

**THE EFFECT OF ACTION POTENTIAL SIMULATION ON POST DRY-
NEEDLING SORENESS IN THE TREATMENT OF ACTIVE
TRAPEZIUS MYOFASCITIS**

By

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**A dissertation submitted to the faculty of health in partial compliance with the
requirements for the Masters Degree in Technology: Chiropractic, at the
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**I, Hitesh Manga, do declare that this dissertation represents my own work in both
conception and execution.**

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DEDICATION

This is dedicated to my late mother and sister, Premilla and Ansuyah Manga, for their continual sacrifices, love, support, encouragement and guidance throughout my childhood.

“Keep your dreams alive. Understand to achieve anything requires faith and belief in yourself, vision, hard work, determination, and dedication. Remember all things are possible for those who believe.”

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ABSTRACT

Introduction: Myofascial Pain Syndrome (MPS) is a painful and prevalent muscular condition. It is characterized by the development of Myofascial trigger points (TrPs) that are locally tender when active and which can refer pain through specific patterns to other areas of the body distal from the trigger point.

There exist many types of treatments for MPS of which dry needling is one of the most effective forms. However, a very common side-effect experienced is post-needling soreness, which when compared to trigger point injections are more painful, with respect to both intensity and duration. Studies have shown that the exact cause of post-needling soreness has not been clearly documented.

Action Potential Simulation (APS) Therapy operates using a direct electric current (DC) on muscles. It stimulates action potentials that are stronger than the natural nerve impulses. It operates on a similar principle to the gate control theory of Melzack and Wall (1988) which results in the inhibition of nociceptive signals. Stimulation by the APS unit creates a normal action potential that restores the inherent biochemical processes in the region. This low to medium frequency current (below 150 Hz) has been reported to alleviate pain, decrease inflammation, enhance blood circulation and aid in wound and bone fracture healing.

Methodology: This study was designed as a prospective, randomised, controlled experimental investigation. Sixty subjects were randomly allocated into three equal groups of 20 subjects each. Group One received the fanning dry needling technique; Group Two received a combination of fanning dry needling plus APS Therapy. Group Three was the control group in which the subjects were treated with fanning dry needling with 'Sham' APS Therapy.

Algometer and Numerical Pain Rating Scale 101 (NRS 101) readings were taken immediately before and after the dry needling procedure and again at the follow-up

visit 24 hours later. Subjects used a 24-hour pain diary and the NRS 101 scale which was filled out at 3 hour intervals, to record any post-needling soreness.

Results: An intra-group analysis revealed that, objectively and subjectively, all groups experienced some degree of post-needling soreness, which decreased significantly over time. This decrease of pain was not significantly related to the treatment group, and there is no evidence of the differential time effect with the treatment. An inter-group analysis yielded no statistically significant results regarding the effectiveness of the treatments received by the patients. This could be because of the small sample size or because “Sham” APS is not a useful intervention.

Conclusion: The results from this study revealed that all three treatment groups responded equally in the alleviation of pain. However, the dry-needling treatment group alone (Group One) revealed a much more significant decrease in pain compared to the other two. It can thus be concluded that APS Therapy had no significant beneficial effects on post-needling soreness.

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CHAPTER ONE

1.1 Introduction

Myofascial Pain Syndrome (MPS) is a painful and prevalent cause of regional musculoskeletal pain. It is characterized by the development of Myofascial trigger points (TrPs) that are locally tender when active and which refer pain through specific patterns to other areas of the body (Bendtsen *et al.*, 1996) distal from the actual trigger point location (Travell *et al.*, 1999). According to Travell (1999), there are two categories of trigger points. Active trigger points refer pain at rest and on activity, whereas, latent trigger points refer pain upon palpation or when injected (Travell *et al.*, 1999).

The formation of trigger points in muscle fibres is often the result of stress caused by acute trauma and repetitive microtrauma (Alvarez and Rockwell, 2003). Possible contributing factors include: incorrect exercise techniques, poor posture, biomechanical malalignment, nutrition deficiencies and psychological stress.

Trigger points are found throughout the body and are equally prevalent in females and males, although the incidence appears to be slightly higher in females (Han and Harrison, 1997). It commonly occurs between the ages of 30 and 60 years, however its prevalence declines with advancing age (Fomby and Mellion, 1997). In a study of 214 women and 103 men, it was reported that the head, neck, shoulder girdle, and the lower back were found to have more trigger points than other regions of the body (Han and Harrison, 1997). Of the trigger points found in these regions, 33% of trigger points were found in the upper trapezius muscles.

Methods usually applied to treat myofascial trigger points include dry-needling, stretch, massage, thermo and cryo-therapy, electrotherapy, laser therapy, trigger point injection, and acupuncture (Hong, 2002).

According to Travell *et al.*, (1999) and Cumming, (2003), the most effective treatment for trigger points is dry needling. Dry-needling can provide pain relief through the mechanical disruption or direct stimulation of myofascial trigger points (Han and Harrison, 1997) (Raj and Paradise, 2004). An immediate anaesthetic effect can be achieved with either technique through accurate dry needling, also known as the needle effect (Rachlin, 2002). Han and Harrison (1997) proposed that the strongest analgesic effect is achieved when the most painful spot is needled.

Two types of needling techniques are used i.e. single insertion and the fanning technique. Single insertion involves the insertion of an acupuncture needle directly into the most painful site of the trigger point (Baldry, 2005) and the needle is left *in situ*, unstimulated for a few minutes. The fanning technique involves stimulation of the trigger point by withdrawing and re-inserting the needle repeatedly from different angles while maintaining the original entry point from the skin (Travell *et al.*, 1999).

Ferreira, (2006) found that post-needling soreness is a common side effect to dry needling. When compared to trigger point injections, using lidocaine, post-needling soreness appears to be more severe after dry needling, with respect to both intensity and duration (Alvarez and Rockwell, 2002). Although the exact cause has not been documented, it has been noted that it does occur if bleeding occurs after needling, but this theory is not conclusive (Travell *et al.*, 1999). Research conducted by Alvarez and Rockwell, (2002) has found that it is unclear whether the pain arises from the tissue damage caused by the needle insertion or from the actual trigger point or even when a trigger point was not precisely needled.

Action Potential Simulation (APS) Therapy® falls under the broad definition of Microcurrent Electrical Stimulation (MET). It operates on a direct current (DC) that stimulates action potentials which are stronger than the body's natural nerve impulses. The brain receives the pain signal more freely, enabling the body's natural substances, neurohormones, to be released (Fengler *et al.*, 2007).

The application of APS to an injured site is purported to enable damaged tissue to heal by reducing the resistance of the injured tissue, allowing bioelectricity to enter the area to re-establish homeostasis (Odendaal, 2001). This low to medium frequency current (below 150 Hz) has been reported to alleviate pain, decrease inflammation, enhance blood circulation and aid in wound and bone fracture healing (Seegers *et al.*, 2001).

APS Therapy is reported to replenish ATP, which is required to control primary functions such as the movement of minerals like sodium, potassium, magnesium and calcium, into and out of the cell (Odendaal, 2001) (Fengler *et al.*, 2007). It also sustains the movement of waste products out of the cell. Furthermore, studies have shown that it is necessary for activating various cellular processes, such as signal transduction mechanisms, through phosphorylation of target proteins (Seegers *et al.*, 2001). Furthermore it has also shown to be an essential factor in the healing process (Odendaal, 2001). It appears that APS Therapy works according to the gate control theory (Melzack and Wall, 1988) where injured cells deficient in ATP are inhibited from transmitting injury signals.

To date very little research has been done to investigate techniques of reducing post-needling soreness which may occur as a result of accumulation of biochemical waste from uric acid, inflammation and excess fluid that APS has been purported to physiologically remove (Odendaal, 2001).

It is therefore the aim of this study to determine the effect of post-needling soreness following the dry-needling of trapezius muscle trigger points using the fanning technique in conjunction with simultaneous Action Potential Simulation (APS) Therapy and “Sham” technique in terms of objective and subjective findings.

1.2 Rationale for this study

1.2.1 Rationale one

Dry needling appears to be one of the most effective forms of therapy for the treatment of myofascial pain syndrome (Travell *et al.*, 1999), in comparison to all the other techniques available. However because of post-needling soreness after this treatment it is advised that strenuous activity of the involved muscle be avoided and further dry-needling treatment be stopped for 3-4 days thereafter (Alvarez and Rockwell, 2002). Studies propose this delay follow-up treatment which may delay recovery. Although the referral pain and other symptoms of the trigger points may be relieved by dry needling, patients report significant discomfort post-needling.

1.2.2 Rationale two

APS therapy has been shown to have the following immediate physiological effects: removal of biochemical mediators of inflammation, reduction of pain due to release of leu-enkephalin, anti-anxiolytic effect due to melatonin release and improvement of circulation. Hence the use of dry needling in conjunction with APS Therapy is hypothesized to quicken recovery time, and reduce the painful needling experience and the post-needling soreness (Van Papendorp *et al.*, 2002).

1.2.3 Rationale three

Post-needling soreness may hinder patients from allowing practitioners to use needling as a modality. Investigating ways to reduce post-needling soreness is suggested for it to be used as a more comfortable modality for patients.

1.3 Aims and Objectives of the study

The aim of this study was to subjectively and objectively determine the relative effectiveness of combined dry-needling and Action Potential Simulation (APS) Therapy® versus dry needling alone on post-needling soreness of active trapezius myofascitis.

1.3.1 Objective one

To subjectively and objectively determine the level of post-needling soreness associated with dry-needling a trapezius muscle trigger point using the fanning technique.

1.3.2 Objective two

To subjectively and objectively determine the level of post-needling soreness associated with dry-needling a trapezius muscle trigger point using the fanning technique in combination with simultaneous APS Therapy.

1.3.3 Objective three

To subjectively and objectively determine the level of post injection soreness associated with dry-needling a trapezius trigger point using the fanning technique in combination with “Sham” APS Therapy.

1.4 The Hypotheses

1.4.1 The First Hypothesis

It is hypothesized that Group One will develop post-needling soreness to a greater degree than Groups Two and Three in symptomatic subjects in terms of subjective clinical findings.

1.4.2 The Second Hypothesis

It is hypothesized that Group Two will develop post-needling soreness to a lesser degree than Groups One and Three in symptomatic subjects in terms of objective clinical findings.

1.4.3 The Third Hypothesis

It is hypothesized that Group Three is equal to Groups One and Group Two with respect to the development of post-needling soreness in terms of subjective and objective clinical findings.

CHAPTER TWO

Literature Review

2.1 Introduction

Myofascial Pain Syndrome (MPS) was first recognised since the early 1950's, and though poorly understood, it was a common source of discomfort and disability for many patients (Fomby and Mellion, 1997). According to Parris, (2002), MPS is defined as chronic pain affecting the superficial regions of the musculoskeletal system. It may be localised and associated with focal pain, affecting a single muscle, or it may affect an entire regional muscle group within the musculoskeletal system (Alvarez and Rockwell, 2003). Furthermore the pain may be referred to distal body regions (Dommerholt *et al.*, 2006).

The presence of trigger points is usually associated with MPS (Travell *et al.*, 1999) (Parris, 2002). Although the trigger points are generally located within the regional part of the body affected, it is not unusual to find trigger points referred to other areas. Trigger points can arise in virtually in any muscle group, however the most common sites are the muscles involved in posture: Levator scapulae, upper trapezius, sternocleidomastoid, scalenes, and quadratus lumborum muscles (Richards, 2006). They may also be found in ligaments, tendons, joint capsule, skin and the periosteum.

Trigger points can be active or latent depending on the clinical pattern and pain referral. Active myofascial trigger points are always tender, painful, and symptomatic. They refer pain at rest, and with muscular activity, and upon direct palpation. Palpation of the trigger point may cause a local or referred pain pattern or both (Rachlin, 2002). This referred pain pattern is characteristic of a trigger point, in that it differentiates a trigger point from a tender point, which is associated with pain at the site of palpation (Alvarez and Rockwell, 2002). It is similar to the patient's pain

complaint and is felt remote from the trigger point origin. Patients describe the pain as spreading or radiating. Hong *et al.*, (1997), found that the greater the intensity of pain of an active trigger point, the greater the occurrence of the referred pain.

In comparison, latent myofascial trigger points remain non-painful and only refer pain when steady direct pressure is applied (Richards, 2006). It is often found coincidentally upon palpation, and may restrict movement or cause muscle weakness. Latent trigger points may predispose to active trigger points if the muscle is stressed by tension, mechanical overloading, or prolonged muscle shortening (Wreje and Brorsson, 1995). They may also demonstrate a local twitch response and show a lowered pressure pain threshold.

Myofascial trigger points (TrPs) are hypersensitive palpable bands, which are painful on compression. This hypersensitivity decreases as the band is palpated further away from the trigger point (Fricton *et al.*, 1985). This compression may give rise to characteristic patterns of referred pain, tenderness, autonomic nervous system symptoms and restricted range of motion (Richards, 2006). The distal area of referred pain is called the zone of reference, which does not follow any dermatomal or myotomal patterns (Fricton *et al.*, 1985).

Trigger points are described as small circumscribed hyperirritable foci in muscles and fascia, often found within a taut band of skeletal muscle. These taut bands of muscle fibres are “ropy” in feel and are tender to the touch. They create a local twitch response which is an involuntary shortening of the fibrous muscle band when palpated (Fomby and Mellion, 1997). This burst of activity is not seen in the other muscle bands that do not contain the active trigger point. Data from several experiments indicate that this local twitch response is a spinal reflex (Rivner, 2001).

2.2 Incidence and prevalence of Myofascial Pain Syndrome

Myofascial pain is commonly encountered in the outpatient setting. It still remains one of the most predominant soft tissue syndromes seen in clinical practice and there is constant interest towards its management within the Chiropractic profession (Schneider, 1995) (Auleciems, 1995) (Esenyel *et al.*, 2000). It has been estimated that some 44 million Americans have myofascial pain problems (Wheeler, 2004). Unfortunately specific figures regarding the incidence and prevalence of MPS in South Africa are not yet known (Ferreira, 2006).

The recent studies that have investigated the incidence and prevalence of myofascial pain syndrome, indicating their study method, sex, age and regions are summarised in the table below.

Authors	Study Method	Incidence/ Prevalence	Male/ Female	Age	Regions
Audette <i>et al.</i> , 2004	Prospective, controlled study; 13 subjects; 8 controls.	61.5% on contralateral side of the active MTP group.		Inclusion criteria: 18- 75 yrs.	Trapezius muscle and Levator scapulae muscles.
Han and Harrison, 1997	Epidemiologic study.	30% woman (20-40yrs) suffered; 6% with severe symptoms. Highest prevalence: 30-49 yrs; decreased with age.	found in both sexes; appear higher in woman		
Fomby <i>et al.</i> , 1997		31% had acute trigger points	Described in all age groups and in both sexes	Occurs between 30-60 yrs; prevalence declines with age.	
Friction, 1985		MPS diagnosed in 164 of 296 pts (54, 4%); highest % of any diagnosis.	29 (12.7%) were male; 135 (82.3%) were female.	Inclusion criteria: 17 to 89 yrs; Mean duration of pain: 5.8 yrs for males and 6.9 yrs for females.	TMJ internal derangement with capsulities.
Simons, 1996	200 asymptomatic Air Force recruits (100 male and 100 female examined.)	5% of these subjects referred pain	Latent trigger points in 54% of woman and 45% of the men.	Mean age was 19.5 yrs.	Shoulder-girdle muscles
Bennett, 2007	A study from the internal medicine group practice	30% of patients with active MTP.			Head and neck pain
Schiffman <i>et al.</i> , 1990	269 unselected female student nurses	TP's active because 28% of subjects had pain in their temple area.	Student nurses		Jaw muscles: TP's in Rt lat. pterygoid; dp masseter; ant. temporalis; med. Pterygoid Neck muscles: TP's found in Rt spl. capitus and upper trapezius.

Yrs = years; % = percentage; pts = patients; TMJ= temporomandibular joint; MTP = myofascial trigger point; TP'S = trigger points; Rt = right; Ant = anterior; Dp. = deep; med. = medial; lat. = lateral; spl. = splenius

A study from an internal-medicine group-practice found that 30% of patients with pain complaints had active myofascial trigger points (Skootsky *et al.*, 1989). A report from a clinic specialising in head and neck pain reported myofascial aetiology in 55 % of cases (Fricton *et al.*, 1985). Patients evaluated in one pain management centre were found to have myofascial component to their pain in 95% of cases (Gerwin, 1995). The incidence of trigger points are clearly found in both sexes, although they appear higher in women (Han and Harrison, 1997). Thirty percent of women between the ages 20-40 years old appeared to have suffered from myofascial trigger points according to a study by Fricton *et al.*, (1985). Patients between the ages of 30-49 years old appeared to have the highest prevalence of trigger points, which decreased with age, as did muscle stress and activity (Fricton *et al.*, 1985).

2.3 Pathophysiology of myofascial trigger points

Trigger points may arise from multiple causes and may occur in any skeletal muscle. They occur most frequently in muscles of the axial skeleton which are required to maintain posture. This is due to the constant tension and microtrauma to the muscle (e.g. sustained muscle contraction due to tension and poor posture (Rachlin, 2002).

Predisposing factors to microtrauma include mechanical stress, such as prolonged poor posture, lack of exercise, nutritional imbalance (especially vitamin deficiencies), sleep disturbances, and joint problems (Han and Harrison, 1997). Other stresses include: allergies, radiculopathy, psychological factors, chronic infection and chronic visceral disease (Richards, 2006). These initiating events may in turn disturb the weakened muscle through muscle injury or sustained muscle contraction (Fricton *et al.*, 1985). It is therefore necessary to interview and physically examine the patient to detect perpetuating factors.

The development of a trigger point is hypothesized to be a progressive process (Han and Harrison, 1997). The stress occurring from acute injury or repetitive microtrauma results in the disruption of the sarcoplasmic reticulum in the muscle fibre (Han and

Harrison, 1997). The proposed hypotheses have included the energy crises theory; the muscle spindle concept; and the motor endplate hypothesis (Simons, 1996) (Huguenin, 2004).

The energy crises theory postulates an initial release of calcium through the injured sarcolemma as a result of the increased demand of the muscle (Bennett, 1990) (Huguenin, 2004). This calcium causes, not only sustained sarcomere shortening, which in turn compromises local circulation, but also results in increased metabolism. Oxygen is therefore reduced as a result of the compromised circulation leaving the cells unable to produce enough ATP to initiate relaxation. According to Simons (1996) ischemic by-products of metabolism accumulate, being partly responsible for some of the pain being produced. This occurs by the process of sensitisation and direct stimulation of the sensory nerves. Adenosine triphosphate, phosphocreatine, and Adenosine diphosphate are phosphate containing compounds used to measure the muscle energy stores. They are capable of donating their phosphate group and releasing energy for muscle activity. In a study by Bengtsson *et al* (1986), it was found that high energy phosphate levels were reduced and low energy phosphate levels were raised at the trigger point sites, therefore supporting the idea of metabolic derangement at trigger point sites.

In the muscle spindle concept, a high electrical activity characteristic of myofascial trigger points was reported. This source of this activity was proposed to be a dysfunctional muscle spindle (Hubbard and Berkoff, 1993). It was later realised that these potentials could not have arisen from the motor endplates. This is due to the fact that the activity is not localised enough to be generated in the endplate and by the fact that it does not have the expected waveform morphology or location (Simons, 1996).

The motor endplate hypothesis could co-exist with the energy crises theory (Huguenin, 2004), and is considered to be the major cause of myofascial trigger points. It is identified to be the dysfunction in the region of extrafusal motor endplates,

where the motor nerve synapses to it. According to Hubbard and Berkhoff (1993), needle electromyography (EMG) studies revealed that each of these trigger points contained minute loci produced characteristic electrical activity, and were located at the motor endplate zone (Simons, 2001; Simons *et al.*, 2002). The increased rate of acetylcholine (ACh) release from the nerve terminal was thought to represent the endplate noise (Huguenin, 2004). Simons (1996) concluded that this small amount of activity at the motor endplate is not sufficient to cause muscle contraction, but could result in action potentials being propagated a small distance along the muscle cell membrane. This however, could activate a few of the contractile elements cause a degree of muscle shortening (Huguenin, 2004).

Travell and Simons (1999) proposed the 'integrated hypothesis', as the aetiology of myofascial trigger points, which incorporates local muscle tissues, the central nervous system, and biochemical factors that could account for the clinical characteristics of myofascial trigger points. This hypothesis expands on the previously proposed hypotheses (Richards, 2006).

According to Gerwin *et al.*, (2004) and Partland, (2004), the 'integrated hypothesis' considers that acute or repeated muscle overloads were events that activated myofascial trigger points. These focal areas of muscle injury and ischemia resulted in low tissue pH and hypoxia thereby inducing histochemical changes. This in turn facilitated the release of resting acetylcholine (ACh) at the myoneural junction, inhibiting ACh breakdown, as well as the removal of Ach from its receptor site (Partland, 2004). Local muscle contracture is then induced as a result, characteristic of myofascial trigger points. Normally, ACh is released into the synaptic cleft by the nerve terminal, at various rates, and in large quantities in response to the motor nerve action potential originating in the motor neuron. Acetylcholine esterase (AChE) limits Ach passage to the acetylcholine receptors (AChR) in the postjunctional membrane of the muscle cell within the synaptic cleft. This in turn also helps to inactivate the ACh receptor (Richards, 2006).

In the region of the active endplates, this acidic environment inhibits the functions of the esterase (Shah *et al.*, 2003). Activation of ACh receptors at the postjunctional membrane by spontaneous ACh release induces an action potential that results in a muscle contraction (twitch). A key feature of this hypothesis is the endplate noise which is produced as well as the occasional threshold responses which is identified as spontaneous endplate spikes. The release of adenosine triphosphate (ATP), substance P (SP), calcitonin gene related peptide (CGRP), bradykinin, cytokines, and other substances are all induced by initial injury-induced muscle fiber ischemic hypoxia and tissue acidity, which sensitizes and activates muscle nociceptors (Mense and Simons, 2001) (Shah *et al.*, 2003). These substances caused local oedema and pain, producing central neuroplastic changes that lead to allodynia, hyperalgesia, and enlargement of the pool of activated dorsal-horn nociceptive neurons (Mense and Simons, 2001).

If the muscle spasm goes untreated, a vicious muscle pain-spasm cycle is initiated, causing decreased local blood flow to the muscle, owing to a lack of ATP and an overflow of free calcium. This release of free calcium within the muscle is caused as a result of disruption of the sarcoplasmic reticulum due to microtrauma or stresses. The effectiveness of the calcium pump is thus minimized, which is highly dependent on the availability of ATP (Han and Harrison, 1997). Several necessary nutrients responsible for the relaxation of the muscle fibres are also impaired (Richards, 2006). The interaction of free calcium, ATP stimulates actin and myosin interaction and local contractile and metabolic activity thus perpetuating the pain- spasm cycle (Fricton *et al.*, 1985). Eventually localised fibrosis results due to the sustained noxious metabolite build up in the connective tissue. This fibrotic tissue in turns stimulates more motor unit firing, and therefore causes pain, leading back to the muscle spasm cycle (Wheeler, 2004).

Metabolites such as serotonin, histamine, kinins and prostaglandins thus accumulates and sensitizes of these nerve endings, which may be primarily responsible for local twitch response and jump signs. The local muscle acidity

increases and stimulates the firing of muscle nociceptors (i.e. group III and group IV nerve endings), causing apparent local and referred pain (Han and Harrison, 1997). By addressing the cause of the predisposing factors, and by restoring the muscle fibres to its original state, this vicious cycle can be broken (Simons, 1996).

2.3.1 Pain referral from trigger points:

According to Huguenin, 2004, the convergence projection theory is used to explain the phenomenon of referred pain. It postulates that previously dormant spinal cord connections are unmasked in response to a painful stimulus, and that not all convergent connections are active all the time (Hong, 1996) (Mense, 1996). Not only is it strongly agreed that the phenomenon of referred muscle pain has a central basis, but that each dorsal horn neurone in its resting state has a receptive field in the body from which it receives noxious input (Huguenin, 2004). Mense, (1996) found that neurons perceived noxious input as coming from more than one source and resulted in pain referral being experienced. As a result of increased spinal cord levels of substance P and CGRP, Hong, 1996 showed that this referral crossed to different spinal cord levels. It is therefore, according to Huguenin, 2004, who theorised that increased release of substance P and CGRP in the dorsal horn in response to a noxious stimulus diffuses around several levels of the spinal cord. This in turn, resulted in the increased sensitivity of those areas to noxious input. The two transmitter levels have been found to be independent, however their source, either being local neurons or released from higher centres is still yet to be determined (Huguenin, 2004). What was previously a harmless stimulus may now be perceived as pain, which may be perceived at a seemingly unrelated anatomical site (Bendtsen *et al.*, 1996).

In muscle pain, muscle spasm may occur which relates to a connection between dorsal horn neurons in the spinal cord and gamma afferent neurons (Huguenin, 2004). Muscle spindles are supplied by gamma afferent neurons, and are responsible

for reflex muscle shortening. The discharge from gamma afferents is indirectly inhibited by the inhibition of dorsal horn neurons (McNulty *et al.*, 1994).

2.4 Management of Myofascial Pain Syndrome

Many modalities are used in the treatment of myofascial pain syndrome, and often when effectively managed it has an excellent prognosis. Although it is not completely curable, it is controllable, requiring long-term management and lifestyle changes to help prevent recurrences (Auleciems, 1995). A multidisciplinary approach to treatment is important and must be directed first toward diagnosing and eliminating perpetuating factors (Bruce, 1995). According to Han and Harrison (1997), the treatment of myofascial pain syndrome must take into account physiologic and psychosocial stresses that are often involved in the development and progression of the condition.

Treatment of MPS appears to be aimed at disrupting the reverberating neural circuits responsible for the self-perpetuating of the pain- spasm pain cycle (Hong, 2002). This occurs as a result of inactivating the active trigger points by releasing the taut bands. Several interventions are used for the treatment of MPS, which is divided into invasive and non-invasive techniques. Non-invasive techniques are traditionally employed by physical and manual therapists. More recently a marked increase in invasive techniques such as dry needling has been used to manage trigger points. Some of the non-invasive techniques include massage, ischemic compression, spray and stretch (MacDougall, 1999), Therapeutic ultrasound (Pillay, 2003), action potential therapy and TENS (Rowley, 2001, Cumming, 2003, Wilks, 2003). The invasive techniques include dry needling and trigger point injection (with anaesthetic and other medication). Of these modalities dry needling appears to be the most effective (Alvarez and Rockwell, 2002, Bennet, 2007) for their direct inactivation.

2.4.1 Non-invasive techniques

Ischemic compression is a technique that was developed by Travell (Travell *et al.*, 1999), and is shown to be the most used form of manual therapy. According to Auleciems (1995), by applying firm, direct pressure to the centre of the trigger point, it has been shown to mechanically break up the fibrous bands of the trigger point. This in turn results in the reduction of the muscle spasm and deactivation of the trigger point (Gatterman, 1990). The application deep pressure produces local ischemia, and when pressure is released, a reactive hyperemia results which improves circulation to the effected area.

Stretching after the application of a vapocoolant spray is reported to be the single most effective treatment for trigger point pain (Travell *et al.*, 1999). This technique has been described as the most common form of treatment. A vapour coolant agent, such a flouoromethane is applied in parallel sweeps on the skin surface overlying the effected muscle, which is held in passive stretch. The aim of the treatment is to decrease the pain sensitivity, restore the muscle to its full normal length thereby improving the range of motion. In a study done by Jaeger and Reeves (1986), revealed a significant reduction in both pain pressure threshold and reported pain after the use of this intervention. There was no correlation between the improvements in these two parameters (Huguenin, 2004). From the results, it was impossible to conclude if spray or stretch in isolation would have the same effects.

A variety of electrotherapeutic modalities have been used in the treatment of myofascial pain syndrome. Some of these include: ultrasound therapy (Gam *et al.*, 1998), action potential therapy (Berger, 1999) and transcutaneous electrical stimulation (TENS) (Esenyel *et al.*, 2000).

Ultrasound therapy involves the reverse piezoelectric effect, which generates the use of high- frequency acoustic energy (Esenyel *et al.*, 2000). This form of treatment can be used to treat acute and chronic musculoskeletal disorders (Gam *et al.*, 1998). The

interaction of ultrasound with tissue results in the biophysical effects which are grouped into two categories by McDiarmed and Burns, (1987). Their effects on tissue are differentiated from one another, due to the continuous and pulsed waveforms respectively.

- **Thermal**—the ability of therapeutic ultrasound elevates the tissue temperature, thereby producing the following therapeutic effects (Lehman and Guy, 1972): The increased extensibility of collagen- rich structures, such a tendons and joint capsules; decrease in joint stiffness; reduction in muscle pain and spasm; production of a mild inflammatory reaction, inducing a marked increase in blood flow, which helps in the resolution of chronic inflammatory processes.
- **Non-thermal**—these effects are attributed to any mechanics other than an increase in tissue temperature. According to Hogan *et al.*, (1982), some of these effects include: Stimulation of tissue regeneration; improves blood flow in chronically ischaemic tissue; stimulation of protein synthesis and soft tissue repair.

Gam *et al.*, (1998) used therapeutic ultrasound in a three- armed trial with subjects randomised to receive ultrasound with home exercise and massage, ‘Sham’ ultrasound with home exercise and massage or a non- intervention control group. Both intervention groups displayed significant improvements in the number and sensitivity of trigger points. Ultrasound however had shown to have no additional advantage.

Transcutaneous Electrical Nerve Stimulation (TENS) is a form of therapy designed to block the pain pathway along the ascending neural tracts as well as to stimulate the large, low threshold sensory nerve fibres (Berger, 1999). TENS produces a balanced biphasic pulse, which inhibits cells responsible for transmitting injury signals. Hence TENS suppresses pain by means of the gate control theory (Berger, 1999) (Melzack and Wall, 1998). It is often used for chronic pain, and at different frequencies and intensities for pain relief (Huguenin, 2004). In a study investigating the use of 100 Hz,

2 Hz and control TENS on subjects with trigger point related chronic pain in the thoracic, neck, or head region (Graff-Redford *et al.*, 1989). The results revealed that low frequency and control TENS had no effect on pain, whereas the high frequency resulted in significant pain relief.

2.4.2 Invasive techniques

Trigger point injection and dry needling

There are two forms of injections into a trigger point, one being dry needling and the other a solution of either local anaesthetic saline (Travell and Simons, 1983). Both are considered safe and more comfortable than what for the patient (Richards, 2006). However, its effectiveness is to an extent dependent upon the ability to accurately palpate the trigger point (Dommerholt *et al.*, 2006).

Esenyel (2000) stated that trigger point injections have been widely used in the management of myofascial trigger points. According to Han and Harrison (1997), it is a technique sometimes preferred to dry needling due to the analgesic effects that local anesthetic agents, such as lidocaine, offer to the surrounding tissue. The proposed mechanisms through which injections inactivate trigger points are as follows (Han and Harrison, 1997):

- The muscle fibres and nerve endings are mechanically disrupted due to the needle.
- Increased levels of extracellular potassium, that in turn leads to the depolarisation of nerve fibres, as a result of the mechanical disruption of the muscle fibres.
- Through the use of hyperstimulation analgesia, the positive feedback mechanism that perpetuates pain (which is the pain-spasm-pain cycle) is interrupted (Gatterman, 1990). Hyperstimulation analgesia is a process, produced by stimulating the myofascial trigger points e.g. by using an

acupuncture needle. A brief painful stimulus occurs which relieves chronic pain. This is achieved by "closing the gate" by means of a central mechanism located in the brainstem reticular formation. For a prolonged relief of pain to occur, disruption of reverberatory neural circuits responsible for the pain memory is required (Melzack and Wall, 1988).

- Injection of local anaesthetics or saline solutions results in the dilution of nociceptive substances.
- Removal of metabolites occurs as a result of the local vasodilation when local anaesthetics are injected.

Clinicians are often faced with a dilemma when deciding on the best treatment for their patients, as each of these therapies require different level of skill and training (Esenyel *et al.*, 2000).

2.4.3 Mechanisms of Trigger point Dry-Needling

Trigger point dry needling is an invasive procedure in which an acupuncture needle is inserted into the most painful site of the trigger point (Lewit, 1979, Dommerholt *et al.*, 2006). Agitation of the trigger point is when the needle is then repeatedly inserted into the trigger point from different angles whilst maintaining the original source of entry into the skin (Travell *et al.*, 1999).

Dry needling has been extensively studied and has been shown to decrease or even abolish MPS if local twitch responses are elicited during needling (Chen *et al.*, 2001). The efficacy of this form of treatment has been found to be related to the intensity of pain produced at the trigger point zone and the precision in needling the exact site of maximal tenderness (Hong, 1994). This effect appears to be mediated by the input into the central nervous system during needle stimulation (Hong, 1994), resulting in hyperstimulation analgesia (Baldry, 1998). Repeated needling, however, during the regeneration phase in the same area of a muscle could exhaust the regenerative capacity of muscle tissue. This could result in an increase in connective tissue and

thus impair the re-innervations process (Reznik, 1973). Dry needling also inhibits nociception and provides pain relief by spinal cord pathway modulation, generalised neurohumoral stimulation and release of endorphins (Yap, 2007).

Lewit (1979) found that dry needling of myofascial trigger points caused immediate analgesia in nearly 87% of patients. In over 31% of cases, the analgesia of patients was permanent, while 20% had several months of pain relief, 22% several weeks, and 11% several days; 14% had no pain relief at all.

In a prospective, randomized, double blind study by Han and Harrison (1997), dry-needling of the lower back region resulted in a 63% improvement rate as opposed to the local anesthetic injectables, which only had a 42% improvement rate.

Many mechanisms have been postulated by which dry-needling maybe effective in deactivation of trigger points (Hong, 1994, Travell *et al.*, 1999). The proposed mechanisms are as follows:

1. Mechanical disruption of the taut palpable band in the muscle, which then desensitises the local nerve endings and also causes the release of increased levels of extracellular potassium, which leads to the depolarisation of nerve fibres (Han and Harrison, 1997).
2. Dry needling utilises hyperstimulation analgesia to interrupt the positive feedback mechanism that perpetuates pain (the pain-spasm-pain cycle) (Gatterman, 1990).
3. Dry-needling damages or even destroys motor endplates and causes distal axon denervations when the needle hits a trigger point (Travell *et al.*, 1999). This in turn triggers changes in the endplate cholinesterase and Ach receptors as part of the normal muscle regeneration process (Gaspersic *et al.*, 2001).

The acupuncture needles used in dry-needling cause very small focal lesions, without the risk of scar tissue formation, since they have a diameter of approximately 160-

300µm. In comparison, muscle fibre diameter ranges from 10-100µm (Dommerholt *et al.*, 2006). When muscle is damaged, satellite cells are activated from other areas in the muscle to repair or replace damaged myofibres in the process of muscle regeneration (Schultz *et al.*, 1985). This process is expected to be complete in approximately 7-10 days (Schultz *et al.*, 1985). Baldry (2005) recommended leaving the needle *in situ* for 30-60 seconds; however in some patients it may be left up to 2-3 minutes.

A localised stretch to the contractured cytoskeletal structures could occur with an accurately placed needle. This in turn reduces the degree of overlap between actin and myosin filaments, allowing the involved sarcomeres to resume their resting length (Dommerholt, 2004).

The phenomenon of the “needle grasp” is a recently described finding by Langevin *et al* (2002). Muscle fibres contract firmly around the acupuncture needle, holding it tightly in place. The inserted needle experiences increased pulling and resistance to further movement. This “grasp” is a result of the subcutaneous tissue and not due to the muscle contractions. Rotation of the needle increased the force on the needle and caused measurable changes of the connective tissue and fibroblasts architecture, leading to a variety of cellular and extracellular events. It was thus concluded that it is more beneficial and effective to rotate the needle when needling superficial muscle as oppose to the deeper muscles due to the fact of the role played by the connective tissue.

2.4.3.1 Local twitch response

Local twitch response (LTR) is a rapid, contractile motor effect elicited by ‘snapping palpation’ of the taut band at the location of the trigger point (Hong, 1994). Studies performed by Hong (1994) and other researchers on rabbits and humans showed that the local twitch responses appears to be a spinal reflex that is not dependent on higher centres (Rachlin, 2002).

When the associated muscle fibres are stimulated with the needle, a burst of electrical electromyographic (EMG) activity was found only within the associated muscle fibres. The adjacent fibres were not effected (Hong, 1994, Bennet, 2007). This local twitch response depends largely upon a central pathway, and to some degree a local pathway (Hong, 1994). Studies performed by Hong and Simons (1993), confirmed that failure of elicitation of a local twitch response resulted in patients' failure to experience immediate and complete pain relief.

In the treatment of myofascial trigger points, the best results were obtained when a local twitch response was elicited when using dry needling or the injection method (Hong, 1994, Simons 1996). Transection of the spinal nerve that innervates the trigger point results in the abolishment of the twitch response (Bennet, 2007).

In an experiment conducted by Chen *et al.*, (2001), it was found that spontaneous electrical activity (SEA) was recorded from an active locus in the region of the myofascial trigger point and has been used to assess the myofascial trigger point sensitivity. It was concluded that if local twitch responses are elicited then dry needling of the myofascial trigger points is effective in diminishing SEA. The elicitation of local twitch responses, other than trauma effects of needling, seems to be the primary inhibitory factor on SEA during dry needling (Chen *et al.*, 2001).

Shah *et al.*, (2005) conducted a study in which the *in vitro* biochemical environment within normal muscle and the active and latent myofascial trigger points in near real time at the sub-nanogram level of concentration was sampled and measured. Significant increased concentrations of bradykin, calcitonin-gene-related-peptide, substance P, tumour necrosis factor-, interleukin-1, serotonin, and norepinephrine in the immediate environment of active myofascial trigger points were found (Shah *et al.*, 2005). Results of this research concluded that both the chemical concentrations in the trigger point vicinity spontaneously and several nociceptive substances were reduced to normal levels when a local twitch response was elicited. Thus an association between a highly significant objective nociceptive environment difference

and the active and latent myofascial trigger points clinical distinction was also confirmed (Shah *et al.*, 2005).

2.4.3.2 Post-needling soreness

Both the single insertion dry-needling and fanning insertion dry-needling techniques showed to be equally effective in the treatment of myofascial trigger points, with resultant post-needling soreness (Rowley, 2001). Travell *et al.*, (1999) however noted that post-needling soreness is more severe if haemorrhaging occurs whilst needling of the trigger point. Since, the fanning method was shown to cause excessive microtrauma in the area relative to single insertion method, as a result of more needle insertions occurring to inactivate the trigger point. This method not only has a higher incidence of penetrating the blood vessel as result of the number of insertions but also has more of chance to accurately elicit the local twitch response.

This is further demonstrated in many studies, whereby a correlation between post-needling soreness to amount of swelling or haemorrhage at the injection site (Travell *et al.*, 1999). Lewit (1979) also concluded that post-needling soreness developed when a trigger point was not precisely needled.

A study conducted by Hong (1994), comparing the effects of dry needling versus local anaesthetic injection into the trigger point concluded that both groups had a significant improvement after the treatment. All the patients in that study suffered from post- needling soreness after being treated by dry-needling, however nearly 50% of patients developed the post-needling soreness with local anaesthetic. Also the post-needling soreness who were treated with dry-needling was of greater intensity and longer duration than those patients treated with local anaesthetic injection (Hong, 1994, Alvarez and Rockwell, 2002).

2.5 Action Potential Simulation Therapy

In 1992, Mr A. Lubbe, a technician employed by parastatal telecommunications company in South Africa initiated the concept of Action Potential Simulation current therapy (Berger, 1999). After reading in a medical journal and realising that if it were possible to simulate and apply a current that was similar to the body's normal nerve impulses, that this pain could be eased. This is due to the fact that the body's natural nerve impulses are restricted or diminished by accumulated waste products. The original prototype of the Action Potential Current (APS) unit was tested at various universities in South Africa with promising results.

2.5.1 Action Potential

A nerve impulse is a transmitted action potential, in a neuron. These neurons communicate by means of generating and propagating action potentials, which travels along the fibre until it comes to the end (Guyton and Wall, 1996). Action Potential is divided into 3 successive stages, these include:

Resting Stage: This stage occurs before the action potential. Because of the large negative membrane potential present at this stage, the membrane is said to be "polarized".

Depolarization Stage: At this stage, the membrane suddenly becomes permeable to sodium ions, allowing an influx of positively charged sodium ions into the axon's interior. At this point, depolarization occurs, whereby the potential rises in a positive direction and the normal "polarized" state of -90mV is lost. The membrane potential may "overshoot" beyond the zero level, becoming positive in large nerve fibers, whereas in the smaller fibers this is not the case.

Repolarization Stage: After the membrane becomes permeable to sodium ions (normally within 10, 000ths of a second), these channels begin to close whilst the

potassium channels open quicker than normal. Potassium ions thus rapidly diffuse to the exterior for a normal negative resting membrane potential to be established.

2.5.2 Action Potential Current Therapy

According to Odendaal (1999), Action Potential Simulation Therapy is a low frequency direct current that stimulates or mimics the physiological action potential of nerve conduction. It is applied via electrodes, with the red electrodes applied directly adjunct to the affected area and the black electrodes slightly distal to it.

The current produced by the APS unit is a combination of direct and alternation current which cannot be compared to any other waveforms. It has mono-phasic square pulse with exponential decay wave type and a pulse rate of 150Hz, which is a low to medium frequency (van Papendorp *et al.*, 2002). Positive clinical effects reported to have occurred at this frequency include: alleviation of pain, decreased inflammation, wound and bone fracture healing, enhanced blood circulation, as well as various other conditions (Berger, 1999, Seegers *et al.*, 2001).

Activation of the processes underlying the functions in the human body takes place at a cellular level. Both the nervous and hormonal system are important communication system which affects this cellular function (Seegers *et al.*, 2001). Cells have a potential current that allows them to communicate with each other by means of electro-magnetic signalling, which remains ordered and regulated during optimum functioning. However, during times of injury, injured cells disrupt the current flow between cells; this negatively affects the normal healing processes (Seegers *et al.*, 2001).

When a muscle experiences trauma it goes into spasm to protect itself. This decreases the blood supply thereby reducing the amount of oxygen and nutrients that reach it. This causes an accumulation of waste products which leads to pain (Fengler *et al.*, 2007).

The injured site has a much higher electrical resistance than that of the surrounding tissue. As electricity flows towards the path of least resistance, the body's own action potential nerve impulse avoids the area of high resistance and takes the easiest path, generally around the injury. The decreased electrical flow through the injured area impairs healing.

The application of APS to an injured site increases the current flow (Odendaal, 2001). This enables damaged tissue to heal by reducing the resistance of the injured tissue, allowing bioelectricity to enter the area to re-establish homeostasis.

APS simulates the body's natural nerve impulses (action potential) and helps the body decrease pain and repair tissue damage. It does this in the following way (Odendaal and Joubert, 1999, Berger, 1999):

1. Pain relief, due to an increase in plasma B-endorphin and leucine enkephalin concentrations as well as the normalisation of plasma serotonin-concentration.
2. Control of the emotional aspects of pain, due to the normalisation of plasma serotonin concentrations and increase in the Melatonin levels.
3. Breakdown of inflammation, due to an increase in plasma B-endorphin and plasma leucine enkephalin concentrations.
4. Limitation of tissue damage, by limiting inflammation. Due to an increase in plasma leucine enkephalin concentration.
5. Increases local blood circulation, due to local vasodilatation, blood circulation is increased, enabling antibodies, hormone, enzymes etc. to reach the effected area much faster, to speed up to the healing process.
6. Increases in mobility, by reducing the inflammatory swelling. This positively affects lymph drainage in the affected limbs.

APS microcurrent replenishes adenosine 5' -triphosphate (ATP), thus allowing nutrients to flow into injured cells and waste products to flow out, a process which is important for the development of healthy tissues (Odendaal, 2001). At a cellular level, whereby signal- transduction mechanisms takes place, ATP is necessary for the

phosphorylation of target proteins and for the removal of cations from the cells after the influx through electrically opened channels (Seegers *et al.*, 2001). Thus APS stimulates cytoplasmic ATP production as well as the release of ATP from the stimulated cell. This ATP release causes a decrease in the healing time.

The Gate control theory of Melzack and Wall (1988) established the fact that the body produces endogenous opiates. Part of the Gate Control Theory suggest that dry needling causes excitation of the thick diameter nerve fibres that results in inhibition of impulses due to noxious stimulation being carried in the thin c- fibres. This explains the quick action to produce analgesia.

2.6 Trapezius Muscle Overview

According to Travell *et al.*, (1999), trigger points appears to be most frequently cited in the trapezius muscle in clinical settings even though they can arise in any muscle group.

The trapezius muscle is a large, flat, triangular muscle which covering the posterior aspect of the neck and trunk. It is divided into upper, middle and lower fibres which function independently. This diamond shaped muscle consists of paired trapezii, which extends in the midline from the occiput above to the T12 below. It extends anteriorly to lateral one-third of the clavical; laterally to the acromion, and posteriorly throughout the length of the scapula spine (Travell *et al.*, 1999) (Sciotti *et al.*, 2001).

The upper fibres of the trapezius muscle have been reported to be commonly affected by myofascial trigger points (Bruce, 1995). Information regarding these fibres is discussed according to the innervation, trigger point location, pain referral patterns and function (Travell *et al.*, 1999) (Sciotti *et al.*, 2001).

- **Innervation-** this muscle is innervated by the spinal part of the accessory nerve (cranial nerve XI), supplying mainly the motor fibres. The sensory fibres of the muscle are supplied by the second to fourth cervical nerves.

- **Trigger point location-** Tp1 is found in the midportion of the anterior border of the upper trapezius and involves the most vertical fibres that attach anteriorly to the clavicle. Tp2 is caudal and slightly lateral to Tp1. It is located in the middle of the more nearly- horizontal fibres of the upper trapezius muscle.
- **Pain referral patterns-** Tp1: Pain is referred unilaterally along the posterolateral aspect of the neck to the mastoid process. This point can be a major source of tension headaches and temporal headaches. When the pain is intense it can be referred up the head centering in the temple and orbital region. This may include the angle of the jaw. It can also produce symptoms of vertigo and dizziness. Tp2: Pain is experienced posterior to the cervical referred pattern of Tp1.
- **Function-** the upper trapezius draws the clavicle (and indirectly the scapula) backwards and raises them by rotating the clavicle at the sternoclavicular joint. This portion of the muscle also complements the serratus anterior in rotation of the scapula so that the glenoid fossa faces upwards.

2.7 Conclusion

Myofascial Pain Syndrome is a common disorder that affects many people; it is caused by myofascial trigger points located within taut bands of skeletal muscle fibres. Dry needling appears to be the most effective way of inactivating myofascial trigger points; however the development of post-needling soreness has been reported to be a hindrance to the use of this modality.

To date very little research has been done to investigate techniques of reducing post-needle soreness which occurs as a result of accumulation of biochemical waste from uric acid, inflammation and excess fluid that APS has been shown to physiologically remove.

It is therefore the aim of this study to combine the use of APS in conjunction with dry needling of myofascial trigger points in order to determine the effect on the level of post-needling soreness.

CHAPTER THREE

Materials and Methods

3.1 Study design

This study was designed as a randomised controlled experimental investigation. Dry needling is very common and effective modality used in the chiropractic profession. However dry-needling has been known to result in post- needling soreness. In this study, dry-needling alone versus dry needling with simultaneous APS therapy of myofascial trigger points of the trapezius muscle (Tp2) in symptomatic patients was investigated to see if it reduced post- needling soreness. This study was approved by the ethics clearance committee (Appendix I).

3.2 Sampling

3.2.1 Subject recruitment

Subjects were recruited by means of convenience sampling. Advertisements were placed at the Chiropractic Day Clinic at the Durban University of Technology (D.U.T) and various other public venues e.g. pharmacies, shopping centres and gyms (Appendix E). The public were also informed by means of a leaflet drop (Appendix E). This study was conducted using symptomatic subjects and patients were only accepted if a positive diagnosis of Myofascial trigger points of the trapezius muscle (Tp2) were made by the researcher. In addition, all patients were only accepted into the study based on the inclusion and exclusion criteria (discussed later in this chapter).

3.2.2 Sample size and randomisation

A non-probability, convenience sampling technique with a sample size of 60 patients suffering from chronic Myofascial Pain Syndrome of the trapezius was used. A

computer generated randomisation table was used to allocate patients to the relevant groups i.e. 20 patients into 3 groups. According to the randomisation table Group One represented A, Group Two represented B and Group Three represented C.

Group One received dry needling using the fanning technique. Group Two received dry-needling using the fanning technique with simultaneous APS Therapy and Group Three received dry-needling using the fanning technique with simultaneous 'Sham' APS Therapy.

3.3 Clinical procedure

Volunteers presenting to the Chiropractic Day Clinic to participate in this study had the details of the study explained to them. Each participant received a copy of letter giving a brief description of the study (Letter of Information) (Appendix B). Once accepted into the study, the patient's details were recorded and were asked to sign the Consent Form (Appendix A).

At the initial consultation, at the Chiropractic Day Clinic, the prospective patients underwent a full case history (Appendix F), a revised physical exam (Appendix G) and upper back orthopaedic examination (Appendix H). The trapezius muscle was screened for Myofascial trigger points (Tp2).

3.3.1 Inclusion criteria:

- 1) Patients must have been between the ages of 18 and 45 years in order to be selected for this study.

- 2) Patients must have been suffering from Myofascial Pain Syndrome (MPS). Trigger points were diagnosed as follows: the patient identified the painful area. The examiner then manually palpated the area for local tenderness. Upon manual palpation of the tender area, the patient must of experienced

referred pain and a twitch response must be felt either by the patient or the examiner.

- 3) Patients were only accepted once they had read and signed the Informed Consent Form.
- 4) Patients were only accepted if they suffered from the chronic stage of MPS, i.e. from 6 to 8 weeks duration.

3.3.2 Exclusion criteria:

- 1) Patients with contra-indications to either dry needling or APS were excluded.
- 2) Contra-indications to dry needles include:
 - Patients suffering from systemic illness e.g. cancer and haemophilia, fever, anxiety, smokers and those under the influence of alcohol (Travell and Simons, 1999). Patients who were afraid of needling were also excluded.
- 3) Contra-indications to APS include: These were:
 - Patients with any electrical medical implants; those patients who suffered from epilepsy; those predisposed to thrombolytic episodes; over the abdominal area of pregnant woman; in the vicinity of a malignant tumour; directly over the eye; those who are on anticoagulant medication or who have allergies to any medications. Action Potential Therapy can, however be safely used on patients that have Harrington rods or other metal surgical rods.
- 4) All patients who were on analgesic or anticoagulant medication or patients who previously received treatment for Myofascial Pain Syndrome were excluded.

- 5) Patients diagnosed with Facet syndrome; CFS (Chronic Fatigue Syndrome); NRE (Nerve Root Entrapments) and frozen shoulder were not considered in this study.
- 6) Patients must not have been needled up to 72 hours prior to treatment (Travell *et al.*, 1999, Alvarez and Rockwell, 2002, Lewit, 1979).

3.4 Intervention

The patients who were interested in participating in the research had the research process explained to them, including the inclusion and exclusion criteria. The Informed Consent Form (Appendix A) was then read and signed by the participants. Patients accepted into the study underwent a full case history; physical examination and orthopaedic cervical regional examination, whereby the trapezius muscles (Tp2) was examined for myofascial trigger points.

The trigger points of the patient were assessed before the treatment, immediately after the treatment, and then again 24 hours after the treatment. The exact location of the insertion of the needle will be marked with Henna paint and the patient was instructed not to remove the marker until after the 24 hour assessment.

The exact nature of the measurements was as follows:

- 1) Subjective measurements were obtained via the numerical pain rating scale-101 (NRS-101) (Jensen *et al.*, 1986). This was obtained from the patient at the initial consult, immediately after the treatment, and then again 24 hours later following the treatment. As the exact point at which post-needling soreness presents following the treatment was not known, the patient was asked to complete the 24 hour diary (Ferreira, 2006), in order to monitor the post-needling soreness at 3 hour intervals.

- 2) Objective measurement included the use of the pressure algometer, which is a proven way of quantifying tenderness of soft tissue (Fischer, 1996).

A randomisation table was created whereby the 60 patients were divided into 3 equal groups i.e. Group One represented A, Group Two represented B and Group Three represented C, according to the table.

Group One received dry needling using fanning technique (Travell *et al.*, 1999).

Group Two received dry needling using the fanning technique (Travell *et al.*, 1999). In addition, two pairs of the APS electrode pads were placed on the skin surrounding the dry needle. Thus fanning took place simultaneous to the APS Therapy. The APS pads were left on for five minutes at a frequency of 1.2Hz.

Group Three received dry needling using the fanning technique (Travell *et al.*, 1999). In addition, two pairs of the APS electrode pads were placed on the skin surrounding the dry needle. However, the APS unit was turned off. Thus fanning took place simultaneous to the 'Sham' APS Therapy. The APS pads were kept on for 5 minutes as in group Two.

3.4.1 Area of intervention:

For all three groups the trigger points of the trapezius muscle (TP2) were needled (using the 0.25 X 25mm acupuncture needles). All subjects in all groups remained prone for the duration of the needling to ensure that they were blind regarding to APS used.

Trigger point 2 in the trapezius muscle is fairly superficial and easily accessible. Observing twitch responses during the needling intervention were thus possible. The twitch response during needling indicated accurate needling of the trigger point and not the surrounding tissue (Travell *et al.*, 1999, Alvarez and Rockwell, 2002).

3.4.2 Procedure for fanning:

In order to make this procedure consistent, the same fanning technique was used in all patients. This was achieved as follows. The needle was inserted and partially withdrawn a total of ten repetitions, within the time in which the APS was left on the patient. This ensured that each of the patients was needled to the same degree.

3.4.3 Needling precaution:

All acupuncture needles were used only once. The needles were opened in full view of the patients. The area needled was sterilised with an alcohol swab and a sterile piece of cotton wool was used with the removal of the needle from the skin. The used needle was then discarded into the sharps waste bin, once they were used. This was done in accordance with clinical procedure. The researcher wore surgical gloves at all times throughout the treatment.

3.5 Outcome Measurements

3.5.1 Subjective Data

3.5.1.1 Numerical Pain Rating Scale 101 (NRS 101):

The NRS-101 (Jensen *et al.*, 1986) involved asking the patient to rate his/ her pain intensity on a numerical scale from a score of 0 to 100, with 0 representing the patient experiencing no pain and 100 representing the patient experiencing the pain at its worst.

3.5.1.2 Pain Diary:

All subjects were required to complete a 24-hour diary, due to the uncertainty regarding to the onset of post- needling soreness following treatment. The pain diary was divided into three- hour periods, commencing straight after the treatment. The subjects were then required to indicate at which time (in hours), they experienced the most pain. They were also required to tick 'yes' or 'no' to whether or not they were experiencing pain at that point. At each of the 3 hour intervals, they were asked to rate pain on a scale of zero (0) to one hundred (100). A zero (0) would mean "no pain at all", and one hundred (100) would mean, "pain as bad as it could be".

3.5.2 Objective Data

3.5.2.1 Pressure Threshold Algometer (Fischer, 1996) :

Pressure algometer is a diagnostic tool used to identify the abnormal tenderness and to quantify the sensitivity of myofascial trigger points (Han and Harrison, 1997). This tool measures the subjects pressure pain threshold which is defined as the minimum pressure (force) that induces pain or discomfort (Fischer, 1996).

3.5.2.1.1 Reliability of pressure threshold measurement

According to Han and Harrison (1997), the pressure algometer appears to be a reliable diagnostic method to quantitatively document the sensitivity of trigger points. As a result of three studies done by Reeve *et al.*, 1986, he further demonstrated the reliability of the pressure threshold meter. From these studies he concluded:

- The high reliability between and within experimenters when measuring marked trigger point (TP) locations;
- Significance between experimenter reliability in locating and measuring the same unmarked trigger point locations was shown, and lastly;

- The idea that TP's are discrete points of focal tenderness within the muscle was supported (Reeve *et al.*, 1986).

3.5.2.1.2 Measurement of Pain Threshold (PTM)

The procedure as recommended by Fischer (1996) was as follows:

- The dial on the pressure gauge was zeroed (0).
- The 1 cm rubber disc of the pressure meter was placed perpendicular to the skin's surface on the point of maximal tenderness.
- The pressure of compression was increased at a rate of 1 kg/cm⁻²/sec.
- The patient was asked to indicate the point at which pain was first perceived by saying "yes". They were asked to remember this level of pain and to apply the same criterion for the next measurement (Hong *et al.*, 1993).
- The patient was asked to pinpoint the maximum pain area with one finger, which was then confirmed by palpation by the researcher.
- At this point the pressure was stopped and the reading was noted.

Three repetitive readings were taken, and an average of these readings was used for data analysis of pain threshold measurement. This was obtained from the patient at the initial consult, immediately after the treatment, and then again 24 hours later following the treatment.

3.6 Statistical procedures

SPSS version 15.0 (SPSS Inc., Chicago, Illinois, USA) was used to analyse the data. A p value of <0.05 was considered as statistically significant.

Demographics and baseline outcomes were compared between the three treatment groups using ANOVA testing with Bonferroni post hoc tests in the case of normally distributed quantitative variables, and Pearson's chi square test for categorical variables.

Repeated measure ANOVA tests were used to compare the outcomes over time between the three treatment groups, and between each combination of the two treatment groups. Time at which pain was more severe (ordinal variable) was compared between treatment groups using a non parametric Kruskal-wallis test. The change in the presence of pain over time was recorded as either 'no change', an increase in presence of pain (from no pain to pain) or a decrease (from pain to no pain). This was compared between treatment groups using the Pearson's chi square test.

Intra-group correlations between changes in outcome variables were achieved with Pearson's correlation coefficient.

3.7 Definitions of tests used

3.7.1. Analysis of variance (ANOVA): ANOVA determines an overall p value and not the differences between specific groups. This statistical technique is used for analysing data that tests for a difference between two or more means, by comparing the variances within and between groups (www.isixsigma.com, 2003).

3.7.2. Bonferroni multiple comparison post hoc test: The Bonferroni is the most commonly used post hoc test, because its highly flexible, simple to compute, and can be used with any type of statistical test. It is done following the ANOVA to determine if a statistically significant difference exists between specific groups. The Bonferroni adjustment is considered more accurate, even

though it is harder to achieve statistical significance with it (www.isixsigma.com, 2005).

3.7.3 Pearson's chi square tests: Pearson's correlation reflects the degree of linear relationship between two variables. Pearson's correlation coefficient for continuous data ranges from -1 to +1. Positive correlation indicates that both variables increase or decrease together, whereas negative correlation indicates that as one variable increases, so the other decreases, and vice versa (www.isixsigma.com, 2005).

3.7.4 Kruskal-Wallis Test: Kruskal-Wallis performs a hypothesis test of the equality of population medians for a one-way design (two or more populations). This test is a generalisation of the procedure used by the Mann-Whitney test and offers a non-parametric alternative to the one-way analysis of variance. This test looks for differences among the population medians (www.isixsigma.com, 2003).

3.8 Abbreviations

SD = Standard Deviation

df = Degrees of freedom

% = Percentage

CI = Confidence interval

N = Number

P = Probability value

Std = Standard

CHAPTER FOUR

Results

4.1 Demographics by group

Table 4.1: Mean and standard deviation for age of subjects

Group	Mean (Years)	N	Std. Deviation
Dry needling	28.20	20	8.740
Dry needling plus APS	21.30	20	4.624
Dry needling plus placebo APS	23.50	20	6.685
Total	<u>24.33</u>	<u>60</u>	<u>7.368</u>

Table 4.1 depicts that sixty participants were randomized into 3 equal groups (n=20). The mean age of the sample was 24.33 years (SD 7.368 years). It also reflects the mean age of each group. The mean age was highest in the dry needling group and lowest in the dry needling plus APS group. This was a random event as subjects were allocated to their groups according to the randomization process.

4.2 Demographics by gender

Table 4.2: Cross tabulation of gender by treatment group

		Gender		Total
		Male	Female	
Group	Dry needling	4(20%)	16(80%)	20(100%)
	Dry needling plus APS	3(15%)	17(85%)	20(100%)
	Dry needling plus placebo APS	8(40%)	12(60%)	20(100%)
Total		<u>15(25%)</u>	<u>45(75%)</u>	<u>60(100%)</u>

Pearson chi square 3.733, p=0.155

Table 4.2 reflects that there was no significance difference in gender distribution between the three treatment groups as p=0.155. There was a greater number of females (75%) in this study compared to the males (25%). This difference in proportions was not significant in the treatment groups (p=0.155).

4.3 Baseline outcomes

Table 4.3: Comparison of mean baseline outcomes in the three treatment groups

	Group						p value*
	Dry needling		Dry needling plus APS		Dry needling plus placebo APS		
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
Algometer 1	1.9	0.5	1.8	0.5	2.0	0.5	<u>0.497</u>
NRS 1	56.1	11.0	52.8	16.4	52.3	11.7	<u>0.611</u>

*ANOVA test

It was evident from table 4.3, that there were no significant differences between the three groups in terms of the baseline outcome measurements.

4.4 Effects of the treatment

4.4.1 Numerical Pain Rating Scale (NRS-101) (Subjective outcome):

Table 4.4: Inter- and intragroup effects for the NRS-101.

Effect	Statistic	p value
Time	Wilk's lambda 0.152	<0.001
Time*group overall	Wilk's lambda 0.943	0.511
Time*group (2 vs. 1)	Wilk's lambda 0.955	0.426
Time*group (2 vs. 3)	Wilk's lambda 0.939	0.309
Time*group (1 vs. 3)	Wilk's lambda 0.971	0.581
Group	<u>F=0.324</u>	<u>0.724</u>

Table 4.4 indicates that all groups similarly improved significantly over time ($p < 0.001$). There was no evidence of a differential time effect with treatment. Overall there was no evidence of a treatment effect in all three groups ($p = 0.511$), nor when each group was compared with each other group.

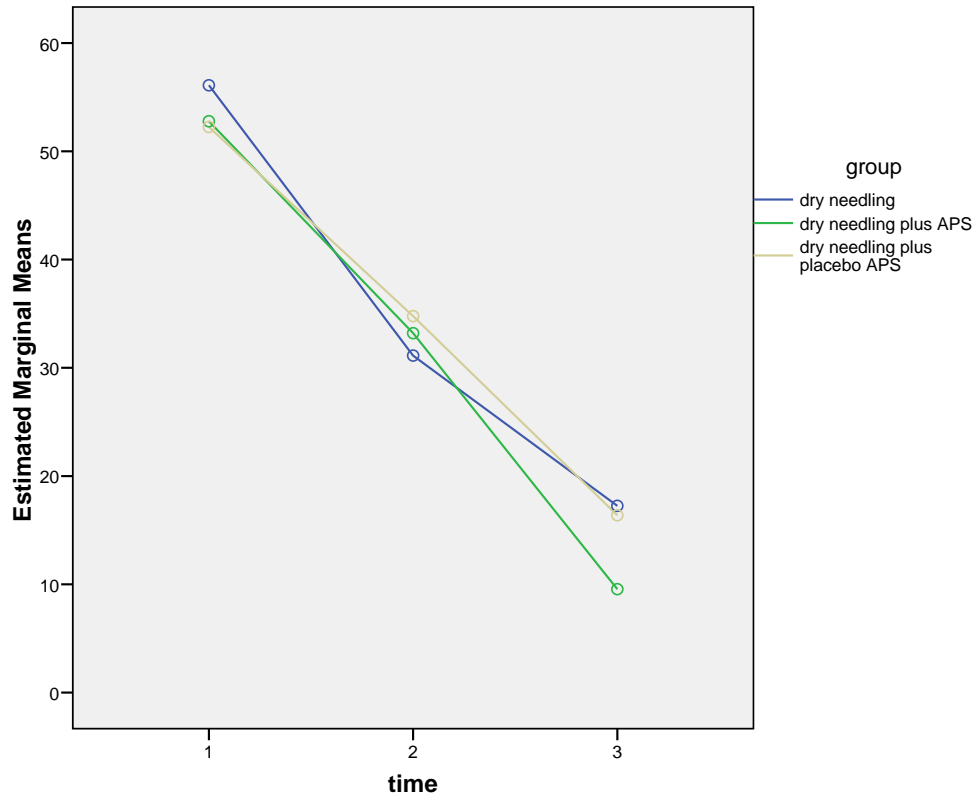


Figure 4.1: Mean NRS over time by group

Figure 4.1, suggests that the rate of decrease in pain was fastest in the intervention group (dry needling plus APS group). Thus there was a trend of efficacy but the sample size was not high enough to show this statistically. This may however affect clinical significance.

4.4.2 Algometer (Objective outcome):

Table 4.5: Inter- and intragroup effects for the algometer readings.

Effect	Statistic	p value
Time	Wilk's lambda 0.869	0.046
Time*group overall	Wilk's lambda 0.947	0.546
Time*group (2 vs. 1)	Wilk's lambda 0.974	0.612
Time*group (2 vs. 3)	Wilk's lambda 0.973	0.600
Time*group (1 vs. 3)	Wilk's lambda 0.943	0.335
Group	<u>F=0.493</u>	<u>0.613</u>

Table 4.5 shows that all groups changed significantly over time ($p=0.046$). However, this change was not significantly related to which treatment group the participant was in and there was no evidence of a differential time effect with treatment. Overall there was no evidence of a treatment effect in all three groups ($p=0.546$), nor when each group was compared with each other group.

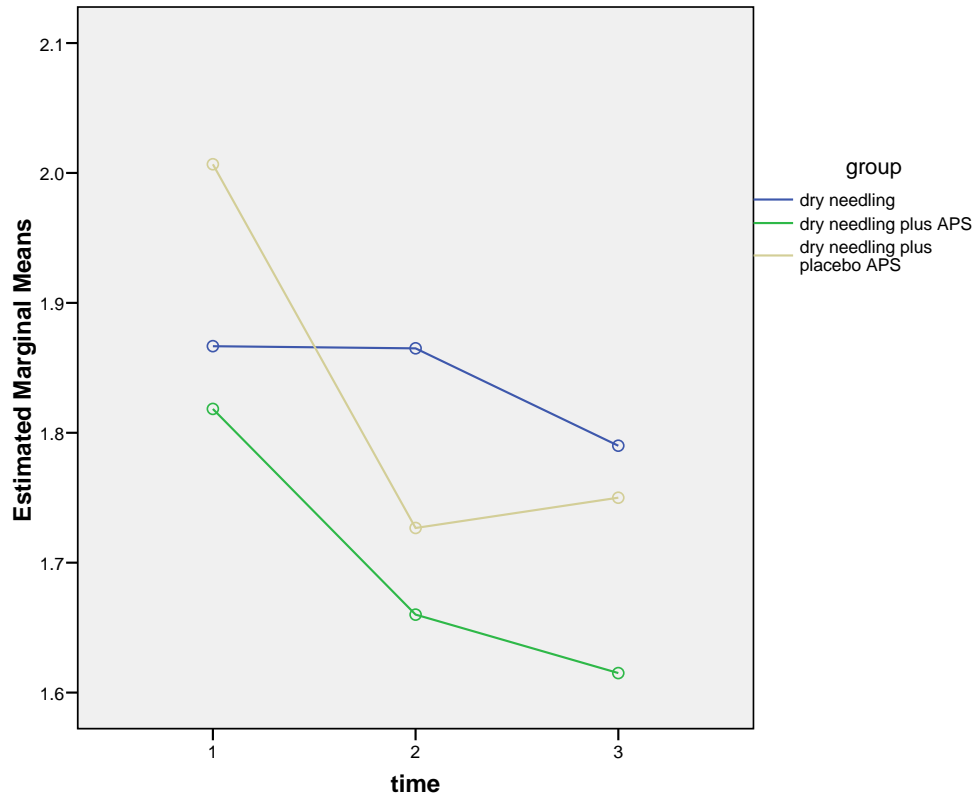


Figure 4.2: Mean Algometer over time by group

Figure 4.2, however, suggests that the rate of decrease in algometer measurements was quickest in the intervention group (dry needling plus APS group). Thus there was a trend of efficacy but the sample size was not high enough to show this statistically.

4.4.3 Post-needling soreness as reported in the 24-hours pain diary (Subjective outcome):

Table 4.6: Inter- and intragroup effects for pain diary

Effect	Statistic	p value
Time	Wilk's lambda 0.391	<0.001
Time*group overall	Wilk's lambda 0.857	0.382
Time*group (2 vs. 1)	Wilk's lambda 0.929	0.618
Time*group (2 vs. 3)	Wilk's lambda 0.892	0.392
Time*group (1 vs. 3)	Wilk's lambda 0.882	0.343
Group	<u>F=1.573</u>	<u>0.216</u>

Table 4.6 reveals that the pain score was recorded at each time point in the pain diary. All groups' pain decreased significantly over time as stated by individuals in their pain diary ($p < 0.001$), however, this change was not significantly related to which treatment group the participant was in and there was no evidence of a differential time effect with treatment. Overall there was no evidence of a treatment effect in all three groups ($p = 0.382$), nor when each group was compared with each other group.

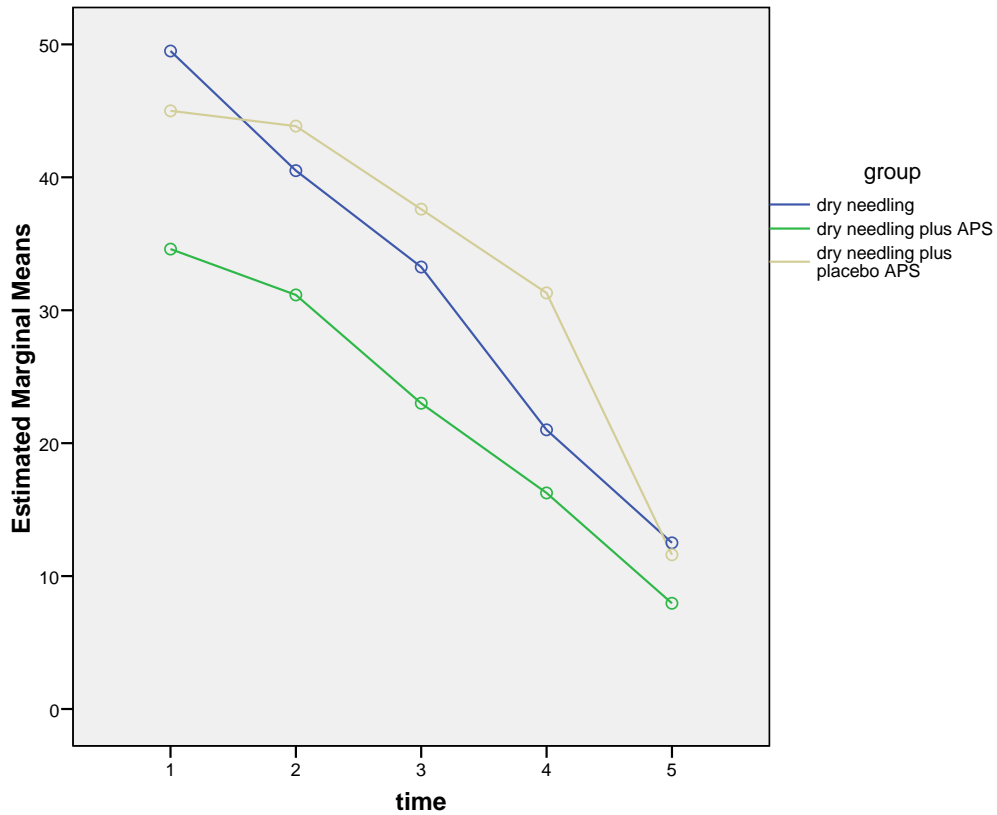


Figure 4.3: Mean pain diary measurement over time by group

Figure 4.3, suggests that the rate of decrease in individuals subjective pain diary measurements was slowest in dry needling plus ‘Sham’ APS group. Both, the dry-needling group and dry needling plus APS group showed similar rates of decrease and almost parallel profiles over time.

4.4.4 Presence of pain (subjective outcome):

The presence and absence of pain was recorded as a binary variable at each time point in the pain diary.

Table 4.7: Change in presence of pain by treatment group

		Change in presence of pain			Total
		decrease	No change	increase	
Group	dry needling	13(65%)	7(35%)	0(0%)	20(100%)
	dry needling plus APS	9(45%)	9(45%)	2(10%)	20(100%)
	dry needling plus placebo APS	7(35%)	13(65%)	0(0%)	20(100%)
Total		<u>29(48.3%)</u>	<u>29(48.3%)</u>	<u>2(3.3%)</u>	<u>60(100%)</u>

Table 4.7 shows that 65% of the dry needling group experienced a decrease in pain from 3 hours to 24 hours post-needling. This was followed by 45% in the intervention group and 35% in dry needling plus placebo APS group. The only two participants who experienced an increase in pain were from the intervention Group Three. However, there was no significant difference overall between change in presence of pain and treatment group.

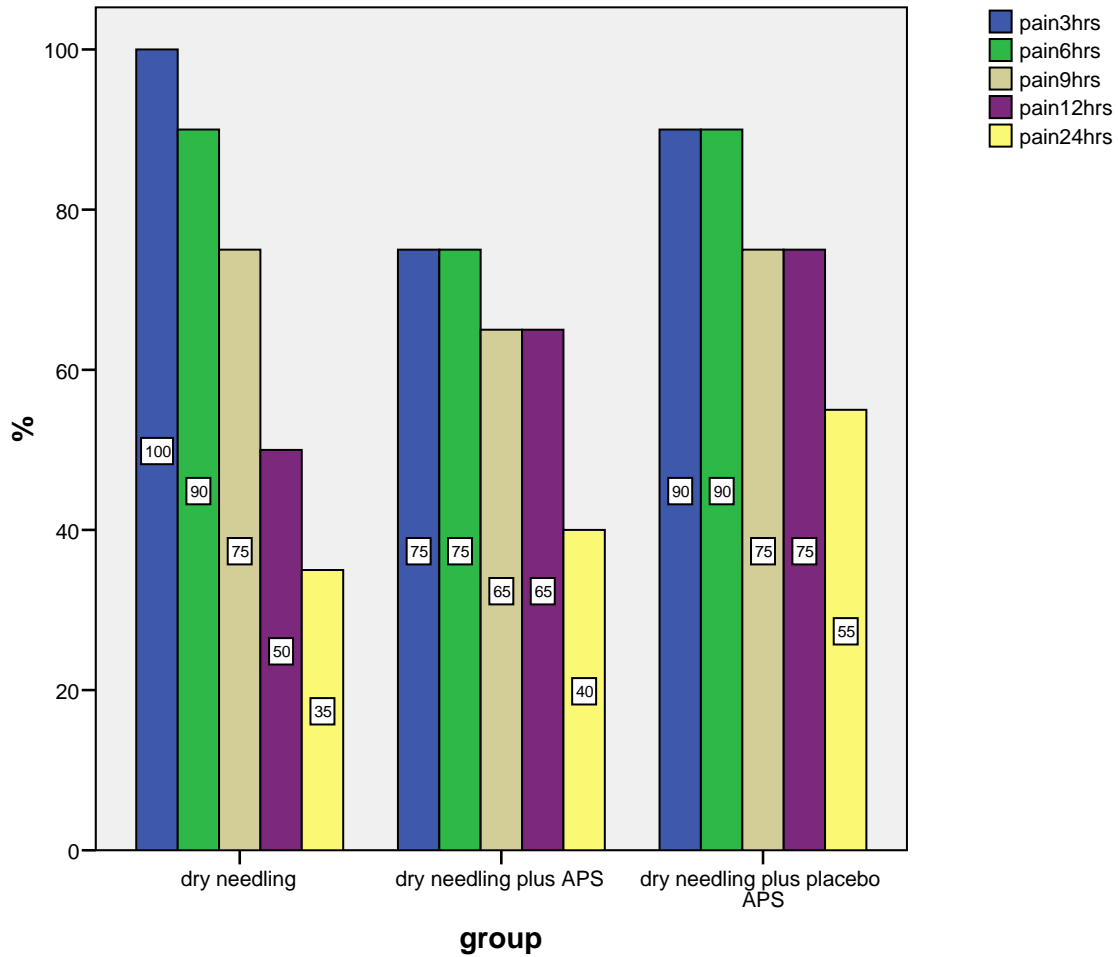


Figure 4.4: Percentage of participants with any pain at each time point by group

Figure 4.4 shows the percentage that each group respondents complained of pain. The presence of pain decreased in all groups. It appeared that the decrease of pain was most marked in the dry needling group.

4.4.4.1 Worst pain as reported in 24-hour diary (Subjective outcome):

There was no significant difference in time of worst pain between the three treatment groups ($p=0.220$).

Table 4.8: At how many hours after needling was pain worst?

Group	Median	Minimum	Maximum
Dry needling	3.00	1	24
Dry needling plus APS	3.00	0	24
Dry needling plus placebo APS	3.00	3	9
Total	<u>3.00</u>	<u>0</u>	<u>24</u>

Table 4.8 shows that the median time of more severe pain in all three groups was 3 hours. The mean rank of the intervention group was lowest of all groups, suggesting a trend towards lower time of worst pain in this group, however, this difference was not statistically significant ($p=0.220$, Table 4.11).

Table 4.9: Kruskal–Wallis test comparing median time of worst pain between the three groups.

	Group	N	Mean Rank
At how many hours after needling was pain worst?	Dry needling	20	33.10
	Dry needling plus APS	20	25.40
	Dry needling plus placebo APS	20	33.00
	Total	<u>60</u>	

Test Statistics(a,b)

	At how many hours after needling was pain worst?
Chi-Square	3.025
Df	2
p value	0.220

a Kruskal Wallis Test

b Grouping Variable: group

4.5 Intra-group correlations between changes in outcome variables

4.5.1 Group One: Dry-needling

Table 4.10: Correlation between change in outcomes in the dry-needling group

		Change in NRS	Change in algometer	Change in pain diary
Change in NRS	Pearson Correlation	1	-.429	.009
	Sig. (2-tailed)		.059	.970
	N	20	20	20
Change in algometer	Pearson Correlation	-.429	1	-.026
	Sig. (2-tailed)	.059		.912
	N	20	20	20
Change in individual perception of pain taken from their pain diary	Pearson Correlation	.009	-.026	1
	Sig. (2-tailed)	.970	.912	
	N	20	20	20

It is evident from table 4.10 that there was a non significant negative correlation between change in NRS and change in algometer measurement in dry needling group ($r=-0.429$, $p=0.059$). Thus there was a trend towards an increase in algometer measurements as NRS decreased in this group. There were no other correlations between changes in outcomes in this group.

4.5.2 Group Two: Dry-needling plus APS

Table 4.11: Correlation between change in outcomes in the dry-needling plus APS group

		Change in NRS	Change in algometer	Change in pain diary
Change in NRS	Pearson Correlation	1	.005	.002
	Sig. (2-tailed)		.982	.992
	N	20	20	20
Change in algometer	Pearson Correlation	.005	1	-.150
	Sig. (2-tailed)	.982		.527
	N	20	20	20
Change in individual perception of pain taken from their pain diary	Pearson Correlation	.002	-.150	1
	Sig. (2-tailed)	.992	.527	
	N	20	20	20

Table 4.11 revealed that there were no correlations between changes in outcomes in the intervention group.

4.5.3 Group Three: Dry-needling plus placebo APS

Table 4.12: Correlation between change in outcomes in the dry-needling plus placebo APS group

		Change in NRS	Change in algometer	Change in pain diary
Change in NRS	Pearson Correlation	1	.205	.003
	Sig. (2-tailed)		.386	.989
	N	20	20	20
Change in algometer	Pearson Correlation	.205	1	.376
	Sig. (2-tailed)	.386		.102
	N	20	20	20
Change in individual perception of pain taken from their pain diary	Pearson Correlation	.003	.376	1
	Sig. (2-tailed)	.989	.102	
	N	20	20	20

Table 4.12 indicates that there were no correlations between changes in outcomes in this group.

CHAPTER FIVE

Discussion of results

5.1 Introduction

This chapter consists of a discussion of the demographic data and results from the statistical analysis of both the subjective (NRS-101 and 24-hour pain diary) and objective data (algometer readings).

5.2 Subjective data

5.2.1 Numerical Pain Rating Scale 101 (NRS-101):

The results from the NRS-101 revealed that all the groups improved significantly over time ($p < 0.001$). However, the subjects in the dry needling plus APS group experienced the fastest decrease in the rate of pain compared to the other two groups.

Rowley (2001) conducted a study on the relative effectiveness of single insertion dry needling versus fanning dry needling in the treatment of myofascial trigger points. Both techniques resulted in post-needling soreness, however he concluded that subjects receiving the fanning dry needling technique experienced greater post-needling soreness than those who received the single insertion. This is possible due to the fact that the fanning technique was shown to cause excessive microtrauma in the area relative to single insertion technique, as a result of more needle insertions occurring to inactivate that trigger point. This method not only has a higher incidence of penetrating blood vessels as a result of the number of insertions but also has more of chance to accurately elicit the local twitch response.

According to Lewit (1979), post-needling soreness occurred even when a trigger point was not precisely needled. It became unclear whether the pain arises from the trigger point itself, or whether the tissue damage caused by the needle insertion is responsible. Travell *et al.*, (1999) however noted that post-needling soreness is more severe if haemorrhaging occurs as a result of needling of the trigger point.

To date, the exact cause of post-needling soreness remains unclear as very little detail is available. Histological studies have been inconclusive according to Huguenin (2004), with either absence of inflammatory cells and non-specific fibrosis changes or negative findings (Yunus *et al.*, 1986). Thermography (Swerdlow and Dieter, 1992) and ultrasound (Lewis and Tehan, 1999) have been unreliable in terms of imaging of the trigger points. A study by Bengtsson *et al.*, (1986) using biopsy indicated that there may be altered levels of high energy phosphates in painful muscles of patients with fibromyalgia. Phosphate compounds (e.g. ATP, Phosphocreatine) in muscle are sources of energy, and quantification could assist in assessing the metabolic status of the muscle. Huguenin (2004) revealed that there is no clear indication of the pathological changes expected in myofascial pain to date (Huguenin, 2004).

5.2.2 Pain diary:

The 24-hour pain diary yielded similar results to the NRS- 101 in that all the groups' pain decreased significantly over time. This change was not significantly related to which treatment group and there was no evidence of the differential time effect with treatment. On average, the median time of worst pain in all three groups was 3 hours. Both, the dry needling and dry needling plus APS group showed similar rates of pain decrease with the dry needling plus placebo group having the slowest rate of decrease. Sixty-five percent of the dry needling group experienced a decrease in pain from 3 hours to 24 hours post-needling. This was followed by 45% in the intervention group and 35% in dry needling plus placebo APS group.

As stated in chapter 2, both the single insertion and fanning insertion dry-needling techniques in the treatment of myofascial trigger points resulted in post-needling soreness (Rowley, 2001). However, Travell *et al.*, (1999) noted that the post-needling soreness is more severe if haemorrhaging occurs whilst needling of the trigger point. This excessive microtrauma is known to occur as a result of the dry needling fanning technique. This is due to the greater incidence of penetrating the blood vessel.

5.3 Objective data

5.3.1 Algometer readings:

The results from the algometer readings indicated that the dry needling plus APS group had the fastest rate of decrease. However, all the groups did change significantly over time. This change was not related to the treatment group and there was no evidence of a differential time effect with respect to the treatment. Overall there was no evidence of a treatment effect in all three groups, nor when each group was compared with each other group.

Farasyn and Meeusen (2005) conducted a study on individuals suffering from non-specific low back pain with regards to their pressure pain thresholds. No significance between the individuals suffering with moderated and severe low back pain was noted. It was concluded that “the perceived ability to control pain and the role of central nervous system modulation” was of extreme importance.

Various hypotheses were formulated in chapter one regarding the possible outcomes of this study. The following conclusions were made after they were compared to the results from the statistical analysis:

The first hypothesis that Group One will develop post-needling soreness to a greater degree than Groups Two and Three in symptomatic subjects in terms of subjective clinical findings. This hypothesis was rejected owing to the fact that the results of the

NRS-101 and 24-hour pain diary revealed that all the groups improved significantly over time. There was no evidence of a differential time effect with treatment or of the treatment effect in all three groups. However, the NRS-101 revealed that the intervention group showed the fastest rate of decrease in pain and the pain diary revealed that Group Three had the slowest rate with respect to decrease in pain.

The second hypothesis, which hypothesized that Group Two will develop post-needling soreness to a lesser degree than Groups One and Three in symptomatic subjects in terms of objective clinical findings, was accepted as indicated in figure 4.2.

The third hypothesis indicated that Group Three is equal to Groups One and Two with respect to the development of post-needling soreness in terms of subjective and objective clinical findings. This hypothesis was accepted, as all three groups developed post-needling soreness to a certain extent.

CHAPTER SIX

Conclusions and Recommendations

6.1 Conclusion

The aim of this study was to investigate the effect of Action Potential Simulation on post dry-needling on post-needling soreness in the treatment of active trapezius myofascitis.

Results revealed that for pain measured by NRS, algometer and pain diary, there was a significant decrease over time in all the groups. However, this change was not significantly related to which treatment group the participant was in and there was no evidence of a differential time effect with treatment.

Any of the treatments received was effective, and statistically there was no difference between them. However, this may have been due to small sample size as some of the outcomes show a trend which suggests that the rate of change was faster in one group compared with the others. This was the intervention Group (Two) in terms of NRS and algometer, and Group Three for the pain diary.

There was no significant difference between the groups in terms of change in the presence of pain over time as well as the time point at which pain was more severe. However, there was a non significant trend in change in presence of pain indicating that the dry-needling Group (One) showed the highest percentage of participants with a decrease in pain compared to the other groups.

Therefore this study concludes that any of the three treatments are equally effective at reducing pain. If the minor trends found are considered clinically important then a larger study is required to confirm the findings, which could have happened by chance alone in this relatively small study.

6.2 Recommendations

It is recommended that larger sample sizes be used for future studies in order to allow for more statistically significant results.

In order to avoid differences in gender pain-perception, the samples should either consist of equal representation of both sexes or of a single sex.

Follow up consultations at various intervals greater than 24 hours should be used in further studies to obtain data on the long term effects of dry needling with respect to post- needling soreness. This will help in obtaining a more accurate duration of post-needling soreness, as the exact time period is still inconclusive.

The use of a double blind procedure can be used for future studies. This will be useful in reducing the researcher's bias toward a favoured treatment protocol. This is achieved by having the treatment interventions being administered by a peer intern or clinician. The researcher, who is unaware of the treatment administered, can then collect the measurements from the patients.

In future studies done on dry needling, various other forms of needle stimulation should be explored, possibly also using the single needle insertion technique.

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APPENDIX A:

INFORMED CONSENT FORM

(To be completed by patient)

Date

Title of research project: The effect of Action Potential Simulation on post dry-needling soreness in the treatment of active trapezius myofascitis.

Name of Supervisor: Dr. A. Docrat (M.Tech: Chiro, CCFC)

Tel: (031) 373 2589

Name of research student: Hitesh Manga

Tel: (031) 373 2205/ (031) 2073141/ 083 777 6556

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? | Yes/ No |
| 3. Have you received satisfactory answers to your questions? | Yes/ No |
| 4. Have you had an opportunity to discuss this study? | Yes/ No |
| 5. Have you received enough information about this study? | Yes/ No |
| 6. 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 reason for withdrawing, and
without affecting your future health care. | Yes/ No |
| 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:.....

Parent/ Guardian:.....Signature:.....

Witness Name:.....Signature:.....

Research Student Name:.....Signature:.....

APPENDIX B:

Letter of Information

Dear Patient.

Welcome to my research study. Dry-needling is very common and effective form of intervention used in the chiropractic profession. However dry-needling has been known result in post- needling soreness. In this study I will be determining whether dry-needling of painful muscles around the neck with simultaneous APS therapy in symptomatic patients results in the decrease of post- needling soreness.

Title of the study:

The effect of Action Potential Simulation on post dry-needling soreness in the treatment of active trapezius myofascitis.

Supervisor: Dr. A. Docrat (M.Tech: Chiro, CCFC) (031) 373 2589

Research Student: Hitesh Manga (031) 373 2205/ 083 777 6556

Institution: Durban University of Technology.

Purpose of the Study:

The purpose of this study is to establish whether dry-needling of painful muscles around the neck with simultaneous APS therapy in symptomatic patients results in the decrease of post-needling soreness.

Procedure:

At the initial consultation you will undergo a history, physical, and a regional examination. You will be selected for the study providing you fit the necessary criteria for the research. Once accepted, you will have a 1 in 3 chance of group allocation and will receive one treatment, and will be required to complete the 24-hour diary, which will be provided. A follow-up assessment will take place 24 hours after the initial treatment. You will remain in the study as long as you commit to the appointment schedule.

Risks or Discomforts:

You may experience soreness in the area that the needle was inserted.

Reasons why you may be withdrawn from this study without your consent:

You may be removed from this study without your consent for the following reasons:

- If you are unable to attend your follow-up appointment.
- If you have changed any lifestyle habits during your participation in this study that may affect the outcome of this research (e.g. Medication, supplements or treatment).

Benefits:

Your contribution to this study, by volunteering to take part, will help us as chiropractors to build on their knowledge. This will benefit you as a patient, as the results from this study will promote future health care.

AS A VOLUNTARY PARTICIPANT IN THIS RESEARCH STUDY, YOU ARE FREE TO WITHDRAW FROM THE STUDY AT ANY TIME, WITHOUT GIVING A REASON.

Remuneration:

None

Costs of Study:

None

Confidentiality:

All patient information is confidential. The results from this study will be used for research purposes only. Only individuals that directly involved in this study (Dr. A. Docrat and I) will be allowed access to these records.

Persons to contact should you have any problems or questions:

Should you have any problems or questions that you would prefer being answered by an independent individual, feel free to contact my supervisor on (031) 373 2589. If you are not satisfied with a particular area of this study, please feel free to forward any concerns to the Durban University of Technology Research and Ethics Committee.

Thank you for participating in my research study.

.....
Hitesh Manga
(Researcher)

.....
Dr. A. Docrat
(Supervisor)

APPENDIX C:

Pain Diary:

Dear patient.

Thank you for participating in my study on post- needling soreness.

Kindly complete this pain dairy documenting any soreness you may experience, in the area that was needed, during the 24 hours following your treatment.

Did you experience pain in the area that was needed? If so, please indicate on the line below, the number between 0 and 100 that best describes the pain you experience. 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.

3 hours	YES/NO	0 _____ 100
6 hours	YES/NO	0 _____ 100
9 hours	YES/NO	0 _____ 100
12 hours	YES/NO	0 _____ 100
24 hours	YES/NO	0 _____ 100

My pain was worst at..... hours after receiving dry-needling therapy.

If you have any questions regarding the research, kindly contact Hitesh Manga on (031) 373 2205, (031) 373 3141 or 083 777 6556 or you can contact my research supervisor Dr. A. Docrat on (031) 373 2589.

Patient Name:.....

Patient Signature:.....

Research Student Name:.....

Research Student’s Signature:.....

APPENDIX D:

Numerical Pain Rating Scale- 101

Date:_____ **File number:**_____ **Visit number:**_____

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 E:

Are you between the ages of

18-45?

Research is currently being conducted at the
Durban University of Technology
Chiropractic Day Clinic.

**Do you suffer from neck
and shoulder pain?**

FREE TREATMENT

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

For more information contact

Hitesh Manga

On

(031) 373 3141/ 083 777 6556

APPENDIX F:

DURBAN UNIVERSITY 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: _____

Case Summary 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

< Hospitalization

6. Current health status and life-style:

- < Allergies
- < Immunizations
- < Screening Tests incl. x-rays
- < 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 G:

**Durban University of Technology
PHYSICAL EXAMINATION: SENIOR**

Patient Name : _____ **File no :** _____ **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

NEUROLOGICAL EXAMINATION

COMMENTS

Clinician: _____

Signature : _____

APPENDIX H:

**DURBAN UNIVERSITY OF TECHNOLOGY
REGIONAL EXAMINATION - CERVICAL SPINE**

Patient: File No:

Date: Student:

Clinician: Sign:

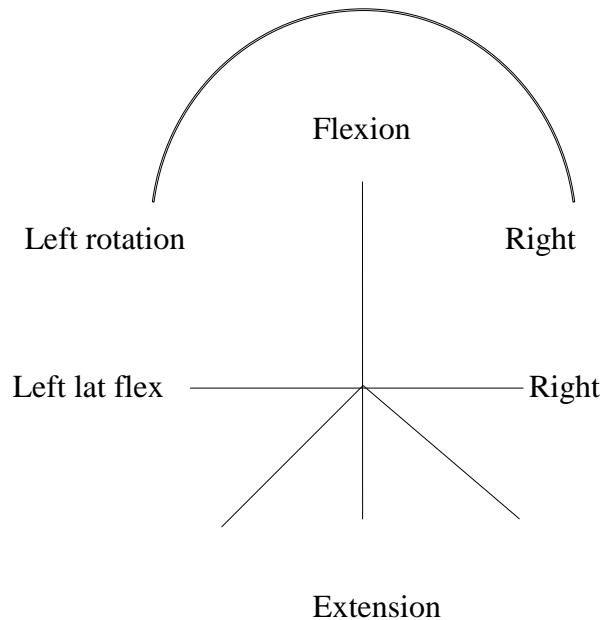
OBSERVATION:

- Posture
- Swellings
- Scars, discolouration
- Hair line
- Body and soft tissue contours

- Shoulder position
 - Left :
 - Right :
- Shoulder dominance (hand):
- Facial expression:

RANGE OF MOTION:

- rotation
- Extension (70°):
- L/R Rotation (70°):
- L/R Lat flex (45°):
- lat flex
- Flexion (45°):



PALPATION:

- Lymph nodes
- Thyroid Gland
- Trachea

ORTHOPAEDIC EXAMINATION:

Tenderness		Right	Left
Trigger Points:	SCM		
	Scalenii		
	Post Cervicals		
	Trapezius		
	Lev scapular		

	Right	Left		Right	Left
Doorbell sign			Cervical compression		
Kemp's test			Lateral compression		
Cervical distraction			Adson's test		
Halstead's test			Costoclavicular test		
Hyper-abduction test			Eden's test		
Shoulder abduction test			Shoulder compression test		
Dizziness rotation test			Lhermitte's sign		
Brachial plexus test					

NEUROLOGICAL EXAMINATION:

Dermatomes	Left	Right	Myotomes	Left	Right	Reflexes	Left	Right
C2			C1			C5		
C3			C2			C6		
C4			C3			C7		
C5			C4					
C6			C5					
C7			C6					
C8			C7					
T1			C8					
			T1					
Cerebellar tests:			Left		Right			
Disdiadochokinesis								

VASCULAR:	Left	Right		Left	Right
Blood pressure			Subclavian arts.		
Carotid arts.			Wallenberg's test		

MOTION PALPATION & JOINT PLAY:

Left: Motion Palpation:

Joint Play:

Right: Motion Palpation:

Joint Play:

BASIC EXAM: SHOULDER:

Case History:

ROM: Active:

Passive:

RIM:

Orthopaedic:

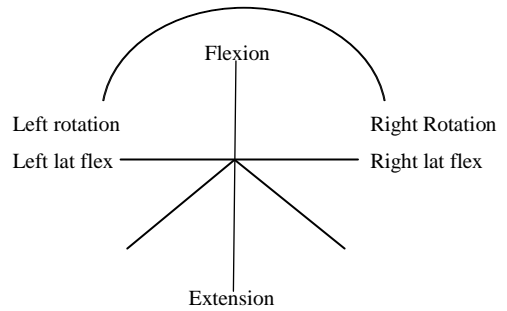
Neuro:

Vascular:

BASIC EXAM: THORACIC SPINE:

Case History:

ROM:



Motion Palpation:	
Orthopaedic:	
Neuro:	
Vascular:	
Observ/Palpation:	
Joint Play:	

**ETHICS CLEARANCE CERTIFICATE**

Student Name	H Manga	Student No	20200729
Ethics Reference Number	FHSEC 019/07	Date of FRC Approval	23/07/2007
Research Title:	The effect of Action Potential Simulation on post dry-needling soreness in the treatment of active trapezius myofascitis.		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with Institutional requirements and confirms the following ethical obligations:

- The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the DUT 186 and agrees to comply with them.
- The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
- The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
- The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
- The following section must be completed if the research involves human participants:**

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	✓		
❖ Potential psychological and physical risks have been considered and minimised	✓		
❖ Provision has been made to avoid undue intrusion with regard to participants and community	✓		
❖ Rights of participants will be safe-guarded in relation to:			
- Measures for the protection of anonymity and the maintenance of Confidentiality.	✓		
- Access to research information and findings.	✓		
- Termination of involvement without compromise	✓		
- Misleading promises regarding benefits of the research	✓		

SIGNATURE OF STUDENT/RESEARCHER

5/11/07
DATE

SIGNATURE OF SUPERVISOR/S

17-10-2007
DATE

SIGNATURE OF HEAD OF DEPARTMENT

05/11/07
DATE

SIGNATURE: CHAIRPERSON OF RESEARCH ETHICS COMMITTEE

08/11/2007
DATE