior but in separate compartments and synovial sheaths. As the tendon approaches the navicular bone and passes into the sole of the foot, it crosses superficial to the flexor hallucis longus tendon. Distally each of the four tendons attach to the base of the distal phalanx of its corresponding lesser toe.

Functions of the flexor digitorum longus:

- Maintains equilibrium when body weight is on the forefoot.
- Helps stabilize the foot and ankle during midstance and late stance phase of walking.
- Flexion of the distal phalanges.
- Controlling movements of the foot in the sagittal and frontal plane.

Innervation of the flexor digitorum longus is the tibial nerve (L5 and S1). Symptoms of active trigger points of the flexor digitorum longus include painful feet especially when weight bearing.

2.4 Biomechanics of the lower limb

Exercise-induced pain in the leg is a frequent complaint of athletes. The excessive stress that results in MTSS has been proposed to be the result of training errors, shoe design, surface type, muscle dysfunction, fatigue, decreased flexibility, structural and biomechanical factors (Bennett, 2001).

According to van Mechelen (1995), during running, ground reaction forces of up to 5 times normal bodyweight are generated. These impact forces have to be disseminated by the body and could contribute to the occurrence of running injuries. Not only are ground reaction (external) forces at impact thought to produce injuries, but bending forces and internal muscle forces are also thought to play a role.

Running may be divided into a stance phase and swing phase (not discussed here). During the stance phase, the foot undergoes several complex, well-timed changes in position (pronation and supination*). At initial foot contact, or foot strike, the foot must function as a relatively rigid structure (supinated position) to provide sufficient stability. The foot then rapidly pronates during early stance. Pronation assists in shock dissipation on initial contact as the foot assumes a flat position. An eccentric action (lengthening “contraction”) of the muscles of the anterior and deep posterior compartments controls this motion. Pronation also allows the foot to adapt to variations in surface (Moore, 1988).

Moore (1988) explains pronation as a combination of movements: eversion of the heel, flattening of the medial longitudinal arch, ankle dorsiflexion and abduction of the forefoot. Maximal pronation occurs during early midstance. The foot then transforms from a flexible structure (pronated position) to a rigid structure

* Pronation is comprised of subtalar dorsiflexion, eversion and abduction.
Supination is comprised of plantar flexion, inversion and adduction (Sommer *et al.*, 1995).

(supinated position) to allow for effective propulsion as weight is transferred to the forefoot during toe-off.

Hyperpronation may lead to excessive stress of the muscles of the anterior and deep posterior compartment (invertors) resulting in injuries with consequent strains, tendonitis or periostitis (Moore, 1988). According to Sommer and Vallentyne (1995) there are several anatomic factors known to be associated with dynamic subtalar pronation. Varus posturing of the forefoot or hindfoot, create an unstable point of contact with the ground that is stabilized by pronation during the contact phase of the gait cycle. Tibia varum also places the foot in an unstable position at heel strike, leading to excessive pronation at midstance.

According to Brukner and Khan (1993) in athletes with excessively pronated feet, the muscles of the superficial and deep compartments are required to contract harder and longer eccentrically to resist pronation after heel strike. On toe-off, they then work hard concentrically to accelerate supination. With fatigue, these muscles fail to provide the normal degree of shock absorption. This mechanism may lead to a tenoperiostitis.

James et al. (1978) reported that 58% of runners with lower leg overuse injuries were pronated in neutral stance. Michael and Holder (1985) stated that 7 of 8 runners with shin splints had pronated feet. Sommer and Vallentyne (1995) examined the foot posture of folk dancers and found a positive relationship between pronation and MTSS. Vittasalo and Kvist (1983) reported that those with shin pain had a more everted calcaneus in standing, greater calcaneal eversion just before heel strike in running and greater maximal eversion during the stance phase in treadmill running.

Brukner and Khan (1993) went on to explain that tight calves can restrict ankle dorsiflexion and increase the tendency of excessive pronation along with increased internal rotation of the tibia. Vittasalo and Kvist (1983) reported that

patients with shin splints had a greater Achilles tendon angle and more pronation in the subtalar joint than patients without shin splints.

Tiberio (1988) proposed that structural deformities of the foot result in abnormal foot mechanics that lead to changes in the amount speed or speed of subtalar joint motion. These compensatory changes impose abnormal stress on surrounding structures, resulting in overuse injury.

2.5 Classification of MTSS

The most common site of overuse pain in the leg and consequently of the symptoms most often referred to as shin splints, is a localized area of tenderness over the posteromedial border of the distal two thirds of the tibia (Beck et al., 1994; Vitasalo et al., 1983; Sommer et al., 1995; Mubarak et al., 1982). This is more accurately described as medial tibial stress syndrome (MTSS).

2.5.1 Type I MTSS (Detmer, 1986; Nicholas et al., 1995)

Type I is primarily a problem of the bone itself. A stress fracture or micro fractures are frequently diagnosed in runners following heavy exercise (a progressive intense training program). The stress that these patients suffer exceeds the ability of the bone to remodel and strengthen itself quickly enough without fracturing. Whatever the role the muscles play, whether being too strong or too weak, the strength of the bone is inadequate and fractures occur. The maximal pain and tenderness should not be in the area of the periosteal attachment to the bone but rather on the bone itself.

2.5.2 Type II MTSS (Detmer, 1986; Nicholas et al., 1995)

Type II or chronic periostalgia, is characterized by persistent pain at the junction of the periosteum and fascia rather than at the level of the bone. This condition has also been called the soleus syndrome (Michael and Holder, 1985). It is usually seen in athletes who participate in sports associated with repetitive, strenuous activity. The pain is recurrent and increases after running a given distance and decreases with rest. There is often tenderness present even without exercise when the posterior-medial edge of the distal tibia is palpated. It ranges from a dull, aching discomfort to an intense persistent pain aggravated by any physical activity (Mubarak et al., 1982).

According to Krivickas et al. (1997) MTSS type II refers to a specific overuse injury producing an inflammatory soft tissue reaction. The most recent and widespread opinion in the literature is that MTSS is a condition of periostitis. Periostitis has been described as the tearing away of the muscle fibers at the muscle-bone interface causing inflammation of the periosteum. (Michael and Holder, 1985; Detmer, 1986; Mubarak et al., 1982; Melberg et al., 1989; Andrish et al., 1974; Krivickas et al., 1997; Bennett et al., 2001; Thacker et al., 2002).

2.5.3 Type III MTSS (Detmer, 1986; Nicholas et al., 1995)

Patients with type III present with symptoms even more posterior, neither on the bone or adjacent to the bone but usually well localized to the muscular soft tissues posterior to the distal tibia. This may involve the soleus but frequently involves the distal posterior compartment. These patients typically have exercise-induced tightness, aching, numbness, pins and needles and occasionally sharp pain.

2.5.4 Grading of MTSS

MTSS is also classified by duration, location and severity of symptoms (Oloff, 1994):

Duration of symptoms is broken down into acute (less than 2 weeks), subacute (2 to 6 weeks), and chronic (more than 6 weeks).

Location of symptoms will be posteromedial, anterior or combined.

Symptoms are graded 1 through 4 in severity:

Grade 1 is characterized by pain to palpation of involved tibial crest, with no symptoms during daily activity or running.

Grade 2 indicates discomfort mainly after running but not during running. Some mild discomfort may be present initially during running.

Grade 3 patients have pain during running and residual discomfort after running.

Grade 4 patients are symptomatic with walking and are unable to run comfortably.

2.5.5 Stages of MTSS

Noakes (2001) characterized exertional shin pain through 4 stages of injury.

In the first and second stage there is a vague discomfort, poorly localized somewhere in the calf and is noted after exercise. As training continues the discomfort comes on during exercise.

In the third stage the athlete's tries to "run though" the pain, but if the training continued without treatment, the pain becomes so severe that proper training is not as enjoyable.

In the fourth stage the injury may be so bad that anything more strenuous than walking is unbearable. In this case of exertional shin pain, it has become a stress fracture.

2.6 Etiology and factors contributing to MTSS

Millions of people exercise for fitness and recreation. These people enjoy the benefits of stress relief and physical conditioning but may also incur injuries secondary to their training. According to Oloff (1994) MTSS is a condition caused by unaccustomed and excessive exertional exercise (overuse) typically associated with running sports, resulting in fatigue at deep fascial attachment sites of the tibia anteriorly and more commonly posteromedially eventually leading to a periostitis. This inflammatory response is due to tension force applied to the fascia by eccentrically contracting muscle–tendon units. Factors causing an overuse of these particular units will eventually lead to MTSS (Oloff,1994).

Thacker et al. (2002) categorized the risk / contributing factors, into intrinsic (anatomical variations and physical fitness) factors or extrinsic (environmental) factors related to the type of sport (athletic field or floor). The intrinsic factors included lack of running experience (inadequate warm-up, increased running intensity, sudden increase in training mileage and inadequate weight training), competitive running, previous injury, excessive weekly running distances and poor physical condition (decreased strength, poor flexibility, imbalance between the quadriceps and hamstrings and muscle fatigue). The extrinsic factors include type of sport, always running on cambered roads, hard running surface or uneven terrain, shoes and in-shoe orthoses.

According to Moore (1988) it has been shown that 60 to 80% of overuse injuries of the lower extremity are attributable to training errors. Sudden increases in total mileage, introducing speed work or hill-running and abrupt changes in training intensity have been associated with increased injury rates.

Noakes (2001) contributing factors included: hereditary factors (hypermobile feet, leg length discrepancy, thin tibias and increased external rotation of the hip). In

addition, decreased flexibility of the ankles was also found to be a hereditary cause. In women, reduced bone density due to hypoestrogenemia secondary to athletic amenorrhea and restricted dietary energy intakes (low calcium diet) are more prone to weaker bones and therefore are more prone to exertional shin pain and stress fractures (Noakes, 2001; Brukner and Khan, 1993). Van Mechelen (1992) added that age, gender, body mass, body height, warming up and stretching were factors related to running injuries.

Bennett et al. (2001) conducted a predictive correlation study on the factors causing MTSS in high school runners and concluded that there was a positive relationship between navicular drop, a measure of pronation and MTSS injury.

Sommer et al. (1995) concluded, in their study of the effect of foot posture on the incidence of MTSS, that hindfoot and forefoot varus alignment (non-weight bearing / probation, weight bearing) occurred more often in most cases of MTSS and that a combination of the two increased the incidence of MTSS. They also found that a standing foot angle* of greater than 140° served as an accurate threshold for assessing the risk of MTSS. Nicholas (1995) found that athletes with hypermobile, pronated feet, increased heel eversion, tibia vara, subtalar varus and forefoot supination were more prone to MTSS than those without these biomechanical abnormalities.

2.7 Clinical diagnosis of MTSS

Exercised-induced pain in the leg is a frequent complaint of athletes and pain is the predominant symptom of shin splints (Moore, 1988). MTSS presents as pain on palpation over the distal two-thirds of the posterior medial tibia, at the junction of the periosteum and fascia. Pain may be described as a recurrent, dull ache

* Standing foot angle (SFA) is a measurement taken while weight bearing. The angle is between the medial malleolus-navicular prominence and the navicular prominence metatarsal head segments.

becoming an intense pain that is exacerbated with repetitive, strenuous, weight-bearing activities and may be continuous or intermittent. The pain increases after running a given distance and decreases with rest (Mubarak et al. 1982; Detmer, 1986; Reber et al., 1993; Sommer et al., 1995; Bennett et al., 2001).

Michael and Holder (1985) added to the clinical characteristics by stating that patients with MTSS had pronated feet, normal x-ray films and no sensory, motor or vascular abnormalities. Oloff (1994) found that loading the involved extremity with a one-legged hop test could usually be performed without problems in grades 1, 2 and 3. Grade 4 patients can perform the test, but symptoms become apparent with increased repetitions.

Moore (1988) proposed that with continued stress, the pain progressively increases in intensity and occurs earlier during exercise. Less often, it may occur with walking or even rest. It may often be elicited by dorsiflexion or plantar flexion of the foot against manual resistance. Acute onset, possibly in inexperienced athletes following a single bout of vigorous exertion, may also occur.

Noakes (2001) clinically describes tibial exertional shin pain as a rough, corrugated feeling owing to a build-up of a new bony (periosteal) layer at the site of irritation. By applying firm finger pressure to these areas, exquisite, well localised, nauseating tenderness is felt. Often there is also mild swelling over the injured bone.

Brukner et al. (1993) stated that the most important aspect of the history was the relationship of pain to exercise. If pain improves after warming up and with continued exercise, then tenoperiosteal problems are most likely. If the pain worsens with exercise and is accompanied by a feeling of tightness, numbness, 'dead' feeling in the leg or pins and needles then a compartment syndrome may be present. If jumping activities increases the pain or if there is pain at rest or a night ache, a stress fracture must be considered.

2.8 Pathophysiology of MTSS

Overuse injuries are caused by repetitive loading of the soft and bony tissues of the lower extremities, leading to micro-trauma and inflammation. This eventually results in an overuse injury when these micro-traumas have not healed properly (van Mechelen, 1995).

The word 'shin splints' covers a wide variety of conditions, divided into acute and chronic. Acute conditions include MTSS or periostitis, enthesitis, fibrositis, myositis, traction periostitis, interosseus membrane pain, bone strain, tenosynovitis and tendonitis of the anterior tibialis, tibialis posterior, soleus, or the flexor digitorum longus. Chronic conditions include a periosteal reaction that may lead to micro fracture, traction periostalgia, chronic tendonitis, fatigue tears of collagen fibres that bridge the connection of muscle fibres to bone and chronic compartment syndrome (Thacker et al., 2002).

It has been suggested that MTSS is a periostitis at the posterior medial border of the distal tibia. Periostitis has been described as the tearing away of muscle fibres at the muscle-bone interface causing inflammation (Mubarak et al., 1982; Detmer, 1986; Michael and Holder, 1985; Moore, 1988; Kues, 1990; Oloff, 1994; Beck et al., 1994; Bennett et al., 2001 and Thacker et al., 2002). The exact pathophysiology of this syndrome remains controversial (Bhatt et al., 2000).

According to Oloff (1994) fatigue failure commences as a fasciitis, progressing to periostitis and eventually developing into increased endosteal activity if the leg continues to be stressed. This inflammatory response is due to tension force applied to the fascia by eccentrically contracting muscle-tendon units of the involved compartment. Pressure exerted by the tendons on the fascia is directed to the fascial-periosteal attachment site on the tibial crest where the stress reaction can occur.

Detmer (1986) hypothesised that the periosteum is traumatically disengaged from the bone either by ballistic avulsion of periosteum off the bone or by subperiosteal bone stress on the tibial edge. This results in sufficient subperiosteal haemorrhage or inflammation to lift the periosteum away from the bone. In this acute stage it might reveal a periostitis with the periosteal and fascial tissues attached to the tibia. In the chronic stage MTSS would appear to be a periostalgia rather than a periostitis.

Noakes (2001) explanation of bone strain is that the injury occurs in bones that are undergoing remodelling in response to an increased loading stress. The initial response in bones subjected to increased loading is the activation of specialized cells, osteoclasts, whose function is to cause bone resorption (removal and absorption of bone tissue). The resorbing bone also becomes highly vascular. During this phase the bone strength is probably reduced, placing the bone at increased risk of fracture. Movement at the site of bone weakness induced by exercise could explain the deep-seated pain of bone strain.

The phase of osteoclonal excavation passes gradually into one in which new bone is laid down at the site of bone resorption by other specialized bone cells, osteoblasts. Noakes (2001) interpretation is that bone strain and stress fractures develop in those bones either undergoing excessive osteoclonal excavation or whose osteoblastic response is delayed. They then develop focal or diffuse areas of bone weakness. These weaker areas are sensitive to touch and to the increased loading stress of exercise.

2.9 X-Rays, scintigraphy (radio isotope or bone scan) and MRI

With the increasing emphasis on fitness and exercise in our society there has been an increasing number of bone and soft tissue injuries among the general population. In addition, better medical supervision of both amateur and professional athletic activities has led to an increased awareness of the improved methods for diagnosis of sports-related injuries (Matin, 1988).

Bone is a dynamic tissue that strengthens and remodels in response to stress. This process occurs by means of the inner layer of periosteum and the endosteum producing osteoclasts to remove dying osteons while generating osteoblasts to provide new bone (Matin, 1988). Maladaptation to stress causes osteoclastic activity to surpass osteoblastic activity, thereby allowing weakening of the bone (Fredericson et al., 1995). Roub et al. (1979) proposed a scheme categorizing bone stress as a continuum starting with normal remodelling, followed by fatigue and bone exhaustion and finally, cortical failure and fracture.

Precise diagnosis of MTSS is important for successful management of the condition. Diagnostic work up of suspected MTSS includes: clinical examination, plain radiography, compartment studies and bone scintigraphy (Bhatt et al., 2000). Although x-ray is the primary diagnosis modality for detection of skeletal trauma, there are still many occasions when x-rays may initially fail to diagnose the injury (Matin, 1988).

In approximately two thirds of symptomatic (tibial stress) patients, the radiographs are initially negative, of these; only half ever develop radiographic evidence of stress reaction (Fredericson et al., 1995; Roub et al., 1979). Therefore plain radiographs are not a sensitive indicator for stress reaction and are specific only if a fracture line is detected. Other radiographic findings include periosteal new bone formation, endosteal thickening or a radiolucent line

extending through one cortex. Oblique views and carefully centred radiographs aid in detection of subtle injury (Fredericson et al., 1995).

The uptake and retention of bone agents (radioactive tracers), in all tissues appears to be proportional to the calcium content of the tissues. Skeletal tissues, which are more metabolically active or have larger surface areas also usually, have greater extracellular fluid exposure and vascular flow. This also increases the uptake and retention of bone agents (Francis et al., 1987). Francis et al. (1987) also showed that the bone agents are much more avidly adsorbed by inorganic calcium-phosphate complex than the organic matrix of bone. They are concentrated in greater amounts where the body is tending to deposit calcium phosphate, such as in an area of increased bone stress. Therefore, the shape, pattern and intensity of the abnormality on the bone scan should depend on the size, extent and activity of the local remodelling process as well as its blood supply.

A muscle-tendon complex which causes superficially increased remodelling due to abnormal stress on Sharpey's fibres might produce an elongated pattern of abnormality on a bone scan. The elongated, less intense lesion is usually indicative of tibial stress syndrome, while the more intense and focal fusiform abnormality indicates that one of the various stages of stress fracture is present (Rupani et al., 1985; Matin, 1988).

Matin (1988) postulated that the Sharpey's fibres extend through the periosteum into the mineralised matrix and with increased forces from the muscle or connective tissue could eventually cause local changes which result in increased bone metabolism. Johnell et al. (1982) showed with bone biopsies that patients with shin splints have increased osteoblastic activity, vascular ingrowth and even osteoid production. Matin (1988) states that because the process is more superficial and more elongated it helps to differentiate tibial stress syndrome from

the scintigraphic appearance of a stress fracture as previously noted was more localized, fusiform and intensely abnormal.

Matin (1988) recommended that a three-phase radionuclide bone scan, in which a radionuclide angiogram and follow-up blood pool images, be used to assess the vascularity of the abnormality. Rupani et al. (1985) showed that patients with MTSS very rarely had increased vascularity and stress fractures always had increased vascularity in the region of the injury.

Matin (1988) concluded by saying that at times it would be essentially impossible to differentiate a stress fracture from MTSS either clinically or by scintigraphic methods. Fredericson et al. (1995) presented a study in which they evaluated MTSS in runners and developed a grading system based on MRI findings. They concluded by stating that, when clinically warranted, MRI was recommended over bone scans because they were more accurate in correlating the degree of bone involvement with clinical symptoms, allowing more accurate recommendations for rehabilitation and return to impact activity. MRI was shown to have multiplanar capability, resulting in precise anatomic localisation, lack of exposure to ionising radiation and significantly less imaging time than the three-phase bone scintigraphy. According to Bhatt et al. (2000) MRI has limited value in diagnosing MTSS because of the wide spectrum of appearance.

2.10 Differential diagnosis (Brukner and Khan, 1993)

Common

Bone

- Stress fracture
- Periosteal contusion
- Fracture

Tenoperiostitis

- Medial border of tibia

Chronic compartment syndrome

- Deep posterior
- Anterior

Less common

Referred pain

- Lumbar spine
- Neuromeningeal structures
- Superior tibiofibular joint
- Ankle joint
- Pes anserinus
- Tendinitis
- Bursitis
- Osgood-Schlatter disease (adolescent)
- Chronic compartment syndrome
 - Peroneal
- Entrapment syndrome
 - Popliteal artery
 - Anterior tibial artery
 - Superficial peroneal nerve

Not to be missed

Tumors

- Osteosarcoma
- Giant Cell tumor
- Chondrosarcoma
- Ewing's Sarcoma

Vascular insufficiency

- Erythema nodosum
- Hyperparathyroidism

Rickets

- Paget's disease
- Sarcoidosis
- Syphilis
- Saber tibiae

Acute anterior compartment syndrome

2.11 Prevention and treatment

Leg pain in athletes has many aetiologies. The clinician must strive to specifically define the clinical problem in order to administer the appropriate treatment for the athletes condition (Touliopoulos et al., 1999). Treatment programs should be individualized to meet the needs and expectations of the athlete (Oloff, 1994). Noakes (2001) explains that the treatment depends on the severity and the location of the injury. Moore (1988) states that the extent of training modification does not only depend on the severity and location but also the duration of symptoms, the patients level of fitness and the sport involved.

2.11.1 Phases of treatment

According to Oloff (1994) and Nicholas et al. (1995) both recommended that treatment for MTSS should be divided into phases:

Phase 1

Decrease acute pain and inflammation. This is accomplished with the use of rest (avoiding the offending activity), absolute rest (crutches in severe cases), cryotherapy (10–15 mins, 2–3 times a day), anti-inflammatory medication (for severe cases), electro-therapeutic modalities, cardiorespiratory exercises (swimming, bicycle riding or rowing) and well-leg exercise. Immobilization should be avoided because this could prolong the recovery period by causing muscle atrophy (Andrish et al., 1974).

Phase 2

Decreasing and preventing scar tissue formation - Moist heat, deep cross friction massage and local anaesthetic/steroid injection. Decreasing tension forces acting on the bone – taping. Progressive resistance exercises, ice therapy,

stretching, cardiorespiratory exercises (swimming, bicycle riding or rowing) and well-leg exercise.

Phase 3

Strengthening the fascial-bone interface. This is accomplished by exercising the deep compartment muscles only once the pain is adequately controlled. The program involves initially isometric then isotonic exercises eventually leading onto resisted isometrics and isokinetic exercises. In other words, strengthening of the tibialis posterior, flexor digitorum longus and flexor hallucis longus muscles and stretching of the Achilles, soleus and tibialis posterior muscles.

Review of equipment and anatomic factors – the athletes limb alignment, shoes and training programme need to be thoroughly reviewed before running is resumed. Fabrication of appropriate orthoses – according to Nicholas *et al.* (1995) an athlete with MTSS and a hypermobile, pronated foot requires either a soft arch supports or a rigid orthotics device. The orthosis prevents or reduces compensatory pronation; this is accomplished by a medial heel and forefoot wedge.

Return to limited running – every other day, limited mileage and speed, appropriate surface (soft and level ground) and continued stretching and strengthening exercises.

Phase 4

Returning the athlete to their desired activity. Fitness, previous training program and personal injury pattern need to be taken into account. This final phase needs to be gradual, systematic and to tolerance. A progressive resistance program and flexibility exercises need to be continued until the athlete reaches preinjury mileage, speed and frequency and is asymptomatic.

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

1. Rest (helpful in 90% of cases).

2. Orthotics (helpful in 25% of cases).
3. Taping (helpful in 40% of cases).
4. NSAIDS (helpful in 50% of cases).

Rarely, patients are resistant to conservative treatment, but they respond to posterior compartment fasciotomy and release of the soleus fascial tissue medially (Touliopoulos et al., 1999). Detmer (1986) reported a 93% improved performance and a 78% complete cure after this type of surgical release. Other desired methods of treatment involve digital ischemic pressure and transverse friction applied to the thickened muscle fibres, evaluation of foot biomechanics (orthoses), a change of running style to heel-toe running, stretching and strengthening and patient education (Sommer et al., 1995; van Mechelen, 1995; Krivickas et al., 1997; Nicholas, 1995; Brukner and Khan, 1993; Cibulka et al., 1994).

2.12 Therapeutic effects of ultrasound

Therapeutic ultrasound is used frequently in the treatment of musculoskeletal disorders (Roebroek et al. 1998), by almost every physical therapist in Canada (94%) and 65% of physical therapists in the United States of America.

The therapeutic effects of ultrasound are attributed to thermal or heating effects and non-thermal or mechanical effects. These effects are said to reduce inflammation, increase local metabolism, accelerate haematoma resorption, reduce muscle pain and spasm, promote healing and increase extensibility of scars, connective tissue and tissue regeneration and musculoskeletal conditions such as athletic injuries. The heating effect may also block or slow down the condition of sensory nerve particularly the small nerve fibers resulting in pain relief (Ried, 1992). The non-thermal effects being cavitation* and acoustic streaming* have the following physiological effects: mast cell degranulation,

* Cavitation is the formation by ultrasound of small bubbles or cavities in gas-containing fluids.

* Acoustic streaming is the unidirectional movement of a fluid in an ultrasound field.

altered cell membrane function, increased intracellular levels of calcium, stimulation of fibroblast activity resulting in an increase in protein synthesis, an increase in vascular permeability and an increase in the tensile strength of collagen (Ballard et al., 2001). According to Baker et al. (2001) it would be incorrect to assume that only one effect is present at any time, the two effects are not separable.

The depth of penetration by the ultrasound wave depends on the frequency selected. Higher frequencies are absorbed more readily by body tissues and are used to treat more superficial wounds. Lower frequencies are less readily absorbed and thus penetrate further and are selected for the treatment of deeper tissues (Ballard et al., 2001). Continuous ultrasound results in a thermal effect whereas pulsed ultrasound, which allows heat dissipation, is used to achieve the non-thermal effects. The non-thermal effects can be both stimulatory and inhibitory, depending on the dose. (Ballard et al., 2001).

Ultrasound is used to treat both acute and chronic conditions, to facilitate healing and for the relief of pain (Ballard et al., 2001). Young and Dyson (1990) stated that ultrasound accelerates the inflammatory phase into the proliferative phase of repair sooner. Bone is a connective tissue. Its healing, therefore, is very similar to that of other soft tissues, the major difference being the deposition of bone salts (Woolf, 1986). Both types of tissues pass through the phases of inflammation, proliferation and remodeling. A prospective, randomized, double-blinded evaluation demonstrated the efficacy of low-intensity ultrasound stimulation in the acceleration of the normal fracture-repair process (Heckman et al., 1994).

The recommended dose to maximally reduce inflammation and promote healing is to use pulsed ultrasound for 2 milliseconds on, 8 milliseconds off, at 0,5 watts cm² giving a spatial average intensity of 0.1 watts cm². For acute or sub-acute conditions treatment of three or more times a week for 10 minutes is recommended (Burns and McDiarmid, 1987; Kahn, 1994; Ried, 1992).

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 into therapeutic ultrasound therapy. The studies show that the use of ultrasound therapy is largely based on empirical evidence and not on clinically controlled trials (Falconer et al., 1990; Gam and Johannsen, 1995). van der Windt et al. (1999) presented a systematic review to evaluate the effectiveness of ultrasound in the treatment of musculoskeletal disorders and found there was little evidence that ultrasound was effective. Robertson and Baker (2001) review into the clinical effectiveness of therapeutic ultrasound when compared to a placebo indicated that out of the 10 randomized clinical trials reviewed; eight studies showed that active ultrasound is no more beneficial than placebo ultrasound for the treatment of people with pain or soft tissue injury.

Within a clinical environment, ultrasound, is regarded as a treatment modality for many musculoskeletal conditions based on the following criteria (Roebroek et al. 1998):

- a. In the treatment of soft tissue injuries
- b. In recent injuries and in the first phases of treatment
- c. In the treatment of signs of inflammation.
- d. In combination with other forms of therapy

Van Lingen (1998) researched the effectiveness of ultrasound therapy as an adjunct to the treatment of MTSS (phases I, II and III) and the results were inconclusive. It has therefore been suggested that the effect of ultrasound on musculoskeletal disorders, needs to be further investigated, future studies should resolve the question whether ultrasound can supplement exercise therapy (Gam and Johannsen, 1995) and in terms of its effect when combined with other therapeutic modalities (van der Windt et al., 1999), hence the motivation for this study.

2.13 Therapeutic effects of periosteal pecking

A therapeutic intervention called periosteal pecking has received increased interest with regards to symptomatic treatment of shin splints. Periosteal pecking is a form of *dry needling in which the tip of the needle contacts the periosteum (Raso, 1997).

The therapeutic effect of periosteal pecking includes a pain suppressing effect, due to its irritant action on the periosteal nerve endings, evoking activity in the pain inhibiting mechanism in the central nervous system (gate control model of pain) thereby decreasing pain and inflammation (Brattberg, 1983). According to Ghia et al. (1976) it seems likely that the process of dry needling may be brought on initially by stimulating the large A delta fibers. This gentle electrical stimulation of the skin and underlying tissues during needling may activate more of the large A delta fibers than the small c fibers, tending to “close the gate” and block the pain signals (Melzack and Wall, 1965). According to Hopwood et al. (1997) the mechanism for clinical pain reduction may utilize supraspinal mechanisms through endogenous opioid circuits for effective pain relief. Hopwood et al. (1997) went on to mention that periosteal pecking is an effective method of treatment for many conditions involving the musculoskeletal system.

Periosteal pecking has received little clinical attention, however four studies indicating the effectiveness of periosteal pecking have been published:

A prospective randomized controlled trial comparing a form of periosteal pecking with intra-articular injections in reducing chronic pain associated with osteoarthritis of the hip (n=32), found that there was equal effectiveness in relieving the associated pain (McIndoe et al., 1995). Another single case study report into the effectiveness of periosteal pecking in the treatment of shin splints found complete resolution of pain in two days (Schulmann, 1995). The third

* Dry Needling- is the insertion of an empty hypodermic needle to stimulate relative areas (Birch et al.1999).

study, a comparative clinical trial, by Callison (2002) into the use of acupuncture and sports medicine (pulsed ultrasound, stretching, strengthening and cryotherapy) in the treatment of shin splints (n=17) showed more effectiveness amongst the acupuncture group. Finally, a comparative clinical trial by Brattberg (1983), comparing corticosteroid injections to periosteal pecking (n=34), showed that periosteal pecking relieved pain by 61,8% compared to 30,8% in the steroid group.

2.14 Conclusion

Overuse running injuries, like medial tibial stress syndrome are caused by repetitive loading of the soft and bony tissues of the lower extremities, leading to micro trauma and inflammation. This eventually results in overuse injury when not healed properly (van Mechelen, 1995). Therapeutic approaches have so far had little focus on resolving the periosteal component of this condition, but have rather targeted the symptomatic pain aspect of the condition including therapeutic ultrasound, NSAIDS, ice and rest (Detmer, 1986).

Further investigations into a treatment protocol of MTSS that provides decreased pain, inflammation and allows the patient to continue with their desired sport without having to decrease their fitness needs to be found. The above evidence into the success of periosteal pecking, in comparison to other modalities, warrants further investigation into this form of treatment, as well as investigating its effect when combined with another common treatment modality, like therapeutic ultrasound, in order to investigate a more effective treatment protocol.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Introduction

This chapter deals with the methods employed in the data collection, as well as the statistical methods used for the interpretation of the data.

3.2 The Data

The data used in this study is divided into two types:

- a. Primary data
- b. Secondary data

3.2.1 The Primary data

The primary data was obtained directly from the patients and consisted of:

- Information gathered from the case history (Appendix A), revised physical examination (Appendix B) and a regional foot examination (Appendix C).
- A clinical diagnosis of medial tibial stress syndrome type II was made if the patient met all three of the following criteria:

1. Pain and tenderness localized to the distal two thirds of the medial border of the tibia at the junction of the periosteum and the fascia (Detmer, 1986; Mubarak et al., 1982).
 2. Pain in this area, exacerbated by weight bearing or physical activity and relieved by rest (Detmer, 1986).
 3. The presence of ‘tender spots’-rough, well localized, exquisitely tender corrugated areas, arising due to the build up of a new periosteal layer, felt when applying firm finger pressure (Noakes, 2001).
- The patient’s pain sensitivity as obtained through the use of an algometer (Appendix K).
 - The patient’s pain sensitivity as perceived by the Pain Disability Index (Appendix D), Numerical Pain Rating Scale (NRS 101) (Appendix E) and the McGill Short Form Pain Questionnaire (Appendix F).

3.2.2 The Secondary Data

The secondary data was obtained from a search of related literature. This included relevant journal articles, published reports and textbooks containing information pertaining to the study being conducted.

3.3 Criteria Governing Admissibility Of Data

The subjective data admitted came from the Pain Disability Index (Appendix D), Numerical Pain Rating Scale (NRS 101) (Appendix E) and the McGill Short Form Pain Questionnaire (Appendix F), which were used to establish the patient’s subjective response during the study. Objective feedback from the patient was obtained through the use of an algometer (Appendix K). All these findings were completed and documented under the supervision of the researcher.

3.4 Research Methodology and Materials Used

3.4.1 The Patients

The objective of this investigation was to evaluate the relative effectiveness of periosteal pecking combined with therapeutic ultrasound versus therapeutic ultrasound alone in the treatment of medial tibial stress syndrome type II (shin splints).

Due to time constraints and the difficulty of recruiting subjects with MTSS a sample size of 44 patients was used in this study instead of 60 patients. These patients presented to the Durban Institute of Technology (D.I.T) Chiropractic Day Clinic with shin splints. Non-probability sampling was employed in this study and therefore inferences drawn was casual. Random allocation was used to divide the study group into two equal samples of 22, Group A, the periosteal pecking and therapeutic ultrasound group and Group B, the therapeutic ultrasound group alone.

This study was limited to patients from KwaZulu-Natal who would be referred by advertisements (Appendix G) placed at the D.I.T Chiropractic Day Clinic as well as at local gyms, sports clubs, rugby clubs, schools and distributed through local sports club's newsletters. Brief talks about the study were given to create an awareness about the study. Talks were given at sports clubs and indoor centres.

Patients were screened telephonically in order to determine the following:

1. The presence of pain and tenderness over the inside area of the lower leg above the ankle.
2. Progression of pain with activity.
3. Relief of pain with rest.
4. Minimum age of 16, maximum age of 52.

Patients were then scheduled for an initial consultation if they met the criteria explained below.

3.4.2 Inclusion and Exclusion Criteria for patients

3.4.2.1 Inclusion criteria

Minimum age:

Bennet *et al.* (2001) study focused on the incidence of shin splints in high school runners (n=125), with an average age of 15.7. This is in line with Detmer's (1986) minimum age of 15, Styf's (1988) minimum age of 16, and Mubarak's (1982) minimum age of 16. The above age distribution is an indicator of the prevalence of this condition in adolescent athletes, but the minimum age for this study was 16.

Maximum age:

Once again, this age is obtained from an average age of other studies carried out into shin splints. Detmer (1986) had a maximum age limit of 52, Van Lingen (1998) and Styf (1988) had a maximum age of 55 and Callison (2002) had a maximum age of 45. The age distribution for this study will therefore be from 16 - 52.

A clinical diagnosis of medial tibial stress syndrome type II was then made if the patient met all three of the following criteria:

1. Pain and tenderness localised to the distal two thirds of the medial border of the tibia at the junction of the periosteum and the fascia (Detmer 1986, Mubarak *et al.* 1982).
2. Pain in this area, exacerbated by weight bearing or physical activity and relieved by rest (Detmer 1986).
3. The presence of 'tender spots'-rough, well localised, exquisitely tender corrugated areas, arising due to the build up of a new periosteal layer, felt when applying firm finger pressure (Noakes, 2001).

3.4.2.2 Exclusion Criteria

Patients were excluded if they were below the age of 16 or above the age of 52. Patients exhibiting any of 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 eg. cysts
- Obvious signs of tibial stress fractures
- Cardiac problems
- Anaesthetised areas

Patients exhibiting any of the following contra-indications to dry needling/periosteal pecking will be excluded from the study (Hopwood et al. 1997):

- Patients with uncontrolled movements who are unable to keep still for any length of time.
- Infection of the skin
- Very thin and fragile skin
- Allergy to any specific metals
- Pregnant patients
- Diabetics
- Patients with pacemakers

Patients were excluded from Group A if they present with any of the following side effects to needling (Birch et al., 1999):

- Fainting during treatment
- Nausea and vomiting
- Skin irritation
- Muscle spasm

3.5 Ethical Considerations

- The rights and welfare of the subject were protected.
- Informed consent was obtained (Appendix H).
- The subject was not coerced into participating in the study.
- Information was given to subjects in an understandable language where possible.
- The research involved no more than minimal risk.
- Confidentiality was maintained.
- Participation was voluntary and did not involve financial benefit.
- The subject was free to withdraw from the study at any time.
- Ethical standards are maintained through the D.I.T ethics committee, which gave its approval to the study.

3.6 Intervention

At the initial consultation, all potential candidates for the study underwent a case history (Appendix A), revised physical examination (Appendix B) and a regional foot examination (Appendix C). Patients were also provided with an Information Sheet (Appendix I) and Informed Consent (Appendix H) was obtained before inclusion into the study.

They were required to fill out the Pain Disability Index (Appendix D), Numerical Pain Rating Scale (NRS 101) (Appendix E) and the McGill Short Form Pain Questionnaire (Appendix F). The Objective measurement of pain perception was taken using the algometer (Appendix K), over the tender spots, before the first and fourth treatments.

Non-probability sampling was employed in this study and therefore random allocation was used to divide the study group into two equal samples of 22.

Patients in Group A received periosteal pecking whereby acupuncture needles (25mm disposable Hwato needles-Suzhou medical instruments, 14 West Qi Lin lane, Siuzhou, China) were inserted into the “tender spots” located at the medial border of the tibia, where the periosteum may have been inflamed. The location and distance from the medial malleolus was documented (Appendix J). Patients then received ultrasound. Ultrasound therapy was administered by a Sonoplus 436 made by Enraf Nonius (E.N.G. 12Pb, ERA 5cm², BMR max 6 watts/cm²). A one MHz applicator head set at 0.5 watts cm² and pulsed at 2 milliseconds on and eight off was used. Ultrasound gel was used as a coupling gel. Each patient in Group A received four treatments over two weeks.

Patients in Group B received the ultrasound treatment alone, and a record of the location and number of tender spots was also kept during the study. Patients in Group B also received four treatments over two weeks.

3.6.1 Measurements

The severity of the patient's pain in both groups was assessed at treatments 1 and 4. Both objective and subjective measurements were assessed before each of the above consultations. A record of these readings was kept.

3.6.1.1 Subjective Measurements

A. Pain Disability Index (Appendix D)

The pain disability index was used to give the researcher an indication of how the pain was affecting the patient's lifestyle. The questionnaire was comprised of five questions. The patient was required to respond to the question scale of 0 to 10. A score of 1 meant no disability at all and 10 meant the pain completely prevent the patient from that activity (Tait et al., 1987).

B. Numerical Pain Rating Scale (NRS 101) (Appendix E)

The questionnaire was used to determine the subjective pain intensity experienced by the patient. The patient was asked to note down their perceived level of pain on the numerical scale of zero to 100, with 0 representing no pain at all and 100 representing pain at its worst. (Jensen et al., 1986).

C. McGill Short Form Pain Questionnaire (Appendix F)

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

3.6.1.2. Objective Measurement

Algometer Readings (Appendix K)

To measure the tenderness at the medial tibial border, a pressure algometer was used. The algometer was used to quantify palpatory pain findings over the bone and consisted of a force dial, which read in kilograms and a one-centimeter diameter rubber-tipped stylus. Pain threshold was determined by the amount of force per square centimeter required for a person to first perceive pain (Fischer, 1987).

3.7 Treatment of the Objectives

The purpose of this study is to investigate the relative effectiveness of periosteal pecking combined with therapeutic ultrasound versus therapeutic ultrasound alone in the treatment of medial tibial stress syndrome type II (shin splints).

3.7.1 The First Objective

The first objective was to investigate the relative effectiveness of periosteal pecking combined with therapeutic ultrasound compared to therapeutic ultrasound alone in terms of objective clinical findings in the treatment of medial tibial stress syndrome type II.

3.7.2 The Second Objective

The second objective was to investigate the relative effectiveness of periosteal pecking combined with therapeutic ultrasound compared to therapeutic ultrasound alone in terms of subjective clinical findings in the treatment of medial tibial stress syndrome type II.

3.8 Statistical Analysis

3.8.1 Intergroup comparison:

1. Subjective data
Mann-Whitney U-test
2. Objective data
Mann-Whitney U-test

3.8.2 Intragroup comparison:

Readings were taken at consultations 1 and 4. (before needling, initial and needling, final)

1. Subjective data
Wilcoxon Signed Rank Test
2. Objective data
Wilcoxon Signed Rank Test

Level of significance will be set at $\alpha = 0,05$ and p-values will be used for decision making. All data was analyzed using the SPSS package.

The subjective data was treated as follows:

- Questionnaires that the patients completed were screened to ensure that they had been completed correctly.
- Raw data from the questionnaires were converted into percentages and recorded separately for each group.
- The data was analyzed using a 5% significance level.

The objective data was treated as follows:

- The algometer readings were recorded separately for each group.
- The data was analyzed using a 5% significance level.

3.9 Statistical Procedure

The statistical package SPSS was used for entry and analysis. The following tests were used:

- The Mann-Whitney U-Test between Group A and Group B.
- The Wilcoxon Signed Rank Test within Group A and Group B.
- Summaries statistics and bar charts.

3.9.1 Non-Parametric Unpaired Tests

Subjective data

The Mann-Whitney U-test was used to compare Groups A and B with respect to each categorical variable. The null hypothesis states that there is no significant difference between Groups A and B with respect to the variables of comparison at the $\alpha = 0.05$ level of significance. The alternative hypothesis states that there is a significance difference at the same level of significance.

According to Zar (1996), the Mann-Whitney U test is one of the most powerful non-parametric tests.

Decision rule:

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

Objective data

The Mann-Whitney U-test was used to compare Groups A and B with respect to each categorical variable. The null hypothesis states that there is no significant difference between Groups A and B with respect to the variables of comparison at the $\alpha = 0.05$ level of significance. The alternative hypothesis states that there is a significance difference at the same level of significance.

According to Zar (1996), the Mann-Whitney U test is one of the most powerful non-parametric tests.

Decision rule:

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

3.9.2 Non-Parametric Paired Tests

Subjective Data

The Wilcoxon Signed Rank 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.

According to Zar (1996), the Wilcoxon signed rank test has its most significant application in paired sampling testing.

Decision rule:

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

Objective Data

The Wilcoxon Signed Rank 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.

According to Zar (1996), the Wilcoxon signed rank test has its most significant application in paired sampling testing.

Decision rule:

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

3.9.3 Comparison using bar charts

Visual summaries of analytical findings were given by the use of bar charts to compare Groups A and B. Average (mean) readings were used to construct bar charts.

CHAPTER FOUR

4. THE RESULTS

4.1 Introduction

The first part of this chapter contains the demographic data of all the patients included in the study. The second part of this chapter contains the statistical analysis of the subjective and objective data obtained from the patients over the treatment period.

The patients in group A received periosteal pecking and ultrasound. The patients in group B received ultrasound alone.

4.2 The criteria for the admissibility of the data

Information obtained from the case history, foot regional, Short-form McGill Pain Questionnaire, Numerical Pain Rating Scale 101 (NRS), Pain Disability Index and algometer readings were used as data for this study. All the pain questionnaires were explained to the patients, who then completed them. The researcher took all the algometer readings. All treatment was done by the researcher.

4.3 Descriptive data

Demographical data included gender, age, race and sport distribution.

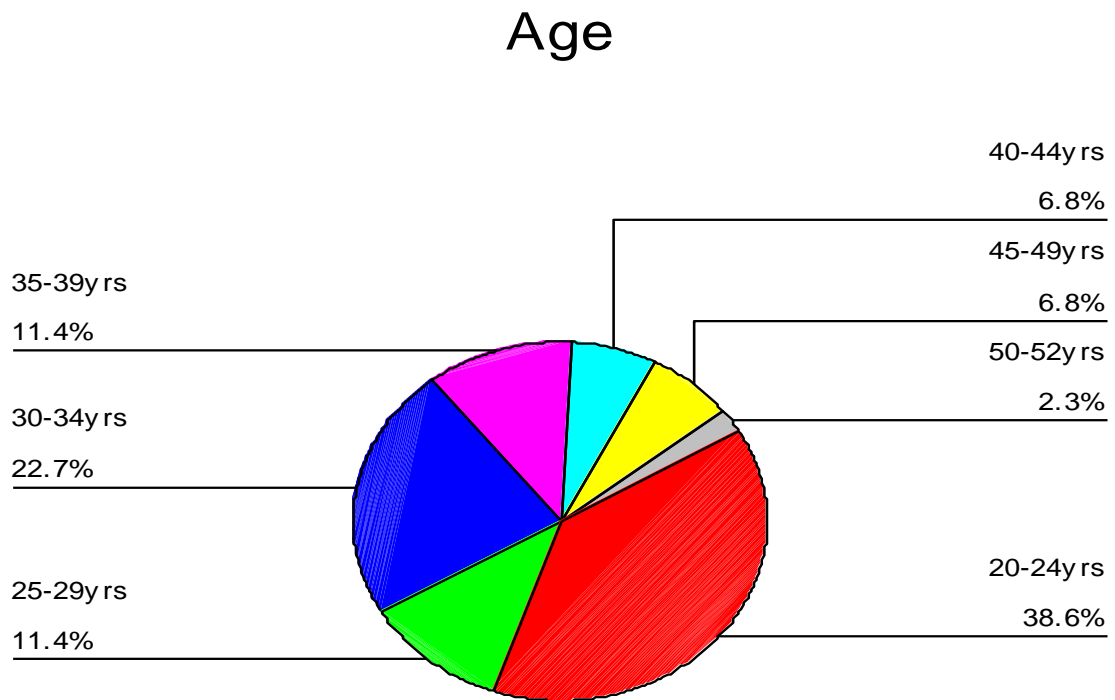


Figure 4.1

Race

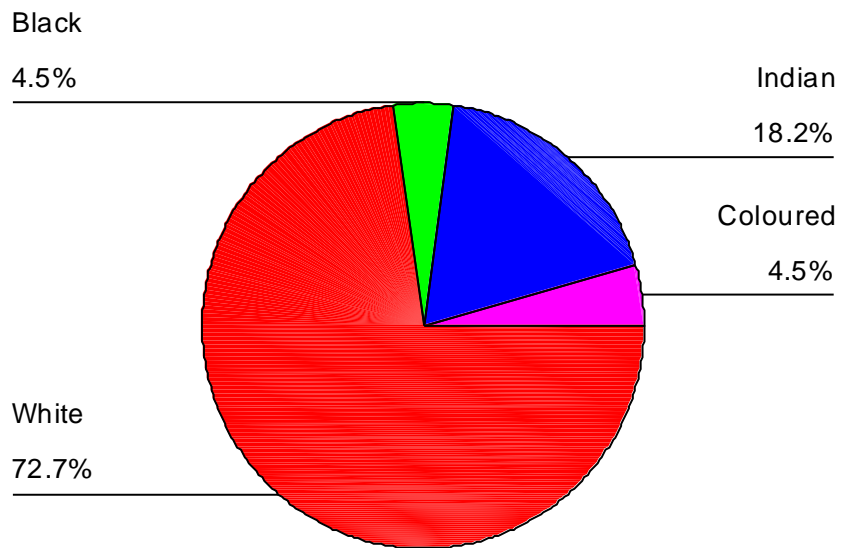


Figure 4.2

Gender

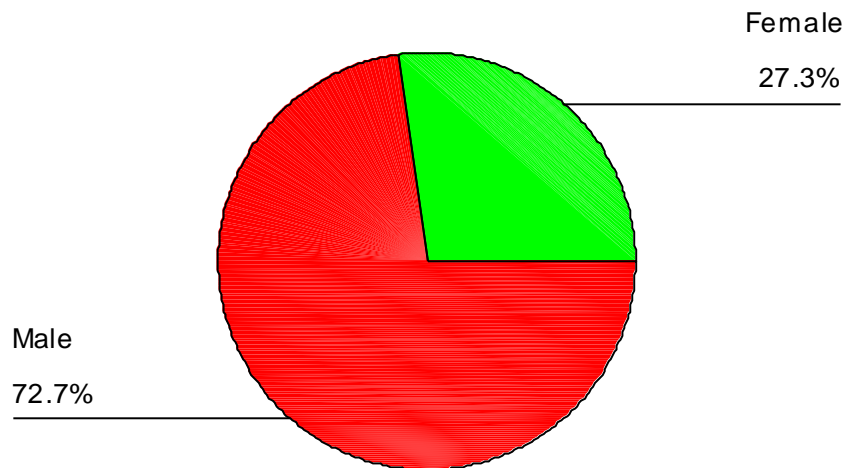


Figure 4.3

Sport Distribution

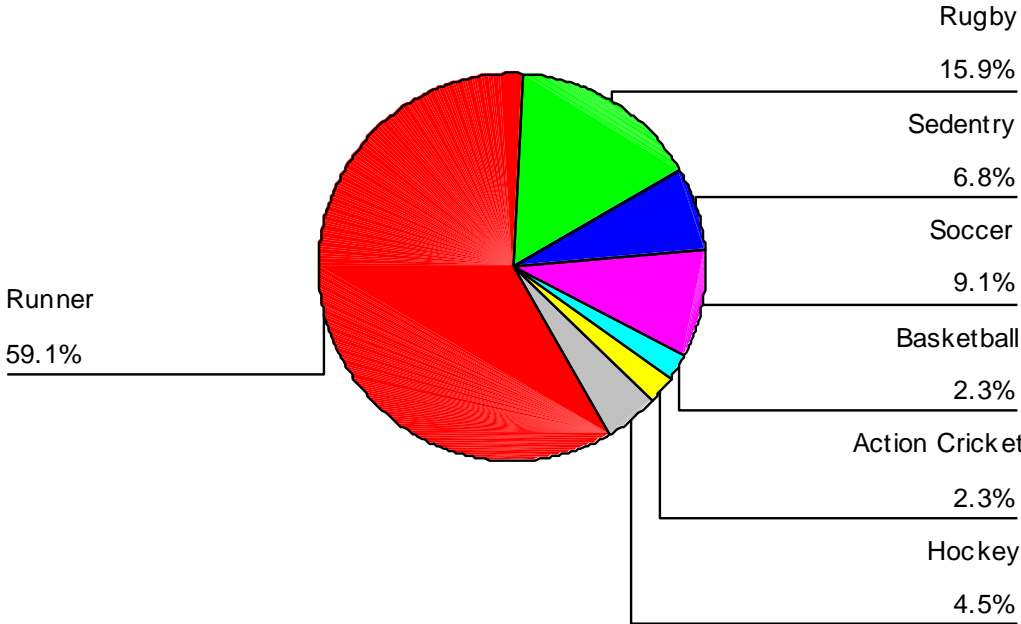


Figure 4.4

4.4 Tabulation of results

4.4.1 Inter-group comparison

The hypotheses were as follows:

Ho (null hypothesis): There is no significant difference between consultations with regards to the variable of interest.

H1 (alternative hypothesis): There is a significant difference between consultations with regards to the variable of interest.

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

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

The H1 was accepted if $P \geq \alpha$

4.4.1.1 Short-form McGill Pain Questionnaire

The Mann-Whitney Unpaired test was used to assess the mean values of the Short-form McGill Pain Questionnaire between Group A and Group B. The initial treatments (Tx 1) and final treatments (Tx 4) were compared.

Table 4.1 Inter-group analysis Short-form McGill Pain Questionnaire

<u>Treatment</u>	<u>Group</u>	<u>Mean</u>	<u>Std. Deviation</u>	<u>Mean Rank</u>	<u>P-Value</u>
Short-form McGill Pain Questionnaire Tx 1	A. Periosteal pecking and Ultrasound	37.8336	17.3755	27.32	0.013
	B. Ultrasound	25.8591	18.2954	17.68	
Short-form McGill Questionnaire Tx 4	A. Periosteal pecking and Ultrasound	11.4686	12.0149	22.59	0.963
	B. Ultrasound	11.4168	12.7471	22.41	

The null hypothesis was rejected for the Short-form McGill Questionnaire Tx 1, P-value = 0.013, therefore a statistically significant difference was noted between Group A and Group B at Treatment 1.

The null hypothesis was accepted for the Short-form McGill Questionnaire Tx 4, P-value = 0.963, indicating that there was no difference between Group A and Group B at Treatment 4.

4.4.1.2 Numerical Pain Rating Scale 101

The Mann-Whitney Unpaired test was used to assess the mean values of the Numerical Pain Rating Scale 101 (NRS) between Group A and Group B. The initial treatments (Tx 1) and final treatments (Tx 4) were compared.

Table 4.2 Inter-group analysis Numerical Pain Rating Scale

<u>Treatment</u>	<u>Group</u>	<u>Mean</u>	<u>Std. Deviation</u>	<u>Mean Rank</u>	<u>P-Value</u>
NRS Tx 1	A. Periosteal pecking and Ultrasound	50.659	18.353	23.93	0.453
	B. Ultrasound	46.705	11.837	21.07	
NRS Tx 4	A. Periosteal pecking and Ultrasound	22.159	22.178	20.55	0.311
	B. Ultrasound	25.795	15.856	24.45	

The null hypothesis was accepted for the Numerical Pain Rating Scale Tx 1, P-value = 0.453, indicating that there was no difference between Group A and Group B at Treatment 1.

The null hypothesis was accepted for the Numerical Pain Rating Scale Tx 4, P-value = 0.311, indicating that there was no difference between Group A and Group B at Treatment 4.

4.4.1.3 Pain Disability Index

The Mann-Whitney Unpaired test was used to assess the mean values of the Pain Disability Index between Group A and Group B. The initial treatments (Tx 1) and final treatments (Tx 4) were compared.

Table 4.3 Inter-group analysis Pain Disability Index

<u>Treatment</u>	<u>Group</u>	<u>Mean</u>	<u>Std. Deviation</u>	<u>Mean Rank</u>	<u>P-Value</u>
Pain Disability Index Tx 1	A. Periosteal pecking and Ultrasound	40.18	20.06	24.36	0.335
	B. Ultrasound	33.91	13.53	20.64	
Pain Disability Index Tx 4	A. Periosteal pecking and Ultrasound	18.05	11.52	18.02	0.020
	B. Ultrasound	24.64	13.54	26.98	

The null hypothesis was accepted for the Pain Disability Index Tx 1, P-value = 0.335, indicating that there was no difference between Group A and Group B at Treatment 1.

The null hypothesis was rejected for the Pain Disability Index Tx 4, P-value = 0.020, therefore a statistically significant difference was noted between Group A and Group B at Treatment 4.

4.4.1.4 Algometer Readings

The Mann-Whitney Unpaired test was used to assess the mean values of the algometer readings between Group A and Group B. The initial treatments (Tx 1) and final treatments (Tx 4) were compared.

Table 4.4 Inter-group analysis Algometer

<u>Treatment</u>	<u>Group</u>	<u>Mean</u>	<u>Std. Deviation</u>	<u>Mean Rank</u>	<u>P-Value</u>
Algometer Tx 1	A. Periosteal pecking and Ultrasound	2.200	0.708	22.30	0.916
	B. Ultrasound	2.155	0.421	22.70	
Algometer Tx 4	A. Periosteal pecking and Ultrasound	2.950	0.768	26.80	0.026
	B. Ultrasound	2.468	0.543	18.20	

The null hypothesis was accepted for the algometer readings Tx 1, P-value = 0.916, indicating that there was no difference between Group A and Group B at Treatment 1.

The null hypothesis was rejected for the algometer readings Tx 4, P-value = 0.026, therefore a statistically significant difference was noted between Group A and Group B at Treatment 4.

4.4.2 Intra-group comparison

The hypotheses were as follows:

Ho (null hypothesis): There is no significant difference between consultations with regards to the variable of interest.

H1 (alternative hypothesis): There is a significant difference between consultations with regards to the variable of interest.

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

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

The H_1 was accepted if $P \geq \alpha$

4.4.2.1 Short-form McGill Pain Questionnaire

The Wilcoxon Signed Rank Test was used to assess the mean values of the Short-form McGill Pain Questionnaire to compare treatments within Group A and Group B. The initial treatments (Tx 1) and final treatments (Tx 4) were compared.

Table 4.5 Intra-group analysis Short-form McGill Pain Questionnaire Group A i

<u>Group</u>	<u>Treatment</u>	<u>Mean</u>	<u>Std Deviation</u>
A. Periosteal pecking and Ultrasound	Short-form McGill Pain Questionnaire Tx 1	37.8336	17.3755
	Short-form McGill Pain Questionnaire Tx4	11.4686	12.0149

Table 4.6 Intra-group analysis Short-form McGill Pain Questionnaire Group A ii

<u>Group</u>	<u>Treatment</u>	<u>Neg/Pos Ranks</u>	<u>N</u>	<u>Mean Rank</u>	<u>P - Value</u>
A. Periosteal pecking and Ultrasound	Short-form McGill Pain Questionnaire Tx 4 – Short-form McGill Pain Questionnaire Tx 1	Neg. ranks	20a	12.05	0.000
		Pos. ranks	2b		
		Ties	0c	6.00	
		Total	22		

- a. Short-form McGill Pain Questionnaire Tx 4 < Short-form McGill Pain Questionnaire Tx 1
- b. Short-form McGill Pain Questionnaire Tx 4 > Short-form McGill Pain Questionnaire Tx 1
- c. Short-form McGill Pain Questionnaire Tx 4 = Short-form McGill Pain Questionnaire Tx 1

The null hypothesis was rejected for Group A , P-value = 0.000, showing a highly significant difference between Tx 1 and Tx 4 within Group A.

Table 4.7 Intra-group analysis Short-form McGill Pain Questionnaire Group B i

<u>Group</u>	<u>Treatment</u>	<u>Mean</u>	<u>Std Deviation</u>
B. Ultrasound	Short-form McGill Pain Questionnaire Tx 1	25.8591	18.2954
	Short-form McGill Pain Questionnaire Tx 4	11.4168	12.7471

Table 4.8 Intra-group analysis Short-form McGill Pain Questionnaire Group B ii

<u>Group</u>	<u>Treatment</u>	<u>Neg/Pos Ranks</u>	<u>N</u>	<u>Mean Rank</u>	<u>P - Value</u>
B. Ultrasound	Short-form McGill Pain Questionnaire Tx 4 –	Neg ranks	20a	10.85	0.000
		Pos ranks	1b		
	Short-form McGill Pain Questionnaire Tx 1	Ties	1c	14.00	
		Total	22		

- a. Short-form McGill Pain Questionnaire Tx 4 < Short-form McGill Pain Questionnaire Tx 1
- b. Short-form McGill Pain Questionnaire Tx 4 > Short-form McGill Pain Questionnaire Tx 1
- c. Short-form McGill Pain Questionnaire Tx 4 = Short-form McGill Pain Questionnaire Tx 1

The null hypothesis was rejected for Group B, P-value = 0.000, showing a highly significant difference between Tx 1 and Tx 4 within Group B.

4.4.2.2 Numerical Pain Rating Scale

The Wilcoxon Signed Rank Test was used to assess the mean values of the Numerical Pain Rating scale to compare treatments within Group A and Group B. The initial treatments (Tx 1) and final treatments (Tx 4) were compared.

Table 4.9 Intra-group analysis Numerical Pain Rating Scale Group A i

<u>Group</u>	<u>Treatment</u>	<u>Mean</u>	<u>Std Deviation</u>
A. Periosteal pecking and Ultrasound	NRS Tx 1	50.659	18.353
	NRS Tx4	22.159	22.178

Table 4.10 Intra-group analysis Numerical Pain Rating Scale Group A ii

<u>Group</u>	<u>Treatment</u>	<u>Neg/Pos Ranks</u>	<u>N</u>	<u>Mean Rank</u>	<u>P - Value</u>
A. Periosteal pecking and Ultrasound	NRS Tx 4 – NRS Tx 1	Neg. ranks	19a	12.76	0.000
		Pos. ranks	3b		
		Ties	0c	3.50	
		Total	22		

- a. NRS Tx 4 < NRS Tx1
- b. NRS Tx 4 > NRS Tx 1
- c. NRS Tx 4 = NRS Tx 1

The null hypothesis was rejected for Group A , P-value = 0.000, therefore a highly statistically significant difference was noted between the Numerical Pain Rating scale Tx 1 and Tx 4 within Group A.

Table 4.11 Intra-group analysis Numerical Pain Rating Scale Group B i

Group	Treatment	Mean	Std Deviation
B. Ultrasound	NRS Tx 1	46.705	11.837
	NRS Tx 4	25.795	15.856

Table 4.12 Intra-group analysis Numerical Pain Rating Scale Group B ii

Group	Treatment	Neg/Pos Ranks	N	Mean Rank	P - Value
B. Ultrasound	NRS Tx 4 – NRS Tx 1	Neg ranks	19a	11.92	0.000
		Pos ranks	2b		
		Ties	1c	2.25	
		Total	22		

- a. NRS Tx 4 < NRS Tx1
- b. NRS Tx 4 > NRS Tx 1
- c. NRS Tx 4 = NRS Tx 1

The null hypothesis was rejected for Group B , P-value = 0.000, therefore a highly statistically significant difference was noted between the Numerical Pain Rating scale Tx 1 and Tx 4 within Group B.

4.4.2.3 Pain Disability Index

The Wilcoxon Signed Rank Test was used to assess the mean values of the Pain Disability Index to compare treatments within Group A and Group B. The initial treatments (Tx 1) and final treatments (Tx 4) where compared.

Table 4.13 Intra-group analysis Pain Disability Index Group A i

Group	Treatment	Mean	Std Deviation
A. Periosteal pecking and Ultrasound	Pain Disability Index Tx 1	40.18	20.06
	Pain Disability Index Tx4	18.05	11.52

Table 4.14 Intra-group analysis Pain Disability Index Group A ii

Group	Treatment	Neg/Pos Ranks	N	Mean Rank	P - Value
A. Periosteal pecking and Ultrasound	Pain Disability Index Tx 4 – Pain Disability Index Tx 1	Neg. ranks	20a	12.10	0.000
		Pos. ranks	2b		
		Ties	0c	5.50	
		Total	22		

- a. Pain Disability Index Tx 4 < Pain Disability Index Tx 1
- b. Pain Disability Index Tx 4 > Pain Disability Index Tx 1
- c. Pain Disability Index Tx 4 = Pain Disability Index Tx 1

The null hypothesis was rejected for Group A , P-value = 0.000, therefore a highly statistically significant difference was noted between the Pain Disability Index Tx 1 and Tx 4 within Group A.

Table 4.15 Intra-group analysis Pain Disability Index Group B i

Group	Treatment	Mean	Std Deviation
B. Ultrasound	Pain Disability Index Tx 1	33.91	13.53
	Pain Disability Index Tx 4	24.64	13.54

Table 4.16 Intra-group analysis Pain Disability Index Group B ii

Group	Treatment	Neg/Pos Ranks	N	Mean Rank	P - Value
B. Ultrasound	Pain Disability Index Tx 4 – Pain Disability Index Tx 1	Neg ranks	19a	11.03	0.001
		Pos ranks	2b		
		Ties	1c	10.75	
		Total	22		

- a. Pain Disability Index Tx 4 < Pain Disability Index Tx 1
- b. Pain Disability Index Tx 4 > Pain Disability Index Tx 1
- c. Pain Disability Index Tx 4 = Pain Disability Index Tx 1

The null hypothesis was rejected for Group B , P-value = 0.001, therefore a highly statistically significant difference was noted between the Pain Disability Index Tx 1 and Tx 4 within Group B.

4.4.2.4 Algometer readings

The Wilcoxon Signed Rank Test was used to assess the mean values of the algometer readings to compare treatments within Group A and Group B. The initial treatments (Tx 1) and final treatments (Tx 4) were compared.

Table 4.17 Intra-group analysis Algometer Group A i

<u>Group</u>	<u>Treatment</u>	<u>Mean</u>	<u>Std Deviation</u>
A. Periosteal pecking and Ultrasound	Algometer Tx 1	2.200	0.708
	Algometer Tx4	2.950	0.768

Table 4.18 Intra-group analysis Algometer Group A ii

<u>Group</u>	<u>Treatment</u>	<u>Neg/Pos Ranks</u>	<u>N</u>	<u>Mean Rank</u>	<u>P - Value</u>
A. Periosteal pecking and Ultrasound	Algometer Tx 4 – Algometer Tx 1	Neg. ranks	1a	20.50	0.001
		Pos. ranks	21b		
		Ties	0c	11.07	
		Total	22		

- a. Algometer Tx 4 < Algometer Tx 1
- b. Algometer Tx 4 > Algometer Tx1
- c. Algometer Tx 4 = Algometer Tx1

The null hypothesis was rejected for Group A , P-value = 0.001, showing a highly significant difference between Tx 1 and Tx 4 within Group A.

Table 4.19 Intra-group analysis Algometer Group B i

<u>Group</u>	<u>Treatment</u>	<u>Mean</u>	<u>Std Deviation</u>
B. Ultrasound	Algometer Tx 1	2.155	0.421
	Algometer Tx 4	2.468	0.543

Table 4.20 Intra-group analysis Algometer Group B ii

<u>Group</u>	<u>Treatment</u>	<u>Neg/Pos Ranks</u>	<u>N</u>	<u>Mean Rank</u>	<u>P - Value</u>
B. Ultrasound	Algometer Tx 4 – Algometer Tx 1	Neg ranks	4a	5.00	0.002
		Pos ranks	15b		
		Ties	3c	11.33	
		Total	22		

- a. Algometer Tx 4 < Algometer Tx 1
- b. Algometer Tx 4 > Algometer Tx1
- c. Algometer Tx 4 = Algometer Tx1

The null hypothesis was rejected for Group B , P-value = 0.002, therefore a statistically significant difference was noted between the algometer reading Tx 1 and Tx 4 within Group B.

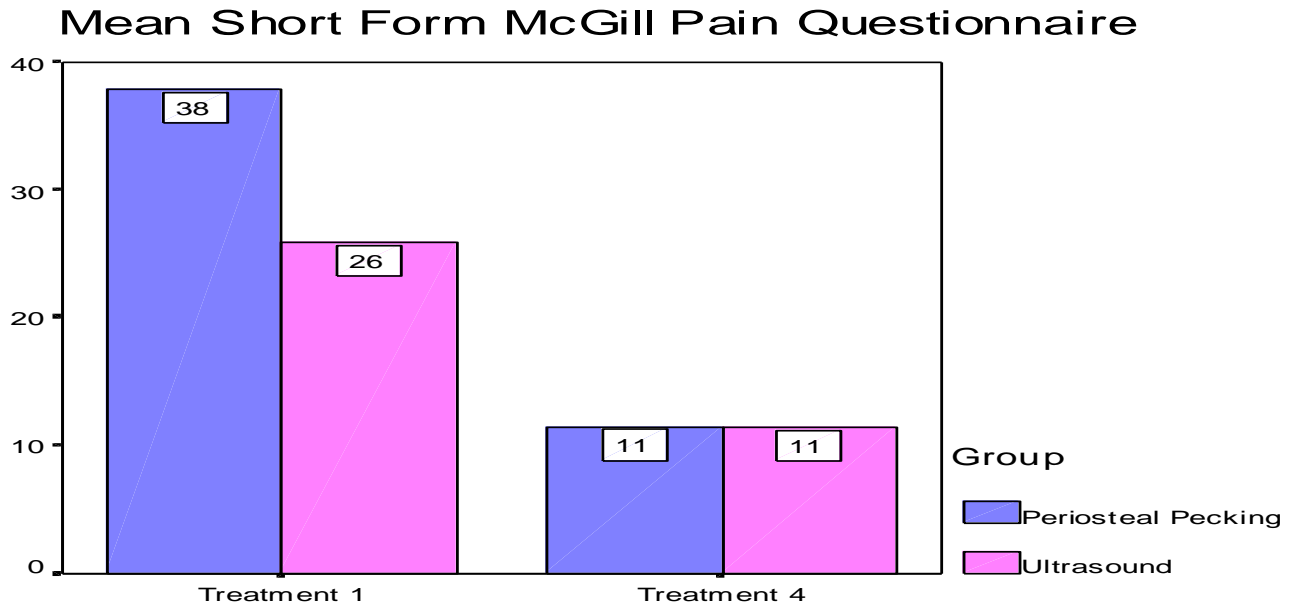


Figure 4.5

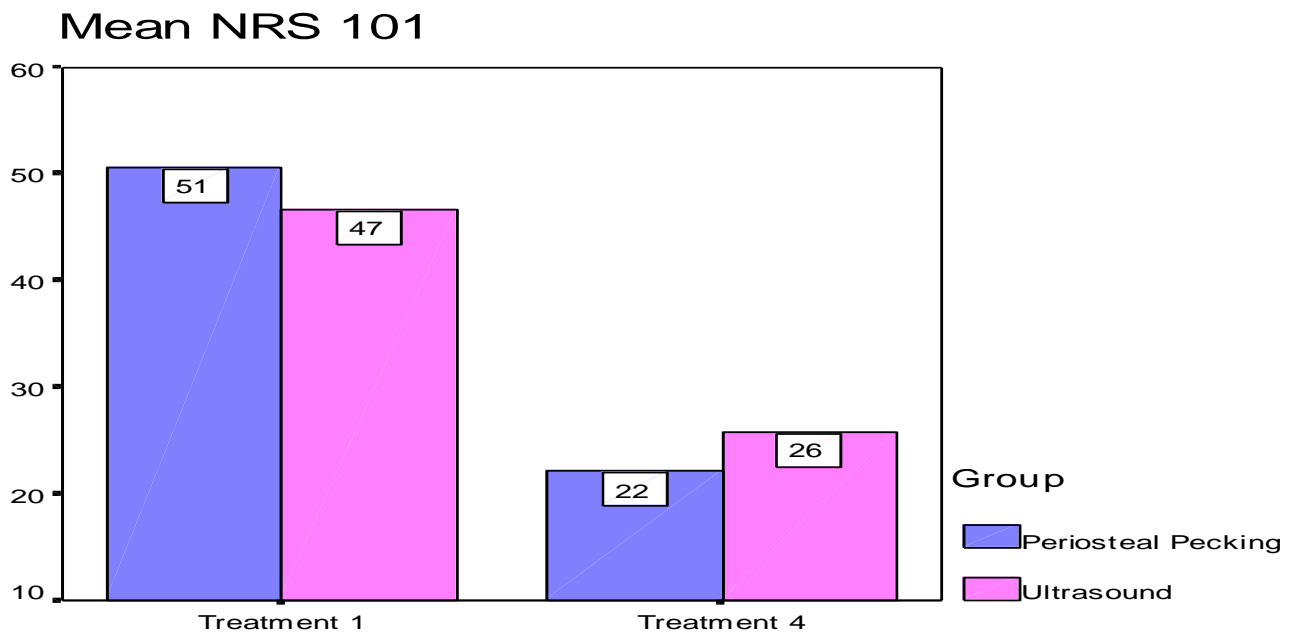


Figure 4.6

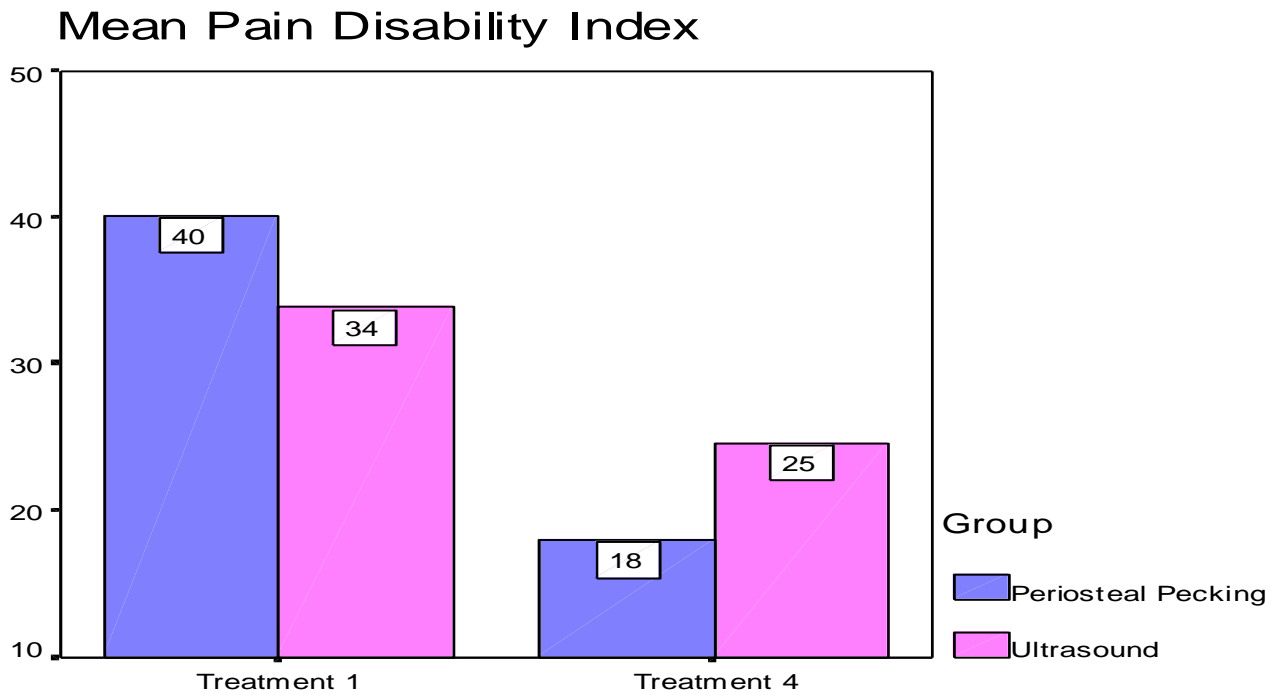


Figure 4.7

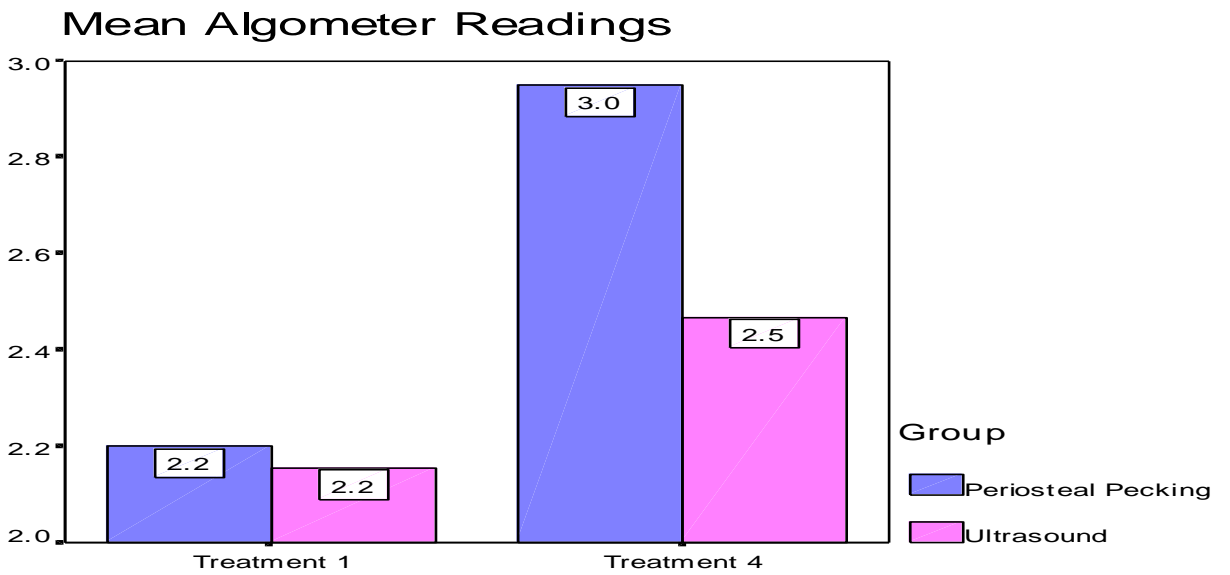


Figure 4.8

CHAPTER FIVE

5. DISCUSSION

5.1 Introduction

This chapter is concerned with the discussion of the objective and subjective data obtained from algometer readings and questionnaires respectively. The subjective data is discussed in terms of intra- and inter-group analysis in order to determine the subjective efficacy of both periosteal pecking and ultrasound therapy. The objective data is then discussed according to the results of the intra- and inter- group analysis in order to evaluate the objective efficacy of periosteal pecking and ultrasound therapy as a treatment for medial tibial stress syndrome type II.

5.2 Subjective Data

5.2.1. Short-form McGill Pain Questionnaire

A. Inter-group analysis

The McGill Questionnaire mean scores were statistically analysed using the Mann-Whitney U-Test. Each patient was randomly allocated into each group even though at Treatment 1 there was a statically significant difference between each group ($P=0.013$). This result indicates that patients in Group A had pain rating scores higher and a baseline difference in this measure than those patients in Group B.

At Treatment 4 there was no significant difference between the two groups ($P=0.963$). This result indicates that patients at Treatment 4 perceived their pain to be at the same level but it also indicates that

Group A (Mean: Tx1=37.8336; Tx4=11.4686) improved more than Group B (Mean: Tx1=25.8591; Tx4=11.4168) with regard to perception of pain levels.

B. Intra-group analysis

The McGill Questionnaire mean scores were statistically analysed using the Wilcoxon Signed Rank Test. Within Group A there was a highly significant difference ($P=0.000$) between Treatment 1 and Treatment 4. Within Group B there was also highly significant difference ($P=0.000$) between Treatment 1 and Treatment 4.

This indicates that from Treatment 1 to Treatment 4 there was a decrease in pain within both Group A and Group B with regard to their perception of pain.

5.2.2 Numerical Pain Rating Scale

A. Inter-group analysis

The NRS 101 mean scores were statistically analysed using the Mann Whitney U-Test. Each patient was randomly allocated into each group. At Treatment 1 there was no significant difference ($P=0.453$) between Group A and Group B. This indicates that at Treatment 1 both groups rated their pain similarly.

At Treatment 4 there was no significant difference ($P=0.311$) between Group A and Group B. This indicates that at Treatment 4 both groups perceived their pain to be at the same level. Both groups improved significantly as shown in the intra-group analysis in part B ($P=0.000$).

B. Intra-group analysis

The NRS 101 mean scores were statistically analysed using the Wilcoxon Signed Rank Test. Within Group A there was a highly significant difference ($P=0.000$) between Treatment 1 (Mean: 50.659) and Treatment 4 (Mean: 22.159). Within

Group B there was also highly significant difference ($P=0.000$) between Treatment 1 (Mean: 46.705) and Treatment 4 (Mean: 25.795).

This indicates that from Treatment 1 to Treatment 4 there was a decrease in pain within both Group A and Group B with regard to their perception of pain.

The standard deviation of both Group A (Tx 1=18.353; Tx 4=22.159) and Group B (Tx 1=11.837; Tx 4=15.856) show a greater increase. This indicates that there is a greater range of values and that this range increases through the treatments. This indicates that both groups were under 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.

5.2.3 Pain Disability Index

A. Inter-group analysis

The Pain Disability Index mean scores were statistically analysed using the Mann Whitney U-Test. Each patient was randomly allocated into each group. At Treatment 1 there was no significant difference ($P=0.335$) between Group A and Group B. This indicates that at Treatment 1 both groups rated their pain similarly.

At Treatment 4 there was significant difference ($P=0.020$) between Group A and Group B. This indicates that at Treatment 4 both groups improved but Group A improved significantly more than Group B with regard to perception of pain.

B. Intra-group analysis

The Pain Disability Index mean scores were statistically analysed using the Wilcoxon Signed Rank Test. Within Group A there was a highly significant difference ($P=0.000$) between Treatment 1 (Mean: 40.18) and Treatment 4 (Mean: 18.05). Within Group B there was also highly significant difference ($P=0.001$) between Treatment 1 (Mean: 33.91) and Treatment 4 (Mean: 24.64).

This indicates that from Treatment 1 to Treatment 4 there was a significant decrease in pain within both Group A and Group B with regard to their perception of pain.

5.3 Objective Data

5.3.1 Algometer Readings

A. Inter-group analysis

The Algometer mean scores were statistically analysed using the Mann Whitney U-Test. At Treatment 1 there was no significant difference ($P=0.916$) between Group A and Group B. This indicates that at Treatment 1 both groups rated their pain similarly showing no bias in group allocation.

At Treatment 4 there was significant difference ($P=0.026$) between both groups. This indicates that at Treatment 4 both groups improved but Group A (Tx 1=2.200; Tx 4=2.950) improved more than Group B (Tx 1=2.155; Tx 4=2.468) with regard to perception of pain.

B. Intra-group analysis

The Pain Disability Index mean scores were statistically analysed using the Wilcoxon Signed Rank Test. Within Group A there was a highly significant difference ($P=0.001$) between Treatment 1 and Treatment 4. Within Group B there was a significant difference ($P=0.002$) between Treatment 1 and Treatment 4.

This indicates that from Treatment 1 to Treatment 4 there was a decrease in pain within both Group A and Group B with regard to their perception of pain.

5.4 Comparison of results

Objectively both Group A (periosteal pecking and ultrasound) and Group B (ultrasound) performed similarly. Both groups improved significantly from the initial treatment to the final treatment. Group A was highly significant ($P=0.001$) while Group B was significant ($P=0.002$). The inter-group analysis showed a significant difference between Group A and Group B at Treatment 4 ($P=0.026$) therefore in terms of the first objective Group A appeared to be more effective for the treatment of MTSS Type II. These results are in line with another study which showed that periosteal pecking and sport medicine are effective for the treatment of MTSS Type II (Callison, 2002).

Subjectively both Group A (periosteal pecking and ultrasound) and Group B (ultrasound) performed similarly. Both groups improved significantly from the initial treatment to the final treatment. In terms of the second objective both treatments appeared to be effective for the treatment of MTSS Type II.

According to Callison (2002) and Hopwood *et al.* (1997) periosteal pecking is effective for treating conditions involving the musculoskeletal system. Gam and Johannsen (1995) and van der Windt *et al.* (1999) found ultrasound alone to be effective for treating the musculoskeletal system however Robertson and Baker (2001) did not support the use of ultrasound therapy alone in the treatment of musculoskeletal disorders. The results of this study however have shown that ultrasound alone is an effective treatment for MTSS Type II and when combined with another physical modality has shown even greater improvement both subjectively and objectively for the treatment of MTSS Type II.

5.5 Conclusion

This study found that ultrasound combined with periosteal pecking is more effective for the treatment of Medial Tibial Stress Syndrome Type II.

CHAPTER SIX

6. CONCLUSIONS

6.1 Recommendations

Sample size

A larger sample size would increase the validity of the study and minimizes the possibility of incorrectly accepting the null hypothesis.

Parameters

More closely defined parameters with regards to using matched pairs with respect to age, gender, race, occupation and extent of pain would greatly enhance the strength of the study.

Diagnosis of MTSS

Until strict, validated, diagnostic criteria are established for this syndrome, the ability to diagnose and treat it will continue to be questionable.

Follow up consultations

No long term follow up consultation was done which would help to address the cost-effectiveness and general efficacy of the treatment protocols utilized.

Blinding

Observer bias could be eliminated by not allowing the examiner to know which group was being assessed, as well as by not allowing the examiner to view the previous treatment readings.

6.2 Findings

The following observations were noted during period of the research:

- At the initial visit it was noted that some patients complained of a morning ache. This pain was described as a sharp ache felt first thing in the morning.
- At the initial visit it was also noted that some patients complained of experiencing pain up and down stairs.
- It was noted when taking a history that marathon runners training long distances, at a certain pace, on the road then wanting to increase their pace by doing track work suffered more from shin splints pain.
- It was noted that patients experienced slight calf stiffness after the first periosteal pecking treatment.
- It was noted that patients that exercised after the periosteal pecking treatment did not respond as well as those patients who rested on the day of treatment.

6.3 Conclusion

Subjectively the patients in this study benefited from both ultrasound alone and when combined with periosteal pecking in the treatment of MTSS. Objectively the patients benefited more when treated with the combination of periosteal pecking and ultrasound.

Early identification of aggravating and perpetuating factors and prompt diagnosis reduces the severity and duration of overuse injuries like MTSS. Periosteal pecking and ultrasound appear to be an effective modality for relieving pain associated with MTSS. Patients receiving the above treatment were least hindered by pain during sporting and non-sporting activities. It was also noted that patients felt the treatment was effective.

The results of this study indicate that periosteal pecking when combined with ultrasound is effective for the treatment of Medial Tibial Stress Syndrome Type II.

No in depth evaluation of the foot biomechanics with regard to pronation, navicular drop and hindfoot or forefoot varus was documented in the study. Measures to prevent MTSS such as patient education, activity modification, a therapeutic exercise program including proper stretching and strengthening techniques as well as evaluation for biomechanical foot orthoses could be instituted at an early stage of treatment in an individual at risk.

This highlights a need for further studies to identify and assess the foot biomechanics of athletes suffering from shin splints and treating accordingly.

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APPENDIX A
CASE HISTORY

APPENDIX B
REVISED PHYSICAL EXAMINATION

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NUMERICAL PAIN RATING SCALE (NRS 101)

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APPENDIX J
DIAGRAM OF THE LEG

APPENDIX K
ALGOMETER

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 centimeter diameter rubber tipped stylus. Pain threshold is determined by the amounts of force per square centimeter 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 to be measured is then localized 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 centimeter per second until the patient first perceives pain and responds by saying now. The stylus is then removed and the recorded value is noted (Fischer, 1987).