

The effect of heat therapy on post-dry needling soreness in the deltoid muscle of asymptomatic subjects.

BY

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the requirements for the Masters Degree in Technology: Chiropractic, at the
Durban University of Technology.**

**I, Merissa Govender do declare that this dissertation represents my own work in both
conception and execution (except where acknowledgements indicate the contrary).**

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DEDICATION

This dissertation is dedicated to my mum, dad, brother and Darren. Thank you for your support, help and understanding. To Darren, thank you for your constant motivation and guidance. I love you.

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ABSTRACT

Background: Myofascial Pain Syndrome is a condition characterized by the development of hyperirritable foci in muscle. Treatments include modalities such as cryotherapy, electrotherapy, ultrasound, ischemic compression and dry-needling, the latter of which is reported to be the most effective. A side-effect of dry-needling is post-needling soreness which results from bleeding in the area of needle insertion. The application of heat as a therapy to an injured area has been reported to decrease pain by blocking nociceptors, decreasing muscle spasm, and increasing connective tissue extensibility.

Objectives: To determine the relative effectiveness of heat therapy immediately after dry-needling versus dry-needling alone on post-needling soreness in the deltoid muscle of asymptomatic subjects. This was done in terms of subjective and objective clinical findings.

Methodology: This study was designed as a randomised, parallel-controlled clinical-trial. Thirty asymptomatic subjects were used. Each subject acted as their own control in that both the left and right arms of each subject were dry-needled. One of the arms received heat therapy after the dry-needling procedure while the other arm acted as a control. Algometer readings, a Numerical Pain Rating Scale-101 (NRS-101) and a 24 Hour Pain Diary were used as assessment tools.

Algometer and NRS-101 readings were taken before and after the dry-needling procedure and during the 24 hour follow up visit. Subjects used a 24 hour pain diary which was filled out at 3 hour intervals, to record the development of post-needling soreness.

Independent samples t-test and Pearson's chi square test were used to compare age and gender between the treatment groups. Repeated measures ANOVA testing was used to compare the effect of heat treatment with no heat treatment in the 60 arms over the three time periods of assessment for the outcomes which were

measured as continuous variables (NRS-101 and algometer). For binary outcomes such as the presence or absence of pain at any time point, Fisher's exact tests were used to compare the heat treated with the control arms in the left and right arms separately. A p value of less than 0.05 was considered as statistically significant.

Results: Both the objective and subjective measurements from the heat intervention and control groups revealed the development of post-needling soreness. There was a slight trend of heat therapy decreasing post-needling soreness in terms of subjective (NRS-101 and pain diary) and objective (algometer) findings which was however, not found to be statistically significant.

Conclusion: Although the results of the study revealed no statistical evidence of a beneficial effect of heat therapy on objective or subjective findings clinical significance could not be excluded due to the observed trend of heat therapy decreasing post-needling soreness in terms of subjective (NRS-101 and pain diary) and objective (algometer) findings. Further investigation is recommended.

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CHAPTER ONE

INTRODUCTION

1.1. INTRODUCTION TO THE STUDY

Myofascial Pain Syndrome is a common muscular pain syndrome seen in clinical practice and is characterized by hyperirritable foci that develop in muscle (Bennett, 2007; Esenyel, 2000). A Myofascial Trigger Point is defined as a hyperirritable spot in a taut band of skeletal muscle or in its fascia (Travell, Simons and Simons, 1999). The spot can cause referred pain on manual compression of the myofascial trigger point and can give rise to characteristic motor dysfunction, autonomic phenomena, referred tenderness and referred pain (Lavelle, Lavelle and Smith, 2007; Travell, Simons and Simons, 1999).

It is estimated that 44 million Americans have myofascial pain problems (Bennett, 2007). Myofascial pain syndrome is a major cause of muscular disability in the shoulder girdle, neck, and lumbar regions (Kamanli et al 2005). An epidemiological study conducted in South Africa, found that Myofascial Pain Syndrome was the second most frequently diagnosed condition in a pain control clinic, (Walker, Odendaal and Esterhuyse, 2006). This shows that this is a common condition affecting South Africans.

There are various methods of treating trigger points such as applying ice packs, heat packs, ischaemic compression, using ultrasound and dry-needling the area (Fleckenstein et al 2010). One of the most commonly used and effective modalities of treatment is dry-needling of the myofascial trigger point, (Kamanli et al 2005). Dry-needling involves the insertion of an acupuncture needle directly into a trigger point. These hyperirritable spots are theorised to be deactivated by dry-needling (Weiner, 2007).

One of the proposed mechanisms by which dry-needling is effective in the deactivation of trigger points is that it is able to mechanically disrupt the muscle or nerve fibers, thus stopping the pain-spasm cycle (Travell, Simons and Simons, 1999). Mechanical disruption of muscle fibres causes increased levels of extracellular potassium, which in turn leads to the depolarisation of nerve fibres, (Dommerholt and Huijbregts, 2009). There is removal of nerve sensitizing substances by local hemorrhage and interruption of the central feedback mechanism, (Travell, Simons and Simons, 1999).

A negative effect of dry-needling experienced by patients is post-needling soreness. Post-needling soreness is a completely separate entity and is not the same as myofascial pain (Lewit, 1979). It has been associated with a constant pressure or a dull aching sensation experienced by the patient after the dry-needling procedure (Hong, 1994). This discourages patients from seeking an effective modality of treatment and may prolong the patient's difficulty (Hong, 1994).

Post-needling soreness is associated with micro-hemorrhage caused by tissue damage at the needled site (Alvarez and Rockwell, 2002; Hong, 1994). It was found to be caused by both single insertions and fanning dry-needling techniques (Ferreira, 2006; Rowley, 2000). This can contribute to the delay of treatment and recovery as the development of post-needling soreness prevents any further needling of the same region for 3-4 days after treatment (Travell, Simons and Simons, 1999).

According to Travell, Simons and Simons (1999) heat, stretching and application of pressure to the needled area, are methods recommended to decrease the development of post-needling soreness.

Heat therapy is the application of heat to the body for pain relief (Lane and Latham, 2009). It has been reported to decrease pain by blocking nociceptors by various

mechanisms around the area of injury (Melzack and Wall, 1988). Heat also leads to an increase in blood flow to the affected area and relaxes underlying muscles (Travell, Simons and Simons, 1999). In this respect the therapeutic benefits of heat have been identified as:

- Increasing pain relief (Nadler, Weignand and Kruse, 2004),
- increasing metabolism (Nadler, Weignand and Kruse, 2004),
- increasing connective tissue extensibility (Nadler, Weignand and Kruse, 2004),
- relieving muscle spasm (Nadler, Weignand and Kruse, 2004),
- reducing disability (Nadler et al 2003)

1.2. RATIONALE FOR THIS STUDY

1.2.1. Rationale One

A frequent side effect of dry needling trigger points is post-needling soreness (Alvarez and Rockwell, 2002) which causes a feeling of constant pressure or a dull aching sensation after the dry needling procedure (Hong, 1994).

1.2.2. Rationale Two

According to Travell, Simons and Simons (1999) heat, stretching and application of pressure to the needled area, are methods recommended to decrease the development of post needling soreness. Some of these modalities have not been objectively assessed for their effectiveness on alleviating post-needling soreness.

1.2.3. Rationale Three

Heat therapy is the application of heat to the body for pain relief (Lane and Latham, 2009). It has been shown to decrease pain, increase the metabolic rate which can increase oxygen uptake and accelerate healing, increase circulation to the affected area, induce relaxation, relieve muscle spasm and increase the elasticity of collagen fibers, (Nadler, Weignand and Kruse, 2004; Travell, Simons and Simons, 1999; Michlovitz, 1996).

1.3. AIM OF THE STUDY

The aim of this study was to determine the effectiveness of heat therapy on post dry-needling soreness in the deltoid muscle of asymptomatic subjects.

1.4. OBJECTIVES OF THE STUDY

1.4.1. Objective 1

To determine the relative effectiveness of heat therapy immediately after dry-needling versus dry-needling alone on post-needling soreness in the deltoid muscle of asymptomatic subjects. This was done in terms of subjective clinical findings.

1.4.2. Objective 2

To determine the relative effectiveness of heat therapy immediately after dry-needling versus dry-needling alone on post-needling soreness in the deltoid muscle of asymptomatic subjects. This was done in terms of objective clinical findings.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION

Myofascial Pain Syndrome (MPS) is a common musculoskeletal condition in which hyperirritable foci develop in muscle (Bennett, 2007; Esenyel 2000). These foci are referred to as myofascial trigger points (MTrPs), and may be associated with sensory, motor and autonomic symptoms (Travell, Simons and Simons, 1999).

MTrPs can occur in any muscle group, however muscles involved in posture are most often affected (Rickards, 2006). Trigger points can develop as a result of an acute trauma or repetitive microtrauma (Alvarez and Rockwell, 2002). Perpetuating factors of MTrPs includes structural and mechanical stresses, psychological factors, and metabolic and endocrine inadequacies (Mense and Gerwin, 2010).

2.2. INCIDENCE AND PREVALENCE OF MYOFASCIAL PAIN SYNDROME

According to Bennett (2007) it has been estimated that 44 million Americans suffer from myofascial pain problems. It is one of the most predominant soft tissue syndromes seen in clinical practice and there is a great interest in its management within the Chiropractic profession (Auleciems, 1995; Schneider, 1995; Esenyel, 2000). An epidemiological study conducted in South Africa, found that Myofascial Pain Syndrome was the second most frequently diagnosed condition in a pain control clinic, with 23% of the sample under investigation exhibiting characteristic features of Myofascial Pain Syndrome (Walker, Odendaal and Esterhuyse, 2006).

According to Friction (1994) epidemiological studies conducted in the United States concluded that 30-85% of patients claimed that MTrPs were the primary source of pain. Gerwin (1995) found that 93% of patients presenting to a pain medical centre

had, at least, part of their pain caused by MTrPs and MTrPs were thought to be the primary cause of their pain in 74% of these cases.

Trigger points have been described in both genders and all age groups. However the incidence of trigger points appears to be more prevalent in women (Mense and Gerwin, 2010). In a study conducted by Sola, Rodenberger and Getty (1955) it was found that trigger points were present in the shoulder muscles in 54% of females and 45% of males, upon examination of 200 asymptomatic young adults. (Tunks and Crook, 1999) suggests that women tend to have a lower tenderness threshold over tender points than men. According to Hou et al (2002) 107 of the 119 patients treated for MPS were female. Walker (2002) found that 72% of the 60 patients treated for MPS were female and Wilks (2003) found that 60% of the 60 patients treated for MTrPs were female.

MTrPs can develop in any age group. However, middle-aged individuals are more prone to present with MTrPs. Young individuals have an increased resistance to injury hence their muscles heal faster and are less likely to develop active MTrPs. Although with age, muscles become more degenerate, less resilient and slower to heal (Cummings and Baldry, 2007). According to Fomby and Mellion (1997) MPS occurs most frequently between the ages of 30 and 60, although it was noted that MPS occurred more often in 30% of women aged 20-40 and in both genders between the ages of 30-49 (Han and Harrison, 1997). Van Aardenne (2002) treated 60 patients between the ages of 20-60 for myofascial pain and found that 48.2% were between the ages of 31-50 while 36.6% were between the ages of 20-31. These studies suggest that the prevalence of MPS increases with advancing age (Fomby and Mellion, 1997) with most sufferers being between the ages of 20-50 years.

2.3. AETIOLOGY OF MYOFASCIAL TRIGGER POINTS

Many factors contribute to the aetiology of MTrPs. However little agreement exists with respect to the exact causes (Huguenin, 2004). According to Dommerholt and Huijbregts (2009) MTrPs can become activated by primary or secondary factors.

Primary Factors

Primary factors are those factors which directly contribute to the development of myofascial trigger points. These factors include trauma, mechanical abuse, adverse environmental conditions, radiculopathy and prolonged contraction of the muscle. Trauma is the most common primary factor leading to the development of MTrPs. Causes of trauma include excessive exercise of the muscle, repeated minor trauma and direct injury or sudden strain to the muscle. Trauma results in an inflammatory response, which leads to the release of bradykinin, prostaglandins, serotonin, histamine and potassium ions which cause the sensitisation of A-delta (Group III) and C (Group IV) sensory fibres leading to pain (Dommerholt and Huijbregts, 2009).

Mechanical abuse, such as an acute sustained or repetitive muscle overload, is a factor which can also lead to the development of MTrPs (Dommerholt and Huijbregts, 2009). MTrPs may also be caused by adverse environmental conditions including exposure to excessive heat, cold or dampness (Dommerholt and Huijbregts, 2009). Radiculopathy caused by a ruptured intervertebral disc can result in the development of trigger points in the muscles supplied by the compressed nerve root (Travell, Simons and Simons, 1999). Leaving a muscle in a shortened contracted position for a prolonged period of time is yet another factor that can produce MTrPs within the muscle (Travell, Simons and Simons, 1999).

Secondary Factors

Secondary factors are factors which lead indirectly to the development of MTrPs. These factors include compensating synergistic or antagonistic muscles which can lead to the development of MTrPs secondary to trigger points in the primary muscle. Synergistic muscles may develop trigger points if these muscles are overloaded. This would transpire when the muscles are compensating for the primary muscle which contains the MTrPs and therefore does not function at maximum strength. Antagonistic muscles may develop MTrPs when the muscle counteracts the tension in the primary muscle which contains the MTrPs (Dommerholt and Huijbregts, 2009). A primary trigger point can also lead to the development of satellite trigger points

which develop in the pain referral zone of the primary trigger point (Dommerholt and Huijbregts, 2009). Low oxygenation of tissues results in muscles being more susceptible to the development of MTrPs (Dommerholt and Huijbregts, 2009).

2.4. PERPETUATING FACTORS OF MYOFASCIAL TRIGGER POINTS

Perpetuating factors make muscles more susceptible to the development of MTrPs. These factors are vital to the treatment protocol and the long-term prognosis of the individual (Auleciems, 1995).

Examples of perpetuating factors include mechanical stresses such as skeletal asymmetry (short leg or small hemipelvis), skeletal disproportion (short upper arms) and muscular stress (poor posture, constricting pressure on muscle, prolonged immobility and abuse of muscles) (Dommerholt and Huijbregts, 2009). Psychological factors including tension, depression and anxiety may prevent rapid recovery from MTrPs (Rickards, 2006).

Nutritional inadequacies are a cause of MTrPs that is often overlooked, clinically. Vitamins B₁, B₆, B₁₂, C and D, potassium, folic acid, calcium, and iron are all fundamental in the normal functioning of muscles. Low levels of these vitamins and minerals often disrupt the energy supply to muscles which consequently aggravates the development of MTrPs (Mense and Gerwin, 2010). A decrease in ferritin commonly leads to an iron deficiency (Mense and Gerwin, 2010). Iron is important for the generation of energy therefore a decrease in iron may lead to the development of MTrPs (Mense and Gerwin, 2010).

Metabolic and endocrine inadequacies are perpetuating factors that include hypothyroidism, hypocalcaemia, hypoxia, hyperuricemia and anemia. These inadequacies can impair muscle metabolism leading to the development of MTrPs (Mense and Gerwin, 2010). Infections such as chronic infections caused by viruses, bacteria or parasites are important factors which can prevent the recovery from

trigger points (Rickards, 2006). Other factors such as allergies and chronic visceral disease can also, perpetuate the development of MTrPs (Rickards, 2006).

2.5. PATHOPHYSIOLOGY OF MYOFASCIAL PAIN SYNDROME

The development of an MTrP is a progressive process (Mense and Gerwin, 2010). The clinical findings of trigger points are complex and there is no scientific theory that fully explains the pathophysiological nature of myofascial trigger points (Bennett, 2007; Rickards, 2006). Several theories have been proposed by various researchers. Such include: the Energy Crisis Theory, the Muscle Spindle Concept, the Motor Endplate Hypothesis and the Integrated Hypothesis.

2.5.1. The Energy Crisis Theory

In the energy crisis theory it is postulated that an increased demand on muscle causes injury to the sarcolemma which leads to the release of calcium from the muscle (Bennett, 2007; Huguenin, 2004). This release of calcium results in a sustained shortening of the sarcomere which compromises local circulation and increases the metabolism of the muscle. The compromised circulation causes a reduction in oxygen within the cells, making the cells unable to produce enough ATP to initiate relaxation (Dommerholt and Huijbregts 2009).

According to the energy crisis theory, the pain experienced at the MTrP locations occurs as a result of a process of sensitisation and direct stimulation of the sensory nerves which causes ischemic by-products of metabolism to accumulate (Dommerholt and Huijbregts, 2009; Kuan, 2009; Hong, 2008). These ischemic by-products of metabolism are Adenosine triphosphate, phosphocreatine, and Adenosine diphosphate. They are phosphate-containing compounds used to measure the muscle energy stores and are capable of donating their phosphate group and releasing energy for muscle activity thus becoming low energy phosphate compounds. According to the energy crisis theory, MTrPs should therefore contain a smaller number of high energy phosphate compounds and a higher number of low energy phosphate compounds (Partanen, Ojala and Arokoski, 2010).

A study conducted by Bengtsson, Henriksson and Larsson (1986) found that high energy phosphate levels were reduced and low energy phosphate levels were raised at trigger point sites. This supports the idea of metabolic derangement at trigger point sites. The findings of this study therefore support the energy crisis theory.

2.5.2. The Muscle Spindle Concept

Myofascial trigger points have been shown to have a high electrical activity (Travell, Simons and Simons, 1999). The source of this activity was proposed to be a dysfunctional muscle spindle (Hubbard and Berkoff, 1993). It was later discovered that these potentials could not have arisen from the motor endplates (Simons, 1996). 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). It has since then been postulated that the electrical activity may be motor endplate noise (Simons, Hong and Simons, 2002; Simons, 2001).

2.5.3. The Motor Endplate Hypothesis

The motor endplate hypothesis is described as dysfunction in the region of extrafusal motor endplates, where the motor nerve synapses to it (Huguenin, 2004). According to Farida (2008) needle electromyography (EMG) studies revealed that each of these trigger points contained minute loci which produced characteristic electrical activity, and were located at the motor endplate zone (Dommerholt and Huijbregts, 2009). The increased rate of acetylcholine (ACh) release from the nerve terminal was thought to represent the endplate noise (Huguenin, 2004). 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 (Simons, 1996). This however, could activate a few of the contractile elements which cause a degree of muscle shortening (Huguenin, 2004).

2.5.4. Integrated Hypothesis

The Integrated Hypothesis appears to have the most consensus in the literature. It unifies both the electrodiagnostic and the histopathological evidence to describe a

possible cycle of MTrP development (Simons, 2004). Acute or repetitive muscle overloads activate myofascial trigger points (Gerwin, Dommerholt and Shah, 2004). It is believed that an initial insult of the muscle causes an increase in the release of acetylcholine by the nerve terminal of an abnormal motor endplate (Partland, 2004). This increase in acetylcholine inhibits polarization of the nerve fibre due to the failure of removal of Ach from its receptor site (Partland, 2004).

An abnormal and sustained depolarization of the post-junctional membrane of the muscle fibre results with prolonged shortening of the sarcomere occurring due to calcium released from the sarcolemma (Simons, 2004). Localised muscle ischemia leads to a prolonged shortening of the sarcomere, an increase in local energy consumption and reduction in local circulation. This causes the release of neurovasoreactive substances such as histamine, serotonin, bradykinin, prostaglandins sensitise nociceptors and capsaicin. Local MTrP pain and tenderness occurs as a result of sensitisation of the nociceptors. According to Simons (2004) these neurovasoreactive substances stimulate the local autonomic system to release more acetylcholine.

Calcium is returned to the sarcoplasmic reticulum under normal circumstances via the calcium pump (Guyton, 1992). This process is dependent on the normal functioning of the ATP. Sufficient amounts of ATP are unavailable due to the energy crisis allowing the contractile elements to be exposed to free calcium (Simons, 2004). According to Simons (2004) the muscle eventually stiffens due to the absence of ATP which leaves the myosin heads firmly attached (the myosin heads fail to recock).

2.6. MANAGEMENT OF MYOFASCIAL PAIN

The aim of treatment is to decrease pain and tightness of the involved muscles (Cummings and Baldry, 2007) by inactivating the MTrP and preventing its reoccurrence (Mense and Gerwin, 2010). According to Dommerholt and Huijbregts (2009) in order to successfully treat MPS the physiologic, psychosocial stresses that are often involved in the development of myofascial pain and the chronic nature of the disease process must be taken into consideration. The trigger point's location in

the muscle is essential in determining the appropriate treatment for the MTrP. Central and attachment trigger points are the two types of trigger point locations that exist. Central trigger points are situated in the endplate region of a muscle while attachment trigger points are found near the area where the muscle attaches to its tendon, bone or aponeurosis. Central trigger points have a better response to the application of warmth and stretching while an attachment trigger point has a better response to cold. Attachment trigger points also respond well to the application of manual therapy, especially when it is directed toward the central trigger point (Mense and Gerwin, 2010; Dommerholt and Huijbregts, 2009).

Perpetuating factors must be corrected in order to maximize the long term response to any treatment. When efficiently managed MPS has an excellent prognosis. However, long-term management and lifestyle modification is necessary to prevent recurrences (Mense and Gerwin, 2010).

The modalities used in the treatment of myofascial pain include spray and stretch, transcutaneous electrical nerve stimulation (TENS), ultrasound, ischemic compression, massage, dry needling (Fleckenstein et al 2010) and the application of heat or ice (Ga et al 2007).

2.6.1. Cryotherapy

Cryotherapy is defined as the therapeutic application of any substance to the body which removes heat from the body thus resulting in a decrease in tissue temperature (Nadler, Weignand and Kruse, 2004). The physiological effects of cryotherapy involve a decrease of tissue blood flow by causing vasoconstriction, and a decrease in tissue metabolism, oxygen utilization, inflammation, and muscle spasm (Nadler, Weignand and Kruse, 2004). These effects decrease tension in the trigger point (Prentice, 1994). Cryotherapy induces effects both locally (at the site of application) and at the level of the spinal cord via neurologic and vascular mechanisms. Schaser et al (2007) used male rats with a closed soft tissue injury in a controlled study to investigate the effects of prolonged cold on inflammation. His results revealed a

reduction in vascular dysfunction, inflammation and tissue damage. Superficial cold activates the cutaneous cold receptors, which stimulates smooth muscle contractions in the walls of blood vessels thus causing vasoconstriction which makes cryotherapy highly effective in controlling pain, inflammation and oedema (Cameron, 1999; Michlovitz, 1996).

2.6.2. Heat

Heat therapy is the therapeutic application of any substance to the body that creates additional heat, resulting in an increase in tissue temperature (Nadler, Weignand and Kruse, 2004). Heat therapy raises tissue temperature, blood flow, metabolism, connective tissue extensibility and provides analgesia (Nadler, Weignand and Kruse, 2004). This results in increased pain relief, flexibility and reduced muscle stiffness (Lane and Latham, 2009). This decreases tension on the trigger point and decreases referred pain (Ga et al 2007). A beneficial type of heat therapy that aids in treating MPS is moist heat as it increases blood flow and relaxes underlying muscles (Travell et al 1999).

2.6.3. Spray and Stretch

A vapocoolant spray is used to block reflex spasm and pain, allowing for gradual and passive stretching of the muscle and inactivation of the trigger point (Lavelle, Lavelle and Smith, 2007). With a restoration of muscle length and reduction in muscle tension, the resultant muscle spasms, sensitive points and referred pain are eliminated (Raj and Paradise, 2004).

2.6.4. Massage

Massage improves circulation and breaks up fibrous bands in muscle. This leads to a reduction in the amount of pain mediators present (Travell, Simons and Simons, 1999). According to Yap (2007) massage is hypothesized to deactivate MTrPs by relaxing muscles and increasing the release of endorphins.

2.6.5. Ischaemic Compression

Ischeamic compression therapy refers to the belief that the application of pressure to a trigger point produces ischemia that deactivates the trigger point. Pressure is applied to the area with increasing resistance and maintained until a relief of tension is felt. The patient may feel mild discomfort, but should not experience profound pain. The process is repeated for each band of taut muscle encountered (Lavelle, Lavelle and Smith, 2007). Improved circulation occurs after this local ischemia is applied to the affected area (Mense and Gerwin, 2010). Hains, Descarreaux and Hains (2010) conducted a clinical trial to evaluate the effect of 15 myofascial therapy treatments using ischemic compression on shoulder trigger points in patients with chronic shoulder pain. The results indicated that the experimental group had a 62% reduction in their Shoulder Pain and Disability Index score compared with an 18% reduction in the control group. This study suggests that myofascial therapy using ischemic compression on shoulder trigger points may reduce chronic shoulder pain (Hains, Descarreaux and Hains, 2010). The study was a well designed cross-over clinical trial, and hence the results could be treated with a high level of significance.

2.6.6. Transcutaneous electrical nerve stimulation (TENS)

Transcutaneous electrical nerve stimulation (TENS) is a commonly used therapy in chronic and acute pain management. Positioning of the TENS electrode is an empiric process and may involve placement at trigger point sites or along zones of referred pain (Lavelle, Lavelle and Smith, 2007). This modality is commonly used, as the low intensity stimulation of TENS selectively activates the large diameter fibres to close the pain gate in the dorsal horn of the spinal cord or at a higher level and resultantly eliminates pain (Melzack and Wall, 1988).

2.6.7. Ultrasound

Ultrasound uses a high-frequency acoustic energy that is generated by using the reverse piezoelectric effect. It has both a thermal and non-thermal effect on tissue (Esenyel, 2000). The Thermal effect is the ability of the therapeutic ultrasound to elevate the tissue temperature, thereby producing the following therapeutic effects

(Rickards, 2006): decrease in joint stiffness, reduction in muscle pain and spasm, production of a mild inflammatory reaction and inducing a marked increase in blood flow, which helps in the resolution of chronic inflammatory processes. The Non-thermal effects are attributed to any mechanics other than an increase in tissue temperature. According to Hogan, Burke and Franklin (1982) some of these effects include: stimulation of tissue regeneration, improvement of 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, was shown to have no additional advantage or significant effect on pain. A significant limitation in this type of research design is that subjects may not have followed the instructed home exercises properly and this may have impacted the results of the study.

2.6.8. Dry-needling

Dry-needling is one of the most effective modalities used in the treatment of MTrPs (Kamanli et al 2005). This involves the insertion of an acupuncture needle directly into a trigger point. Trigger points are theorised to be deactivated by dry-needling (Weiner, 2007). This aids in the reduction of pain, referred pain and muscle spasm (Ga et al 2007).

2.7. Dry-needling

The dry-needling of a trigger point is a procedure that involves the insertion of an acupuncture needle into the skin and muscle (Dommerholt and Huijbregts, 2009). Over 75% of South African physical therapists use dry-needling at least once daily and in combination with other physical therapy interventions (Dommerholt, Bron and Franssen, 2006).

According to Kamanli et al (2005) dry needling is one of the most effective treatment options available and appears to be as effective as an injection of medication in the treatment of myofascial trigger points (Speed, 2007). The benefits of other methods of treatment take a longer time to show results when compared to injection type treatments (Srbely, 2010). Medicinal trigger point injections are associated with unwanted side effects i.e. allergic reactions, muscle necrosis (Baldry, 2002; Travell, Simons and Simons, 1999), tendon atrophy, skin de-pigmentation, apnoea, syncope and palpitations (Ruane, 2001), therefore dry-needling is recommended as a safer option for the patient (Rickards, 2006).

Trigger points are located by digital palpation and the needle is inserted 1-2 cms away and directed towards the trigger point such that the needle approaches at an angle of 30 degrees to the skin (Travell, Simons and Simons, 1999). A variety of techniques may be used to stimulate the needle once it has been inserted into a trigger point. This includes twirling and twisting, vibration, rotation, lifting and thrusting and snapping (Mense and Gerwin, 2010). Although all these techniques exist, the fanning dry needling technique was selected for this research. This involves partially withdrawing the needle from the skin and redirecting it in a fan-like manner, in order to inactivate all active foci (Travell, Simons and Simons, 1999). According to the literature, to inactivate active foci it is necessary to illicit a local twitch response when needling (Ga et al 2007). In a study conducted by Hong (1994) it was found that a local twitch response could be obtained between 10-60 needle insertions and this could indicate the length of time for which needling may need to be done in order for it to have a beneficial effect.

Various mechanisms have been proposed to play a role in the deactivation of MTrPs by the use of dry-needling (Dommerholt and Huijbregts, 2009). Dry needling is believed to lead to the deactivation of myofascial trigger points through various postulated mechanisms.

Dry needling leads to the desensitization of the local nerve endings by mechanical disruption of a taut palpable band in muscles (Travell, Simons and Simons, 1999). Dry needling also uses hyperstimulation analgesia to disrupt the positive feedback mechanism that perpetuates pain (Kuan, 2009). The release of increased levels of

extracellular potassium, due to mechanical disruption of muscle fibres causes the depolarization of nerve fibres (Dommerholt and Huijbregts, 2009). Dry needling alters motor endplates leading to the denervation of distal axons when the needle hits a trigger point (Travell, Simons and Simons, 1999). This causes interruption of the central feedback mechanism (Travell, Simons and Simons, 1999).

The process of dry-needling leads to the mechanical disruption of the muscle tissue and can injure neighbouring structures i.e. nerves and blood vessels (Baldry, 2002). This causes a series of responses, namely inflammation. Inflammation is characterized by swelling, redness, heat and pain (Michlovitz, 1996). This pain is frequently perceived as post-needling soreness (Travell, Simons and Simons, 1999).

2.8. Post-needling Soreness

Post-needling soreness is a negative effect of dry-needling that patients experience and has been commented on by numerous authors (Alvarez and Rockwell, 2002; Travell, Simons and Simons, 1999; Lewit, 1979). It is an entirely separate entity and is not the same as myofascial pain (Lewit, 1979). Post-needling soreness is associated with a constant pressure or a dull aching sensation experienced by the patient after the dry-needling procedure; this discourages patients from seeking an effective modality of treatment and may prolong the patient's recovery (Hong, 1994).

Post-needling soreness is related to micro-hemorrhage caused by tissue damage at the needled site (Alvarez and Rockwell, 2002; Hong, 1994). It was found to be caused by both single insertions and fanning dry-needling techniques (Ferreira, 2006; Rowley, 2000). This can contribute to the delay of treatment and recovery as the development of post-needling soreness prevents any further needling of the same region for 3-4 days after treatment (Travell, Simons and Simons, 1999).

In prior studies, the origin of post-needling soreness was unclear as to whether it developed from the trigger point itself or whether the tissue damage caused by the needle insertion was responsible. A study was conducted by Ferreira (2006) to

investigate whether dry-needling muscle tissue in asymptomatic subjects resulted in post-needling soreness. This study was a randomised, placebo-controlled experimental investigation comprising 60 subjects between the ages of 18 and 50 that were asymptomatic of lower back pain and were randomly allocated into three equal groups. The first group received the single needle insertion technique, the second group received the fanning dry-needling technique which involves the insertion of a needle into the muscle, removal of the needle to the subcutaneous tissue layer and re-orientation to another position ten times, without completely removing the needle from the skin (Travell, Simons and Simons, 1999; Hong, 1994). The final group made up the control group. Placebo needles were used to treat those subjects. The findings according to the NRS 101 and 24-hour pain diaries, showed that asymptomatic subjects did experience post-needling soreness in group 1 (single needle insertion group) and group 2 (fanning dry-needling group).

Hong (1994) conducted a double-blinded controlled study to investigate the effects of lidocaine injections versus dry-needling of the upper trapezius myofascial trigger points in 58 patients. He reported that all patients within the dry-needling group developed post-needling soreness 2-8 hours after receiving needling. Post-needling soreness of greater intensity and longer duration was noted than those treated with a lidocaine injection. Post-needling soreness appears to be most severe 22-24 hours after injection (Hugenin, 2004).

Manga (2008) conducted a prospective, randomised, controlled experimental investigation to determine the effect of action potential simulation on post dry-needling soreness in the treatment of active trapezius myofascitis. The study consisted of 60 subjects divided into 3 groups of 20 subjects. The first group received the fanning dry-needling technique, the second group received a combination of fanning and APS therapy and the third group which was the control group received fanning dry-needling with Sham APS therapy. The results revealed that all three treatment groups responded equally in the alleviation of pain. However, the dry-needling treatment group alone (Group One) had a significant decrease in pain compared to the other two groups. It was concluded that APS Therapy had no

significant beneficial effects on post-needling soreness. However, in this study, there was no blinding applied to the design. This could have introduced a possible researcher bias which could have significantly influenced the results.

Chonan (2008) conducted a randomised, two group parallel controlled trial to determine the effect of cryotherapy on post dry-needling soreness. The study consisted of 60 asymptomatic participants between the ages of 18 and 50. These individuals were divided randomly into two equal groups. Group A received dry-needling and cryotherapy with a cold gel pack and group B receives dry-needling only. The findings of the study showed no beneficial effect of cryotherapy on objective and subjective findings and thus no significant effect on reducing post dry-needling soreness. In this study, individual pain thresholds were not accounted for as the dry-needling group may have had a different pain threshold to the dry-needling and cryotherapy group, which may have affected the results of the study. In addition, the sample size may have been too small in order to have elicited any differences.

Previous authors (Chonan, 2008; Manga, 2008; Ferreira, 2006; Travell, Simons and Simons, 1999) have recommended moist heat, the application of pressure to the needled area and stretching, to aid in the prevention of post-needling soreness. According to Huguenin (2004) patients still find dry-needling painful, hence an effective modality to reduce post-needling soreness needs further investigation.

2.9. Heat Therapy

Heat therapy is the application of heat to the body for pain relief (Lane and Latham, 2009). This therapy is one of the oldest forms of treatment for pain. The first documented use dates back to around 3000BC as this was found in the Egyptian Edwin Smith's surgical papyrus (van der Zee, 2002). According to Melzack and Wall (1988) heat has been reported to decrease pain by blocking nociceptors by various mechanisms around the area of injury. In addition this therapy leads to an increase in blood flow to the affected area and relaxes underlying muscles (Travell, Simons and Simons, 1999). The therapeutic benefits of heat have been identified as:

- Increasing pain relief (Nadler, Weignand and Kruse, 2004),

- increasing metabolism (Nadler, Weignand and Kruse, 2004),
- increasing connective tissue extensibility (Nadler, Weignand and Kruse, 2004),
- decreasing muscle spasm (Nadler, Weignand and Kruse, 2004),
- reducing muscle stiffness (Nadler et al 2003)
- reducing disability (Nadler et al 2003)
- Increasing flexibility (Nadler et al 2003)

An increase in blood flow facilitates tissue healing by supplying nutrients, protein and oxygen at the site of injury. A 1°C increase in tissue temperature is associated with a 10% to 15% increase in local tissue metabolism (Cameron, 1999). This increase in metabolism aids the healing process by increasing both catabolic and anabolic reactions needed to degrade and remove metabolic by-products of tissue damage. In addition the increase provides the milieu necessary for tissue repair. Some of the benefits provided by topical heat therapy may be mediated directly in the brain. Davis et al (1998) conducted functional brain imaging research which has revealed central effects of non-noxious skin warming with increased activation of the thalamus and posterior insula of the brain. In addition, innocuous tactile stimulation of the skin activates the thalamus and S2 region of the cerebral cortex. These direct effects on the brain may mitigate the sensation of pain in the brain, thus providing pain relief. Topical heat treatment applied directly on the skin increases both deep tissue temperature and blood flow. Mulkern et al (1999) found that heating pad treatment on the skin of the lower back region at 40°C increased deep muscle tissue temperature 5°C, 3.5°C, and 2°C at muscle tissue depths of 19 mm, 28 mm, and 38 mm below the surface of the skin, respectively.

Nadler et al (2002) conducted a study that evaluated a continuous low-level topical heat wrap therapy for the treatment of acute low back pain. Subjects were randomised to heat wrap, acetaminophen, ibuprofen, placebo, or un-warmed heat wrap for four days. It was found that during all four days, pain relief with the heat wrap was significantly higher than with ibuprofen or acetaminophen. Additionally, the

heat wrap group experienced improved lateral trunk flexibility, reduction in muscle stiffness, and reduced disability overall. The heat wrap performed better than either ibuprofen or acetaminophen in this study.

In a later study, Nadler et al (2003) evaluated the efficacy of eight hours of continuous heat wrap therapy for the treatment of acute non-specific lower back pain of non-traumatic origin. The study was a randomised, placebo-controlled, single-blinded trial using subjects between 18 and 55 years. The four groups of subjects were stratified according to pre-treatment pain intensity and gender. Group one used a wearable heat wrap, which heated up to 40 degrees Celsius and retained this temperature for at least eight hours. Group two received an oral placebo consisting of 2 tablets, 3 times a day taken 6 hours apart. Group three received an oral analgesic, ibuprofen 200mg consisting of 2 tablets, 3 times a day taken 6 hours apart. Group four received an unheated heat wrap. Baseline measures were completed using the Roland-Morris Disability Questionnaire in order to assess any improvements. The results of the study found that the level of pain relief was significantly higher in the heated wrap group over the 3-day treatment period and a comparison of the heat wrap group with the small oral ibuprofen group indicated a statistically significant decrease in the level of pain relief in the group that received a warmed heat wrap intervention. Continuous low-level heat wrap therapy was shown to provide significant therapeutic benefits in patients with acute non-specific LBP, as indicated by increased pain relief and trunk flexibility, and it provided decreased muscle stiffness and disability when compared with the placebo. However, in this study, the age range was too wide, and a significant confounding factor could be the degeneration of the spine in older individuals. Another, factor that may have affected the results of this study was that the subjects in group two and three may have not taken the required dosage of tablets, due to possibly forgetting to take the correct number of tablets or taking the tablets at different time intervals.

Francis (2005) conducted a comparative, randomised study to investigate the effectiveness of proprioceptive neuromuscular facilitation combined with heat therapy as opposed to proprioceptive neuromuscular facilitation combined with

cryotherapy in the treatment of mechanical neck pain caused by hypertonic posterior cervical muscles in 60 patients. A starting temperature of 60 degrees Celsius was used and it was reported that heat therapy yielded more positive results in participants in the older age groups.

2.10. ANATOMY OF THE MUSCLES

According to Travell, Simons and Simons (1999) the deltoid muscle is a muscle that commonly develops MTrPs and was the muscle used in this study. The anatomical attachments, trigger point location, referral pain patterns and innervation of the deltoid muscle are described below:

Anatomical Attachments- The proximal fibres of the anterior, middle and posterior parts attach to the lateral third of the clavicle, acromion and spine of the scapula, respectively. Distally, they all attach to the deltoid tuberosity of the humerus (Moore and Dalley, 2006).

Trigger point location- The muscle is examined by snapping palpation across the MTrPs with the arm positioned in 30 degrees of abduction. Trigger points in the middle deltoid can develop anywhere along the muscle (Travell, Simons and Simons, 1999).

Referral Pain pattern- Active trigger points in the deltoid muscle do not commonly refer pain to a distant site. Pain is often spread locally in the area of the affected part. Active MTrPs in the anterior deltoid refer pain to the anterior and middle regions. Active MTrPs in the middle deltoid refer pain in the corresponding region with minimal spill over pain to adjacent areas. Active MTrPs in the posterior deltoid refers pain that concentrates over the posterior shoulder while sometimes spilling into adjacent areas of the arm (Travell, Simons and Simons, 1999).

Innervation- The deltoid is innervated by the axillary nerve (Moore and Dalley, 2006).

In this study subjects were excluded from the study if they were found to have either active or latent MTrPs in the muscle as this study did not permit dry-needling of trigger points.

2.11. Summary

MPS is a prevalent musculoskeletal condition which is associated with the development of MTrPs. Various therapies are available to treat this condition, however dry-needling has been found to be one of the most effective therapies. A negative effect of dry-needling is post-needling soreness which can cause a dull aching sensation and further prolong the patient's pain.

Heat therapy has been used for the treatment of pain for many generations and consists of numerous therapeutic benefits. However, studies found related to heat therapy have been old. Many of the research studies are of a poor methodological quality. Despite the limitations in research studies, heat therapy still remains one of the oldest and simplest therapies used to treat myofascial injuries, due to its ability to relieve pain, muscle spasm, increase blood flow and facilitate tissue healing.

It has already been established that post-needling soreness is thought to be caused by tissue damage as a result of dry-needling. Thus heat could be applied immediately after this acute trauma to limit pain and aid in tissue healing. Therefore the aim of this study is to investigate the application of heat as a modality to reduce post-needling soreness after dry-needling the deltoid muscle in asymptomatic subjects.

CHAPTER THREE

MATERIALS AND METHODS

3.1. Study design

The study was designed as a randomised, parallel-controlled clinical-trial in which subjects acted as their own controls. A sample of 30 asymptomatic subjects between the ages of 18 to 50 was used. The study was approved by the ethics clearance committee at the Durban University of Technology (Appendix I).

3.2. Subject recruitment

Subjects were selected from those who responded to advertisements (Appendix B) placed at the Chiropractic Day Clinic at the Durban University of Technology and various other public places. The public were also informed by pamphlet distribution and word of mouth. This study was conducted using asymptomatic subjects only and all volunteers were screened prior to their acceptance into the study based on the inclusion and exclusion criteria (discussed later in this chapter). There was no restriction on ethnicity, gender, cultural or socioeconomic background.

3.3. Sample size and randomisation

A sample size of 30 subjects was used for this study. Each subject acted as their own control in that both the left and right arms of each subject were dry-needled. However, one of the arms received heat therapy after the dry-needling procedure while the other arm acted as a control. Randomising which arm would belong to which group was done by placing 15 A's and 15 B's into a box, the subjects were asked to remove a piece of paper from the box and without looking at it, hand it to the researcher. The paper that was removed from the box determined which arm received heat therapy. An A indicated that the subject's right arm received heat

therapy and a B indicated that the participant's left arm received heat therapy.

Thus at the end of the study, there were two groups of subjects. Those who received dry-needling and heat therapy on the right arm, which was referred to as the intervention arm while the left acted as the control and only received dry-needling. The opposite is true for the second group in which the left arm was now called the intervention arm (dry-needling and heat therapy) while the right arm only received dry-needling and acted as the control arm.

3.4. Clinical procedure

3.4.1. Patient procedure

Volunteers who showed an interest in participating in the study had the details of the study explained to them. Each subject was given a Letter of Information (Appendix A) which outlined the research details and all the relevant information regarding the research procedure. Each subject signed an Informed Consent Form (Appendix A) and completed a Numerical Pain Rating Scale-101 (NRS-101) form (Appendix G).

Each subject underwent a full case history (Appendix D) and physical examination (Appendix E). A shoulder regional examination (Appendix F) was performed in detail. The skin-fold thickness measurement over the deltoid region was taken using a caliper (Slimguide Skinfold) and was recorded. Subjects were only accepted into the study if subjects fulfilled the inclusion and exclusion criteria.

3.4.2. Inclusion Criteria

1. Past epidemiological studies suggested that the greatest prevalence of MPS were between the ages 20-50 (Van Aardenne, 2002; Fomby and Mellion, 1997; Han and Harrison, 1997; Sola, Rodenberger and Getty, 1955) thus subjects between the ages of 18 and 50 were selected for this study.
2. Otte et al (2002) found that a 20-25 minute treatment time was sufficient to reach deep tissue in subjects with a skin-fold thickness of 20mm or less. In this

study a 20 minute heat application was used hence only subjects with a skin-fold thickness of 20mm and less were included.

3. Subjects were only accepted once they had read and signed the Informed Consent form (Appendix A) and had undergone a complete case history (Appendix D), a physical examination (Appendix E) and a shoulder regional examination (Appendix F).
4. All subjects were required to be asymptomatic in the shoulder region bilaterally.

3.4.3. Exclusion Criteria

1. Subjects with contra-indications to dry-needling and heat therapy were excluded. These were:
 - a. Subjects under the influence of alcohol or those suffering from systemic illness, fever, bleeding disorders, anxiety or syncopial reactions (Travell, Simons and Simons, 1999). Subjects who reported initially being adverse to the thought of dry needling were excluded. All smokers were excluded as tobacco causes low vitamin C levels which can lead to increased fragility of capillaries, possibly resulting in subcutaneous bleeding and altered development of post-needling soreness, (Travell, Simons and Simons, 1999).
 - b. Subjects who had areas of recent bleeding or haemorrhage, lack of local thermal sensation, devitalised tissue e.g. after deep X ray therapy, open wounds and impaired circulation to the part being treated.
2. Subjects receiving or those who have received dry-needling in the three months prior to the initial consultation were excluded, as maximal naivety regarding the onset of post-needling soreness was desired (Mouton, 1996).
3. Subjects found to have either active or latent myofascial trigger points in the

middle deltoid muscle.

4. Subjects who were unable to commit to the 24 hour follow up appointment.

3.4.4. Intervention

Once subjects were accepted into the study, subjects were positioned in a seated position for the duration of the treatment. The arm was placed in 30 degrees of flexion. Subjects were tested for their ability to feel hot and cold, by placing glasses filled with hot and cold water on the deltoid area. An Algometer reading (Appendix H) was taken from the spot to be needled prior to the commencement of dry-needling.

The area to be dry-needled was located in the mid-belly of the middle deltoid muscle. The needle was inserted into the muscle. It was then removed to the subcutaneous tissue layer and redirected to another position ten times, without completely withdrawing the needle from the skin (Ferriera, 2006; Travell, Simons and Simons, 1999; Hong, 1994). The left and right arms both received the fanning technique. It was assumed that the fanning technique used in asymptomatic deltoid muscles will result in post-needling soreness.

Solid bore 0.25x25mm needles were used and all needles were only used once and were opened in front of the subjects. The areas that were needled were sterilized with alcohol before and after the treatment. The used needles were then discarded into the medical waste bin which was done in accordance with normal clinical procedure. Immediately after the needle was removed the area was cleaned with alcohol and the needled spot was marked with henna. The examiner wore surgical gloves at all times throughout the entire procedure and the aseptic technique was followed.

Dry-needling and Heat pack intervention

Visit 1

The areas to be dry-needled were exposed and Algometer (Appendix H) readings

were taken. The subject was asked to fill out NRS-101 forms (Appendix G) prior to the dry-needling. The area was then cleaned with alcohol and the needle was inserted into the muscle. The needle was then withdrawn to the subcutaneous tissue layer and then re-orientated to another position with a total of ten repetitions, (Ferriera, 2006; Travell, Simons and Simons, 1999; Hong, 1994).

The needles were inserted into both deltoid muscles one immediately after the other. Only after the needles were inserted into the respective arms did the fanning technique begin. The fanning technique was alternated between both the arms. Thereafter the needles were withdrawn and the heat therapy intervention was applied to the intervention arm, while the non-intervention arm received no heat therapy (no intervention). Immediately after the needle had been removed the area was cleaned with alcohol and the needled spot was marked with henna and then covered with a plaster. The henna was used to mark the area in order to make sure that all measurements were obtained from the exact spot that was needled and that consistency occurred.

Subjects were treated with 20 minutes of heat therapy following the dry-needling procedure, (Otte et al 2002) a wheat heat bag was placed over the middle deltoid muscle of the intervention arm at a starting temperature of 60° C (Francis, 2005). Care was taken to shape the heat pack to the contour of the subject's deltoid muscle. The starting temperature was measured by placing a thermometer between the heat pack and the arm. A period of 60 seconds was allocated for the thermometer to read the temperature. The thermometer was then removed and the temperature was recorded.

The subject's response was verbally checked after the first 2 minutes for discomfort, then after every 5 minutes. If the subject experienced discomfort a visual check was performed. A visual check for blisters and skin colour changes was done after the first 4 minutes and at 20 minutes after the treatment was completed (Quillen and Underwood, 1995). After the heat pack was removed, subjects were asked to complete an NRS-101 form and an Algometer reading was

taken of the needled spot.

Subjects were all given a 24 hour pain diary (Appendix C) to complete, in order to monitor the development of post-needling soreness following treatment. Subjects were instructed to not apply ice to the needled area, to not take any medication (anti-inflammatory drugs) and to fill in the pain diary precisely according to the allocated times.

Visit 2

This occurred approximately 24 hours after the first treatment. Subjects completed a NRS-101 form and Algometer readings of the dry-needled areas were taken and the Pain Diaries were collected.

3.5. Outcome measures

3.5.1. Subjective data

3.5.1.1. Numerical Pain Rating Scale-101 (NRS-101)

The NRS-101 is used in order to monitor the development of post-needling soreness as perceived by the subject. The NRS-101 involves asking the subject to rate his or her pain intensity on a numerical scale from a score of 0 to 100, with 0 representing the subject experiencing no pain and 100 representing the subject experiencing the pain at its worst. Subjects in this study were required to complete the NRS-101 at three different time intervals: 1.] prior to the dry-needling intervention, 2.] immediately after the dry-needling intervention and 3.] Twenty four hours post-needling (Appendix G).

3.5.1.2. Pain Diary

Due to the uncertainty regarding the time period pertaining to the onset of post-needling soreness, all subjects were required to complete a 24 Hour Pain Diary (Appendix C) in order to monitor its onset and duration following the treatment. The Pain Diary had 5 time points (3 hrs, 6 hrs, 9 hrs, 12 hrs and 24 hrs), starting immediately after the treatment, and subjects were required to either tick 'yes' or

'no' to indicate whether or not they are experiencing pain at that point. The Pain Diary requires subjects to record at which time, in hours, they experience the most pain. Subjects were not allowed to take any drugs during this 24 hour period.

3.5.2. Objective data

3.5.2.1. Pressure Threshold Algometry

The Algometer is a diagnostic tool used to identify abnormal tenderness and to quantify the sensitivity of myofascial trigger points (Han and Harrison, 1997). This tool measures the subject's pressure pain threshold which is defined as the minimum pressure (force) that induces pain or discomfort (Fischer, 1996). In a study performed by Nussbaum and Downes (1998) it was concluded that the non-electronic Algometer is a reliable way of measuring the pressure pain threshold over three consecutive days. In this study, the Algometer reading was taken once the area of needle insertion was marked. Pressure was gradually applied until the subject indicated the point at which they first felt pain. A reading was then taken and recorded. This procedure was performed three times: 1.] prior to the dry-needling intervention, 2.] immediately after the dry-needling intervention and 3.] Twenty four hours post-needling (Appendix H). A general decrease in measurements indicates an increase in pain.

3.6. Statistical Analysis

SPSS version 18 was used for analysis of data (SPSS Inc. Chicago, Ill, USA). Thirty subjects were randomized to two equal treatment groups. Both their left and right arms were used as units of analysis (n=60). Independent samples t-test and Pearson's chi square tests were used to compare age and gender between the treatment groups. Each subject had either their left or right arm treated with heat. Outcomes of pain were assessed at three time points. Repeated measures ANOVA testing was used to compare the effect of heat treatment with no heat treatment in the 60 arms over the three time periods of assessment for the outcomes which were measured as continuous variables (NRS and algometer). For binary outcomes such as the presence or absence of pain at any time point, Fisher's exact tests

were used to compare the heat treated with the control arms in the left and right arms separately. Caliper measurements were compared between right and left arms in each treatment group using paired t-tests. A p value <0.05 was considered as statistically significant.

3.7. Definitions of tests used

3.7.1. Independent samples t-test

An independent samples t-test is used when you want to compare the means of a normally distributed interval dependent variable for two independent groups (Statistical Tests in SPSS, 2011).

3.7.2. ANOVA

A one-way analysis of variance (ANOVA) is used when you have a categorical independent variable (with two or more categories) and a normally distributed interval dependent variable and you wish to test for differences in the means of the dependent variable broken down by the levels of the independent variable (Statistical Tests in SPSS, 2011).

3.7.3. Pearson's Chi-square test

The most common type of chi-square test is Pearson's Chi-square test (McDonald, 2009). A chi-square test is used when you want to see if there is a relationship between two categorical variables. In SPSS, the chi square option is used on the statistics subcommand of the crosstabs command to obtain the test statistic and its associated p-value (Statistical Tests in SPSS, 2011).

3.7.4. Fisher's exact test

The Fisher's exact test is used when you want to conduct a chi-square test but one or more of your cells has an expected frequency of five or less. The chi-square test assumes that each cell has an expected frequency of five or more, but the Fisher's exact test has no such assumption and can be used regardless of how small the expected frequency is (Statistical Tests in SPSS, 2011). Fisher's exact test has a greater accuracy than the chi-squared test when the expected numbers are small (McDonald, 2009).

CHAPTER FOUR

RESULTS

The results displayed in this chapter and the one which follows, are tabulated and discussed according to the arm in which the subjects received the treatment (dry-needling and heat therapy combined). Therefore, the tables and graphs reflect the results for “right-arm-intervention” and “left-arm-intervention” and the corresponding appropriate arm was the control (dry-needling only). The reason for this format of analysis is that each subject acted as their own control, and hence received dry-needling on both arms. Therefore this factor had to be accounted for, during the statistical analysis. The results could not be combined as purely “intervention- arm” and “control-arm”.

4.1. Demographics by groups

4.1.1. Demographics by age

Table 1: Comparison of mean age in the two treatment groups

	Treatment Group	N	Mean	Standard Deviation	P Value
Age in years	Right arm intervention	15	24.1	7.2	0.702
	Left arm intervention	15	25.0	4.8	

Table 1 shows that there was no statistically significant difference in age between the subjects of the two groups ($p=0.702$). The mean age of subjects was 24,55 years overall with a standard deviation of 6 years and a range from 19 to 48 years.

4.1.2. Demographics by gender

Table 2: Cross tabulation of gender by treatment group

			gender		Total
			Male	female	
Group	Right arm intervention	Count	5	10	15
		% within group	33.3%	66.7%	100.0%
	Left arm intervention	Count	8	7	15
		% within group	53.3%	46.7%	100.0%
Total		Count	13	17	30
		% within group	43.3%	56.7%	100.0%

P=0.269

Table 2 illustrates that there was no significant difference between the percentage of males and females in the two groups ($p=0.269$). The percentage distribution between males and females was similar in the two groups.

4.2. Statistical Analysis for Objective One

4.2.1. Objective 1

To determine the relative effectiveness of heat therapy immediately after dry-needling versus dry-needling alone on post-needling soreness in the deltoid muscle of asymptomatic subjects. This was done in terms of subjective clinical findings.

Table 3: Repeated measures ANOVA testing on NRS measurements

Multivariate Tests ^b						
Effect		Value	F	Hypothesis df	Error df	Sig.
side	Wilks' Lambda	.996	.116 ^a	1.000	28.000	.736
side * treatmentgroup	Wilks' Lambda	.932	2.043 ^a	1.000	28.000	.164
time	Wilks' Lambda	.622	8.221 ^a	2.000	27.000	.002
time * treatmentgroup	Wilks' Lambda	.980	.269 ^a	2.000	27.000	.766
side * time	Wilks' Lambda	.996	.057 ^a	2.000	27.000	.945
side * time * treatmentgroup	Wilks' Lambda	.932	.985 ^a	2.000	27.000	.386
a. Exact statistic						
b. Design: Intercept + treatmentgroup						
Within Subjects Design: side + time + side * time						

Table 3 shows that there was no effect of the heat treatment vs. no heat treatment with regards to NRS ($p=0.776$). Both the heat treated and control arms showed an increase in NRS score from time 1 to 2, followed by a decrease to time 3. The rate of decrease was the same in the heat treated and control arms.

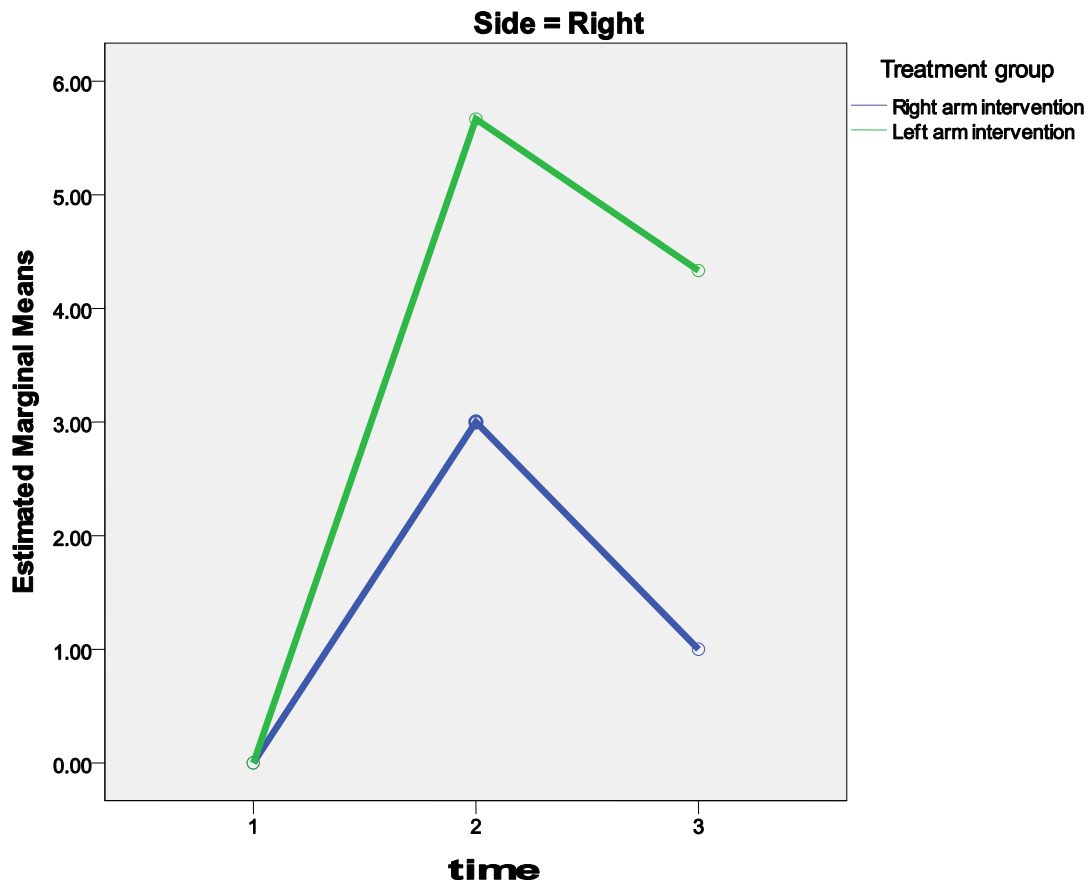


Figure 1: Mean NRS-101 score by time and treatment group in Right arms

Figure 1 depicts that on the right arms, where the right arm was treated with heat, the increase in NRS score was not as high as the increase in pain in the control arm. However, both groups experienced a decrease in pain between times 2 and 3. Those whose right arms were treated with heat returned to almost baseline NRS scores but those whose right arms were the control remained at slightly higher NRS scores, suggesting that heat treatment has an effect, but this was not demonstrated statistically in this study.

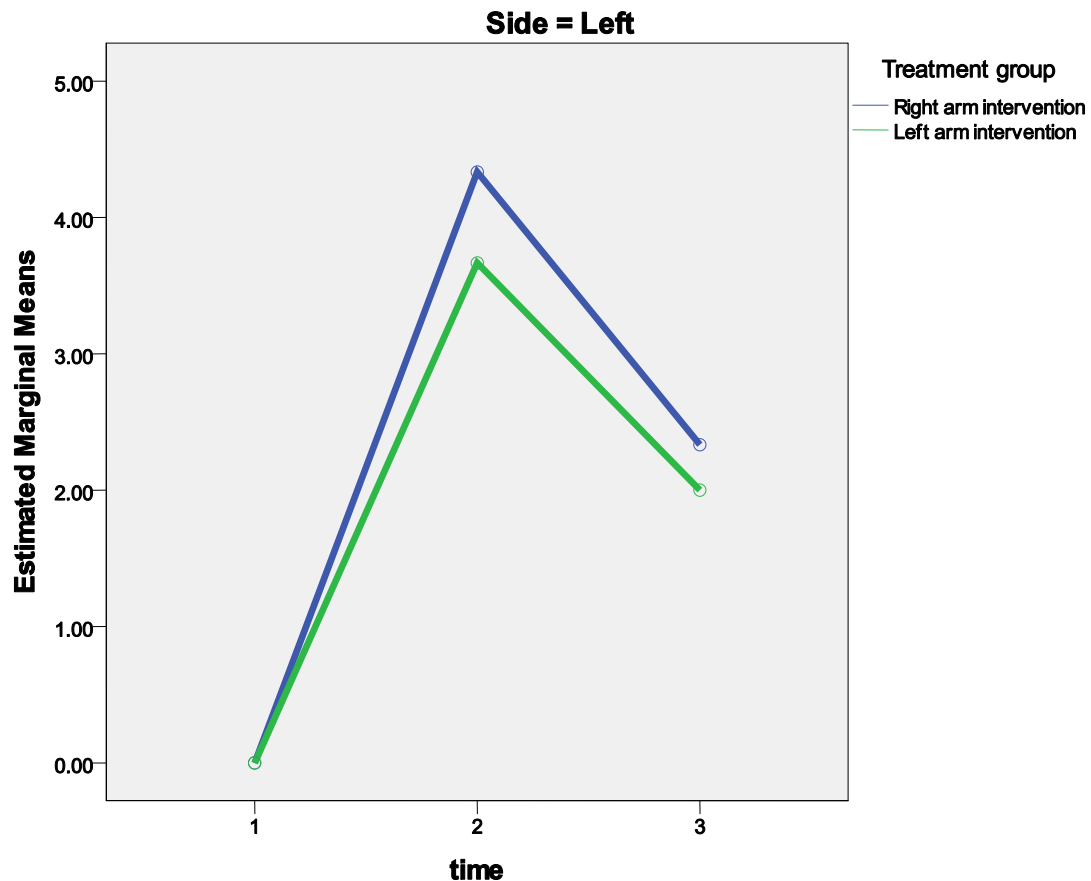


Figure 2: Mean NRS-101 score by time and treatment group in Left arms

Figure 2 shows that on the left arms, where the left arm was treated with heat, the increase in NRS score was almost as high as the increase in pain where that arm was the control. However, both groups experienced a decrease in pain between times 2 and 3. The profiles are almost parallel, indicating that the effect of heat treatment was minor.

Therefore for NRS scores, there was a slight trend that heat intervention on the right arm led to slightly lower pain at time 2 and 3 on the right arm, but heat intervention on the left arm did not affect pain scores on either arm.

Pain diary

The pain diary measured presence or absence of pain up to 24 hours post intervention, and it measured at which time point the pain was the most intense. To compare whether any pain was reported up to 24 hours post intervention, Fisher's exact tests were used since the number of subjects reporting any pain was small.

Table 4: Cross-tabulation of treatment group by any pain in the right arm reported by pain diary

			Any pain right arm		Total
			yes	no	
Treatment group	Right arm intervention	Count	1	14	15
		% within Treatment group	6.7%	93.3%	100.0 %
	Left arm intervention	Count	5	10	15
		% within Treatment group	33.3%	66.7%	100.0 %
Total		Count	6	24	30
		% within Treatment group	20.0%	80.0%	100.0 %

P=0.169

It is evident that in Table 1 there was only one subject who reported any pain in the right arm from the group who had their right arm treated with heat. The corresponding number was 5 from the control group. However, this difference was not statistically significant (p=0.169).

Table 5: Cross-tabulation of treatment group by any pain in the left arm reported by pain diary

			Any pain left arm		Total
			Yes	No	
Treatment group	Right arm intervention	Count	3	12	15
		% within Treatment group	20.0%	80.0%	100.0 %
	Left arm intervention	Count	4	11	15
		% within Treatment group	26.7%	73.3%	100.0 %
Total		Count	7	23	30
		% within Treatment group	23.3%	76.7%	100.0 %

P=1.000

Table 5 depicts that there were four subjects who reported any pain in their left arms from the group who had their left arms treated with heat. The corresponding number was 3 from the control group. There was no difference statistically between these two proportions ($p=1.000$).

Therefore in terms of any pain reported by the pain diary, there was a slight trend that treatment of the right arm led to slightly less pain in the right arm, but no evidence that heat treatment of the left arm led to reduced pain in the left arm.

Table 6: Treatment group by pain reported at various time points on right and left arms

		Treatment group			
		Right arm intervention		Left arm intervention	
		Count	Column N %	Count	Column N %
Pain 6hrs right arm	no	14	93.3%	12	80.0%
	yes	1	6.7%	3	20.0%
Pain 6 hrs left arm	no	13	86.7%	13	86.7%
	yes	2	13.3%	2	13.3%
Pain 9 hrs right arm	no	15	100.0%	12	80.0%
	yes	0	.0%	3	20.0%
Pain 9 hrs left arm	no	14	93.3%	14	93.3%
	yes	1	6.7%	1	6.7%
Pain 12 hrs right arm	no	15	100.0%	14	93.3%
	yes	0	.0%	1	6.7%
Pain 12 hrs left arm	no	15	100.0%	13	86.7%
	yes	0	.0%	2	13.3%
Pain 24 hrs right arm	no	15	100.0%	14	93.3%
	yes	0	.0%	1	6.7%
Pain 24 hrs left arm	no	15	100.0%	14	93.3%
	yes	0	.0%	1	6.7%

Table 6 above shows that there were very few instances of pain reported at each time point. None of the sides or time points was significantly different between the two treatment groups.

4.3. Statistical Analysis for Objective Two

4.3.1. Objective 2

To determine the relative effectiveness of heat therapy immediately after dry-needling versus dry-needling alone on post-needling soreness in the deltoid muscle of asymptomatic subjects. This will be done in terms of objective clinical findings.

Table 7: Repeated measures ANOVA testing on algometer measurements

Multivariate Tests ^b						
Effect		Value	F	Hypothesis df	Error df	Sig.
side	Wilks' Lambda	.933	2.027 ^a	1.0	28.00	.166
side * treatment group	Wilks' Lambda	.978	.638 ^a	1.0	28.00	.431
time	Wilks' Lambda	.531	11.944 ^a	2.0	27.00	.000
time * treatment group	Wilks' Lambda	.989	.148 ^a	2.0	27.00	.863
side * time	Wilks' Lambda	.936	.922 ^a	2.0	27.00	.410
side * time * treatment group	Wilks' Lambda	.919	1.193 ^a	2.0	27.00	.319
a. Exact statistic						
b. Design: Intercept + treatment group Within Subjects Design: side + time + side * time						

Table 7 shows that there was no effect of the heat treatment vs. no heat treatment with regards to algometer measurements ($p=0.863$).

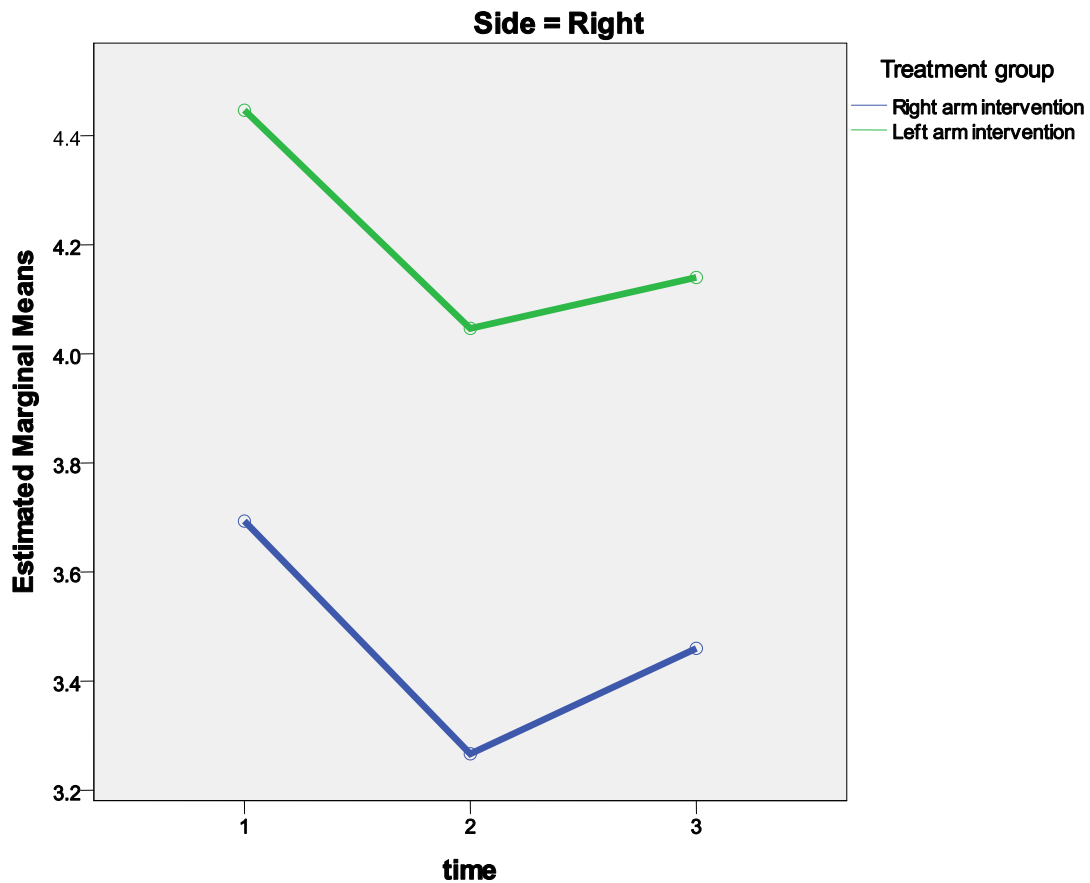


Figure 3: Mean algometer measurement by time and treatment group in Right arms

It is evident that in Figure 3 on right arms, both treated and control arms showed a decrease in algometer measurement from time 1 to 2, followed by a slight increase to time 3. The rate of change was the same in the heat treated and control arms.

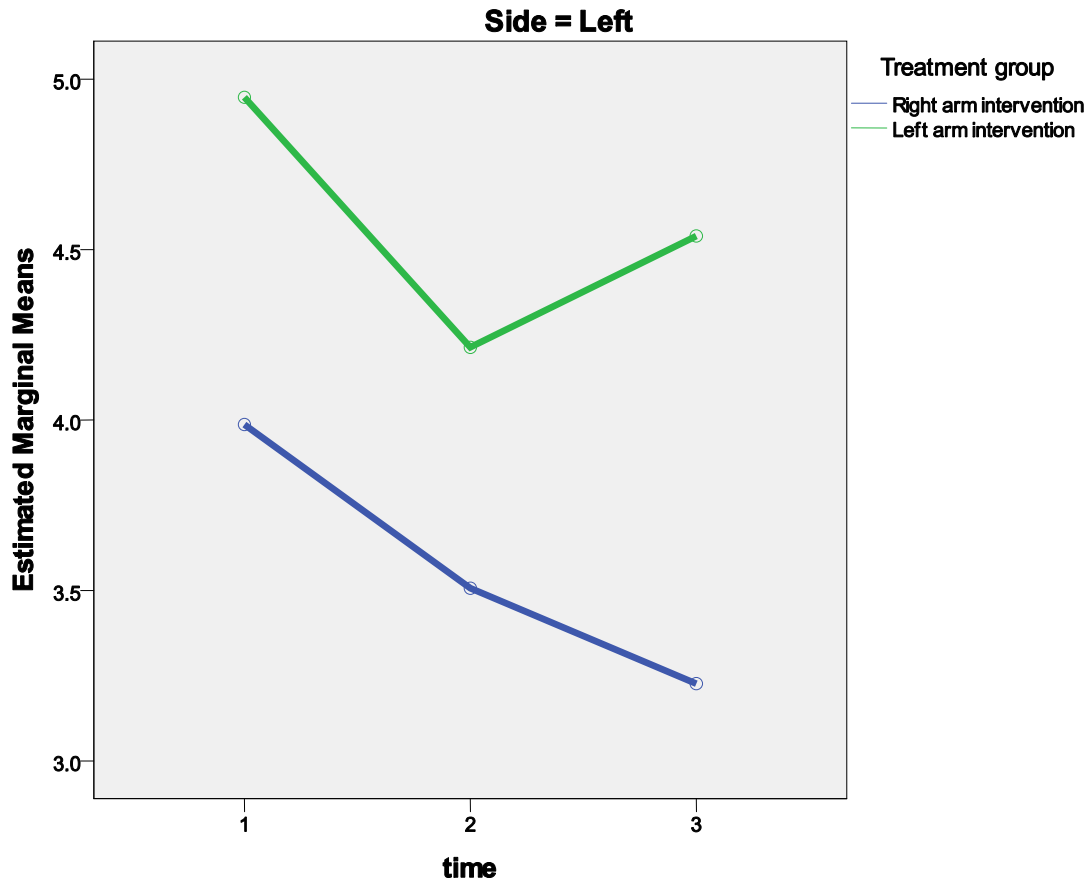


Figure 4: Mean algometer measurement by time and treatment group in Left arms

Figure 4 shows that on the left arms the control arms continued to experience a decrease in algometer measurement consistent with an increase in pain from time 2 to time 3 while the heat treated arms showed an increase in algometer measurement. However, this trend was not statistically significant.

Therefore there was a slight trend in left arms which were heat treated, that algometer measurements decreased further over time whilst control arms did not.

Table 8: Paired t-tests between calliper measurements of left and right arms, in left and right arm intervention groups separately

Paired Samples Test										
Treatment group			Paired Differences				t	df	Sig. (2-tailed)	
			Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower				Upper
Right arm intervention		Calliper R - Calliper L	.133	.915	.236	-.374	.640	.56 4	14	.582
Left arm intervention		Calliper R - Calliper L	.000	.655	.169	-.363	.363	.00 0	14	1.000

Table 8 depicts that there was no significant difference between the calliper measurements of the left or right arms in either of the treatment groups ($p=0.582$ and $p=1.000$ respectively).

CHAPTER FIVE

DISCUSSION OF RESULTS

5.1. Introduction

The following chapter consists of a discussion of the results from the statistical analysis of the demographic (age and gender), subjective data (Numerical Pain Rating Scale-101 (NRS-101) and 24 hour pain diary), objective data (algometer readings) and calliper readings.

5.2. Demographics

5.2.1. Age

The findings of the age analysis showed that there was no statistically significant difference in age between the subjects of both the intervention and control groups ($p=0.702$). The age of subjects ranged from 19 to 48 years. This range was similar to a study conducted by Chonan (2008) which investigated the effect of cryotherapy on post-needling soreness and included subjects who ranged from 18 to 47 years of age.

5.2.2. Gender

The percentage of males in this study was 43% and the percentage of females in this study was 57% ($p=0.269$). This ratio of males to females differed significantly from Chonan (2008) and Manga (2008) who had a higher percentage of females in their study. Chonan (2008) had a 70% female participation and Manga (2008) had a 75% female participation. This difference in gender could possibly account for some of the differing results found in this study.

5.3. Subjective data

5.3.1. Numerical Pain Rating Scale-101 (NRS-101)

The results from the NRS-101 revealed that both groups experienced an increase in pain from the baseline ($p=0.776$). Both the treatment and control groups showed a sharp increase in pain between NRS-101 reading time 1 (measurement prior to dry-needling) and time 2 (measurement immediately after the intervention) [Figures 1 and 2]. The increase in pain readings between these two time periods could be due to the development of post-needling soreness. Although relatively little detail is available on post-needling soreness and its exact cause, the development of this phenomenon has been attributed to the haemorrhage caused by tissue damage as a result of dry-needling (Ga et al 2007). This is supported by Rowley (2000) who reported that subjects who had received the fanning dry-needling technique experienced greater post-needling soreness than those who received single needle insertion. The fanning technique was therefore used in this study for the purpose of generating post-needling soreness.

According to Lewit (1979) post-needling soreness occurred even when a trigger point was not precisely dry-needled. As a result it was uncertain whether the pain developed from the trigger point itself or if the tissue damage caused by the needle insertion was responsible. During an investigation of the effect of dry-needling of asymptomatic subjects with respect to post-needling soreness, Ferriera (2006) found that both intervention groups experienced some degree of soreness according to the findings from the NRS-101. Therefore it would seem that the needle insertion was responsible for post-needling soreness. Asymptomatic subjects were used in this study to exclude the confounding effect of actually having a trigger point.

Heat is used to decrease pain, relieve muscle spasm and stiffness (Nadler, Weignand and Kruse, 2004; Nadler et al 2003). According to Otte et al (2002) a 20 minute application is therapeutically sufficient to reach tissue 20mm and less deep. The heat treatment in this study resulted in NRS-101 scores which showed a slight

trend indicating that the heat intervention, on the right arm led to slightly lower pain at time 2 (immediately after the intervention) and time 3 (24 hours post-needling), although the heat intervention on the left arm did not affect pain scores on either arm. This suggests that heat treatment has an effect, but this was not demonstrated statistically in this study. Pain readings showed a decline when taken 24 hours post-needling (time 3). This decrease in pain was found to be similar in both the groups. Thus these readings have shown no evidence of a beneficial effect of heat therapy as used in this study on subjective pain.

Chonan (2008) when investigating the effect of cryotherapy on post-needling soreness, showed similar results with respect to the NRS-101, as there was also little difference in pain experienced between the control group and the cryotherapy intervention group which was followed by a decrease in pain 24 hours post-needling as well.

5.3.2. Pain Diary

Pain was reported by most subjects in both groups during the 6 hour post-needling soreness period: right arm ($p=0.169$), left arm $P=1.000$. Hong (1994) reported that the effects of lidocaine against dry-needling of trigger points revealed that all patients in the dry-needling group reported pain within the first 2-8 hours after needling. Chonan (2008) when investigating the effect of cryotherapy on post-needling soreness reported that the majority of subjects reported pain in both the intervention (cryotherapy and dry-needling) and control (dry-needling only) groups during the initial 3 hour post-needling soreness period.

The 3 hour delay in onset of post-needling soreness in this study compared to the cryotherapy study may have occurred due to the effect of heat therapy which, as previously mentioned, causes an increase in blood flow to the area which facilitates tissue healing by supplying nutrients, protein and oxygen at the site of injury. This increase in tissue temperature is associated with an increase in local tissue

metabolism (Cameron, 1999) which aids in the healing process by increasing both catabolic and anabolic reactions needed to degrade and remove metabolic by-products of tissue damage (Davis et al 1998).

In this study the least amount of pain observed by the untreated arms was at 24 hours where 6,7% experienced pain. In the treated arms the least amount of pain experienced was also 6,7% and at 24 hours. This was different from Ferriera (2006) who found in his study, which investigated the effect of dry-needling of asymptomatic subjects with respect to post-needling soreness, found that no subjects reported pain between 12-24 hours.

During this clinical trial subjects were needled in both their left and right arms. The majority of subjects reported an increase in pain in the left arm as compared to the right arm during the needling process. This could be due to the majority of subjects being right handed therefore using the right arm more than the left arm during daily activities which may have resulted in a stronger right deltoid muscle than the left. This may have caused the right deltoid muscle to have a higher pain threshold and tolerance than the left deltoid muscle which resulted in many subjects experiencing more pain in the left arm compared to the right arm (Pud, Golan and Pesta, 2009).

5.4. Objective Data

5.4.1. Algometer readings

The results from the algometer readings indicated that both the treated and untreated right arms showed a decrease in algometer measurement from time 1(measurement prior to dry-needling) to 2 (measurement immediately after the intervention), followed by a slight increase to time 3 (24 hours post-needling) [Figure 3] which occurred at the same rate ($p=0.863$). This indicates that the needling process did cause an increase in tenderness in the deltoid area in both the treated and untreated right arms.

Chonan (2008) reported that both groups showed a decrease in Algometer readings over the three time points (prior to dry-needling, after dry-needling and 24 hours

post-needling). Ferriera (2006), Rowley (2000) and Hong (1994), experienced similar findings in the algometer readings within their studies as well.

In an attempt to ensure consistency, the researcher was the only examiner used in this study. Therefore the study did not use a double blinded procedure with regards to taking the algometer readings, as none of the usual blinding mechanisms could be used in this study. The same examiner was used to administer the treatment and to take the algometer readings. The examiner was therefore aware of which treatment group each subject belonged to and may have been biased towards a particular group. This factor could have affected the way the examiner took the results and hence this may have affected the outcome results of this study (McGauran et al 2010).

5.5. Calliper Readings

To be included in this study, subjects needed to have a skin-fold thickness of 2cms and less. There was no statistical difference in calliper measurements in either the control or intervention group. There was no significant difference between the caliper measurements of left or right arms in either of the treatment groups ($p=0.582$ and $p=1.000$ respectively). The calliper readings of Chonan (2008) showed similar results as no significant difference between both groups resulted as well.

5.6. Summary

In chapter one, various objectives were used in determining the possible outcomes of this study. Once they were compared to the results from the statistical analysis the following conclusions were made:

The purpose of the first objective was to establish whether the control group would develop post-needling soreness to a greater degree than the intervention group in terms of subjective clinical findings. The results of the NRS-101 and 24 hour pain diary revealed that both groups showed no statistical difference with regards to pain experienced. However the NRS-101 showed that the right arm intervention group

had lower NRS-101 scores than the control group and the pain diary revealed that treatment of the right arm led to slightly less pain in the right arm.

The purpose of the second objective was to find out if the control group would develop post-needling soreness to a greater degree than the intervention group in terms of objective clinical findings. The results of the algometer readings showed no difference statistically with regards to pain, although the left arm intervention group showed an increase in algometer readings, indicating that there was a decrease in pain in the left treated arm. Although there were certain trends regarding the benefits of heat therapy, there was no statistical evidence to support this. Therefore heat therapy does not appear to decrease post-needling soreness.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusion

The aim of this study was to determine the effectiveness of heat therapy on post-needling soreness in the deltoid muscle of asymptomatic subjects.

The objective and subjective measurements from both the heat intervention and control groups showed the development of post-needling soreness. However the study has shown no statistical evidence of a beneficial effect of heat therapy on post-needling soreness. There was a slight trend of heat therapy decreasing post-needling soreness in terms of subjective (NRS-101 and pain diary) and objective (algometer) findings. However, this was not found to be statistically significant although it could have some clinical value which needs further investigation.

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 addition, limiting subjects to one gender only to avoid differences in pain perception between genders, as a confounding factor is recommended.

Follow-up consultations conducted 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.

In future studies post-needling soreness should be investigated in only one arm of subjects, as a possible cross over effect and arm dominance could affect statistical analysis.

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APPENDIX A:

LETTER OF INFORMATION AND INFORMED CONSENT

Title of the Research Study

The effect of heat therapy on post dry-needling soreness in the deltoid muscle of asymptomatic subjects.

Principle Investigator/s: Merissa Govender

(031 373 2094/ 082 467 8923)

Co-Investigator/s: Dr. A. Docrat M.Tech.:Chiropractic

(031) 373 2589

Brief Introduction and Purpose of the Study:

Dear Subject.

Welcome and thank you for participating in my research.

Dry-needling is the insertion of an acupuncture needle into the skin and is frequently used in the chiropractic profession however a common side effect of dry-needling is post-needling soreness. Due to convenience of heat and its many therapeutic properties, this study aims to find out if using heat after dry-needling can decrease the occurrence of post-needling soreness.

Outline of the Procedures:

During the initial consultation you will undergo a history, physical, and shoulder regional examination, at the Chiropractic Day Clinic, after which you will be selected providing you fit the necessary criteria for the research.

To participate in the research you are required to be between the ages of 18-50 years and have a skin-fold thickness of 20mm. You will only be accepted once you have read and signed the Informed Consent form, and have undergone a complete case history, physical examination and shoulder regional examination.

The following will exclude participation in the research, subjects that are contra-indicated to dry needling and heat therapy will be excluded. This includes subjects under the influence of alcohol or those suffering from systemic illness. All smokers will be excluded. Subjects receiving or those who have received dry needling in the three months prior to the initial consultation will be excluded. Subjects that have shoulder pain and subjects that are unable to commit to the 24 hour follow up appointment.

The first consultation will last approximately 2hours 30minutes – 3 hours. Once accepted into the study you will have the option of a free clinical spinal assessment and one free treatment following the research, during the consultation you will be dry-needled in the deltoid muscles (a muscle of the arm) of both arms, an algometer (an instrument used to measure pressure pain threshold), and heat pack will be used. The Numerical Pain Rating Scale will be used (involves asking subjects to rate their pain intensity on a numerical scale from a score of 0 to 100). You will then be required to complete a 24hour diary, which will be provided. A follow-up assessment will take place 24hours after the initial consultation. This consultation will last for approximately 45minutes-1hour.

Risks or Discomforts to the subject:

You may experience mild discomfort in the area of needle insertion for approximately 24 hours.

Benefits:

This will benefit you as a patient in the long run, as we will be able to provide you with more effective health care in the future. You have the option of a free clinical spinal assessment and one free treatment following your participation in the research. The research may be published in the future.

Reasons why the Subject May Be Withdrawn from the Study

You will be withdrawn from the study if you do not comply with the scheduled appointments, become ill or have an adverse reaction during or after the procedure. As a voluntary subject in this research study, you are free to withdraw from the study at any time, without giving a reason.

Remuneration:

None

Costs of the study:

None

Confidentiality:

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

Research-related Injury: The likely hood of injury for this type of research is very slim and we do not anticipate any adverse reactions.

Persons to Contact in the Event of Any Problems or Queries:

Supervisor: Dr. A. Docrat (031) 373 2589

Head of Department: Dr. C. Korporaal (031) 373 2611

Faculty Officer : Vikesh Singh (031) 373 2701

Statement of Agreement to Participate in the Research Study:

(I,....., ID number....., have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me byto my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in this study.

Subject's name (print)

Subject's signature:..... Date:.....

Researcher's name (print).....

Researcher's signature:..... Date:.....

Witness name (print).....

Witness signature:..... Date:.....

APPENDIX B:

ARE YOU BETWEEN THE AGES OF

18 TO 50?

A NON-SMOKER?

Have NO SHOULDER PAIN?

**INTERESTED IN
PARTICIPATING IN
RESEARCH?**

**At
THE DURBAN UNIVERSITY OF
TECHNOLOGY
CHIROPRACTIC DAY CLINIC**

**One FREE Clinical Spinal
Assessment and One FREE
Treatment**

(if you fit the research criteria)

**CONTACT: MERISSA
(031) 373 2094 / 082 467 8923**

PAIN DIARY

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

Please do not apply ice to the needled area, do not take any medication (anti-inflammatory drugs) and fill in the pain diary precisely according to the allocated times.

Did you experienced pain in the area that was needed at: YES NO

3 hours

6 hours

9 hours

12 hours

24hours

My pain was worst at _____ hours after receiving dry needling therapy. If you have any questions regarding the research, kindly contact Merissa Govender on (031) 373 2094 or 082 467 8923 or you can contact my research supervisor Dr. A. Docrat on (031) 373 2589.

Patient Name: _____ Signature: _____

Research Student Name:_____ Signature:_____

APPENDIX D:
DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: _____ Date: _____

File # _____

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
- < Hospitalizations

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 E:
DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
PHYSICAL EXAMINATION

Patient: _____ File#: _____ Date: _____

Clinician: _____ Signature: _____

Student: _____ Signature: _____

1. VITALS

Pulse rate:

Respiratory rate:

Blood pressure: R L Medication if hypertensive:

Temperature:

Height:

Weight: Any change Y/N If Yes : how much gain/loss
Over what period

2. GENERAL EXAMINATION

General Impression:

Skin:

Jaundice:

Pallor:

Clubbing:

Cyanosis (Central/Peripheral):

Oedema:

Lymph nodes - Head and neck:

- Axillary:

- Epitrochlear:

- Inguinal:

Urinalysis:

3. CARDIOVASCULAR EXAMINATION

1) Is this patient in **Cardiac Failure** ?

2) Does this patient have signs of **Infective Endocarditis** ?

3) Does this patient have **Rheumatic Heart Disease** ?

Inspection - Scars
 - Chest deformity:
 - Precordial bulge:
 - Neck -JVP:

Palpation: - Apex Beat (character + location):
 - Right or left ventricular heave:
 - Epigastric Pulsations:
 - Palpable P2:
 - Palpable A2:

- Pulses:**
- General Impression:
 - Radio-femoral delay:
 - Carotid:
 - Radial:
 - Dorsalis pedis:
 - Posterior tibial:
 - Popliteal:
 - Femoral:
- Percussion:** - borders of heart

Auscultation: - heart valves (mitral, aortic, tricuspid, pulmonary)
 - Murmurs (timing, systolic/diastolic, site, radiation, grade).

4. RESPIRATORY EXAMINATION

1) Is this patient in **Respiratory Distress** ?

- Inspection**
- Barrel chest:
 - Pectus carinatum/cavinatum:
 - Left precordial bulge:
 - Symmetry of movement:
 - Scars:
- Palpation**
- Tracheal symmetry:
 - Tracheal tug:
 - Thyroid Gland:
 - Symmetry of movement (ant + post)
 - Tactile fremitus:
- Percussion**
- Percussion note:
 - Cardiac dullness:
 - Liver dullness:
- Auscultation**
- Normal breath sounds bilat.:
 - Adventitious sounds (crackles, wheezes, crepitations)
 - Pleural frictional rub:
 - Vocal resonance
 - Whispering pectoriloquy:
 - Bronchophony:
 - Egophony:

5. ABDOMINAL EXAMINATION

1) Is this patient in **Liver Failure** ?

- Inspection**
- Shape:
 - Scars:
 - Hernias:
- Palpation**
- Superficial:
 - Deep = Organomegally:
 - Masses (intra- or extramural)
 - Aorta:
- Percussion**
- Rebound tenderness:
 - Ascites:
 - Masses:
- Auscultation**
- Bowel sounds:
 - Arteries (aortic, renal, iliac, femoral, hepatic)

- Rectal Examination**
- Perianal skin:
 - Sphincter tone & S4 Dermatome:
 - Obvious masses:
 - Prostate:
 - Appendix:

6. G.U.T EXAMINATION

External genitalia:

Hernias:

Masses:

Discharges:

7. NEUROLOGICAL EXAMINATION

- Gait and Posture**
- Abnormalities in gait:
 - Walking on heels (L4-L5):
 - Walking on toes (S1-S2):
 - Rombergs test (Pronator Drift):

- Higher Mental Function**
- Information and Vocabulary:
 - Calculating ability:
 - Abstract Thinking:

- G.C.S.:**
- Eyes:
 - Motor:
 - Verbal:

Evidence of head trauma:

- Evidence of Meningism:**
- Neck mobility and Brudzinski's sign:
 - Kernigs sign:

Cranial Nerves:

- I** Any loss of smell/taste:
Nose examination:
- II** External examination of eye: - Visual Acuity:
- Visual fields by confrontation:
- Pupillary light reflexes = Direct:
= Consensual:
- Fundoscopy findings:
- III** Ocular Muscles:
Eye opening strength:
- IV** Inferior and Medial movement of eye:
- V**
- a. Sensory
 - Ophthalmic:
 - Maxillary:
 - Mandibular:
 - b. Motor
 - Masseter:
 - Jaw lateral movement:
 - c. Reflexes
 - Corneal reflex
 - Jaw jerk
- VI** Lateral movement of eyes

Sensory System:

- a. Dermatomes - Light touch:
 - Crude touch:
 - Pain:
 - Temperature:
 - Two point discrimination:
- b. Joint position sense - Finger:
 - Toe:
- c. Vibration: - Big toe:
 - Tibial tuberosity:
 - ASIS:
 - Interphalangeal Joint:
 - Sternum:

Cerebellar function:

Obvious signs of cerebellar dysfunction:

- = Intention Tremor:
- = Nystagmus:
- = Truncal Ataxia:

Finger-nose test (Dysmetria):

Rapid alternating movements (Dysdiadochokinesia):

Heel-shin test:

Heel-toe gait:

Reflexes:

Signs of Parkinsons:

8. SPINAL EXAMINATION:(See Regional examination)

Obvious Abnormalities:

Spinous Percussion:

R.O.M:

Other:

9. BREAST EXAMINATION:

Summon female chaperon.

Inspection - Hands rested in lap:
 - Hands pressed on hips:
 - Arms above head:
 - Leaning forward:

Palpation - masses:
 - tenderness:
 - axillary tail:
 - nipple:
 - regional lymph nodes:



SHOULDER REGIONAL EXAMINATION

Patient: File No: Date:

Intern: Signature:

Clinician: Signature:

Observation

Posture		S-C Joints	
Skin		Clavicles	
Swelling		A-C Joints	
Shoulder levels		Scapulae	
Comments			

Palpation

S-C Joint:		SCM:	Scalenes:
Sternum:		Ribs and costal cartridge:	
Clavicle:		Coracoid process:	
A-C Joint:		Acromion:	
Greater Tuberosity:			
Lesser Tuberosity:			
Intertubercular (bicipital groove):			
Trapezius:		Deltoid:	
Biceps:		Triceps:	
Supraspinatus insertion:			
Musculotendinous portion of supraspinatus:			
Axilla:	Lymph nodes:		
	Brachial artery:		
	Serratus anterior (medial wall):		
	Pectoralis major (anterior wall):		
	Lattisimus dorsi (posterior wall):		
Scapula	Borders:		Spine:
	Supraspinous fossa:		
	Infraspinous fossa:		
Cervico-thoracic spine:			

Active Movements (note ROM and pain)

Elevation through abduction (170-180°):	
Painful arc with abduction:	
Elevation through forward flexion (160-180°):	
Elevation through scapula plane (170-180°):	
Lateral rotation (80-90°):	Medial rotation (60-100°):
Extension (50-60°):	Adduction (50-75°):
Horizontal adduction/abduction (130°):	
Circumduction (200°):	
Apley's Scratch:	

Passive movements (note end-feel, ROM and pain)

Elevation through abduction (bone to bone or tissue stretch).....
Elevation through forward flexion (tissue stretch).....
Lateral rotation (tissue stretch).....
Medial rotation (tissue stretch).....
Extension (tissue stretch).....
Adduction (tissue approximation)
Horizontal adduction (tissue stretch or approximation).....
Horizontal abduction (tissue stretch).....
Quadrant Test.....

Resisted Isometric Movements (note strength and pain)

Flexion		Medial rotation	
Extension		Lateral Rotation	
Adduction		Elbow flexion	
Abduction		Elbow extension	

Joint Play Movements (and motion palpation)

SC Joint	Supero-inferior (shrug shoulder with arm at side):
	Horizontal add/abduction (arm abducted 90°):
AC Joint	A-P Shear:
	Supero-inferior shear:
Scapula	Normal scapulo-humeral rhythm?:
	General mobility of scapula:

Glenohumeral Joint

Lateral movement of humeral head	_____
Inferior movement of humeral head (Caudal glide)(50°)	_____
Anterior movement of humeral head (P-A glide) (25°)	_____
Posterior shear of humeral head (A-P glide) >50%	At 10° flexion _____
	At 90° flexion _____
Backward glide of humeral head in abduction	_____
Long-axis distraction of humeral head in abduction	_____
Downward and backward (S-I → A-P)	_____
Outward and backward (med-lat → A-P)	_____
External rotation of humeral head	_____
Internal rotation of humeral head	_____

Instability Tests

1. Anterior Instability Tests

	R			L		
	Pos	Neg	n/a	Pos	Neg	n/a
Anterior drawer Test						
Rowe Test						
Fulcrum Test						
Apprehension (crank) Test						
Clunk Test (tear of labrum)						
Rockwood Test						

2. Posterior Instability Tests

	Pos	Neg	n/a	Pos	Neg	n/a
Posterior Apprehension Test						
Norwood Stress Test						
Push-pull Test						
Jerk Test						

3. Inferior and Multi-directional instability tests

	Pos	Neg	n/a	Pos	Neg	n/a
Inferior Shoulder Instability Test						
Feagin Test (antero-inferior instability)						

A-C Joint Stress Test: _____

S-C Joint Stress Test: _____

Tests for Muscle or Tendon Pathology

1.	Speed's Test (bicipital tendonitis)	
2.	Gilchrest Sign (bicipital tendonitis)	
3.	Supraspinatus Test (supraspinatus tendonitis)	
4.	Hawkins-Kennedy Impingement Test (supraspinatus tendonitis)	
5.	Drop –arm Test (rotator cuff tear)	
6.	Impingement Test	
7.	Pectoralis Major Contracture Test	
8.	Ludington's Test (rupture of long head of biceps)	

Tests for neurological function

Brachial Plexus Tension Test			Radial Nerve											
			Median Nerve											
Tinel's Sign (Scalene triangle)														
Dermatones	C4		C5		C6		C7		C8		T1		T2	
Reflexes	Biceps(C5/6)						Triceps (C7/8)							

Thoracic Outlet Syndrome Tests

Adson's Test		Halstead's Test	
Costoclavicular Test		Eden's Test (cervical rib)	
Hyperabduction Test		Roos Test	
Allen's Test			

APPENDIX G:

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 H:

Algometer readings:

PATIENT NAME: _____			
ALGOMETER READING	PRIOR TO DRY- NEEDLING	IMMEDIATELY AFTER THE INTERVENTION	24HOURS AFTER DRY- NEEDLING

APPENDIX I:

ETHICS CLEARANCE CERTIFICATE

Student Name	Merissa Govender	Student No	20603269
Ethics Reference Number	015/10	Date of FRC Approval	31/05/2010
Qualification	M. Tech: Chiropractic		
Research Title:	The effect of heat therapy on post dry-needling soreness in the deltoid muscle of asymptomatic subjects.		

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:

1. 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.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. 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.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. **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	✓		

07/06/10.
DATE

07-06-2010
DATE

8/6/2010
DATE

8/6/2010
DATE