The relative effectiveness of three treatment protocols in the treatment of Medial Tibial Stress Syndrome Type II.

BY
Liza Payne

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I, Liza Payne do declare that this dissertation is representative of my own work.

Signed: _____ Date:_____

Approved for final examination by
Dr C.Korporaal, M Tech:Chiropractic,
CCFC, CCSP, ICSSD
Supervisor

Signed: _____ Date:_____

DEDICATION

I dedicate my research to my parents for their constant support, motivation, love and prayers and for always believing in me even when I didn't believe in myself.

And to my Saviour for giving me the abilities and allowing me the opportunities to put these abilities to use.

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To my family, you are amazing. Thank you for all your encouragement, love and support. I wouldn't have made it without you.

ABSTRACT

The relative effectiveness of three treatment protocols in the treatment of Medial Tibial Stress Syndrome Type II.

Objective:

The aim of this study was to investigate the relative effectiveness of TENS, versus, needling, versus Electro-needling in the treatment of MTSS.

First objective

The first objective was to evaluate the effectiveness of TENS therapy on MTSS with respect to the patients subjective and objective responses to the treatment.

Second Objective

The second objective was to evaluate the effectiveness of needling therapy on MTSS, with respect to the patient's subjective and objective responses to the treatment.

Third Objective

The third objective was to evaluate the effects of electro-needling on MTSS, with respect to the patients' subjective and objective responses to the treatment.

Fourth Objective

The fourth objective was to integrate the subjective and objective data collected in order to determine the viability of each of the therapies in comparison to one another as treatment options of MTSS.

Design:

A sample of forty five patients diagnosed with medial tibial stress syndrome were accepted into the study.

These Participants were randomly divided into three groups of 15, which received different treatment protocols for MTSS.

Outcome Measure:

A decrease in pain (measured on the algometer) with an increase in activity.

Results:

All groups improved with the treatments they received; however, no treatment alone was better than any other treatment tested.

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DEFINITION OF TERMS

Algometer:

An instrument used to determine pain threshold. It is calibrated in kilograms per square centimetre. The instrument and its use is described in Appendix K (Fischer, 1986).

Dry Needling:

Is the insertion of an empty hypodermic needle to stimulate a relative area (Birch et al., 1999). For the purposes of this study however an acupuncture needle was use in the treatment of medial tibial stress syndrome.

Electro – needling:

This is when the needles which are inserted into the tender spots along the medial tibia are connected to TENS by crocodile clips, and therefore an electric stimulation is thus sent to the affected area (Chen et al., 1986).

Medial Tibial Stress Syndrome Type II (MTSS):

Medial Tibial Stress Syndrome Type II (MTSS), otherwise known as shin splints according to the American Medical Association (1966) 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 ischaemic disorders” (Thacker et al., 2002).

MTSS Type I: (Detmer, 1986

With this diagnosis, the primary problem is located within the bone itself. This would include stress fractures and / or stress micro fractures being frequently diagnosed.

MTSS Type II: (Detmer, 1986)

Type II or Chronic periostalgia, is characterised 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).

MTSS Type III: (Detmer, 1986)

The symptoms are localized over the distal, deep posterior compartment musculature. This may involve the soleus but frequently involves the distal posterior compartment.

Objective changes:

Those changes observed in the level of tenderness experienced by the patient as measured by the algometer and noted by the practitioner (Fischer, 1986).

Shin Splints:

Shin splints is a non specific term that has been applied to a variety of disorders causing pain in the lower leg (Michael and Holder, 1986).

Subjective changes:

Those changes personally perceived by the patient and reported to the practitioner and noted in the Short-Form McGill Pain Questionnaire (Melzack and Katz, 1992), Numerical Pain Rating Scale (Jenson et al., 1986) and the Pain Disability Scale (Tait et al., 1987).

Transcutaneous Electrical Nerve Stimulation,(TENS):

The application of a pulsed rectangular wave current via surface electrodes on the patient's skin (Bazin and Kitchen, 1996).

CHAPTER ONE

1.1 INTRODUCTION:

MTSS is pain or discomfort along the distal 2/3 of the medial tibia as a result of inflammatory periositis or chronic periostalgia. In this respect periositis has been defined as tearing away of the muscle fibres at the muscle-bone interface causing inflammation and pain.

Based on this presentation it commonly affects runners, aerobic dancers, and military recruits (Mubarak et al., 1982). The pain presents mainly during activity, although it can occur with minimal exertion and / or after activity depending on the stage of pathogenesis.

As a result Detmer (1986) classified MTSS pathogenesis into three components according to the tissues involved:

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

MTSS has also been referred to as a soleus syndrome, as the resultant periositis has been localised to the medial insertion of the soleus muscle (Michael and Holder, et al., 1985).

Based on the pathogenesis, treatment and therapeutic approaches that have targeted the symptomatic pain aspect of this condition, Treatment protocols have varied from biomechanical interventions, like orthotics, to non-steroidal anti-inflammatory medication and modalities such as ultrasound; but all have had varying degrees of success (Noakes, 2001). These treatments and therapeutic

approaches have however had little focus on resolving the periosteal component of this condition.

There is however evidence to suggest that TENS and needling, which both have similar effects (they both assist with pain control and to help decrease inflammation), may produce better clinical effects when combined by addressing the periosteal component more directly.

Therefore, in this study, the researcher tested which of the treatments were most effective in treating MTSS, with the aim of this study having been to determine whether TENS, needling and / or electro-needling was an effective treatment for the treatment of MTSS.

1.2 Aims and Objectives:

The aim of this study was to investigate the relative effectiveness of TENS, versus, needling, versus electro-needling in the treatment of MTSS.

1.2.1 The first objective:

The first objective was to evaluate the effectiveness of TENS therapy on MTSS with respect to the patient's subjective and objective responses to the treatment.

1.2.2 The second objective:

The second objective was to evaluate the effectiveness of needling therapy on MTSS, with respect to the patient's subjective and objective responses to the treatment.

1.2.3 The third objective:

The third objective was to evaluate the effects of electro-needling on MTSS, with respect to the patient's subjective and objective responses to the treatment.

1.2.4 The fourth objective:

The fourth objective was to integrate the subjective and objective data collected in order to determine the viability of each of the therapies in comparison to one another as treatment options of MTSS.

1.3 Hypothesis

Therefore, the hypothesis was that dry needling combined with TENS using crocodile clips would be more effective in the treatment of MTSS than needling or TENS on their own. This is based in the fact that the needling combined with the TENS should penetrate through the skin's resistance to a greater degree and therefore the electric stimuli should reach the tissues and muscles that are inflamed and thereby improve the recovery rate at a faster rate.

1.4 Rationale

1. With the combination of using needles attached to the TENS it was thought that the effect of TENS will be enhanced. The needle creates a magnetic field around the area it is inserted into, therefore when TENS was attached, this electrical stimulus reaches a deeper and larger area than it usually would on its own (Chen et al., 1998).

2. Post needling stiffness is often an effect of needling. TENS however, is a pain reducing modality, therefore when TENS was applied in conjunction with the needling it should help reduce this stiffness and pain.

3. MTSS is pain or discomfort along the medial tibia as a result of inflammatory periositis or chronic periostalgia. Therefore with the use of TENS and needling should decrease the inflammation and pain, and thus

should speed up the recovery process, as compared to either modality used in isolation.

1.5 Benefits

Patients participating in this study were hypothesised to experience a treatment effect no matter which group they were placed.

The overall implications for the outcomes of this study are to assist practitioners in effecting a treatment protocol that is more effective in treating this recalcitrant condition.

1.6 Limitations

As with all studies that utilise subjective outcomes as part of the measurement and reporting process, it is assumed that all patients answered the questions open and honestly and therefore reflected their condition accurately at the time of measurement.

1.7 Conclusion

Therefore, this study aimed to find a treatment protocol for MTSS that would help speed up the healing process and allow the participants to continue with the chosen sport while receiving treatment. Chapter Two therefore covers the literature with respect to the MTSS, the causative factors and relieving factors of MTSS. Chapter three then goes on to present the research methodology with Chapter Four presenting and discussing the results and Chapter Five presenting the conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW:

2.1 Introduction

The term shin splints is a commonly phrase that refers to pain in the lower leg of athletes (Detmer, 1986). Slocum (1966) suggested that the terminology was confusing as the term “shin” was vague and could be used to describe any area between the knee and the ankle. Thus the American Medical Association (1966) defined shin splints as: “pain and discomfort in the leg from repetitive running on hard surfaces or forcible, excessive use of foot flexors; where the diagnosis should be limited to the musculotendinous inflammations excluding fracture and ischeamic disorders”. Michael and Holder (1985) agree and go further to state that “shin splints” is only a description and not a diagnosis as it broadly describes any leg pain.

As a result the term ”MTSS” was suggested by Mubarak et al., (1982), which was further subdivided into ”posterior tibial tendonitis” and “anterior shin splints” as a result of an effort to describe exertional shin pain. In congruence with this, other classifications for this syndrome included stress fractures, acute or chronic compartment syndromes, myositis and periositis (Micheal and Holder 1985).

With the above in mind Detmer (1986) classified MTSS pathogenesis into three components according to the tissues involved:

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

This was supported in more recent literature by Styf (1988) and Moore (1988), who suggested that exertional shin pain represents a spectrum of syndromes which can reduce or prevent further activity.

However, in order to understand the pathogenesis, clinical features and accurate diagnosis of MTSS we first need to understand the anatomy of the region. This follows in the next section.

2.2. ANATOMY:

Bone is a living, constantly 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, and like the endosteum, it contains osteogenic cells (Oloff, 1994) and therefore 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 fibro cartilage 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 may eventually cause local changes which result in increased bone metabolism.

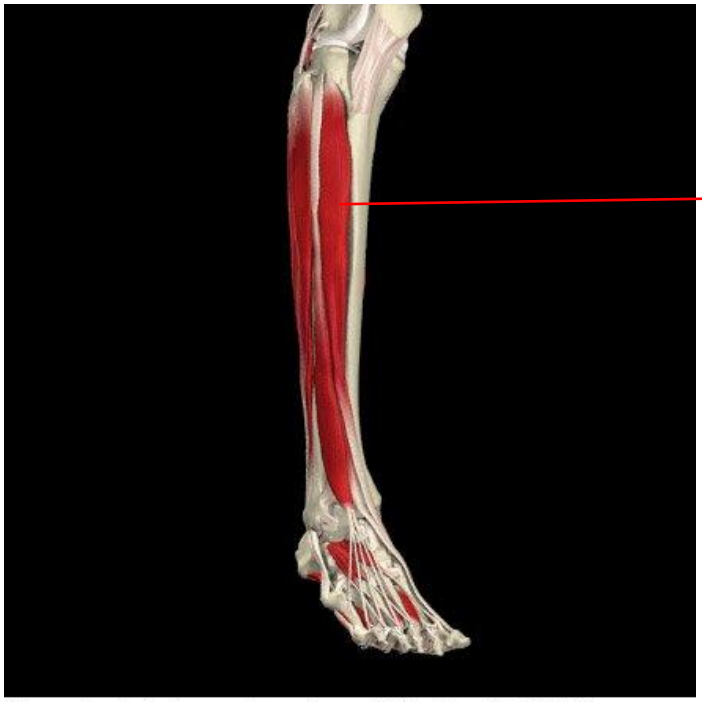
According to Moore (2006) shin splints is believed to be stress or overuse related injury to the muscle-tendon units of the deep posterior compartment or the anterior tibial compartment with a resultant impact on the periosteum and underlying bone.

This results from fatigue failure and overload that is thought to 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 to the muscle, muscle-tendon units and the periosteum (Moore, 1988).

With particular respect to the leg, there are four fascial compartments (Moore, 2006):

1. Anterior Tibial Compartment:

The tibialis anterior functions as a dorsiflexor and inverter of the foot. The extensor digitorum longus and extensor hallicus longus extend the toes and assist in dorsiflexion and eversion of the forefoot (Moore, 2006).



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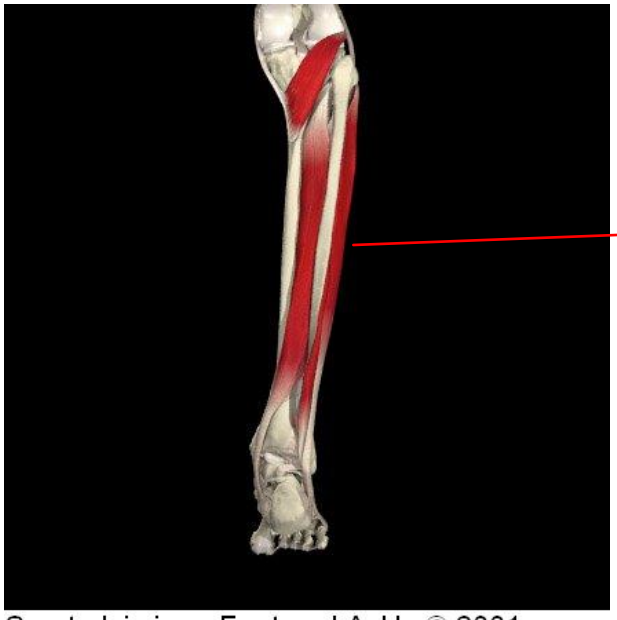
2. Deep posterior compartment:

The tibialis posterior functions as a primary plantar flexor and invertor of the foot. The flexor digitorium longus and flexor hallicus longus flex the toes and assist the primary plantar flexors (Moore, 2006).



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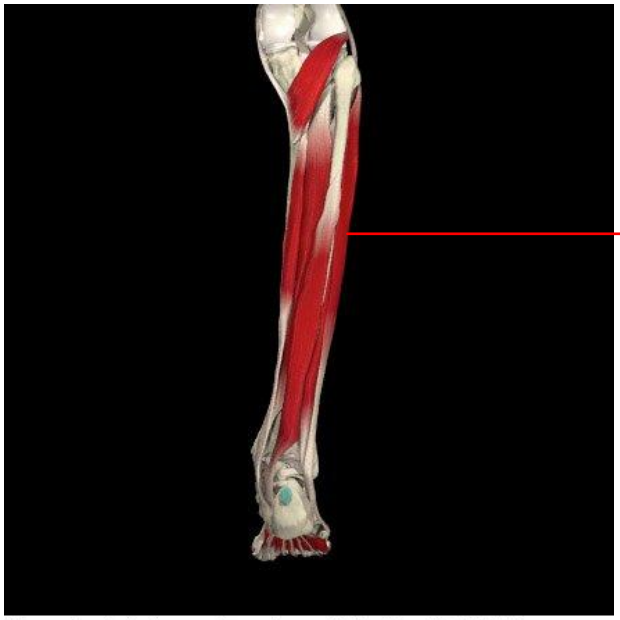

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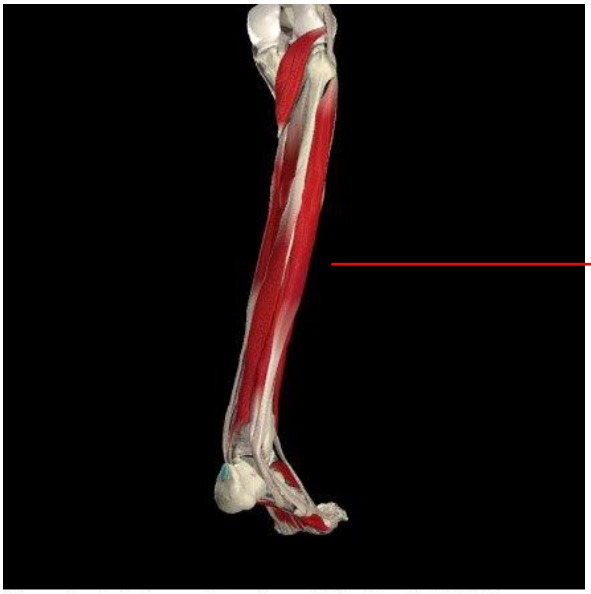
3. Lateral compartment:

The peroneus longus and peroneus brevis evert the foot and assist in plantar flexion (Moore, 2006).



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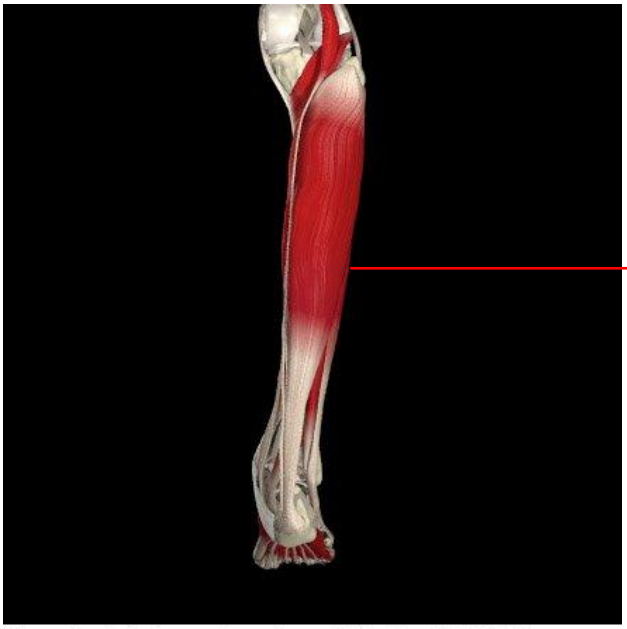
4. Superficial posterior compartment:



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The large soleus and the two heads of the gastrocnemius function as the primary plantar flexors of the foot (Moore, 2006).

Based on the available literature at that time, Michael and Holder (1985) and Detmer (1986) proposed that “medial tibial stress syndrome is a consequence of traction stress on the periosteum applied by the medial arising fibres of the soleus muscle.” In contrast to this Garth and Miller (1989) suggested the flexor digitorum longus as the principle cause of medial tibial stress syndrome, whereas Saxena et al. (1990) concluded that the tibialis posterior was a potential contributor to medial tibial stress syndrome.

However, Beck and Ostering (1994) did a study on 50 cadavers. On dissection it was determined that the muscle attachments that coincide with MTSS were the :soleus, flexor digitorium longus and the deep crural fascia. Therefore, according to Beck and Ostering (1994), the soleus is the major contributor towards MTSS and the tibialis posterior can be excluded as a cause of MTSS.

Anatomy texts (Moore, 2006) reveal that only the soleus and the flexor digitorum longus muscles attach at or near the site of the symptoms of the medial tibial stress syndrome. Therefore, it seems from an anatomical view point, that only the soleus and the flexor digitorum longus are the only muscles capable of applying traction to the periosteum at this site, which support research by Michael and Holder (1985), Detmer (1986) and Garth and Miller (1989)

Notwithstanding the above indecisiveness of the literature, all muscles thought to be involved in medial tibial stress syndrome will be discussed in the following section.

2.3. ANATOMY AND BIOMECHANICS OF THE MUSCLES OF THE POSTERIOR COMPARTMENT

2.3.1. SOLEUS MUSCLE:

The soleus is a flat thick muscle which attaches proximally to the posterior surface of the head of the fibula to the middle third of the medial border of the tibia. Michael and Holder (1985), Moore (2006). It is variable in length ending approximately four inches above the medial malleolus. The tendinous portion of the soleus makes up the anterior one half of the Achilles tendon, which attaches to the posterior part of the calcaneus (Travell and Simons 1999). The soleus bridge is a tough aponeurotic layer, which inserts on the tibial periosteum. Traction at this site may produce a periostitis (Michael and Holder 1985).

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, which could be a cause of symptoms of MTSS. He stated 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. This would be consistent with the theory that ballistic action and / or hard surfaces play a role in precipitating MTSS as the functions of the Soleus muscle include (Travell and Simon's 1999):

- Provides ankle stability,
- Contributes to knee stability during walking,
- Inverts the calcaneus,
- The main dynamic and static controller of ankle plantar flexion,
- Restrains forward rotation of the tibia over the fixed foot and
- Contracts eccentrically to limit pronation.

2.3.2. FLEXOR DIGITORUM LONGUS MUSCLE:

The flexor digitorum longus muscle lies on the back of the tibia deep to the soleus and gastrocnemius and medial to the tibialis posterior (Travell and Simon's 1999). The proximal attachment is 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 hallicus longus tendon. Distally each of the four tendons attach to the base of the distal phalanx of its corresponding lesser toe. (Travell and Simon's 1999)

In addition to the location of the muscle the following functions of flexor digitorum longus, may predispose it to injury as a result of repetitive fatigue (Travell and Simons 1999).

- Helping to stabilize the foot and ankle during midstance and late stance phase of walking.
- Controlling movements of the foot in saggital and frontal planes,
- Maintaining equilibrium when body weight is on the forefoot and
- Flexing of the distal phalanges.

2.3.3. TIBIALIS POSTERIOR MUSCLE:

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 interosseus 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 the intermuscular septa of the adjacent muscles. 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 medial malleolus together but in separate sheaths.

Distally it anchors to the plantar surface of most of the tarsals that form the arch (medial longitudinal) (Moore, 2006) of the foot, primarily the navicular but also to the calcaneus, each cuneiform, the cuboids and the bases of the 2nd, 3rd and 4th metatarsals.

With the need for the tibialis posterior to assist in supporting the arches of the foot, its role becomes twofold. Therefore the likelihood of repetitive strain injury is more likely as a result of the following movements which it also controls (Travell and Simons 1999):

- Supination of the foot,
- Prevention of excessive weight bearing on the medial side of the foot,
- Assisting in plantar flexion of the foot,
- Prevention of excessive pronation of the foot in midstance and
- Distribution of weight among the heads of the metatarsals.

2.4. Biomechanics:

Studies (Sommer and Vallentyne, 1995 and Viitasalo, 1983) done on MTSS have shown that of the patients that suffer with this syndrome, many have pronated feet. Viitasalo (1983) went as far as to state that the degree of pronation would determine the severity of the shin splints.

In this respect it is noted that rearfoot pronation (weight bearing valgus) results in an increase traction of the soleus muscle as the soleus resists heel pronation both by the soleus muscle traction and its point of insertion, resulting in eccentric contraction during activity. The net result being a traction avulsion of the periosteum along the posterior medial tibial border at the site of the origin of the soleus muscle (Detmer 1983, Viitasalo and Kvist, 1983).

As there are many factors known to be associated with dynamic subtalar pronation, these need to be considered as predisposing factors in the development of shin splints. These factors include but are not limited to (Viitasalo and Kvist, 1983; Noakes, 1992: Reid, 1992; Sommer and Vallentyne, 1995):

- Varus posturing of the forefoot on the hind foot creates an unstable point of contact with the ground that is then stabilized by pronation during the contact phase of the gait cycle.
- Tibia varum places the foot in an unstable position at heel strike,leading to excessive pronation to arrive at midstance.
- Equinus foot and tight calf muscles both lead to excessive pronation by requiring the midfoot and forefoot allow for increased compensatory dorsiflexion (a component of pronation) in order to absorb the energy of foot contact more efficiently.
- Increased passive mobility of the foot structures. This may be seen in hypermobile feet, were excessive mobility in the subtalar and talar joints is associated with increased lower limb injuries as well as overpronation. It must be noted that this association is generalised as the association between the injuries and overpronation have not been concretised in the literature.
- An externally rotated hip, which results in the lower limb being externally rotated and therefore prevents correct toe-off, and as a result, the foot over pronates during the stance phase when the foot is weight bearing.

- Adduction of the lower limb across the midline, as this results in functional overpronation.
- Camber of the training surface, which has been shown to cause a functional overpronation on the side of the elevated foot.
- Leaning to one side as is associated with track running, which causes a functional overpronation of the inside foot.
- Collapsed soles of training shoes, which has been associated with decreased support and possible medial compression of the sole. The shoe loses support and overpronation of the foot results.

All of the above lead to various degrees of overpronation (excessive functional pronation) at some point in the gait. To support the above, a study of 25 dancers suffering from MTSS found that there was a higher incidence of forefoot and hindfoot varus (non-weight bearing) amongst the symptomatic subjects. The researchers concluded that hyperpronation of the subtalar joint might be the most important factor in patients suffering from medial tibial stress syndrome (Sommer and Vallentyne, 1995).

In a similar comparative study involving long distance runners and orienteerers showed that injured athletes had greater passive mobility with respect to inversion, eversion and their sum when compared to uninjured runners. The study also indicated that there might be an elongated pronation time in injured runners as a result of this increased passive mobility (Viitasalo and Kvist, 1983).

Therefore it can be seen that there are multiple predisposing factors to MTSS and thus it is not uncommon to have patients present in a clinical practice with this complaint which may also be responsible for the various presentations that occur for MTSS. Therefore the next section will detail the epidemiology of MTSS.

2.5. Epidemiology:

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), where stress related bone injuries are common in athletes and account for up to 10% of cases in sports medicine practice (Bhatt et al., 2000). With respect to these stress injuries, it was found by Bhatt et al. (2000) that those involving the tibia account for up to 75% of exertional leg pain. A common cause of exertional leg pain is MTSS (Bennett et al., 2001), which commonly occurs in runners (Drez, 1994).

This is supported by a study done, in which over 4000 runners were used. It was noted in this study that 20% had sustained injuries severe enough to terminate training and 6% of those runners reported an injury to the medial tibial region (Drez, 1994). Furthermore MTSS has also been shown to affect more female runners than male runners (Bennette, 2000) and has been found to be a disabling leg pain in young competitive athletes and often occurs at the beginning of a season or when training is significantly increased (Van Mechelen, 1992).

In addition to the above Michael and Holder (1985), Viitasalo and Kvist (1983) and Detmer (1986) have indicated that people involved in ballistic sports i.e. jumping, or powerful contractions of the soleus muscle are most likely to be afflicted with MTSS.

This research was done using participants between the ages of 18 to 50 years of age. According to previous research been done on MTSS, this appears to be the age with the highest incidence of patients who are affected by MTSS (Van Lingen 1998; Robertson, 2003).

As with most other overuse conditions, MTSS often occurs after a change in athletic activity or an increase in mileage. Some research has shown (Andrish, 1974) that navy midshipmen who had no prior physical training before entering the Naval Academy were twice as likely to experience MTSS as those with prior training.

According to Detmer (1986) chronic medial tibial stress syndrome affects runners, (especially sprinters or hurdlers), and athletes in ballistic sports, i.e. gymnasts, dancers, basketball players, aerobic dancers, tennis players and long jumpers (Michael and Holder, et al., 1985, Viitasalo and Kvist, 1983).

2.6. Diagnostic Classification:

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; Viitasalo et al., 1983; Sommer et al., 1995; Mubarak et al., 1982). This is more accurately described MTSS (Mubarak et al., 1982, James, 1988 and Saxena, 1990).

MTSS is also classified diagnostically with respect to 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.
- **Severity**

  Grade 1: This 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: Requires patients to have pain while running and residual discomfort after running.

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

On a practical level, 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 tries to “run through” the pain, but if training continues without treatment, the pain becomes so severe that proper training is not 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 becomes a stress fracture.

Similarly to Noakes (2001) and according to Devas (1958) symptoms start insidiously, at first a dull gnawing pain in the shin, which occurs towards the end of a run. The intensity of the pain increases over the days and becomes so severe that running cannot be continued. At first the pain passes off with rest but recurs with further running. Over the days running shorter and shorter distances produce the pain, which persists for some hours after athletic activity has ceased or can even persist for days.

Detmer (1986) suggested that this is due to the periosteum becoming traumatically disengaged from the bone, which could be due to either ballistic avulsion of the periosteum from the bone or less frequently due to subperiosteal bone stress on the tibial edge resulting in subperiosteal bone haemorrhage that causes the periosteum to be lifted away from the bone.

This periosteal avulsion (Detmer, 1986) is thought to be as a result of the powerful contractions of the soleus muscle at the site of its insertion.

2.7. DIAGNOSIS OF MTSS:.

Tenderness along the posteromedial border of the tibia is the most reproducible finding on examination. It is often located over the middle and distal thirds of the tibia, typically between 4 and 12cm from the medial malleolus (Detmer, 1986), and is more pronounced if examined immediately after exercise (Mubarak et al., 1982). Swelling and induration may be noted locally (Moore MP, 1988 and Clanton TO, Solcher BW, 1994). Bony tenderness is usual along the medial distal third of the tibia (Pell, Khanuja, and Cooley, 2004). Active resisted flexion of the ankle may produce pain. Neurological examination as well as the pulses should be normal (Clanton and ,Solcher BW,1994, and Kortebein ,Kaufman and ,Basford, Stuart, 2000). Excess pronation or excess subtalar and talar joint motion are often associated with this condition (Mubarak et al., 1982, and Sommer and Vallentyne, 1995).

A clinical diagnosis of MTSS was made -patients needed to meet the following criteria:

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). The main complaint amongst this group of patients with medial tibial stress

syndrome is pain along the posteromedial border of the middle and distal thirds of the tibia.

Patients experienced pain in this area, exacerbated by weight bearing or physical activity and which is relieved by rest (Detmer, 1986). They also had the presence of 'tender spots' -rough, well localised, exquisitely tender corrugated areas, arising from the build up of new periosteal layer which is felt when applying firm finger pressure (Noakes, 2001).

The study was for both males and females as had been done in previous studies (van Lingen, 1997 and Roberson, 2003). Those who met the inclusion criteria needed to meet a pain rating on the NRS between 5-10 in order to qualify for the study. This was done to get a group of participants with similar NRS readings in order to get more accurate results.

2.8. SPECIAL INVESTIGATIONS:

Plain film x-rays most often are normal in medial tibial stress syndrome (Fredericson et al., 1995; Roub et al., 1979), however there may be signs of posterior tibial cortical hypertrophy as well as periosteal new bone formation (Fredericson et al., 1995). There may also be signs of healed stress fractures (Fredericson et al., 1995). Therefore, as we can see, plain x-rays are not a sensitive indicator for stress reaction and are only specific if a fracture line is detected (Fredericson et al., 1995).

A bone scan is a very good diagnostic tool in the evaluation of medial tibial stress syndrome (Michael and Holder, 1985). Technetium-99 bone scans demonstrate a characteristic pattern of increased radiotracer signal uptake. There is increased signal noted along the posteromedial border of the tibia on the delayed phase of the scan in medial tibial stress syndrome. According to Rupani (1985), the

character of this uptake distinguishes medial tibial stress syndrome from tibial stress fracture. In medial tibial stress syndrome, the signal uptake is moderate and extends for about one third the length of the tibia. Bone scan abnormalities in tibial stress fractures are typically more intense and focal (Rupani et al., 1985).

Some years later, Matin (1988) recommended that a three-phase radionuclide bone scan, in which a radionuclide angiogram and a follow up blood pool images,be used to assess the vascularity of the abnormality. However, Rupani (1985) showed that patients with medial tibial stress syndrome very rarely had increase vascularity and stress fractures always had increased vascularity in the region of the injury, thus it would seem that Matin's (1988) recommendation utilised this diagnostic procedure as a process of exclusion rather than as a diagnostic tool to detect MTSS. In addition to this Matin (1988) concluded by saying that at times it would be essentially impossible to differentiate a stress fracture from medial tibial stress syndrome either clinically or by scintigraphic methods.

Following the above recommendations Fredericson et al. (1995) presented a study in which they evaluated medial tibial stress syndrome 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. This recommendation was based on the fact that 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 scan. Kimmo et al.(1999) found that MRI has a significant role in establishing the correct diagnosis, eventually leading the physian to select a proper treatment for a given patient. MRI well depicts bone stress reaction and a

special technique, Dynamic Contrast Enhanced Imaging (DECS),can show compromised compartmental perfusion. However, according to Bhatt et al. (2000) MRI has limited value in diagnosing medial tibial stress syndrome because of the wide spectrum of appearance of MTSS.

If there is question as to the symptoms being a compartment syndrome or medial tibial stress syndrome, compartment pressures should be taken. They would remain normal in medial tibial stress syndrome. Mubarak (1982) did a study using two groups- one group had be diagnosed with anterior compartment syndrome while the other group had been diagnosed with MTSS. Compartment pressures were measured at rest, pre-exercise and post exercise. Although the MTSS group levels were slightly raised with exercise, they were still within normal range of pressures. Therefore it is thought that MTSS does not represent a compartment syndrome (Mubarak et al., 1982).

Another way of diagnosing medial tibial stress syndrome is by giving a local injection of a short acting anesthetic such as lidocaine into the periosteum on the posteromedial border of the tibia. If symptoms are relieved, then it is medial tibial stress syndrome (Allen, 1986). However, as this relieves the symptoms, it doesn't help much with the diagnosis of MTSS as it blocks the pain in the area, and this pain could be caused by many things, not just MTSS.

2.9. MANAGEMENT:

Patients have been treated with a number of non-operative therapies, including rest, anti-inflammatory medications, heel cord stretching orthoses and casting (Mubarak, 1982, and Detmer, 1986). However, no treatments alone or in combination were superior to rest alone. As with all overuse syndromes, modification of activities or avoidance altogether may prove effective for a patient willing to do so (Detmer, 1986). However, in the case of a professional athlete or sportsmen, this is not always possible, therefore a treatment protocol is needed that allows patients to continue their normal training whilst receiving treatment.

Properly fitted orthoses may prove beneficial in such circumstances (Mubarak et al., 1982). The main problem with this treatment is the recurrence of symptoms of medial tibial stress syndrome.

Patients who are suffering with MTSS should follow a graduated program of activity reintroduction. Noakes (1992) suggests that beginner runners incorporate a programme of alternate running and walking in order to adapt to the initial stress that running places on the bones. He (Noakes, 1992) also suggests that novices be advised to avoid over striding and pushing off with their toes. Activities such as jumping in volleyball, dancing and gymnastics should be reduced to minimum and running may be substituted with cycling or running in the pool (Reid, 1992)

Athletes' shoes should also be examined. Worn or collapsed shoes should be replaced and the new shoes should be examined for compatibility with the runners' biomechanics. Encourage training on grass and trails, as well as running on opposite sides of the road as this too may reduce training stress (Noakes 1992).

Other treatments for MTSS have been used, but with little or no relief. Modalities such as ultrasound (van Lingen,1998; Robertson 2003), periosteal pecking

(Robertson,2003), orthotics, arch supports and heel pads (Mubarak, 1982 and Detmer, 1986), immobilisations and taping (Mubarak, 1982), stretching (Mubarak,1982 and Detmer,1986) as well as NSAIDS which were only successful in 50% of cases (Mubarak, 1982, and Detmer, 1986).

In this study, the researcher decided to focus on the treatment of MTSS by using TENS, needling or electro-needling as the treatment protocol as other research has been done that has focus on ultrasound (Van Lingen 1995) and needling (Robertson, 2003), but not TENS and electro-needling .The theory behind this was that the with the combination of TENS and needling, the electrical current would get to the source of pain as the needles would help reduce the skin's resistance to the electrical current supplied by the TENS unit (Chen et al., 1998).

2.9.1. Therapeutic effects of TENS:

TENS, according to Melzack (1981) selectively stimulates the large fast A beta fibres, whose electrical impulses are then transmitted to the spinal cord. On the converse noxious impulses are conducted via the small slow A delta and C fibres. Both these large and small afferent nerve fibres converge on the substantia gelatinosa (Forster and Palastanga 1985).

Based on the Gate Control Theory as proposed by Melzack and Wall (1965) these noxious impulses would be blocked via the large A beta afferent nerve fibres, which in turn would help block perceived pain. Therefore according to the literature, TENS assists with principally with pain control (Barlos and Lundeberg, 2006) and could therefore help with pain control in the treatment of MTSS.

Research has been done using TENS as a treatment for pain in myofascial syndromes (Graff-Radford et al., 1988). These showed that TENS help relieve the pain, therefore in theory, it should help with the pain in MTSS.
TENS is an easy to use, non-invasive analgesic intervention, applied for diverse pain states .A study done by Osiri et al (2004) on patients with osteoarthritis of the knee showed that they benefited greatly from the use of TENS.
However the use of TENS does have limitations. Patients exhibiting any contra-indications to TENS cannot use this as a mode of treatment. Contra-indications include patients with cardiac pacemakers, patients with cardiac arrhythmias, patients with epilepsy, patients who are in the first three months of pregnancy and any patient who has any broken or infected skin or who have recently undergone trauma.

2.9.2 Therapeutic effects of needling:

The therapeutic effects of needling includes a pain suppressing effect due to its irritant action on the periosteum, which in turns evokes activity in pain inhibiting mechanism in the central nervous system (gate control model of pain) (Melzack and Wall,1965,) thereby decreasing pain and inflammation (Brattberg, 1983). According to Ghia et al. (1976) it seems likely that the effects of dry needling may be brought on initially by stimulating the large A delta fibres. This gentle electrical stimulation of the skin (without TENS) and underlying tissues during needling may activate more of the large A delta fibres than the small c fibres, tending to “close the gate” and block the pain signals (Melzack and Wall, 1965).

According to Ghia et al. (1976) the process of dry needling results in gentle electrical stimulation of the skin and underlying tissues and may activate more of the large fast A delta fibres than the small C fibres, tending to” close the gate” and therefore blocking pain signals (Melzack and Wall 1965). Needling also helps stimulate the release of various neuro-transmitters including the opoid peptides

which play a major role in inhibiting pain (Hans et al.,1982) as well as increasing the blood flow to the area (Han and Harrison, 1997). In a study done by Sandberg et al(2004) deep needle stimulation resulted in an increase in blood flow to the muscle and skin, compared to subcutaneous insertion which only resulted in an increase of blood to the skin. With a very similar theory and hypothesised mechanism of action to needling is TENS. Acupuncture and TENS are commonly used to alleviate pain in various pain conditions (Ezzo et al., 2001; Proctor et al.,2002). TENS is also hypothesised to reduce the post stiffness resulting from the needling. However, there are some contra-indications to needling e.g., Infection of the skin, diabetics, pregnant patient, patients with pacemakers so only patients who had no contra-indications were used in this study.

If needling helps increase blood flow in the area, then this would help decrease inflammation and swelling in the area due to the removal of metabolites and waste products(Hans and Harrison,1997).

2.9.3. Electro-needling

With needling being effective through electrical stimulation as well as TENS being effective through electrical stimulation, it stands to reason that these two modalities could act synergistically in aiding each others treatment potential, .However, no research has been done on the effectiveness of TENS as a treatment of MTSS, even though Walsh et al. (1995) found that it helped relieve pain when treating myofascial trigger points. Melzack (1981) found that by placing electrodes pads on myofascial trigger points, it was able to help with pain control.
Experimental studies of TENS and electro-needling are shown to enhance subcutaneous blood flow and recovery in surgical flaps (Jansen et al. ,1989).

Therefore, the hypothesise is that dry needling combined with TENS using crocodile clips (TENS) will be more effective in the treatment of MTSS than

needling or TENS on there own as the needling combined with the TENS should penetrate through the skin's resistance to a greater degree and therefore the electric stimuli should reach the tissues and muscles that are inflamed and thereby improve the recovery rate. With the combination of using needles attached to the TENS, it is thought that the effect of TENS will be enhanced .The needle creates a magnetic field around the area it is inserted into, therefore when TENS is attached, this electrical stimuli reaches a deeper and larger area than it usually would on its own. Therefore, if this is the case, it should help improve and speed up the treatment of MTSS.

The contra-indications of electro-needling would therefore be the same as needling and TENS stated above.

2.10. Conclusion:

We know that medial tibial stress syndrome is caused by repetitive loading of the soft and bony tissues of the lower extremities due to overuse and is made worse if it is not given enough time to heal before returning to the previous athletic activity (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, Van Lingen, 1997 and Robertson, 2003) According to Detmer (1986) rest is shown to be the most effective form of treatment in medial tibial stress syndrome. Therefore as we can see, a treatment that is effective and fast needs to be found in order to help professional athletes return to normal training as fast as possible.

The evidence above of the therapeutic effects of TENS and needling warrants further investigation in order to find a more effective treatment for medial tibial stress syndrome.

Therefore this research was aimed at determining whether electro-needling, TENS or dry needling would help speed up the recovery process of those patients suffering with Medial Tibial Stress Syndrome.

CHAPTER THREE

METHOD AND MATERIALS:

3.1 The Objective:

This study was to investigate the effectiveness of TENS, needling, and electro-needling on patients presenting with medial tibial stress syndrome. This was done using both the patients' subjective and objective pain readings in order to establish the efficacy of TENS, needling and electrotherapy as an adjunct in the management of medial tibial stress syndrome.

The research as presented here was approved by the Faculty of Health Sciences Research and Ethics Committee and meets the requirements of the Declaration of Helsinki 1975.

3.2 The Research Methodology:

3.2.1. Research Design

A sample of forty five patients diagnosed with medial tibial stress syndrome were accepted into the study.

3.2.2 Advertising

The sample group was obtained by advertising at the local sports clubs, and gymnasia (Appendix H). Flyers (the same as the advert, but on a smaller scale)

were also given out at sports events. Patients were also obtained via word of mouth and referral from other patients.

3.2.3 Telephonic screening

Patients that phoned into the clinic were asked certain questions (Appendix N). If these participants qualified for the study over the phone, they were asked to come into the clinic for an appointment and if they then qualified, were asked to join the study.

3.2.4. Sample size

This consisted of three groups of 15 participants in each, therefore a total of 45 participants. This sample size was the chosen number as previous research done also used this number (Van Lingen, 1997 and Robertson, 2003).

3.2. 5 Sample Method

The method will be that of patient self selection sampling in response to the advert, with random allocation once the subjects have been accepted into the study.

3.2.6 Sample allocation of the subjects:

All the participants accepted into the study were randomly divided into three equal groups. This was done by placing letters A, B and C in an envelope and having the patients pick one of these, which was unknown to them. They were then placed in the group that was picked from the envelope (Mouton, 1996.

3.2.7 Standards of Acceptance and sample characteristics:

At the initial consultation all subjects underwent a detailed case history (Appendix A), a general physical examination (Appendix B), and a foot and ankle regional examination (Appendix C).

3.3 Exclusion Criteria

Patients were not accepted into the study if they showed any of the following symptoms:

Patients exhibiting any of the following contra-indications to TENS (Bazin and Kitchen, 1998):

- Patients with cardiac pacemakers,
- Any broken skin or anaesthetic skin or infected skin,
- Patients with cardiac arrhythmias,
- Patients with epilepsy,
- Patients who are in the first three months of pregnancy,
- Patients who have recently undergone trauma and
- Patients who have or do undergo surgery prior to or during the research.

Patients exhibiting any of the following contra-indications to dry-needling (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 with tumours or any patients that need to be referred for any reason,
- Any patients that respond badly to needling; e.g., faint, nausea and
- Participants who have failed to complete or sign the informed consent will automatically be excluded from the study.

The patients were then examined for signs and symptoms of MTSS. Patients that were diagnosed with medial tibial stress syndrome were then accepted into the study.

Patients that met the research criteria and who accepted to join the study were then informed about the study.

3.4. INCLUSION CRITERIA

Patients between the ages of 18 to 50 years of age. According to research on MTSS, this appears to be the age with the highest incidence of patients who are affected by MTSS (Van Lingen 1998; Robertson, 2003).

A clinical diagnosis of MTSS was made- patients needed to meet 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 which is 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 new periosteal layer, felt when applying firm finger pressure (Noakes, 2001).

Both males and females meeting the inclusion criteria were included into the study.

A pain rating on the NRS between 5 -10 allowed the participants to qualify for the study. This was done to help get homogeneity within the group. Neither of the previous researchers (Van Lingen, 1997 and Robertson, 2003) done prior to this research had a limitation in this respect. This was important as it helped show more accurate results as all the participants were in a similar category to begin with.

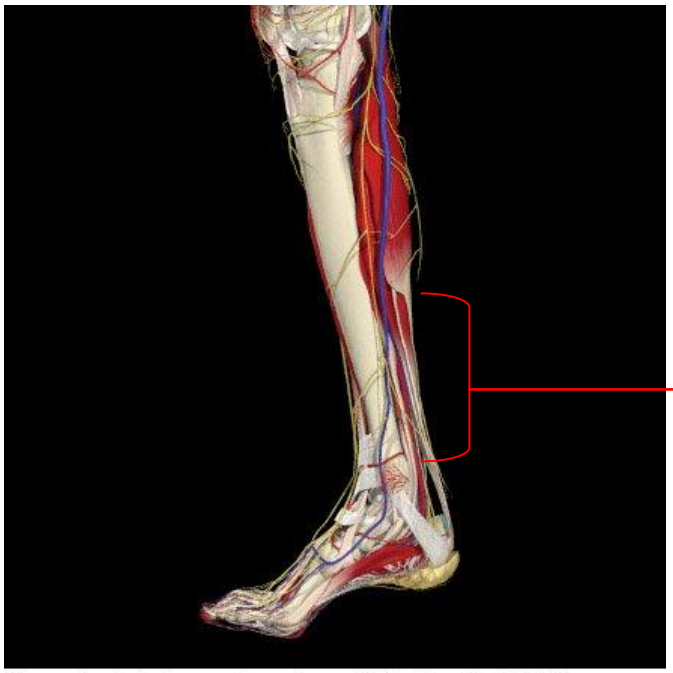
The subjects were then asked to sign a written consent form (Appendix I) before the study commenced.

3.5. Interventions:

The patients accepted into the study were then asked to complete the Numerical Pain Rating Scale (Jenson et al., 1986) (Appendix F), the McGill Short Form Questionnaire (Melzack and Katz, 1992) (Appendix G), and the Pain Disability Index (Tait et al., 1987), (Appendix E) under the researcher’s supervision. An algometer reading (Fischer, 1986) (Appendix L) of the most tender area of their shin was then taken from the subject and the point where it was taken from was recorded so that the same point could be used at each visit to allow for accurate readings.

The first part of the study commenced where the patient was treated according to which treatment group they were placed in.

Each subject received four treatments and a fifth follow up consultation (Robertson, 2003).



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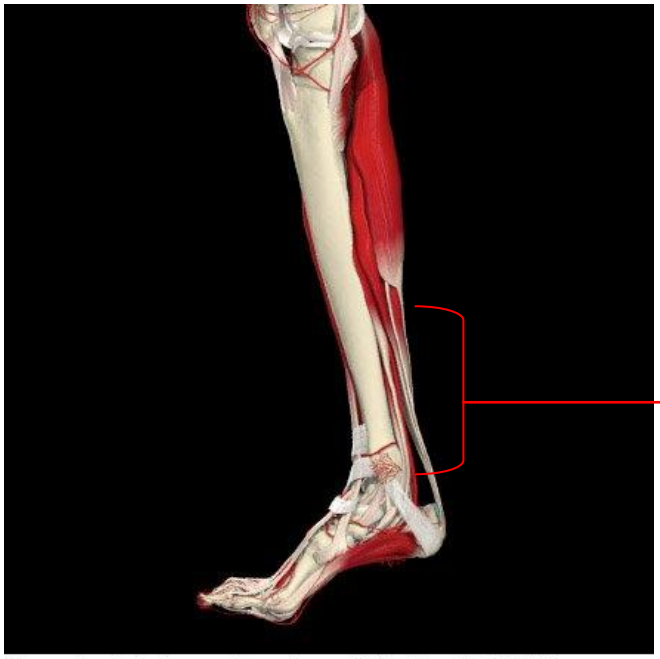

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Group 1

The treatment for the group receiving TENS consisted of the application of TENS to the most tender areas on the tibia at a frequency that was suitable and comfortable for the patient (Melzack, 1977). Each treatment was twenty minutes. The point at which the pads were applied was measured to make sure the exact point was treated at each visit. Each patient received four treatments. (Robertson, 2003).

Group 2

The group receiving needling also received four treatments and the point at which the needle was inserted was recorded as above. The needles were left in for an average of five minutes. (Robertson, 2003).

Group 3

The final group received electrotherapy, where the needles that had been inserted into the tender points on the patients tibias were connected to the TENS machine using crocodile clips (Chen et al., 1998). The TENS was then turned to a frequency that was comfortable for the patient. This was done for twenty minutes a treatment for four treatments (Robertson, 2003).

3.5.1 Measurement frequency:

Subjective and objective pain readings where taken at the first, third and final consultations.

3.5.2 Measurement methods:

3.5.2.1 Subjective Measurements:

A: The Pain Disability Index (Appendix E)

The Pain Disability Index was used to give the researcher an indication of how the level of pain was affecting the patient in general lifestyle activities. The patient's response was noted at the initial visit as well as the third, and then the fifth final visit.

The questionnaire comprised of five questions. The patient was required to respond to the questions on a scale of one to ten. A score of one meant no disability, and ten meant that the pain completely prevented the patient from normal daily activities. The result was the sum of the scores expressed as a percentage of the total of 50 (Tait et al., 1987).

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

This questionnaire was used to determine the subjective pain intensity experienced by the patient. The patient's response was noted at the initial visit, the third visit and the fifth and final visit.

The patient was asked to note down their perceived level of pain on a numerical scale of zero to 100, with the zero representing no pain and the 100 representing

pain at its worst. The number noted represented the patient's level of pain intensity (Jenson et al., 1986).

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

C. McGill Short Form Pain Questionnaire (Appendix G)

This questionnaire assesses the sensory dimension of the pain experienced by the patient (Melzack and Katz 1992).

The questionnaire was derived from the McGill Long Form Pain Questionnaire and consisted of a list of 15 words that describe pain. Each description was ranked on an intensity scale: 0=none, 1=mild, 2=moderate, 3=severe (Melzack and Katz 1992).

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

3.5.2.2 Objective Measurement: Algometer readings:

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 tip stylus is then placed over the tender area with the dial perpendicular to the skin surface. Steady, gentle pressure is then applied at the rate of 1 kilogram per square centimetre per second until the patient first perceives pain and responds by saying so. The stylus is then removed and the recorded value is noted (Fischer, 1987).

This was used to measure the tenderness at the medial tibial border.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-centimetre diameter rubber-tipped stylus. Pain threshold was determined by the amount of force per square centimetre for a person to first perceive pain (Fischer, 1987). The points that were measured were roughened painful areas along the medial tibia that were found on palpation. The most tender spot was used. The distance from the tip of the medial malleolus to this point was measured in order to keep an accurate reading in the follow-up treatments.

3.6 Treatment of the Data:

3.6.1 Treatment of the subjective data:

The questionnaires where totals converted to numbers out of the total i.e. 6 out of 10 were examined to assess whether they had been correctly completed and the results were transferred onto a spreadsheet. These underwent statistical analysis as discussed below.

3.6.2 Treatment of objective data:

The algometer readings which were the average of three readings were transferred to a spreadsheet and then underwent statistical analysis as discussed below.

3.7 Statistical methodology

SPSS version 11.5 (SPSS Inc, Chicago, Ill, USA) was used for data analysis. A p value of <0.05 was considered as statistically significant.

Baseline demographics and outcomes were compared between the treatment groups using one-way ANOVA for quantitative variables, and Pearson's chi square tests for categorical variables.

Evaluation of the treatment effect was achieved using repeated measures ANOVA with between-subjects effects as the three treatment groups and within-subjects effects as the time periods of evaluation (baseline to week 3). A significant time by group interaction indicated a significant treatment effect. When the treatment effect was statistically significant overall ($p<0.05$) or borderline non significant, additional post hoc multiple comparisons of two groups were done, adjusting for increased type I errors using a Bonferroni adjustment. The p values from the post hoc tests were multiplied by 3 (because there were three different 2 group comparisons) to adjust for the increased probability of a type 1 error.

Since the observations (legs) were not completely independent of each other (two belonged to the same person) and since a lot of the outcomes were measured subjectively, which could have resulted in a correlation within participants, models were checked using Stata version 9.0 (StataCorp, Texas, USA), where GLM models can be adjusted for clustering by individual and over time. Both time*group p values were reported (with and without clustering adjustment). Profile plots were generated to examine trends by group over time. This was done separately for each of the 4 pain outcomes. Finally intra-group correlation analysis was undertaken to examine relationships between changes in the outcome variables over time.

CHAPTER FOUR

Introduction

This chapter contains the statistical analysis of the subjective and objective data obtained from the patients over the treatment period. The patients in group 1 received TENS, group 2 received needling and group 3 received electro-needling.

Information was obtained from case history, foot regional, short-form McGill Pain Questionnaire, Numerical Pain Rating Scale, Pain Disability Index and algometer readings were used as data for this study. The questionnaires were all explained fully to the patients before they filled them in. The researcher took all the algometer readings and all treatment was done by the researcher.

4.1 The Data:

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

4.1.1 The Primary data:

There were four types of primary data:

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

4.1.2 The Secondary Data:

The published documentation and accepted theories on medial tibial stress syndrome, needling, and TENS.

4.2 Results

4.2.1. Demographics

Both legs of 23 participants (46 legs) were randomized into three treatment groups. For all but one participant, both legs received the same treatment, thus there were 15 legs in each of groups 1 and 3, and 16 legs in group 2.

Majority of the participants were male (n=18, 78.3%), while 5 (21.7%) were female. The sports that they played are listed in Table 1. The most common sport was rugby (47.8%), followed by running (30.4%).

4.2.1.1 Sports

Table 1: Sports played by participants (n=23)

	Frequency	Percent
Rugby	11	47.9
Running	7	30.5
Netball	2	8.7
Cricket	1	4.3
Hockey	1	4.3
Walking	1	4.3
Total	23	100.0

Their mean age was 25.3 years (SD 5.9 years), with a range from 19 to 40 years.

4.2.1.2 Comparison of baseline outcomes and demographics between treatment groups

This was done in order to establish that there were no pre-existing differences between the groups which could have influenced the outcomes after treatment, in other words, that the randomization process was complete. The analysis was done at the "leg" level rather than at the participant level since one person had 2 legs in different treatment groups, thus treatment group was not unique to participant.

4.2.1.2.1 Gender

Table 2 shows that there was no difference in terms of gender between the three treatment groups (p=0.113). There tended to be a predominance of females in group 1, but the difference was not statistically significant.

Table 2: Cross-tabulation of gender by treatment group

			Group			Total
			TENS	Needling	Electroneedling	
gender	male	Count	9	14	13	36
		% within gender	25.0%	38.9%	36.1%	100.0%
	female	Count	6	2	2	10
		% within gender	60.0%	20.0%	20.0%	100.0%
Total		Count	15	16	15	46
		% within gender	32.6%	34.8%	32.6%	100.0%

Pearson chi square 4.36, p=0.113

4.2.1.2.2 Age

Tables 3 and 4 show that there was no significant difference between the mean ages of the three groups (p=0.139), although the mean age of the second group tended to be lower than that of the other two.

Table 3: Descriptive statistics of age by treatment group

group	Mean	N	Std. Deviation
TENS	26.20	15	7.123
Needling	23.00	16	3.225
Electroneedling	26.87	15	6.105
Total	25.30	46	5.815

Table 4: ANOVA comparison of mean age between the three treatment groups

	Sum of Squares	df	Mean Square	F	p value
Between Groups	133.606	2	66.803	2.069	0.139
Within Groups	1388.133	43	32.282		
Total	1521.739	45			

4.2.1.2.3 NRS, Algometer, PDI, RMQ

In terms of baseline outcome values, only NRS showed a statistically significant difference between treatment groups at baseline (p=0.008). The post hoc tests showed that it was only the needling group and the electro-needling group that were significantly different from each other (p=0.007). The needling group had higher baseline pain scores than the electro-needling group.

Table 5: Descriptive statistics of baseline outcomes by treatment group

Group		Baseline algometer	Baseline PDI	Baseline NRS	Baseline RMQ
TENS	Mean	8.607	20.20	54.83	19.00
	N	15	15	15	15
	Std. Deviation	1.5549	7.002	13.806	8.009
Needling	Mean	8.331	19.13	60.00	12.88
	N	16	16	16	16
	Std. Deviation	2.0590	8.724	14.434	7.365
Electroneedling	Mean	8.200	20.07	45.37	14.40
	N	15	15	15	15
	Std. Deviation	1.0644	7.732	8.189	10.098
Total	Mean	8.378	19.78	53.54	15.37
	N	46	46	46	46
	Std. Deviation	1.5958	7.711	13.684	8.757

Table 6a: ANOVA comparison of mean baseline outcomes between the three treatment groups

		Sum of Squares	df	Mean Square	F	P value
Baseline algometer	Between Groups	1.295	2	.647	.246	0.783
	Within Groups	113.304	43	2.635		
	Total	114.598	45			
Baseline PDI	Between Groups	10.743	2	5.371	.087	0.917
	Within Groups	2665.083	43	61.979		
	Total	2675.826	45			
Baseline NRS	Between Groups	1694.846	2	847.423	5.413	0.008
	Within Groups	6732.067	43	156.560		
	Total	8426.913	45			
Baseline RMQ	Between Groups	311.367	2	155.684	2.132	0.131
	Within Groups	3139.350	43	73.008		
	Total	3450.717	45			

Table 6b: Bonferroni post hoc comparison of mean NRS between the three treatment groups

(I) group	(J) group	Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval	
TENS	Needling	-5.167	4.497	0.771	-16.37	6.04
	Electro needling	9.467	4.569	0.133	-1.92	20.85
Needling	TENS	5.167	4.497	0.771	-6.04	16.37
	Electro needling	14.633(*)	4.497	0.007	3.43	25.84
Electro needling	TENS	-9.467	4.569	0.133	-20.85	1.92
	Needling	-14.633(*)	4.497	0.007	-25.84	-3.43

* The mean difference is significant at the .05 level.

It is very important, when doing a study like this to have groups that are similar. ie, gender, age, sporting activity. This would help prevent extreme differences in readings in amongst the group and help give more accurate readings and results when comparing the groups.

The baseline NRS readings were similar between TENS and needling, however the baseline NRS readings were quite a bit lower in the electro-needling group. This on its own could give a false result as it does not show the true results of the electro-needling group as they started at a lower reading on the scale. For future studies, it may be beneficial to have stricter inclusion criteria into the study. All patients included into the study should have a narrower range on the NRS scale, as this would give a more accurate result of the treatments undergone.

Also it means that there is the possibility that differences observed between the groups after the intervention may have been due to the baseline differences and not to the intervention itself, which is why it's important to have similar groups at baseline. Fortunately the statistical procedures used can control for any baseline differences between groups.

4.2.2 Inter and Intra-group analysis

4.2.2.1 Objective findings

With respect to this study, objective one was set out to investigate the relative effectiveness of TENS compared to needling compared to electro - needling in terms of objective clinical findings in the treatment of MTSS.

The resultant Null hypothesis therefore read: “There is no difference in the treatment effect of the three groups in terms of algometer measurements”.

Based on Table 7, where it shows that the null hypothesis was not rejected in this case (p=0.113). The treatment effect was not statistically significant overall. Thus no further post hoc tests were done to compare the individual treatment groups. Even after adjustment for the clustering by individual person, the effect was not statistically significant (p=0.094).

However, all treatment groups showed a highly significant increase in algometer measurements (decrease in pain) over time (p<0.001), indicating that any form of treatment is effective for pain measured objectively. Figure 1 shows that there was a trend towards the electro-needling group showing a faster decrease in pain than the other two groups, which performed very similarly over time.

Table 7: Within and Between Subjects Effects for Algometer Measurements

Effect	**Statistic**	**p value**
Time	Wilk’s Lambda = 0.289	<0.001
Group	F=1.204	0.310
Time*group (total – unadjusted for clustering)	Wilk’s Lambda = 0.839	0.113
Time*group (total –adjusted for clustering)	Coefficient = 0.255	0.094

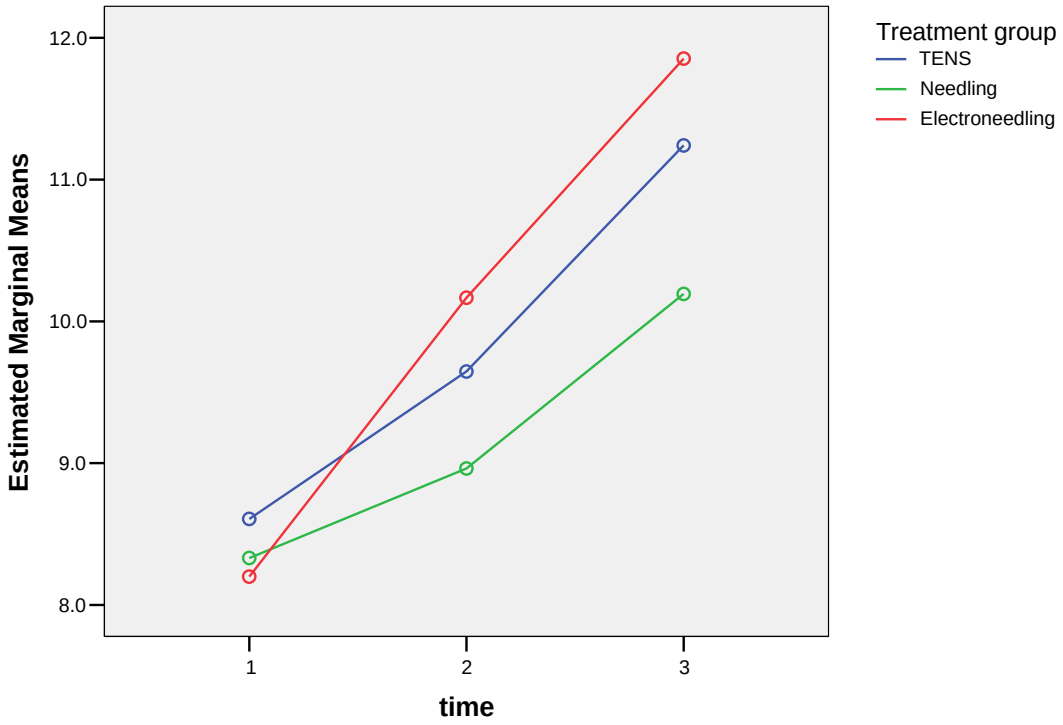

Figure 1: Profile plot of Algometer measurements over time by group

Although the results where not significant for this objective measurement, there are a number of things that should be considered;

- There was a reduction in the p value (p = 0.113) from the initial analysis to p = 0.094 after controlling for individual confounding variables (including all individual factors that were marginally different between the groups with respect to their demographics). This indicates that there are variables that were not appropriately controlled for in the design of this study, even though the inclusion criteria were comprehensive in terms of the MTSS. It is therefore recommended that the following criteria be considered for future research:

- Many patients were apprehensive about having the algometer readings taken as they said it caused more pain. This apprehension could affect the readings as well as the fact that every person has a different pain threshold and something that is painful to one person may not be painful to another.
- For future studies, it would be preferable to use a group of patients that do the same type of sport. In order to get accurate readings and results it is best if you use patients that have a similar routine and that there is no one person who does a whole lot more than the other.
- Another important factor that should be taken into account is when the last activity was performed before the readings were taken .It was found in this research that a few of the patients had training the day before the measurements were taken, and although they said they had felt better during the training, the readings did not show much improvement or they showed a slight decline.
    - The pressure algometer consists of a force dial which reads in kilograms and a centimetre diameter rubber tipped stylus. Using an algometer, pressure pain threshold is used to quantify palpatory pain findings for myofascial trigger points and pain over the bone .Pain threshold is determined by the amount of force per square centimetre required for a person to first perceive pain. From this we get our objective readings.

- A trend is also evident indicating that electro-needling improved at a faster rate than the other two groups. It should therefore be considered that additional measures such as the following should be considered in future research:
    - Measurement intervals should be done as usual, but the treatment should be continued for longer a period with more measurements

being done over this period. This would help determine if it is a permanent solution to MTSS, or a temporary measure of pain relief.

- Treatment intervals should be kept as usual, however a group of patients that do the same activities and have a similar training programme would help with making the results more accurate.

These measures may be able to then assist with defining whether any significant difference exists between the groups with respect to algometer measures, which was not attained in this study.

4.2.2.2 Subjective findings

With respect to this study, Objective 2 was to investigate the relative effectiveness of TENS compared to needling compared to electro - needling in terms of subjective clinical findings in the treatment of MTSS.

4.2.2.2.1 Subjective findings : NRS

Null hypothesis: There is no difference in the treatment effect of the three groups in terms of NRS measurements.

The overall treatment effect (unadjusted for clustering) was statistically significant (p=0.007). In order to identify which specific treatment groups were significantly different to each other, individual 2 group comparisons were done. The only significance was found between the needling and electro-needling groups (p=0.003). Figure 2 shows that the pain scores in the needling groups decreased at a faster rate than the electro-needling group. Thus the null hypothesis is rejected for this outcome and we conclude that there was a significant treatment effect for NRS, specifically that needling (and perhaps TENS) are preferable to

electro-needling. It should be noted that when the adjustment for clustering at the individual level was made, the significance no longer remained.

Table 8: Within and Between Subjects Effects for NRS

Effect	**Statistic**	**p value**
Time	Wilk's Lambda = 0.176	<0.001
Group	F=0.268	0.766
Time*group (total – unadjusted for clustering)	Wilk's Lambda = 0.719	0.007
Time*group (TENS vs. Needling)	Wilk's Lambda = 0.965	1.000
Time*group (TENS vs. Electroneedling)	Wilk's Lambda = 0.781	0.108
Time*group (Needling vs. Electroneedling)	Wilk's Lambda = 0.550	0.003
Time*group (total –adjusted for clustering)	Coefficient = 3.167	0.122

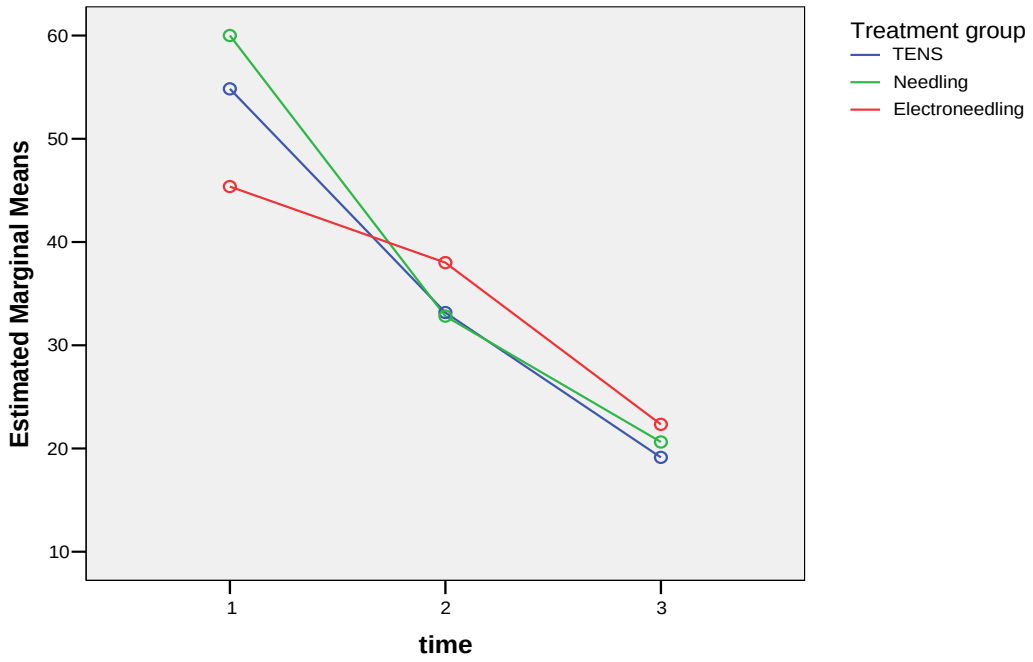

Figure 2: Profile plot of NRS measurements over time by group

Discussion:

Significant difference between TENS / Needling and the electro-needling (p = 0.007 or with adjustment for clustering p = 0.003). Since the baseline readings had no effect on the electro-needling group, as the repeated measure ANOVA adjusts for baseline differences by looking at the rate of change over time. It is clear from the figure that the slope of the electro - needling group over time was not as steep as that of the other 2 groups and that although the electro - needling group started out with an advantage (lower pain at baseline) they ended up with higher pain than the other groups (TENS / Needling).

As was noted and discussed in 4.2.1.2.3 earlier in this chapter, that the NRS readings between the groups at the baseline was significantly different between the needling and the electro-needling, with there being no difference between

these groups and the TENS group. This indicted that the TENS group had to have presented with NRS mean readings somewhere between the needling and electro-needling groups, however from this discussion it was not evident which group (needling / electro-needling) presented with more or less severe cases at entry. This is clarified in Figure 2, where it can now be seen that the patients in the electro-needling group presented at a lesser NRS rating than those in the needling group.

The cumulative effect of the differences presented between the 3 groups seen from Figure 2 could therefore be responsible for the outcomes achieved for this measure. Thus the rejection of this hypothesis may indeed be incorrect based on the differential of entry level ratings on the NRS.

It is therefore suggested that future research should consider the following:

- The methodology should include a stricter entry requirement based on the NRS scores. The only parameters that needs to be considered if the NRS scores where to be amended is that the length of the data collection phase would be increased substantially due to the low incidence and prevalence of the condition (American Medical Association),
- Based on the suggestion above a long term study may be best suited for the purposes of an amended entry requirement.

4.2.2.2.2. Subjective findings: PDI

Null hypothesis: There is no difference in the treatment effect of the three groups in terms of Pain Disability Index scores.

Table 9 shows that the null hypothesis was not rejected (p=0.106) and that the treatment effects were the same in all groups. Overall there was a significant improvement over time in all groups (p<0.001), thus all treatments were effective at reducing disability. Figure 3 suggests that the TENS and needling groups experienced a slightly faster rate of change over time than the electro-needling group, but this trend was not statistically significant.

Table 9: Within and Between Subjects Effects for Pain Disability Index Scores

Effect	**Statistic**	**p value**
Time	Wilk's Lambda = 0.252	<0.001
Group	F=0.600	0.553
Time*group (total – unadjusted for clustering)	Wilk's Lambda = 0.836	0.106
Time*group (total –adjusted for clustering)	Coefficient = 0.150	0.847

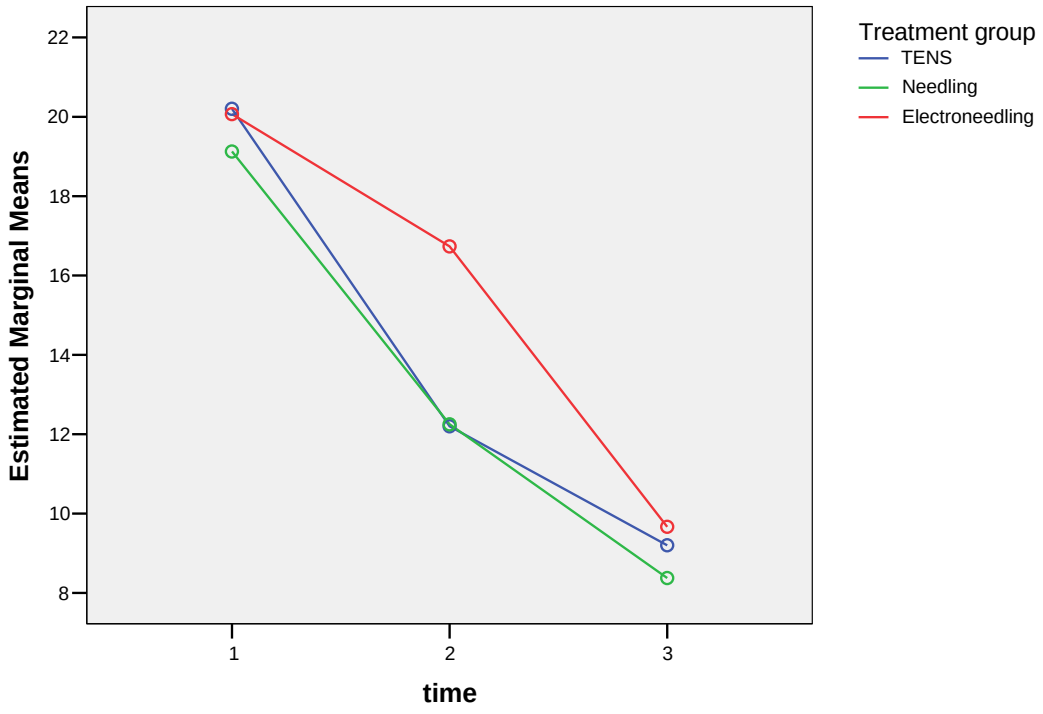

Figure 3: Profile plot of Pain Disability Index Scores over time by group

Discussion:

There is an insignificant finding between TENS, needling and electro-needling (p=0.106 or with adjustment for clustering p= 0.847)

All the groups improved over the treatment time, however, it was said that there is no difference between treatments.

This is in contrast to the improvements seen in the NRS (section 4.2.2.2.1), where there was a significant difference between the needling and electro-needling, but not between these two and TENS group. The results of the NRS would seem to suggest that the functional improvement of the patients should follow a similar

format One could however argue that there could be inherent differences in the reporting for pain (NRS) and PDI (functional ability) for any one of the following reasons :

- With increased activity a patient is thought to experience a decrease in pain (Melzack and Wall, 1975). Therefore, the patient may report the pain as high at the measurement interval (i.e. at the measurement time) in contrast to the patient reporting functional ability, where the theory proposed by Melzack and Wall (1975) expounds the possibility that increased activity decreases pain (gate control theory). Thus the amount of functional ability may not actually be reflective of the pain experienced by the patient.

  This is consistent with the pathophysiololgy of the MTSS, where with increased activity there is an increase in pain (Bhatt et al.,2000) as opposed to a decrease in activity with an decrease in pain (particularly a decrease of activity directly after activity) (Bhatt et al.,2000).

- Following from the above, reporting during (PDI reflects activity related functions) or after activity (NRS or pain related dysfunction) may also have played a role in the results obtained.

- Gender, could also have been a confounding variable, however with the baseline assessment of the groups, gender was found to be homogenous and thus this influence is unlikely.

With respect to the overall improvement, all groups appear to have started out with similar PDI's, the needling and TENS groups appeared to improve at a faster rate than the electro-needling group. This difference in trends may have been related to the fact that electro-needling is a more aggressive and deeper form of therapeutic approach, as the effects of skin resistance would have been eliminated (Chen et al., 1998) and it would also have been a dual function modality as

opposed to the other 2 groups. This may have resulted in a slow initial response to treatment followed by a sudden improvement as compared to the consistent improvement seen in the TENS and needling groups (Figure 3).

Therefore in order to elicit the trends more exactly and possibly to the point of significance, it is suggested the future research consider:

- The research should be done over a longer period of time,
- With more measurements (frequency of measurements), as well as
- Including an ankle regional exam when the research is complete to be able to determine dysfunction more objectively such that one is able to confirm or refute the possible reasons suggested above for the differences between the NRS and the PDI.

4.2.2.2.3. Subjective findings : RMQ

Null hypothesis: There is no difference in the treatment effect of the three groups in terms of RMQ scores.

Table 10 shows that the treatment effect was borderline statistically significant (p=0.063), thus post hoc tests were performed. The post hoc tests showed that there was a statistically significant difference in treatment effect between TENS and electro-needling (p=0.042) even after Bonferroni adjustment. Figure 4 shows that the TENS groups scores decreased at a faster rate than those of the electro-needling group. Thus the null hypothesis is rejected for this outcome and we conclude that TENS was significantly better than electro-needling. However, after adjusting for the clustering effect of the individual the effect was no longer significant (p=0.351).

Table 10: Within and Between Subjects Effects for RMQ scores

Effect	Statistic	p value
Time	Wilk's Lambda = 0.357	<0.001
Group	F=1.204	0.310
Time*group (total – unadjusted for clustering)	Wilk's Lambda = 0.811	0.063
Time*group (TENS vs. Needling)	Wilk's Lambda = 0.844	0.276
Time*group (TENS vs. Electroneedling)	Wilk's Lambda = 0.728	0.042
Time*group (Needling vs. Electroneedling)	Wilk's Lambda = 0.978	1.000
Time*group (total –adjusted for clustering)	Coefficient = 1.217	0.351

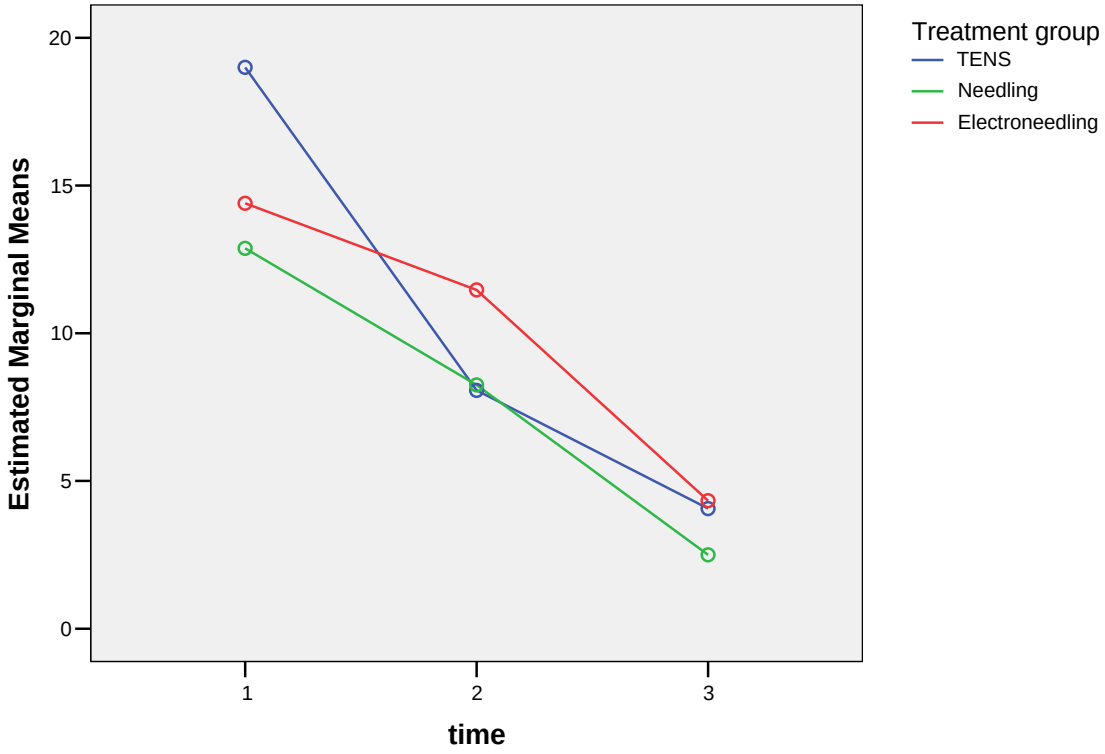

Figure 4: Profile plot of RMQ Scores over time by group

Discussion

Significant difference between TENS and electro-needling (p=0.042), with the TENS group showing a faster rate of improvement than the electro-needling group.

4.3 Correlation tables and group correlations

Objective 3: To investigate correlations between changes in objective and subjective outcomes in each treatment group.

The TENS group

The objective measurement (algometer) was not correlated with any of the subjective measurements. However, some of the subjective measurements were correlated together.

Change in PDI and change in RMQ showed a strong positive correlation ($r=0.715$, $p=0.003$), as well as change in MRS and change in RMQ ($r=0.887$, $p<0.001$).

Table 11: Pearson's correlation between changes in outcomes in the TENS group

		Change in algometer	Change in PDI	Change in NRS	Change in RMQ
Change in algometer	Pearson Correlation	1	-.186	-.131	-.106
	Sig. (2-tailed)		.508	.642	.707
	N	15	15	15	15
Change in PDI	Pearson Correlation	-.186	1	.432	.715(**)
	Sig. (2-tailed)	.508		.107	.003
	N	15	15	15	15
Change in NRS	Pearson Correlation	-.131	.432	1	.887(**)
	Sig. (2-tailed)	.642	.107		<0.001
	N	15	15	15	15
Change in RMQ	Pearson Correlation	-.106	.715(**)	.887(**)	1
	Sig. (2-tailed)	.707	.003	<0.001	
	N	15	15	15	15

** Correlation is significant at the 0.01 level (2-tailed)

The needling group

No correlations were shown between changes in outcomes in this group.

Table 12: Pearson's correlation between changes in outcomes in the needling group

		Change in algometer	Change in PDI	Change in NRS	Change in RMQ
Change in algometer	Pearson Correlation	1	.118	-.483	-.116
	Sig. (2-tailed)		.663	.058	.669
	N	16	16	16	16
Change in PDI	Pearson Correlation	.118	1	.348	-.223
	Sig. (2-tailed)	.663		.186	.406
	N	16	16	16	16
Change in NRS	Pearson Correlation	-.483	.348	1	-.478
	Sig. (2-tailed)	.058	.186		.061
	N	16	16	16	16
Change in RMQ	Pearson Correlation	-.116	-.223	-.478	1
	Sig. (2-tailed)	.669	.406	.061	
	N	16	16	16	16

The electro- needling group

Again, there was no correlation between changes in objective and subjective findings in this group. However, there were strong positive correlations between changes in PDI and RMQ (r=0.719, p=0.003), between PDI and NRS (r=0.700, p=0.004) and between NRS and RMQ (r=0.773, p=0.001).

Table 13: Pearson's correlation between changes in outcomes in the electro-needling group

		Change in algometer	Change in PDI	Change in NRS	Change in RMQ
Change in algometer	Pearson Correlation	1	.281	.164	.241
	Sig. (2-tailed)		.310	.560	.386
	N	15	15	15	15
Change in PDI	Pearson Correlation	.281	1	.700(**)	.719(**)
	Sig. (2-tailed)	.310		.004	.003
	N	15	15	15	15
Change in NRS	Pearson Correlation	.164	.700(**)	1	.773(**)
	Sig. (2-tailed)	.560	.004		.001
	N	15	15	15	15
Change in RMQ	Pearson Correlation	.241	.719(**)	.773(**)	1
	Sig. (2-tailed)	.386	.003	.001	
	N	15	15	15	15

** Correlation is significant at the 0.01 level (2-tailed).

4.4 Results in the context of the objectives and hypotheses:

The aim of this study was to investigate the relative effectiveness of TENS, versus, needling, versus electro-needling in the treatment of medial tibial stress syndrome (shin splints)

Therefore with respect to the hypothesis that dry needling combined with TENS using crocodile clips (PENS) would be more effective in the treatment of MTSS than needling or TENS on their own, the following measured parameters are rejected:

- RMQ,
- PDI,
- NRS and
- Algometer.

Thus there was no one instance with respect to the clinical outcome measures that could conclusively indicate the combination therapy was better than either of the single therapies as applied in MTSS.

4.5 Conclusion:

This study has shown conflicting findings. According to objective measurements of pain, the treatment effect was not statistically significant, but there was a trend towards the electro-needling group showing a faster decrease in pain than the other two groups. In terms of subjective outcomes, the electro-needling treatment performed the worst of the three groups (significantly worse than needling for NRS and significantly worse than the RMQ for TENS).

The subjective and objective pain scores showed no correlation in any of the groups. This could therefore be the reason for the conflicting findings regarding the effect of electro- needling.

This is consistent with the literature cited in this research (Detmer, 1986, Van Lingen, 1997), where researchers have used numerous treatment protocols with little or short lasting relief from the pain and symptoms. Even when rest has been incorporated into this treatment protocol, as soon as the patient returns to the sport the symptoms commonly recur. This protocol without rest seems to have reached similar conclusions. This therefore indicates that rest is the major factor in the treatment of MTSS with respect to the most important intervention protocol.

CHAPTER FIVE:

5.1 Conclusion and recommendations:

5.1.1 Findings

The following points were noted during the time of research:

- Patients that exercised soon after needling or electro-needling did not respond as well as those that rested the day of treatment.

- Those patients that were long distance runners complained more of a dull cramping sensation in comparison to the general sharp, achy, shooting pain experienced by the other participants.

- Patients that had some form of foot biomechanical problems, i.e., overpronation or flatfoot, responded slightly slower than participants with normal foot biomechanics.

- At the initial visit, some participants explained that the pain was there when they started exercising, but seemed to decrease as they continued with the exercise, only to feel worse afterwards.

5.1.2. Recommendations:

- A larger sample size would increase the validity of the study and a more significant reflection of the results as well as minimizing the possibility of incorrectly accepting the null hypothesis.

- The group of participants taking part in the study should all be from the same or similar recreational groups i.e. runners who are doing similar training.

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

- Participants with similar foot biomechanics should be grouped together i.e. overpronators, as this is thought to be a major contributing factor to medial tibial stress syndrome.

- Observer bias could be eliminated by not allowing the examiner to view the previous treatment readings.

- A long term follow up consultation would help to see if results were short lived or long lasting.

- Diagnostic ultrasound, although expensive may help with the diagnosis of medial tibial stress syndrome and therefore greatly enhance this study.

- Questionnaires should only be filled in by the patient on the first and final visit. These should be done verbally to the patient so as to get a more

accurate understanding of each question and what the researcher is expecting from the patient.

- The electrical parameters for TENS and Electro-needling should be standardised eg: chronic cases should be treated with low frequencies 2-4 Hz for 20 minutes to make it homogenous.

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APPENDICES

Appendix A: Case History

DURBAN INSTITUTE OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

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

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

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

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

FOR CLINICIANS USE ONLY:

Initial visit

Clinician: Signature :

Case History:

Examination:

Previous: Current:

X-Ray Studies:

Previous: Current:

Clinical Path. lab:

Previous: Current:

Case Status:

PTT:	Signature:	Date:

CONDITIONAL: Reason for Conditional:
Signature: Date:

Conditions met in Visit No:	Signed into PTT:	Date:

Signed off:	Date:

Intern's Case History:

1. **Source of History:**
2. **Chief Complaint : (patient's own words):**
3. **Present Illness:**

Complaint 1	**Complaint 2**

- Location
- Onset : Initial:

  Recent:
- Cause:
- Duration
- Frequency
- Pain (Character)
- Progression
- Aggravating Factors
- Relieving Factors
- Associated S & S
- Previous Occurrences
- Past Treatment
- **Outcome:**

4. **Other Complaints:**

5. **Past Medical History:**
   - General Health Status
   - Childhood Illnesses
   - Adult Illnesses
   - Psychiatric Illnesses
   - Accidents/Injuries
   - Surgery
   - Hospitalizations

6. **Current health status and life-style:**

- Allergies
- Immunizations
- Screening Tests incl. xrays
- Environmental Hazards (Home, School, Work)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication
  Analgesics/week:
- Tobacco
- Alcohol
- Social Drugs

7. **Immediate Family Medical History:**

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

8. **Psychosocial history:**

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

9. **Review of Systems:**

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

Appendix B: Physical Examination

DURBAN INSTITUTE OF TECHNOLOGY 22/10/2002

PHYSICAL EXAMINATION
SENIOR & RESEARCH

Patient:_____ **File#:**_____ **Date:**_____
_Student: **Signature:**

VITALS

Pulse rate			Respiratory rate	
Blood pressure	R	L	Medication if hypertensive:	
Temperature			Height	
Weight:	Any recent change Y/N	If Yes : how much gain/loss		Over what period

GENERAL EXAMINATION

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

SYSTEM SPECIFIC EXAMINATION

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION

COMMENTS

NEUROLOGICAL EXAMINATION: See regionals

Clinician: **Signature:**

Appendix C: Regional Examination

DURBAN INSTITUTE of TECHNOLOGY

Foot and ankle regional examination

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

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

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

Active movements

weight bearing:	**R**	**L**	***Non weight bearing:***	**R**	**L**
Plantar flexion			50°		
Dorsiflexion			20°		
Supination					
Pronation					
Toe dorsiflexion			40°(mtp)		
Toe plantar flexion			40° (mtp)		
		Big toe dorsiflexion (mtp) (65-70°)			
		Big toe plantar flexion (mtp) 45°			
		Toe abduction + adduction			
		5° first ray dorsiflexion			
		5° first ray plantar flexion			

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

	R	L		R	L
Ankle joint: *Plantarflexion*			Subtalar joint: *Varus*		
Dorsiflexion			*Valgus*		
Talocrural: *Long axis distraction*			Midtarsal:*A-P glide*		
First ray: *Dorsiflexion*			*P-A glide*		
Plantarflexion			*rotation*		
Circumduction of forefoot on fixed rearfoot			Intermetatarsal glide		
			Tarso metatarsal joints: *A-P*		
Interphalangeal joints: *L→A dist*			Metatarsophalangeal dorsiflexion (with associated plantar flexion of each toe		
A-P glide					
lat and med glide					
rotation					

Resisted Isometric movements

	R	L		R	L
Knee flexion			Pronation (eversion)		
Plantar flexion			Toe extension (dorsiflexion)		
Dorsiflexion			Toe flexion (plantar flexion)		
Supination (inversion)					

Neurological	R	L
Dermatomes		
Myotomes		
Reflexes		
Balance/proprioception		

Special tests	R	L
Anterior drawer test		
Talar tilt		
Thompson test		
Homan sign		
Tinel's sign		
Test for rigid/flexible flatfoot		
Kleiger test (med. deltoid)		

Alignment	R	L
Heel to ground		
Feiss line		
Tibial torsion		
Heel to leg (subtalar neutral)		
Subtalar neutral position:		
Forefoot to heel (subtalar & Midtarsal neutral)		
First ray alignment		
Digital deformities		
Digital deformity flexible		

Palpation

Anteriorly	R	L
Medial maleoli		
Med tarsal bones, tibial (post) artery		
Lat.malleolous, calcaneus, sinus tarsi, and cuboid bones		
Inferior tib/fib joint, tibia, mm of leg		
Anterior tibia, neck of talus, dorsalis pedis artery		
Posteriorly		
Calcaneus, Achilles tendon, Musculotendinous junction		
Plantarily		
Plantar muscles and fascia		
Sesamoids		

21/10/2002

Appendix D; SOAPE Note

DURBAN INSTITUTE OF TECHNOLOGY

Patient Name: ***File #:*** ***Page:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: *Numerical Pain Rating Scale (Patient)* *Intern Rating* ***A:***
Least ***0 1 2 3 4 5 6 7 8 9 10*** *Worst* ☐

0: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: *Numerical Pain Rating Scale (Patient)* *Intern Rating* ***A:***
Least ***0 1 2 3 4 5 6 7 8 9 10*** *Worst* ☐

O: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature***

S: *Numerical Pain Rating Scale (Patient)* *Intern Rating* ***A:***
Least ***0 1 2 3 4 5 6 7 8 9 10*** *Worst* ☐

O: ***P:***

E:

Special attention to: ***Next appointment:***

Appendix E; Pain Disability

Pain Disability Index

Patient Name: .....

File No: ..... **Date:** .....

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

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

A. Family and home responsibilities. This category refers to activities related to the home and family

1	2	3	4	5	6	7	8	9	10

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

1	2	3	4	5	6	7	8	9	10

C. Social activity. This category refers to activities which involve participation with friends and family

1	2	3	4	5	6	7	8	9	10

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

1	2	3	4	5	6	7	8	9	10

E. Self care. This category includes activities which involve personal maintenance and independence

1	2	3	4	5	6	7	8	9	10

Appendix F; Numerical Rating Scale

Numerical Rating Scale - 101 Questionnaire

Date:_____ File no:_____ Visit no:

Patient name: _____

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience **when it is at its worst**. A zero (0) would mean "no pain at all", and one hundred (100) would mean "pain as bad as it could be".

Please write only **one** number.

0 _____ 100

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience **when it is at its least**. A zero (0) would mean "no pain at all" and one hundred (100) would mean "pain as bad as it could be".

Please write only **one** number.

0 _____ 100

Appendix G; Short Form McGill Questionnaire

Short-form McGill Pain Questionnaire (SF-MPQ)

Ronald Melzack (1984)

Date:_____File no.:_____ Visit no:____

Patient name:_____

	NONE 0	MILD 1	MODERATE 2	SEVERE 3
THROBBING				
SHOOTING				
STABBING				
SHARP				
CRAMPING				
GNAWING				
HOT-BURNING				
ACHING				
HEAVY				
TENDER				
SPLITTING				
TIRING-EXHAUSTING				
SICKENING				
FEARFUL				
PUNISHING-CRUEL				

Appendix H; Advert

ARE YOU BETWEEN THE AGES OF 18 AND 50 AND SUFFERING FROM

SHIN

SPLINTS

RESEARCH IS CURRENTLY BEING CARRIED OUT AT THE DURBAN INSTITUTE OF TECHNOLOGY CHIROPRACTIC DAY CLINIC

FREE TREATMENT

IS AVAILABLE TO THOSE WHO QUALIFY TO TAKE PART IN THIS STUDY

FOR MORE INFORMATION CONTACT *LIZA ON 2042205/2512*

Appendix I; Informed Consent Form

INFORMED CONSENT FORM
(To be completed by patient / subject)

Date:

Title of research project:
The Relative Effectiveness of Three Treatment Protocols in the Treatment of Medial Tibial Stress Syndrome.

Name of supervisor: Dr. Charmaine Korporaal
Tel: 031-2042611

Name of research student: Liza Payne
Tel 0823297150

Please circle the appropriate answer

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

Please ensure that the researcher completes each section with you
If you have answered NO to any of the above, please obtain the necessary information before signing

Please Print in block letters:

Patient /Subject Name:_____Signature: _____

Appendix J: Letter of Information

COVERING LETTER FOR PATIENTS ENTERING THIS STUDY.

20 FEBRUARY 2006

Dear Patient / Participant

Thank you for agreeing to take part in this study. I am currently a 5th year chiropractic student doing my final research dissertation (The Relative Effectiveness of Three Treatment Protocols in the Treatment of Medial Tibial Stress Syndrome). You have been selected to participate in a clinical trial comparing the effectiveness of three treatment protocols in the treatment of Medial Tibial Stress Syndrome.

As you are aware, shin splints is a very debilitating and painful condition, which at its worst can prevent you from participating in your normal exercise routines. Therefore, this research aims to find a treatment protocol which helps relieve the pain and inflammation and by doing so, help reduce the recovery time.

PROCEDURE:

You will be randomly divided into one of three groups, 1, 2, or 3. Group 1will receive TENS, Group 2 will receive needling, while Group 3 will receive a combined treatment of both dry needling and TENS. The treatment will entail of 4 treatments over 2 weeks, with a follow up treatment in the third week.

All treatments will be free of charge and will be conducted at the Durban University of Technology Chiropractic Day Clinic under the supervision of a qualified chiropractor.
During this study, it is requested that you please:

- Refrain, where possible from taking anti-inflammatory drugs
- Refrain from seeking any other treatments for shin splints
- Do not make any major changes to your normal training/exercise programs.

RISKS AND BENEFITS:

Pain may be experienced during needling, however this is temporary.
There are a few side effects related to the needling component, and these include:

- Possible dizziness
- Skin irritation
- Muscle spasm
- Nausea and vomiting

- Fainting during treatment

The risks however of the above occurring are very low.
Benefits of these treatments may include a decrease in pain and inflammation or complete pain relief.

ETHICAL CONSIDERATION:

You, the patient will have to give written consent to join this study. Please note that you are free to withdraw from the study at any time. Please also note that your compliance to the number of treatments is vital for the outcome of this study. Usual infection control will be used (eg: HIV protection) alcohol swabs, surgical gloves and sealed sterile needles will be used during the treatment

CONFIDENTIALITY:

All information will be regarded as strictly confidential, only the researcher, supervisor and relevant authorities will have access to it. If you are interested in finding out the results of this study, they can be made available to you at your request.

CONTACT FOR ETHICS COMMITTEE:
Mr Vikesh Singh
Tel no: 031 2042701

Thank you for participating in this study.

Yours sincerely,

Liza Payne (Chiropractic student)
Cell no: 0823297150

SUPERVISOR: Dr Charmaine Korporaal
TEL no: 031-2042611

Appendix K; Algometer Instructions

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 the 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 tip 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 so. The stylus is then removed and the recorded value is noted (Fischer, 1987).

Appendix L; Algometer Readings

PATIENT'S NAME:
GROUP:

	READING 1:	READING 2:	READING 3	AVERAGE:
1st reading: visit 1				
2nd reading: visit 3				
3rd reading: visit 5				

Appendix M: TENS DATA SHEET

PATIENT'S NAME:
GROUP:

TREATMENT	SETTINGS	LOCATION	TIME
Tx 1			
Tx2			
Tx3			
Tx 4			

APPENDIX N: Questions asked during a telephonic interview.

1. How old are you?

2. What sports do you do?

3. Have you had any recent trauma?

4. Where about on your leg is the pain?

5. When is the pain worse, before or after exercise?

6. Have you ever had MTSS before?

7. Were you treated previously?

ARTICLE FOR REVIEW

The relative effectiveness of three treatment protocols in the treatment of Medial Tibial Stress Syndrome Type II.

Liza Payne[1]
M.Tech Chiropractic (SA)

Dr.C.Korporaal[2]
M.Tech;Chiropractic(SA) CCFC (SA),CCSP (USA),ICSSD(USA)

1. Dept Chiropractic, D.U.T.,P.O.box 1334,Durban 4001
2. Dept Chiropractic, D.U.T.,P.O.box 1334,Durban 4001

All correspondence addressed to: Mrs Inez Ireland : Tel; 031-204 2605; fax; 031-2023632; E-mail: inezi@du.ac.za ;Durban university of Technology; P.O.box 1334,Durban,4001,South Africa (RSA)

The relative effectiveness of three treatment protocols in the treatment of Medial Tibial Stress Syndrome Type II.

Objective:

The aim of this study was to investigate the relative effectiveness of TENS, versus, needling, versus Electro-needling in the treatment of MTSS.

First objective

The first objective was to evaluate the effectiveness of TENS therapy on MTSS with respect to the patients subjective and objective responses to the treatment.

Second Objective

The second objective was to evaluate the effectiveness of needling therapy on MTSS, with respect to the patient's subjective and objective responses to the treatment.

Third Objective

The third objective was to evaluate the effects of electro-needling on MTSS, with respect to the patients' subjective and objective responses to the treatment.

Fourth Objective

The fourth objective was to integrate the subjective and objective data collected in order to determine the viability of each of the therapies in comparison to one another as treatment options of MTSS.

Design:

A sample of forty five patients diagnosed with medial tibial stress syndrome were accepted into the study.

These Participants were randomly divided into three groups of 15, which received different treatment protocols for MTSS.

Outcome Measure:

A decrease in pain (measured on the algometer) with an increase in activity.

Results:

All groups improved with the treatments they received; however, no treatment alone was better than any other treatment tested.

INTRODUCTION:

MTSS is pain or discomfort along the distal 2/3 of the medial tibia as a result of inflammatory periositis or chronic periostalgia. In this respect periositis has been defined as tearing away of the muscle fibers at the muscle-bone interface causing inflammation and pain.

Based on this presentation it commonly affects runners, aerobic dancers, and military recruits[1]. The pain presents mainly during activity, although it can occur with minimal exertion and / or after activity depending on the stage of pathogenesis.

As a result Detmer[2] classified MTSS pathogenesis into three components according to the tissues involved:

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

MTSS has also been referred to as a soleus syndrome, as the resultant periositis has been localised to the medial insertion of the soleus muscle [3].

Based on the pathogenesis, treatment and therapeutic approaches that have targeted the symptomatic pain aspect of this condition, Treatment protocols have varied from biomechanical interventions, like orthotics, to non-steroidal anti-inflammatory drugs and modalities such as ultrasound; but all have had varying degrees of success [4]. These treatment and therapeutic approaches have however had little focus on resolving the periosteal component of this condition.

There is however evidence to suggest that TENS and needling, which both have similar effects (they both assist with pain control and to help decrease inflammation), may produce better clinical effects when combined, by addressing the periosteal component more directly.

Therefore, in this study, the researcher tested which of the treatments were most effective in treating MTSS, with the aim of this study having been to determine whether TENS, needling and / or electro- needling was an effective treatment for the treatment of MTSS.

This study therefore comprised of 45 participants suffering from MTSS. The participants were divided into 3 groups of 15. Group 1 received TENS, Group 2 received Needling and Group 3 received electro-needling. Participants were evaluated at an initial consultation. Participants who complied with the inclusion criteria for the study were accepted into the research study. Participants who displayed any of the exclusion criteria were not accepted into the study.
The initial consultation was carried out at the Durban University of Technology campus. Subjective and objective findings were recorded using the NRS, RMQ, PDI and the algometer.

SPSS version 11.5 (SPSS Inc, Chicago, Ill, USA) was used for data analysis. A p value of <0.05 was considered as statistically significant.

Method:

Design:

A sample of forty five patients diagnosed with medial tibial stress syndrome were accepted into the study [5,6].

These participants were randomly divided into three groups of 15, which received different treatment protocols for MTSS.

Sample:

Participants were evaluated at an initial consultation. At that consultation a diagnosis was made based on a case history, physical examination and a foot and ankle regional in order to establish whether they were eligible for this study. Forty five participants were divided into 3 groups of 15. Group 1 received TENS, Group 2 received Needling and Group 3 received electro-needling. Each group of fifteen participants had MTSS.

Inclusion Criteria:

Patients between the ages of 18 to 50 years of age. According to research been done on MTSS, this appears to be the age with the highest incidence of patients who are affected by MTSS [5,6].

A clinical diagnosis of MTSS was made-patients needed to meet 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 [1,2].
2. Pain in this area, exacerbated by weight bearing or physical activity and which is relieved by rest [2].
3. The Presence of 'tender spots'-rough, well localised, exquisitely tender corrugated areas, arising due to the build up of new periosteal layer, felt when applying firm finger pressure [4].

Both male and females meeting the inclusion criteria were included into the study.

A pain rating on the NRS between 5 -10 allowed the participants to qualify for the study. This was done to help get homogeneity within the group. Neither of the researchers [5,6] done prior to this research had a limitation in this respect. This was important as it helped show more accurate results as all the participants were in a similar category to begin with.

The subjects were then asked to sign a written consent form before the study commenced.

Exclusion Criteria:

Patients were not accepted into the study if they showed any of the following symptoms:

Patients exhibiting any of the following contra-indications to TENS [7]:

- Patients with cardiac pacemakers,
- Any broken skin or anaesthetic skin or infected skin,
- Patients with cardiac arrhythmias,
- Patients with epilepsy,
- Patients who are in the first three months of pregnancy,
- Patients who have recently undergone trauma and
- Patients who have or do undergo surgery prior to or during the research.

Patients exhibiting any of the following contra-indications to dry-needling [8]:

- 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 with tumors or any patients that need to be referred for any reason.
- Any patients that respond badly to needling; e.g., faint, nausea.
- Participants who have failed to complete or sign the informed consent will automatically be excluded from the study.

The patients were then examined for signs and symptoms of medial tibial stress syndrome. Patients that were diagnosed with medial tibial stress syndrome were the accepted into the study.
Patients that met the research criteria and who accepted to join the study were then informed about the study.

Intervention Frequency:

Participants had 5 visits over a period of 3 weeks. At the 1st, 3rd and last visit, readings were taken and the participant was asked to fill in questionnaires.

Measurement tools:

A: The Pain Disability Index

The pain Disability Index was used to give the researcher an indication of how the level of pain was affecting the patient in general lifestyle activities. The patient's response was noted at the initial visit as well as the third, and then the fifth final visit.

The questionnaire comprised five questions. The patient was required to respond to the questions on a scale of one to ten. A score of one meant no disability, and ten meant that the pain completely prevented the patient from normal daily

activities. The result was the sum of the scores expressed as a percentage of the total of 50 [9]

B. The Numerical Pain Rating Scale (NRS 101)

The questionnaire was used to determine the subjective pain intensity experienced by the patient. The Patients response was noted at the initial visit, the third visit and the fifth and final visit.

The patient was asked to note down there perceived level of pain on a numerical scale of zero to 100, with the zero representing no pain and the 100 representing pain at its worst. The number noted represented the patients' level of pain intensity [10].

The numerical Pain Rating Scale (NRS-101) has been shown to be simple, effective and the recommended choice in a study comparing six methods of measuring clinical pain intensity [10].

C. McGill Short Form Pain Questionnaire

The questionnaire assesses the sensory dimension of the pain experienced by the patient [11].

The questionnaire was derived from the McGill long form pain questionnaire and consisted of a list of 15 words that describe pain. Each description was ranked on an intensity scale: 0=none, 1=mild, 2=moderate, 3=severe [11].

The short form pain questionnaire compares closely to the long form of the questionnaire and is considered to be a reliable and consistent subjective measuring device [11].

Objective feedback:

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 tip stylus is then placed over the tender area with the dial perpendicular to the skin surface. Steady, gentle pressure is the applied at the rate of 1 kilogram per square centimeter per second until the patient first perceives pain and responds by saying so. The stylus is then removed and the recorded value is noted [(12)].

This was used to measure the tenderness at the medial tibial border, 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 for a person to first perceive pain [(12)]. The points that were measured were roughened, painful areas along the medial tibia that were found on palpation. The most tender spot was used. The distance from the medial malleolus to this point was measured in order to keep an accurate reading in the follow-up treatments.

Statistical methods:

SPSS version 11.5 (SPSS Inc, Chicago, Ill, USA) was used for data analysis. A p value of <0.05 was considered as statistically significant.

Baseline demographics and outcomes were compared between the treatment groups using one-way ANOVA for quantitative variables, and Pearson's chi square tests for categorical variables.

Evaluation of the treatment effect was achieved using repeated measures ANOVA with between-subjects effects as the three treatment groups and within-subjects effects as the time periods of evaluation (baseline to week 3). A

significant time by group interaction indicated a significant treatment effect. When the treatment effect was statistically significant overall ($p<0.05$) or borderline non significant, additional post hoc multiple comparisons of two groups were done, adjusting for increased type I errors using a Bonferroni adjustment. The p values from the post hoc tests were multiplied by 3 (because there were three different 2 group comparisons) to adjust for the increased probability of a type 1 error.

Since the observations (legs) were not completely independent of each other (two belonged to the same person) and since a lot of the outcomes were measured subjectively, which could have resulted in a correlation within participants, models were checked using Stata version 9.0 (StataCorp, Texas, USA), where GLM models can be adjusted for clustering by individual and over time. Both time*group p values were reported (with and without clustering adjustment). Profile plots were generated to examine trends by group over time. This was done separately for each of the 4 pain outcomes. Finally intra-group correlation analysis was undertaken to examine relationships between changes in the outcome variables over time.

Demographics

Both legs of 23 participants (46 legs) were randomized into three treatment groups. For all but one participant, both legs received the same treatment, thus there were 15 legs in each of groups 1 and 3, and 16 legs in group 2.

Majority of the participants were male (n=18, 78.3%), while 5 (21.7%) were female. The sports that they played are listed in Table 1. The most common sport was rugby (47.8%) followed by running (30.4%).

Sports

Table 1: Sports played by participants (n=23)

	Frequency	Percent
Rugby	11	47.8
Running	7	30.4
Netball	2	8.7
Cricket	1	4.3
Hockey	1	4.3
Walking	1	4.3
Total	23	100.0

Their mean age was 25.3 years (SD 5.9 years), with a range from 19 to 40 years.

4.2.1.2 Comparison of baseline outcomes and demographics between treatment groups

This was done in order to establish that there were no pre-existing differences between the groups which could have influenced the outcomes after treatment, in other words, that the randomization process was complete. The analysis was done at the “leg” level rather than at the participant level since one person had 2 legs in different treatment groups, thus treatment group was not unique to participant.

4.2.1.2.1 Gender

Table 2 shows that there was no difference in terms of gender between the three treatment groups (p=0.113). There tended to be a predominance of females in group 1, but the difference was not statistically significant.

Table 2: Cross-tabulation of gender by treatment group

			Group			Total
			TENS	Needling	Electroneedling	
gender	male	Count	9	14	13	36
		% within gender	25.0%	38.9%	36.1%	100.0%
	female	Count	6	2	2	10
		% within gender	60.0%	20.0%	20.0%	100.0%
Total		Count	15	16	15	46
		% within gender	32.6%	34.8%	32.6%	100.0%

Pearson chi square 4.36, p=0.113

4.2.1.2.2 Age

Tables 3 and 4 show that there was no significant difference between the mean ages of the three groups (p=0.139), although the mean age of the second group tended to be lower than that of the other two.

Table 3: Descriptive statistics of age by treatment group

group	Mean	N	Std. Deviation
TENS	26.20	15	7.123
Needling	23.00	16	3.225
Electroneedling	26.87	15	6.105
Total	25.30	46	5.815

Table 4: ANOVA comparison of mean age between the three treatment groups

	Sum of Squares	df	Mean Square	F	p value
Between Groups	133.606	2	66.803	2.069	0.139
Within Groups	1388.133	43	32.282		
Total	1521.739	45			

Results:

NRS, Algometer, PDI, RMQ

In terms of baseline outcome values, only NRS showed a statistically significant difference between treatment groups at baseline (p=0.008). The post hoc tests showed that it was only the Needling group and the electro-needling that were significantly different from each other (p=0.007). The Needling group had higher baseline pain scores than the electro-needling group.

Table 5: Descriptive statistics of baseline outcomes by treatment group

Group		Baseline algometer	Baseline PDI	Baseline NRS	Baseline RMQ
TENS	Mean	8.607	20.20	54.83	19.00
	N	15	15	15	15
	Std. Deviation	1.5549	7.002	13.806	8.009
Needling	Mean	8.331	19.13	60.00	12.88
	N	16	16	16	16
	Std. Deviation	2.0590	8.724	14.434	7.365
Electroneedling	Mean	8.200	20.07	45.37	14.40
	N	15	15	15	15
	Std. Deviation	1.0644	7.732	8.189	10.098
Total	Mean	8.378	19.78	53.54	15.37
	N	46	46	46	46
	Std. Deviation	1.5958	7.711	13.684	8.757

Table 6a: ANOVA comparison of mean baseline outcomes between the three treatment groups

		Sum of Squares	df	Mean Square	F	P value
Baseline algometer	Between Groups	1.295	2	.647	.246	0.783
	Within Groups	113.304	43	2.635		
	Total	114.598	45			
Baseline PDI	Between Groups	10.743	2	5.371	.087	0.917
	Within Groups	2665.083	43	61.979		
	Total	2675.826	45			
Baseline NRS	Between Groups	1694.846	2	847.423	5.413	0.008
	Within Groups	6732.067	43	156.560		
	Total	8426.913	45			
Baseline RMQ	Between Groups	311.367	2	155.684	2.132	0.131
	Within Groups	3139.350	43	73.008		
	Total	3450.717	45			

Table 6b: Bonferroni post hoc comparison of mean NRS between the three treatment groups

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval	
TENS	Needling	-5.167	4.497	0.771	-16.37	6.04
	Electro needling	9.467	4.569	0.133	-1.92	20.85
Needling	TENS	5.167	4.497	0.771	-6.04	16.37
	Electro needling	14.633(*)	4.497	0.007	3.43	25.84
Electro needling	TENS	-9.467	4.569	0.133	-20.85	1.92
	Needling	-14.633(*)	4.497	0.007	-25.84	-3.43

* The mean difference is significant at the .05 level.

It is very important, when doing a study like this to have groups that are similar. i.e., gender, age, sporting activity. This would help prevent big differences in readings in amongst the group and help give more accurate readings and results when comparing the groups.

The baseline NRS readings were similar between TENS and Needling; however the baseline NRS readings were quite a bit lower in the electro-needling group. This on its own could give a false result as it does not show the true results of the electro-needling group as they started at a lower reading on the scale. For future studies, it may be beneficial to have stricter inclusion criteria into the study. All patients include into the study should have a narrower range on the NRS scale, as this would give a more accurate result of the treatments undergone.
Also it means that there is the possibility that differences observed between the groups after the intervention may have been due to the baseline differences and

not to the intervention itself, which is why its important to have similar groups at baseline. Fortunately the statistical procedures used can control for any baseline differences between groups.

Inter and Intra-group analysis

Objective findings

With respect to this study objective one was set out to investigate the relative effectiveness of TENS compared to needling compared to electro needling in terms of objective clinical findings in the treatment of MTSS.

The resultant Null hypothesis therefore read: “There is no difference in the treatment effect of the three groups in terms of algometer measurements”.

Based on Table 7, where it shows that the null hypothesis was not rejected in this case ($p=0.113$). The treatment effect was not statistically significant overall. Thus no further post hoc tests were done to compare the individual treatment groups. Even after adjustment for the clustering by individual person, the effect was not statistically significant ($p=0.094$).

However, all treatment groups showed a highly significant increase in algometer measurement (decrease in pain) over time ($p<0.001$), indicating that any form of treatment is effective for pain measured objectively. Figure 1 shows that there was a trend towards the electro-needling group showing a faster decrease in pain than the other two groups, which performed very similarly over time.

Table 7: Within and Between Subjects Effects for Algometer Measurements

Effect	Statistic	p value
Time	Wilk's Lambda = 0.289	<0.001
Group	F=1.204	0.310
Time*group (total – unadjusted for clustering)	Wilk's Lambda = 0.839	0.113
Time*group (total –adjusted for clustering)	Coefficient = 0.255	0.094

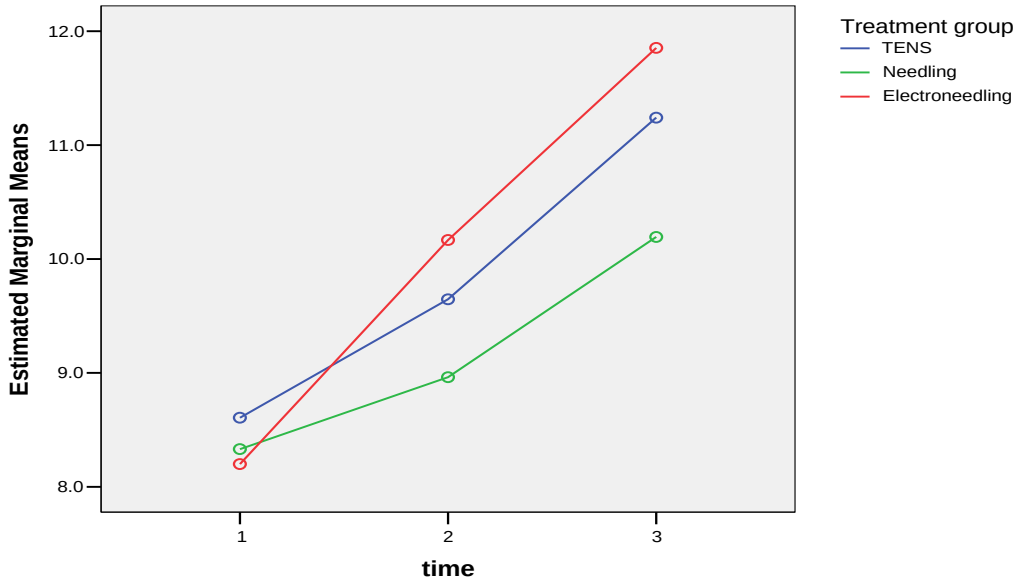

Figure 1: Profile plot of Algometer measurements over time by group

Although the results where not significant for this objective measurement, there are a number of things that should be considered;

- There was a reduction in the p value (p = 0.113) from the initial analysis to p = 0.094 after controlling for individual confounding variables (including all individual factors that were marginally different between the groups with respect to their demographics). This indicates that there are variables that

were not appropriately controlled for in the design of this study, even though the inclusion criteria were comprehensive in terms of the MTSS. It is therefore recommended that the following criteria be considered for future research:

- Many patients were apprehensive about having the algometer readings taken as they said it caused more pain. This apprehension could affect the readings as well as the fact that every person has a different pain threshold and something that is painful to one person may not be painful to another.
- If a study like this is being done, it would be preferable to use a group of patients that do the same type of sport .In order to get accurate readings and results it is best if you use patients that have a similar routine and that there is no one person who does a whole lot more than the other.
- Another important factor that should be taken into account is when the last activity was performed before the readings were taken .It was found in this research that a few of the patients had training the day before the measurements were taken, and although they said they had felt better during the training, the readings didn't show much improvement or they showed a slight decline.
    - The pressure algometer consists of a force dial which reads in kilograms and a centimeter diameter rubber tipped stylus. Using an algometer, pressure pain threshold is used to quantify palpatory pain findings for myofascial trigger points and pain over the bone .Pain threshold is determined by the amount of force per square centimetre required for a person to first perceive pain. From this we get our objective readings.

- A trend is also evident indicating that electro-needling improved at a faster rate than the other two groups. It should therefore be considered that

additional measures such as the following should be considered in future research:

- Measurement intervals should be done as usual, but the treatment should be continued for longer period with more measurements being done over this period. This would help determine if it is a permanent solution to MTSS, or a temporary measure of pain relief.
- Treatment intervals should be kept as usual, however a group of patients that do the same activities and have a similar training programme would help with making the results more accurate.

These measures may be able to then assist with defining whether any significant difference exists between the groups with respect to algometer measures, which were not attained in this study.

Subjective findings

With respect to this study, Objective 2 was to investigate the relative effectiveness of TENS compared to needling compared to electro needling in terms of subjective clinical findings in the treatment of MTSS.

Subjective findings : NRS

Null hypothesis: There is no difference in the treatment effect of the three groups in terms of NRS measurements.

The overall treatment effect (unadjusted for clustering) was statistically significant (p=0.007). In order to identify which specific treatment groups were significantly different to each other, individual 2 group comparisons were done. The only significance was found between the needling and electro-needling groups (p=0.003). Figure 2 shows that the pain scores in the needling groups decreased at a faster rate than the electro-needling group. Thus the null hypothesis is

rejected for this outcome and it is concluded that there was a significant treatment effect for NRS, specifically that needling (and perhaps TENS) are preferable to electro-needling. It should be noted that when the adjustment for clustering at the individual level was made, the significance no longer remained.

Table 8: Within and Between Subjects Effects for NRS

Effect	Statistic	p value
Time	Wilk's Lambda = 0.176	<0.001
Group	F=0.268	0.766
Time*group (total – unadjusted for clustering)	Wilk's Lambda = 0.719	0.007
Time*group (TENS vs. Needling)	Wilk's Lambda = 0.965	1.000
Time*group (TENS vs. Electroneedling)	Wilk's Lambda = 0.781	0.108
Time*group (Needling vs. Electroneedling)	Wilk's Lambda = 0.550	0.003
Time*group (total –adjusted for clustering)	Coefficient = 3.167	0.122

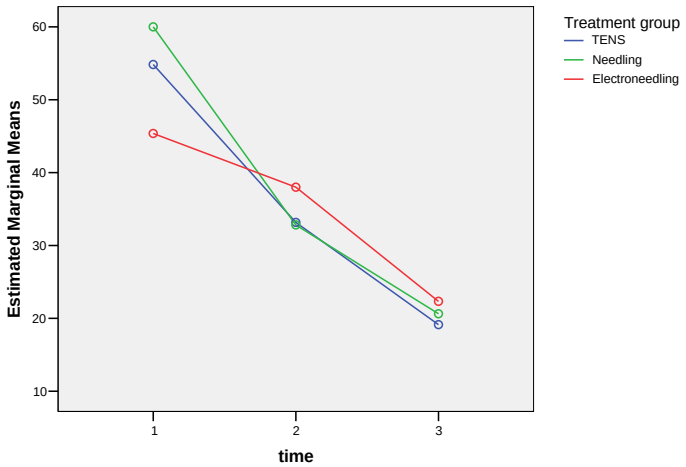

Figure 2: Profile plot of NRS measurements over time by group

Discussion:

Significant difference between TENS / Needling and the electro needling ($p = 0.007$ or with adjustment for clustering $p = 0.003$). Since the baseline readings had no effect on the electro needling group, as the repeated measure ANOVA adjusts for baseline differences by looking at the rate of change over time; it is clear from the figure that the slope of the electro needling group over time was not as steep as that of the other 2 groups and that although the electro needling group started out with an advantage (lower pain at baseline) they ended up with higher pain than the other groups (TENS / Needling).

As was noted and discussed in 4.2.1.2.3 earlier in this chapter, that the NRS readings between the groups at the baseline was significantly different between the needling and the electro-needling, with there being no difference between these groups and the TENS group. This indicted that the TENS group had to have presented with NRS mean readings somewhere between the needling and electro-needling groups, however from this discussion it was not evident which group (needling / electro-needling) presented with more or less severe cases at entry. This is clarified in Figure 2, where it can now be seen that the patients in the electro-needling group presented at a lesser NRS rating than those in the needling group.

The cumulative effect of the differences presented between the 3 groups seen from Figure 2 could therefore be responsible for the outcomes achieved for this measure. Thus the rejection of this hypothesis may indeed be incorrect based on the differential of entry level ratings on the NRS.

It is therefore suggested that future research should consider:

- The methodology should include a stricter entry requirement based on the NRS scores. The only parameters that needs to be considered if the NRS scores where to be amended is that the length of the data collection phase

would be increased substantially due to the low incidence and prevalence of the condition [13]

- Based on the suggestion above a long term study may be best suited for the purposes of an amended entry requirement.

Subjective findings: PDI

Null hypothesis: There is no difference in the treatment effect of the three groups in terms of Pain Disability Index scores.

Table 9 shows that the null hypothesis was not rejected (p=0.106) and that the treatment effects were the same in all groups. Overall there was a significant improvement over time in all groups (p<0.001), thus all treatments were effective at reducing disability. Figure 3 suggests that the TENS and needling groups experienced a slightly faster rate of change over time than the electro-needling group, but this trend was not statistically significant.

Table 9: Within and Between Subjects Effects for Pain Disability Index Scores

Effect	Statistic	p value
Time	Wilk's Lambda = 0.252	<0.001
Group	F=0.600	0.553
Time*group (total – unadjusted for clustering)	Wilk's Lambda = 0.836	0.106
Time*group (total –adjusted for clustering)	Coefficient = 0.150	0.847

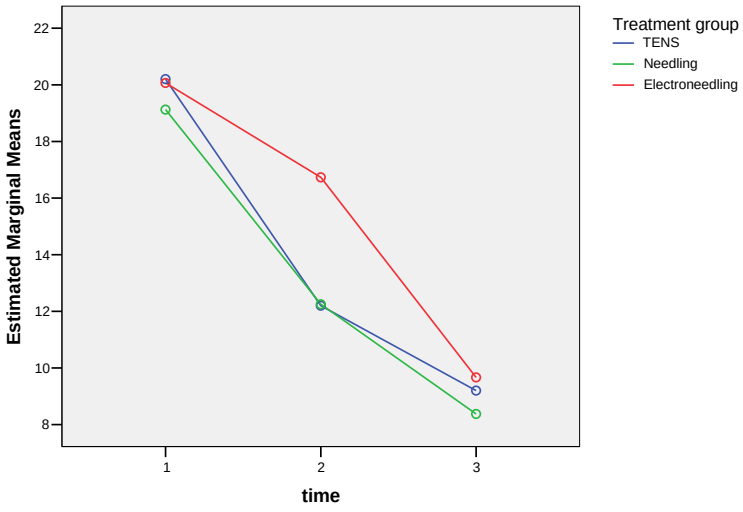

Figure 3: Profile plot of Pain Disability Index Scores over time by group

Discussion

There is an insignificance finding between TENS, needling and electro-needling (p=0.106 or with adjustment for clustering p= 0.847)

All the groups improved over the treatment time, however, it was said that there is no difference between treatments.

This is in contrast to the improvements seen in the NRS (section 4.2.2.2.1), where there was a significant difference between the needling and electro-needling, but not between these two and TENS group. The results of the NRS would seem to suggest that the functional improvement of the patients should follow a similar format. One could however argue that there could be inherent differences in the reporting for pain (NRS) and PDI (functional ability) for any one of the following reasons :

- With increased activity a patient is thought to experience a decrease in pain (Melzack and Wall, 1975). Therefore the patient may report the pain

as high at the measurement interval (i.e. at the measurement time) in contrast to the patient reporting functional ability, where the theory proposed by Melzack and Wall (1975) expounds the possibility that increased activity decreases pain (gate control theory). Thus the amount of functional ability may not actually be reflective of the pain experienced by the patient.

This is consistent with the pathophysiololgy of the MTSS, where with increased activity there is a increase in pain [14] as opposed to a decrease in activity with an decrease in pain (particularly a decrease of activity directly after activity) [14].

- Following from the above, reporting during (PDI reflects activity related functions) or after activity (NRS or pain related dysfunction) may also have played a role in the results obtained.

- Gender, could also have been a confounding variable, however with the baseline assessment of the groups, gender was found to be homogenous and thus this influence is unlikely.

With respect to the overall improvement, all groups appear to have started out with similar PDI's, the needling and TENS groups appeared to improve at a faster rate than the electro-needling group. This difference in trends may have been related to the fact that electro-needling is a more aggressive and deeper form of therapeutic approach, as the effects of skin resistance would have been eliminated and it would also have been a dual function modality as opposed to the other 2 groups. This may have resulted in a slow initial response to treatment followed by a sudden improvement as compared to the consistent improvement seen in the TENS and needling groups (Figure 3).

Therefore in order to elicit the trends more exactly and possibly to the point of significance, it is suggested the future research consider:

- The research should be done over a longer period of time,
- With more measurements (frequency of measurements), as well as
- Including an ankle regional exam when the research is complete to be able to determine dysfunction more objectively such that one is able to confirm or refute the possible reasons suggested above for the differences between the NRS and the PDI.

Subjective findings : RMQ

Null hypothesis: There is no difference in the treatment effect of the three groups in terms of RMQ scores.

Table 10 shows that the treatment effect was borderline statistically significant (p=0.063), thus post hoc tests were performed. The post hoc tests showed that there was a statistically significant difference in treatment effect between TENS and electro needling (p=0.042) even after Bonferroni adjustment. Figure 4 shows that the TENS groups scores decreased at a faster rate than those of the electro needling group. Thus the null hypothesis is rejected for this outcome and we conclude that TENS was significantly better than electro needling. However, after adjusting for the clustering effect of the individual the effect was no longer significant (p=0.351).

Table 10: Within and Between Subjects Effects for RMQ scores

Effect	Statistic	p value
Time	Wilk's Lambda = 0.357	<0.001
Group	F=1.204	0.310
Time*group (total – unadjusted for clustering)	Wilk's Lambda = 0.811	0.063
Time*group (TENS vs. Needling)	Wilk's Lambda = 0.844	0.276
Time*group (TENS vs. Electroneedling)	Wilk's Lambda = 0.728	0.042
Time*group (Needling vs. Electroneedling)	Wilk's Lambda = 0.978	1.000
Time*group (total –adjusted for clustering)	Coefficient = 1.217	0.351

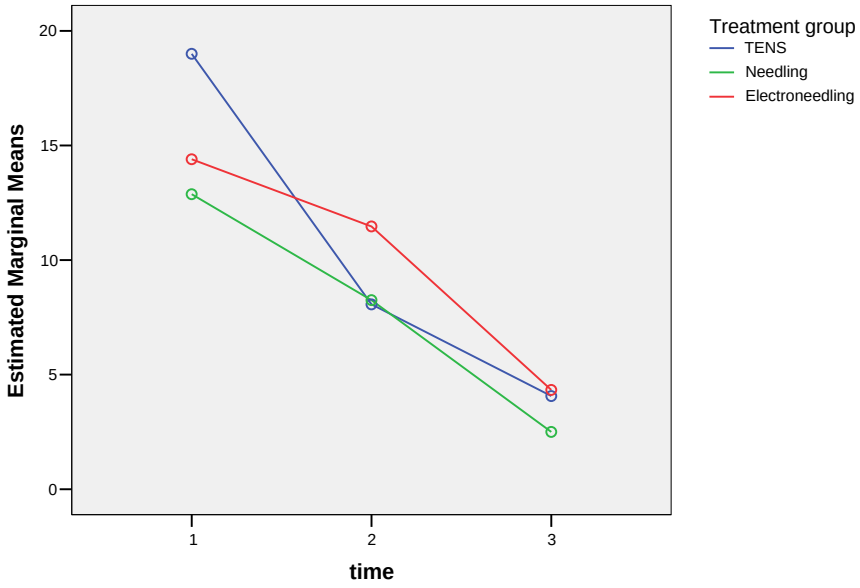

Figure 4: Profile plot of RMQ Scores over time by group

Discussion

Significant difference between TENS and electro-needling (p=0.042), with the TENS group showing a faster rate of improvement than the electro needling group.

Correlation tables and group correlations

Objective 3: To investigate correlations between changes in objective and subjective outcomes in each treatment group.

The TENS group

The objective measurement (algometer) was not correlated with any of the subjective measurements. However, some of the subjective measurements were correlated together.

Change in PDI and change in RMQ showed a strong positive correlation (r=0.715, p=0.003), as well as change in MRS and change in RMQ (r=0.887, p<0.001).

Table 11: Pearson's correlation between changes in outcomes in the TENS group

		Change in algometer	Change in PDI	Change in NRS	Change in RMQ
Change in algometer	Pearson Correlation	1	-.186	-.131	-.106
	Sig. (2-tailed)		.508	.642	.707
	N	15	15	15	15
Change in PDI	Pearson Correlation	-.186	1	.432	.715(**)
	Sig. (2-tailed)	.508		.107	.003
	N	15	15	15	15
Change in NRS	Pearson Correlation	-.131	.432	1	.887(**)
	Sig. (2-tailed)	.642	.107		<0.001
	N	15	15	15	15
Change in RMQ	Pearson Correlation	-.106	.715(**)	.887(**)	1
	Sig. (2-tailed)	.707	.003	<0.001	
	N	15	15	15	15

** Correlation is significant at the 0.01 level (2-tailed)

The needling group

No correlations were shown between changes in outcomes in this group.

Table 12: Pearson's correlation between changes in outcomes in the needling group

		Change in algometer	Change in PDI	Change in NRS	Change in RMQ
Change in algometer	Pearson Correlation	1	.118	-.483	-.116
	Sig. (2-tailed)		.663	.058	.669
	N	16	16	16	16
Change in PDI	Pearson Correlation	.118	1	.348	-.223
	Sig. (2-tailed)	.663		.186	.406
	N	16	16	16	16
Change in NRS	Pearson Correlation	-.483	.348	1	-.478
	Sig. (2-tailed)	.058	.186		.061
	N	16	16	16	16
Change in RMQ	Pearson Correlation	-.116	-.223	-.478	1
	Sig. (2-tailed)	.669	.406	.061	
	N	16	16	16	16

The electro needling group

Again, there was no correlation between changes in objective and subjective findings in this group. However, there were strong positive correlations between changes in PDI and RMQ (r=0.719, p=0.003), between PDI and NRS (r=0.700, p=0.004) and between NRS and RMQ (r=0.773, p=0.001).

Table 13: Pearson's correlation between changes in outcomes in the electroneedling group

		Change in algometer	Change in PDI	Change in NRS	Change in RMQ
Change in algometer	Pearson Correlation	1	.281	.164	.241
	Sig. (2-tailed)		.310	.560	.386
	N	15	15	15	15
Change in PDI	Pearson Correlation	.281	1	.700(**)	.719(**)
	Sig. (2-tailed)	.310		.004	.003
	N	15	15	15	15
Change in NRS	Pearson Correlation	.164	.700(**)	1	.773(**)
	Sig. (2-tailed)	.560	.004		.001
	N	15	15	15	15
Change in RMQ	Pearson Correlation	.241	.719(**)	.773(**)	1
	Sig. (2-tailed)	.386	.003	.001	
	N	15	15	15	15

** Correlation is significant at the 0.01 level (2-tailed).

Results in the context of the objectives and hypotheses:

The aim of this study was to investigate the relative effectiveness of TENS, versus, needling, versus Electro-needling in the treatment of medial tibial stress syndrome (shin splints)

Therefore with respect to the hypothesis that dry needling combined with TENS using crocodile clips (PENS) would be more effective in the treatment of MTSS than needling or TENS on their own, the following measured parameters are rejected:

- RMQ,
- PDI,

- NRS and
- Algometer.

Thus there was no one instance with respect to the clinical outcome measures that could conclusively indicate the combination therapy was better than either of the single therapies as applied in MTSS.

Conclusion:

This study has shown conflicting findings. According to objective measurements of pain, the treatment effect was not statistically significant, but there was a trend towards the electro needling group showing a faster decrease in pain than the other two groups. In terms of subjective outcomes, the electro needling treatment performed the worst of the three groups (significantly worse than needling for NRS and significantly worse than the RMQ for TENS).

The subjective and objective pain scores showed no correlation in any of the groups. This could therefore be the reason for the conflicting findings regarding the effect of electro needling.

This is consistent with the literature cited in this research [2,5], where researchers have used numerous treatment protocols with little or short lasting relief from the pain and symptoms. Even when rest has been incorporated into this treatment protocol, as soon as the patient returns to the sport the symptoms commonly recur. This protocol without rest seems to have reached similar conclusions. This therefore indicates that rest is the major factor in the treatment of MTSS with respect to the most important intervention protocol.

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