THE EFFECT OF DRY NEEDLING ON TRAPEZIUS MUSCLE ACTIVITY AND POST NEEDLING SORENESS IN PARTICIPANTS WITH LATENT TRAPEZIUS MYOFASCIAL TRIGGER POINTS

By

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I, Steven Peter do declare that this dissertation represents my own work in both conception and execution (except were acknowledgements indicate the contrary).

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DEDICATION

I dedicate this research to God Almighty who made me, died for me and lives in me. It is because of Him that I have the amazing wife that I do, who stood beside me through the ups and downs that being a masters student brings. Only with His strength have I been able to be a husband, full time student and hold down a job while remaining a balanced individual.

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ABSTRACT

Background:

Dry needling (DN) is an established and effective modality which is used globally for the treatment of myofascial trigger points (MFTPs). Post-needling soreness (PNS) is a common side effect which is felt shortly after DN at the site of needle insertion and peaks at 24 hours post-treatment. Research of its effects on muscle activity, range of motion, numerical pain rating scale and pain pressure threshold exist but focuses on pre- and post-needling measurements and a follow up measurement at 24 hours. This study objectively tried to investigate the effects of DN in the first few hours after treatment, in terms of pain pressure threshold (PPT), range of motion (ROM), surface electromyography (sEMG), and post needling soreness.

Objectives

To determine the effect of dry needling latent myofascial trigger points (LMFTPs) in the upper trapezius muscle with respect to: numerical pain rating scale (NRS), PPT, ROM and sEMG in the first four hours after treatment.

Methodology

This was a quantitative pre-test post-test design study with repeated follow up measurements. Through a purposive convenient sampling strategy, 15 asymptomatic volunteers were recruited into the study.

Baseline readings were taken for the NRS, sEMG, PPT and ROM readings were then taken.

After baseline readings were taken, the LMFTP was dry needled, and the measurements were taken again in the same order. The measurements were taken every hour for four hours post needling.

IBM SPSS version 25 was used to analyse the data. A p value <0.05 was considered as statistically significant. Comparison of measurements over time were achieved using non-parametric Friedman tests for paired data. Post hoc tests were done in the case of a significant Friedman's test in order to determine which pairs of measurements differed. Correlations between the changes over time of each measurement were done using non-parametric Spearman's correlation.

Results

For the NRS there was a statistically significant increase in perceived pain at the first measurement post treatment ($p < 0.001$). While there was no significant difference in algometer measurements over time ($p = 0.321$). CROM showed an improvement in all tested movements: ipsilateral PA rotation ($p < 0.001$), contralateral PA rotation ($p < 0.001$), ipsilateral lateral flexion ($p = 0.001$) and contralateral lateral flexion ($p < 0.001$). With regards to sEMG root mean square (RMS) There was no difference between the time points ($p = 0.534$).

The following correlations were noted:

Changes in contralateral and ipsilateral PA rotation were strongly positively correlated together (rho = 0.711).

Changes in ipsilateral PA rotation was negatively correlated with change in 1-minute rest (rho = -0.569).

Changes in contralateral PA rotation was positively correlated with change in mean contraction (rho = 0.527).

Conclusions

In conclusion, the results of this study show that DN of LMFTPs in the upper trapezius muscle may be effective at improving CROM without eliciting a strong PNS effect or a significant drop in PPT. As this is one of the few studies that exist to test objective and subjective results in the first four hours after needling, it is difficult to draw strong conclusions.

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DEFINITIONS

Cervical range of motion: This is the degree to which the cervical spine is able to move in the different anatomical planes (Audette *et al.* 2010).

Maximum voluntary contraction: Is when a muscle is actively contracted to the best of a person's ability (Criswell 2011).

Myofascial trigger point: This is "a hyperirritable spot in skeletal muscle that is associated with a hypersensitive palpable nodule in a taut band. The spot is painful on compression and can give rise to characteristic referred pain, referred tenderness, motor dysfunction, and autonomic phenomena" (Simons, Travell and Simons 1999).

Active myofascial trigger point: This is a myofascial trigger point that is spontaneously causing pain and pain referral without stimulation (Simons, Travell and Simons 1999).

Latent myofascial trigger point: This is a myofascial trigger point that does not spontaneously generate pain but may still affect muscle function(Celik and Mutlu 2013)

Numerical pain rating scale: This is a subjective pain measurement tool by which patients may report back any pain they may be feeling (Hjermstad *et al.* 2011).

Pain pressure threshold: This is the amount of pressure that can be placed on a point before it becomes painful, and is measured using an algometer (Potter, McCarthy and Oldham 2006).

Post needling soreness: This is pain felt shortly after dry needling at the site of needle insertion (Simons, Travell and Simons 1999; Huguenin 2004).

Surface electromyography: sEMG is a safe and non-invasive way to measure the electrical energy in muscles, using surface electrodes(Criswell 2011).

LIST OF ABBREVIATIONS

ACH	– Acetylcholine
ATP	– Adenosine Triphosphate
Ca^{2+}	– Calcium Ions
CROM	– Cervical Range of Motion
DN	– Dry Needling
IC	– Ischaemic Compression
MET	– Muscle Energy Technique
MFTP	– Myofascial Trigger Point
AMFTP	– Active Myofascial Trigger Point
LMFTP	– Latent Myofascial Trigger Point
LTR	– Local Twitch Response
MUAP	– Motor Unit Action Potentials
NRS	– Numerical Pain Rating Scale
PNS	– Post Needling Soreness
PPR	– Progressive Pressure Release
PPT	– Pain Pressure Threshold
ROM	– Range of Motion
SEA	– Spontaneous Electrical Activity
sEMG	– Surface Electromyography
SR	– Sarcoplasmic Reticulum
VAS	– Visual Analogue Scale

CHAPTER 1

INTRODUCTION

1.1 The problem and its setting

Dry needling (DN) is an established and effective modality (Cummings and Baldry 2007; Vulfsons, Ratmansky and Kalichman 2012) which is used globally for the treatment of myofascial trigger points (MFTPs) (Cummings and Baldry 2007). These MFTPs result in what is called myofascial pain syndrome (MPS), a common cause of musculoskeletal pain (Simons, Travell and Simons 1999; Graff-Radford 2004; Gerwin 2005; Yap 2007; Fleckenstein *et al.* 2010).

The mechanism of how dry needling works is not yet exactly understood (Cagnie *et al.* 2013), though there is research of its effects on blood flow, tissue oxygenation, muscle activity, biochemistry and neurophysiology. Research into the immediate or short term effects of DN (Jimbo *et al.* 2008; Fernández-Carnero *et al.* 2010; Tsai *et al.* 2010; Westhuizen 2012; Tekin *et al.* 2013; Calvo-Lobo *et al.* 2018), focuses on pre- and post-needling measurements and a follow up measurement at 24 hours. However, no study was found that objectively investigated the effects of DN in the first few hours after treatment, in terms of pain pressure threshold (PPT), range of motion (ROM) and surface electromyography (sEMG).

Studies typically document pre- and post-needling measurements (Ferreira 2006; Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero 2016; Martın-Pintado-Zugasti *et al.* 2018). (Martin-Pintado Zugasti *et al.* 2014; Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero 2016)) were the only studies found that had a follow up measurement sooner, at six hours post-needling. This measurement was a subjective one, with the next objective measurement documented at 24 hours. Post-needling soreness (PNS) is a common side effect which is felt shortly after DN at the site of needle insertion and peaks at 24 hours post-treatment (Simons, Travell and Simons 1999; Huguenin 2004). Research on PNS - where subjective and objective measurements have been taken in the first few hours after needling - is lacking.

1.2 Aims

The aim of this research is to determine the immediate and short-term effect of DN latent myofascial trigger points (LMFTPs) in the upper trapezius muscle with regards to subjective and objective measures. These include the numerical pain rating scale (NRS), pain pressure threshold (PPT), cervical range of motion (CROM) and surface electromyography (sEMG).

1.3 Objectives

1. To determine the effect of DN LMFTPs in the upper trapezius muscle, on NRS in the first four hours after treatment.
2. To determine the effect of DN LMFTPs in the upper trapezius muscle, on muscle activity (sEMG) during treatment and in the first four hours after treatment.
3. To determine the effect of DN LMFTPs in the upper trapezius muscle, on CROM in the first four hours after treatment.
4. To determine the effect of DN LMFTPs in the upper trapezius muscle, on PPT in the first four hours after treatment.
5. To compare the findings of the different measures against one another and to pre-treatment measures.

1.4 Null hypotheses

1. DN LMFTPs in the upper trapezius muscle will have no effect on NRS in the first four hours after treatment.
2. DN LMFTPs in the upper trapezius muscle will have no effect on muscle activity (sEMG) during treatment and in the first four hours after treatment.
3. DN LMFTPs in the upper trapezius muscle will have no effect on CROM in the first four hours after treatment.
4. DN LMFTPs in the upper trapezius muscle will have no effect on PPT in the first four hours after treatment
5. No correlations will be found when comparing the findings of the different measures against one another and to pre-treatment measures.

1.5 Rationale

There is a lack of understanding and research on the effects of dry needling in the first few hours after needling. The first few hours post-needling are significant as it is during this time that post-needling soreness may set in (Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero 2016). A better understanding of what happens to muscle activity after dry needling LMFTPs during this time frame could allow a better understanding for outcomes after needling. It is also a timeframe during which a home management therapy could be applied.

1.6 Benefits of the research

The research will provide a better understanding of how the trapezius muscle responds in the first four hours. This could indicate a need for a post-needling treatment program. It could also indicate a need for research into the effects of needling on other muscles and their response to needling in the first four hours.

1.7 Conclusion

This clinical trial will identify the effects of dry needling the trapezius muscle in the first four hours after needling. Chapter two will discuss the relevant anatomy and physiology involved in the study and the literature with regards to MPS, MFTPs, DN and PNS. Chapter three will discuss the methodology used, as well as the study design and statistical analysis used. Chapter four will cover the results with brief interpretations. Chapter five will discuss the results obtained. Chapter six will cover the conclusion and recommendations for future studies.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Introduction

In this chapter the anatomy of the trapezius muscle will be described as well as the physiology of muscle contraction, leading into a review of the literature regarding myofascial trigger points and their treatment.

2.2 Trapezius anatomy

The Trapezius muscle is a large diamond-shaped muscle that is divided into three sections which are distinguished from one another by their fibre orientation and the anatomical attachment points into the upper, middle and lower sections (Simons, Travell and Simons 1999; Moore and Dalley 2005; Tortora and Derrickson 2015).

2.2.1 Attachments

The proximal attachments form a line down the centre of the diamond shape of the trapezius muscle while the distal attachments form the lateral points. The muscle attaches proximally to the medial third of the nuchal line, the external occipital protuberance, the nuchal ligament, spinous processes starting from the seventh cervical vertebrae down to the twelfth thoracic vertebrae and the associated interspinous ligaments. Distally the muscle attaches to the lateral third of the clavicle, the spine of the scapula and the acromion (Simons, Travell and Simons 1999; Moore and Dalley 2005; Tortora and Derrickson 2015).

2.2.2 Innervation and blood supply

The spinal accessory nerve provides the trapezius muscle with its motor neuron input, with pain and proprioception being transmitted by the third and fourth level cervical spinal nerves. Blood to the trapezius is supplied by the transverse cervical

and dorsal scapular arteries (Simons, Travell and Simons 1999; Moore and Dalley 2005; Tortora and Derrickson 2015).

2.2.3 Action

The upper trapezius is involved in lateral flexion and rotation of the head and neck when unilaterally activated and extension when bilaterally activated (Simons, Travell and Simons 1999). The middle trapezius is responsible for scapular retraction. The lower trapezius depresses the scapula (Simons, Travell and Simons 1999; Moore and Dalley 2005; Tortora and Derrickson 2015). Therefore, in this study ROM for the upper trapezius was measured, using rotation and lateral flexion.

2.3 Basic anatomy and physiology of muscle contraction

The muscle fibre is the structural unit of muscle, together with innervation supplied by a motor neuron connecting to it via the motor endplate. It is the smallest functional unit of skeletal muscle. These fibres are enveloped in connective tissue called endomysium. Groups of these fibres, together with nerve and blood supply, are bound by another connective tissue sheath called the perimysium to form fascicles, which in turn are enveloped by the outer most layer of connective tissue called the epimysium. The three layers of connective tissue extend past the length of the structures that they envelop to form tendons (Simons, Travell and Simons 1999; Moore and Dalley 2005; Tortora and Derrickson 2015).

Within each muscle fibre myofibrils are found which contain actin and myosin protein filaments. These filaments are arranged in an overlapping manner and are responsible for the process of contraction. Troponin and tropomyosin are two other proteins which act as regulators to the binding process between actin and myosin. The filaments do not span the length of the fibre and they are organised into compartments called sarcomeres (Simons, Travell and Simons 1999; Moore and Dalley 2005; Tortora and Derrickson 2015).

Supplying the myofibrils with what they need is the sarcoplasm (cytoplasm of a muscle cell), which contains glycogen, myoglobin and the mitochondria organelles. The mitochondria produce adenosine triphosphate (ATP) using glycogen and oxygen. Oxygen is supplied by the myoglobin when required. ATP is the source of energy used by every cell and powers muscle contraction. A network of membranous sacs called the sarcoplasmic reticulum (SR) surrounds the myofibrils. The SR contains calcium ions (Ca^{2+}) essential to muscle contraction (Simons, Travell and Simons 1999; Moore and Dalley 2005; Tortora and Derrickson 2015).

When a nerve impulse reaches the neuromuscular junction, the synaptic end bulb of the motor neuron releases the neurotransmitter acetylcholine (ACH) into the synaptic cleft. ACH traverses this space and binds to the motor endplate, causing a muscle action potential to propagate along the sarcolemma. The muscle action potential causes the SR to release its Ca^{2+} ions into the sarcoplasm through voltage-gated channels. The Ca^{2+} ions bind to the troponin and tropomyosin, freeing the actin and myosin to bind to one another and causing a shortening of the myofibrils (muscle contraction), using ATP in the process. When the nerve impulse stops it results in the cessation of the muscle action potential and the closing of the voltage-gated ion channels. Ca^{2+} is actively pumped back into the SR, using ATP in the process. Actin and myosin separate, causing a lengthening of the myofibrils (muscle relaxation) (Simons, Travell and Simons 1999; Moore and Dalley 2005; Tortora and Derrickson 2015).

2.4 Myofascial trigger points

A myofascial trigger point (MFTP) is “a hyperirritable spot in skeletal muscle that is associated with a hypersensitive palpable nodule in a taut band. The spot is painful tenderness, motor dysfunction, and autonomic phenomena” (Simons, Travell and Simons 1999). These MFTPs result in what is called Myofascial Pain Syndrome (MPS), a common cause of musculoskeletal pain (Simons, Travell and Simons 1999; Graff-Radford 2004; Gerwin 2005; Yap 2007; Fleckenstein *et al.* 2010)

Clinically one can differentiate between MFTPs in terms of them being either: active MFTPs (AMFTP) or latent MFTPs (LMFTP), the difference being that AMFTPs will cause pain without stimulation and LMFTPs only produce pain with stimulation.

Both, however, can produce referred pain, muscle weakness, local twitch responses (LTR) and reduced range of motion (Simons, Travell and Simons 1999). While LMFTPs do not generate pain spontaneously, their effects are not insignificant (Celik and Mutlu 2013). With regards to range of motion (ROM), Trampas *et al.* (2010) showed that LMFTPs can negatively affect knee ROM, Aguilera *et al.* (2009) showed that LMFTPs can negatively affect cervical ROM and Grieve *et al.* (2011) showed that LMFTPs can negatively affect ankle dorsiflexion. LMFTPs can also negatively affect the rate of muscular fatigue as shown by Ge, Arendt-Nielsen and Madeleine (2012) as well as alter normal muscular activation patterns as shown by (Lucas, Rich and Polus 2010).

As LMFTPs are quite prevalent in the upper body, it is important to note that a LMFTP can become an AMFTP if exposed to an aggravating factor like muscular overload or sustained contraction (Hong 2004; Simons 2005). In one study (Lucas, Rich and Polus 2009), 89.8 percent of the 154 subjects had at least one LMFTP in the scapular positioning muscles.Gemmell and Bagust (2009) were unable to form a control group for their study, due to not being able to find participants fee of upper trapezius MFTPs. In another study 20 percent of the 220 subjects had a LMFTP in their upper trapezius muscle (Grieve *et al.* 2013).

2.4.1 Pathophysiology

These MFTPs may result from numerous triggers such as mechanical stress, nutritional deficiencies, metabolic and endocrine inadequacies, psychological factors and chronic infection (Simons, Travell and Simons 1999; Gerwin 2001; Gerwin 2005; Yap 2007). While the exact pathophysiology is not completely understood yet, the prevailing hypothesis is the “Integrated” hypothesis. It is a combination of two previous hypotheses namely the “energy crisis” and “motor endplate hypothesis” (Simons 2008).

In brief, this hypothesis states that there are dysfunctional motor endplates in certain muscle fibres which produce and release the neurotransmitter Acetylcholine (ACH) in excess, even if the muscle is at rest. This results in miniature endplate potentials occurring up to a thousand-fold of the normal rate. These endplate potentials overlap and can be detected as spontaneous electrical activity (SEA)/endplate noise

by electromyography. This results in a sustained partial depolarization of the post-junctional membrane. This membrane is linked to the sarcoplasmic reticulum which controls the contraction of the muscle fibre with the release and re-uptake of calcium ions through voltage-gated channels.

Due to this link and the sustained partial depolarization a continuous release and re-uptake of calcium ions is initiated causing contraction of the muscle fibre (the taut band) which in turn restricts local blood flow. This pathological process results in an increased energy demand and reduced local blood flow, leading to local hypoxia and a build-up of metabolic waste.

The substances released as a result (which include bradykinins, substance P, calcitonin gene-related peptide, tumour necrosis factor, interleukin 1/6/8, serotonin, prostaglandins and norepinephrine) may interact with local autonomic and sensory nerves, causing an increase in pain (also known as peripheral sensitization), as well as perpetuate this vicious cycle by stimulating the continued release of ACH (Simons, Travell and Simons 1999; Huguenin 2004; Rickards 2006; Shah and Gilliams 2008).

Continuous input from the sensitized sensory nerves may result in central sensitization which is characterized by hyperalgesia (increased sensitivity to pain) allodynia (pain experienced from a normally non-painful stimulus) and referred pain (pain experienced at a point away from the noxious stimulus) (Simons, Travell and Simons 1999; Cagnie *et al.* 2013).

2.4.2 Treatments

There are numerous treatments for MFTPs and they are commonly divided into two groups: non-invasive and invasive. Some non-invasive treatments include spray and stretch, ischaemic compression, massage, biofeedback, hot or cold therapy, ultrasound, laser and medications. Invasive treatment of MFTPs involves injection into the MFTP with an anaesthetic or inserting a needle without any medication which is also known as “dry needling” (Simons, Travell and Simons 1999; Vazquez-Delgado, Cascos-Romero and Gay-Escoda 2010).

2.5 Dry Needling

2.5.1 Introduction

Dry needling (DN) is an established and effective modality (Cummings and Baldry 2007; Vulfsons, Ratmansky and Kalichman 2012) which is used globally for the treatment of MFTPs (Cummings and Baldry 2007) as well as other musculoskeletal pain disorders such as low back pain, headaches, fibromyalgia and tendinopathy. The needle used in dry needling (DN) is typically a solid, small gauge steel acupuncture needle. It is inserted into structures such as muscles, ligaments, tendons, subcutaneous fascia, and scar tissue, or near structures such as peripheral nerves and/or neurovascular bundles, depending on the condition being treated (Cagnie *et al.* 2013).

The upper trapezius and the MFTPs located in the upper trapezius are frequently used as sites for DN research (Ilbuldu *et al.* 2004; Tsai *et al.* 2010; Llamas-Ramos *et al.* 2014; Martin-Pintado Zugasti *et al.* 2014; Mejuto-Vazquez *et al.* 2014; Arias-Buria *et al.* 2015; Campa-Moran *et al.* 2015; Martin-Pintado-Zugasti *et al.* 2015; Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero 2016; Martin-Pintado-Zugasti *et al.* 2017; Martın-Pintado-Zugasti *et al.* 2018). This may be due to the ease of access of the area and the high incidence of MFTPs in the area.

While research on DN in the treatment of MFTPs is more abundant than in the other conditions such as tendonitis and scar tissue (Legge 2014), the exact mechanisms behind its therapeutic effects are not yet understood (Cagnie *et al.* 2013). However, there are proposed mechanisms and research that investigates the effects of dry needling.

2.5.2 Proposed Mechanisms

- Simons, Travell and Simons (1999) proposed that the beneficial effect of dry needling lay in the mechanical disruption of the integrity of the dysfunctional endplate, thereby releasing the contraction of the taut band and ending the cycle.

- Simons, Travell and Simons (1999) also proposed that mechanical disruption/microtrauma of muscle tissue results in increased levels of extracellular potassium which causes depolarisation and desensitisation.
- Local haemorrhage and vasodilation results in removal of sensitizing substances and metabolites (Simons, Travell and Simons 1999).

2.5.3 Dry Needling Effects

Although there is evidence as to the efficacy of DN, the after effects of DN need to be more carefully researched.

Commonly measured effects of dry needling are ROM, PPT, NRS and EMG (Dommerholt, Bron and Franssen 2006; Kietrys *et al.* 2013; Ong and Claydon 2014; Espejo-Antunez *et al.* 2017; Gattie, Cleland and Snodgrass 2017; Hall, Mackie and Ribeiro 2018; Martin-Pintado-Zugasti *et al.* 2018). Dry needling of both active and latent MFTPs has been shown to improve range of motion of the area associated with the afflicted muscle. Ziaeifar *et al.* (2014) investigated the effect of DN AMFTP of the trapezius on lateral flexion by comparing DN to ischaemic compression. Both were shown to be effective with contralateral lateral flexion while on DN improved ipsilateral lateral flexion. The improvement in ROM is supported by other studies seeing similar results (Ilbuldu *et al.* 2004; Tsai *et al.* 2010; Llamas-Ramos *et al.* 2014; Mejuto-Vazquez *et al.* 2014; Arias-Buria *et al.* 2015; Campa-Moran *et al.* 2015).

Yeganeh Lari *et al.* (2016) investigated the effect of dry needling and muscle energy technique (MET) on latent trapezius MFTPs using the visual analogue scale (VAS), PPT and Contralateral lateral flexion. Three groups were used: DN only, MET only and DN+MET. All three groups showed statistically significant improvement ($p = 0.001$). Takla, Atwa and El-Latif (2017) investigated the effect of progressive pressure release (PPR) versus DN on latent cervical (upper trapezius) MFTPs. The measurement tools used to do this were PPT and CROM (lateral flexion and rotation). Both groups showed improvement, though PPR was shown to be more effective. Martin-Pintado-Zugasti *et al.* (2015) investigated the effect of ischaemic compression (IC) on PNS soreness in LMFTPs using VAS and CROM. Both groups (DN only – control, DN+IC) showed improvement.

Research on how DN affects LMFTPs is scarce (Celik and Mutlu 2013), especially with regards to ROM. The above articles (Martin-Pintado-Zugasti *et al.* 2015; Yeganeh Lari *et al.* 2016; Takla, Atwa and El-Latif 2017) were the only ones found that regarded ROM, although - due to the study designs of the other two studies - Martin-Pintado-Zugasti *et al.* (2015) is the only one of the three that truly investigates ROM.

DN is well documented to show an increase in PPT in AMFTPs (Gattie, Cleland and Snodgrass 2017). However, research using LMFTPs is scarce and the research that is available seems to show a different trend of a decrease in PPT after DN between the first 24-48 hours (Martin-Pintado Zugasti *et al.* 2014; Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero 2016). Calvo-Lobo, Pacheco-da-Costa and Hita-Herranz (2017) and Calvo-Lobo *et al.* (2018) included DN LMFTP in the treatment however they also DN AMFTPs simultaneously which may have influenced results.

Electromyography is widely used to study muscle disfunction. Research shows that MFTPS generate abnormal EMG patterns. Wytrazek, Huber and Lisinski (2011) showed that muscles with active MFTPs showed a greater resting sEMG amplitude and decreased sEMG amplitude on contraction when compared with MFTP free muscles. Wytrazek *et al.* (2015) found that all MFTPs, regardless of type, have a raised resting sEMG amplitude.

Dry needling seems to improve SEA in animal studies (Chen *et al.* 2001; Fu *et al.* 2012; Liu *et al.* 2017) which Chen *et al.* (2001) and Hsieh *et al.* (2012) associate with eliciting a LTR. Some doubt is cast onto this however by De Meulemeester *et al.* (2017) which showed a decrease in sEMG after needling AMFTPs but failed to show a correlation between LTR and the change in sEMG. The review by Perreault, Dunning and Butts (2017) shows that LTRs appear to be unnecessary to achieve the benefits of DN.

De Meulemeester *et al.* (2017) noted that despite the research showing the disturbed EMG patterns of MFTPs, there is little research on the effect that DN would have on those patterns in humans. Cagnie *et al.* (2012) investigated the influence of dry needling on blood flow and oxygenation in the trapezius muscle and found that blood flow and oxygenation had significantly increased in the vicinity of the

treated area. This may be another factor in the decreased SEA as this seems to support the mechanism of therapeutic effect proposed by Simons, Travell and Simons (1999).

Post-needling soreness (PNS) is a common side effect. It is pain felt shortly after DN at the site of needle insertion which peaks at 24 hours post-treatment (Simons, Travell and Simons 1999; Huguenin 2004). It is thought that local haemorrhaging, caused by the needle, results in muscle irritation which causes the PNS (Simons, Travell and Simons 1999). There is a lack of literature and understanding with regards to the onset, duration and progression of PNS (Martin-Pintado-Zugasti *et al.* 2018). This may be due in part to PNS being a secondary concern in the majority of the research surrounding PNS, and as such the study designs vary widely, making comparisons difficult. Aside from this, research where both subjective and objective measurements have been taken within the first few hours after treatment and can be compared is scarce or non-existent. Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero (2016) was the only study found to have a follow up measurement sooner, at 6 hours post-needling. The measurement was a subjective one with the next objective measurement documented at 24 hours.

2.6 Conclusion

While there are commonly studied physical effects of dry needling there is a significant gap in the research regarding the short term effects of dry needling. Even the studies that do focus on the short-term effects, focus on pre-/post- designs with a possible follow up 24 hours later. No study was found that investigates the effects of DN or PNS in the first few hours after treatment. Celik and Mutlu (2013) also noted that there is a lack of research on DN with regards to LMFTPs.

The literature review also indicated the gap in the literature for commonly measured outcomes of DN as used in this study which are: ROM, PPT, sEMG and PNS.

Only three studies were found that regarded ROM with DN of LMFTPs, and only one of those studies truly investigated ROM.

Martin-Pintado Zugasti *et al.* (2014) and Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero (2016) emphasize the need for more research

by showing that LMFTPs may respond differently to DN than AMFTPs with regards to PPT. Both articles show a decrease in PPT as opposed to an increase as seen in AMFTPs.

While sEMG studies show that MFTPs cause disturbed EMG patterns, the studies that show the effect of DN on the aberrant patterns are predominantly animal studies which may not have the same results in humans (De Meulemeester *et al.* 2017).

Despite PNS being a common side effect of DN MFTPs the is a lack of literature regarding its onset duration and progression.

Therefor this study is required to investigate the gap in the literature on the short-term effects of dry needling with regards to ROM, PPT, sEMG and PNS.

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

This chapter discusses the methodology of this study and covers study design, population, sampling, recruitment, inclusion/exclusion criteria, measurement tools, intervention, procedure, methods for statistical analysis and ethical considerations.

3.2 Study design

A quantitative randomized pre-test post-test design with repeated follow up measurements.

3.3 Population

The study population consisted of a sample of the local general population who met the inclusion and exclusion criteria.

3.4 Sampling

Through a purposive convenient sampling strategy, 15 volunteers were recruited into the study, through a local advertisement on campus and at local stores.

3.5 Recruitment

Advertisements (Appendix A) were placed on the notice boards at the Durban University of Technology (DUT) Berea campuses and the Chiropractic Day Clinic (CDC). Advertisements were also placed at local stores after permission had been granted by the store managers. The researcher also handed out advertisements around the Berea campuses. All prospective volunteers were asked the following questions (Appendix B) before being considered. If any of the responses did not meet the inclusion criteria, the individual was not included in the study.

Questions	Answers required
"Would you mind answering some questions to see if you meet the requirements to participate in the study?"	Yes
"How old are you?"	18-25
"Do you have any head, neck or shoulder pain?"	No
"Do you have a recent history of trauma?"	No
"Are you currently taking any painkillers and/or anti-inflammatory medications?"	No
"Are you on any blood thinning medication?"	No
"Are you pregnant, or is there a chance that you may be pregnant?" (For females)	No
"Do you have a phobia of needles?"	No
"Do you have, or have you had any malignant diseases?"	No
"Have you had any surgery done to your neck, back or shoulder(s)?"	No

3.6 Inclusion/exclusion criteria

3.6.1 Inclusion criteria

- Age: 18-25 years
- Free of head or neck pain
- Presence of a LMFTP in the upper trapezius. This was diagnosed using pincer palpation and by identifying the characteristics set out by Simons, Travell and Simons (1999):
    - Presence of a taut palpable band
    - A tender nodule in the band
    - Local twitch response to snapping palpation of the band
    - Pain on palpation with or without referral

3.6.2 Exclusion criteria

- If the participant did not fit into the age range
- If the participant had any contraindication(s) to dry needling (Wang and Audette 2008):
    - Phobia or severe fear of needles
    - Mental illness (delusions/hallucinations/paranoia)
    - Local infection
    - Systemic infection/disease
    - Anti-coagulation or bleeding disorders
    - Pregnancy
- If the participant had acute or chronic neck and/or shoulder pain
- Use of anti-inflammatory or analgesic medication during the research period or within 72 hours prior to the initial consultation, as this may have affected results. A washout period of 72 hours was suggested by Poul *et al.* (1993)
- If the participant had received dry needling or acupuncture in the last three months (Ferreira 2006). This was to allow for memory decay to take place, to mitigate the influence of previous experiences on the participant's expectations (Mouton 1996)
- If the participant had had any surgery on the neck back or shoulder(s)

3.7 Measurement tools

The algometer, which measures pain pressure threshold (PPT), is a reliable and useful tool for research or clinical purposes to monitor treatment effects in myofascial conditions (Potter, McCarthy and Oldham 2006; van Wilgen, van der Noord and Zwerver 2011; Walton *et al.* 2011). To measure PPT the algometer is placed perpendicular to the skin with the rubber stopper against the skin over the area which is to be assessed. A force of 1 kg per second is applied until the participant notices the sensation of pressure changes to that of pain and says "yes" or another agreed upon phrase (Potter, McCarthy and Oldham 2006).

sEMG is a safe and non-invasive way to measure the electrical energy in muscles, more specifically the motor unit action potentials (MUAP) by muscle motor units during contraction. sEMG is best used on superficial muscles as there is less

interference with the MUAP before they are picked up by electrodes. Electrodes are attached to the skin overlying the muscle being observed; these are used to detect the MUAP. The MUAP picked up by the electrodes are filtered and amplified by the sEMG device. This data can then be processed or not and be displayed in multiple ways, each with advantages and disadvantages (Criswell 2011). Wytrazek, Huber and Lisinski (2011) showed that muscles with active MFTPs showed a greater resting sEMG amplitude and decreased sEMG amplitude on contraction when compared with MFTP free muscles. Gemmell and Bagust (2009) found that LMFTPs had slightly, but not significantly, greater sEMG readings than AMFTPs. Unfortunately, there was no control in this study as none of the subjects were free of MFTPs. Wytrazek *et al.* (2015) found that all MFTPs, regardless of type, have a raised resting sEMG amplitude. The sEMG in this study was measured using the Bionomadix 2CH wireless EMG amplifier, paired with a data acquisition and analysis platform. The supplied software, AcqKnowledge 4.4, was set to record at 5000kHz (all produced by BIOPAC Systems Inc.) and the root mean (RMS) was calculated afterwards, measured in micro-volt (µV). Disposable electrodes were used in this study.

The CROM (cervical range of motion) was measured using a goniometer device with a magnetic yoke and gravity goniometers. It is a reliable tool used to measure the range of motion of the cervical spine in the frontal and sagittal planes (Audette *et al.* 2010). The upper trapezius is involved in lateral flexion and rotation of the head and neck when unilaterally activated and extension when bilaterally activated (Simons, Travell and Simons 1999). As such, ipsilateral and contralateral rotation and lateral flexion of the neck were measured. The CROM device was used to measure treatment outcomes as latent MFTP's are proposed to cause stiffness and/or weakness in a muscle thereby reducing range of motion (ROM) (Simons, Travell and Simons 1999).

Numerical Rating Scale (NRS) was used to subjectively monitor the development and progression of any PNS that occured. The NRS requires the participant to rate their pain on a scale of 0–10 with 0 being no pain and 10 being pain at its maximum intensity. Hjermstad *et al.* (2011) found that numerical pain scales are applicable in the assessment of pain intensity and Ferreira-Valente, Pais-Ribeiro and Jensen

(2011) found that numerical pain rating scales are more responsive compared to the Visual Analogue Scale, Verbal Rating Scales and the Faces Pain Scale – Revised.

Each participant was given an activity diary - a small book in which to record their activities between measurement sessions. This was less of a measurement tool and more of a control method to remind participants to avoid strenuous activities between sessions, which was also explained to them (Appendix B).

The readings for PPT, CROM and NRS were recorded on Appendix C. All data sheets have a participant code and not their names to ensure anonymity and confidentiality.

3.8 Intervention

3.8.1 Needles used

The needles used for all participants were Ø0.30 x 30mm, single use, sterile, disposable acupuncture needles. The shafts of the needles are made of surgical steel with a wound copper handle (Chi™).

3.8.2 Technique

Dry needling was performed using standard clinic aseptic technique. The examiner used latex gloves during the procedure. The area of skin overlying the LMFTP was cleaned using an alcohol swab after which the trigger point was remarked using a felt marker, as the LMFTP had already been located using pincer palpation and marked for pre-intervention measurements.

Pincer palpation was done by gripping the muscle between thumb and index finger, while looking for the following characteristics of a LMFTP: the presence of a taut palpable band, a tender nodule in the band, and pain (with or without referral) on palpation only. Local twitch response to snapping palpation, which is snapping a finger perpendicularly across a muscle, is another characteristic (Simons, Travell and Simons 1999).

With the participant in a prone position, the needle was inserted into the marked trigger point, the fanning technique of DN was used where the needle is partially withdrawn and reinserted. This would be done 10 times as was done by Ferreira

(2006), after which the needle was withdrawn and the area cleaned with another alcohol swab and the trigger point remarked if necessary.

All needles, swabs and gloves were disposed of appropriately as per clinic regulations.

3.9 Procedure

Each potential participant was first verbally or telephonically interviewed. If the potential participant passed the interview and wished to participate in the research, they were given the informed consent form (Appendix D) to read and sign. Each participant went through an initial consultation, like all new patients of the Durban University of Technology Chiropractic Day Clinic, consisting of a case history, physical examination and regional examination (Appendices E, F, G and H respectively). This was to ensure that each participant met the inclusion criteria. After this, the location of the LMFTP and electrode placements were marked, using a felt tip pen for easy relocation. The locating and marking of the LMFTP was done with the participant in the prone position as this was the same position in which they were DN. The sites for electrode placement were prepared using an abrasive gel to ensure maximum connectivity.

Baseline readings were taken starting with the NRS then followed by sEMG. For the sEMG readings the participant was seated in a chair with no back rest and their arms at their sides (Criswell 2011). There was a one-minute period of inactivity for a baseline reading followed by three maximal shoulder shrugs (the participants must elevate their shoulders, exerting the maximum amount of force possible) each of a three-second duration, followed by three minutes of rest. This is the same method of sEMG assessment as done by Gemmell and Bagust (2009). PPT and CROM readings were then taken.

After baseline readings had been taken the LMFTP was DN in the fashion described earlier. The markings were checked to ensure that they remained clear and the measurements were taken again in the same order. The measurements were taken every hour for four hours. The participant was asked to keep a diary of the activities they performed/took part in during the hours between measurements and was

advised to avoid all strenuous activity during the research period. All readings were taken at each visit.

3.10 Statistical analysis

The sample size of 15 was chosen as similar studies had used the same sample size or smaller (Fernandez-Carnero *et al.* 2010; Ibarra *et al.* 2011; Ge, Arendt-Nielsen and Madeleine 2012; Ge *et al.* 2014). The sample size was also approved by a statistician.

3.10.1 Statistical methodology

IBM SPSS version 25 was used to analyse the data. A p value <0.05 was considered as statistically significant. Comparison of measurements over time were achieved using non-parametric Friedman tests for paired data. Post hoc tests were done in the case of significant Friedman's test in order to determine which pairs of measurements differed. Box and whisker plots were used to display the distributions of the variables over time. Correlations between the changes over time of each measurement were done using non-parametric Spearman's correlation.

3.11 Ethical considerations

Post-treatment care as an ethical consideration: should a participant have experienced unbearable post-needling soreness, the clinician on duty would have been informed and an appropriate intervention(s) would have been applied to help reduce the pain. The intervention(s) applied would have depended on the clinical judgement of the researcher, the permission of the clinician on duty and the acceptance of the intervention by the participant. Such interventions may have included ice, stretching, ultrasound therapy and transcutaneous electrical nerve stimulation.

Participants were provided with reading material (magazines/newspapers) and refreshments (juice and biscuits) while they waited out the period between measurements. Any of the participants who were DUT staff or students were

allowed to return to work/class, provided that they avoided excessive activity and returned on time for the measurements.

As remuneration each participant received one free treatment at the CDC. A note was made in their file to indicate this remuneration.

CHAPTER 4

RESULTS

4.1 Introduction

Detailed statistical results for all readings are included in the appendix.

This chapter will display the results of the statistical analysis on data captured by the measures described in chapter three, and pertaining to the following objectives:

- To determine the effect of DN LMFTPs in the upper trapezius muscle on NRS in the first four hours after treatment.

- To determine the effect of DN LMFTPs in the upper trapezius muscle on PPT in the first four hours after treatment.

- To determine the effect of DN LMFTPs in the upper trapezius muscle on CROM in the first four hours after treatment.

- To determine the effect of DN LMFTPs in the upper trapezius muscle on muscle activity (sEMG) during treatment and in the first four hours after treatment.

4.2 Demographics

The sample was 47% male and 67% White. The mean age was 21.6 years (sd 2.5 years), range 18 to 25 years.

TABLE 4.2.1 Gender distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FEMALE	8	53.3	53.3	53.3
	MALE	7	46.7	46.7	100.0
	Total	15	100.0	100.0	

TABLE 4.2.2 Race distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	BLACK	5	33.3	33.3	33.3
	WHITE	10	66.7	66.7	100.0
	Total	15	100.0	100.0	

TABLE 4.2.3 Age distribution

Statistics		
AGE		
N	Valid	15
	Missing	0
Mean		21.60
Std. Deviation		2.473
Minimum		18
Maximum		25

4.3 NRS

There was a statistically significant overall change in NRS ($p < 0.001$). However, after adjustment for multiple comparisons, no pairwise comparisons were statistically significant. The change that was noted was a rise in the NRS, indicating an increase in perceived pain. This occurred at the post-treatment measurement and can be clearly seen in the box and whisker graph (Figure 4.3.1).

TABLE 4.3.1 NRS hypothesis test summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment NRS, Post-Treatment NRS, 1st Hour NRS, 2nd Hour NRS, 3rd Hour NRS and 4th Hour NRS are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.000	Reject Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

Table 4.3.2 NRS pairwise comparisons

Sample 1 – Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Pre-Treatment NRS – 4th Hour NRS	-.267	.683	-.390	.696	1.000
Pre-Treatment NRS – 1st Hour NRS	-.300	.683	-.439	.661	1.000
Pre-Treatment NRS – 2nd Hour NRS	-.567	.683	-.830	.407	1.000
Pre-Treatment NRS – 3rd Hour NRS	-.567	.683	-.830	.407	1.000
Pre-Treatment NRS – Post-Treatment NRS	-.1.900	.683	-2.781	.005	.081
4th Hour NRS – 1st Hour NRS	.033	.683	.049	.961	1.000
4th Hour NRS – 2nd Hour NRS	.300	.683	.439	.661	1.000
4th Hour NRS - 3rd Hour NRS	.300	.683	.439	.661	1.000
4th Hour NRS - Post-Treatment NRS	1.633	.683	2.391	.017	.252
1st Hour NRS - 2nd Hour NRS	-.267	.683	-.390	.696	1.000
1st Hour NRS - 3rd Hour NRS	-.267	.683	-.390	.696	1.000
1st Hour NRS - Post-Treatment NRS	1.600	.683	2.342	.019	.288
2nd Hour NRS - 3rd Hour NRS	.000	.683	.000	1.000	1.000
2nd Hour NRS - Post-Treatment NRS	1.333	.683	1.952	.051	.764
3rd Hour NRS - Post-Treatment NRS	1.333	.683	1.952	.051	.764

Each row tests the null hypothesis that Sample 1 and Sample 2 are the same. Asymptomatic significances (2-sided tests) are displayed. The significance is .05. Significance values have been adjusted by the Bonferroni correction for multiple tests.

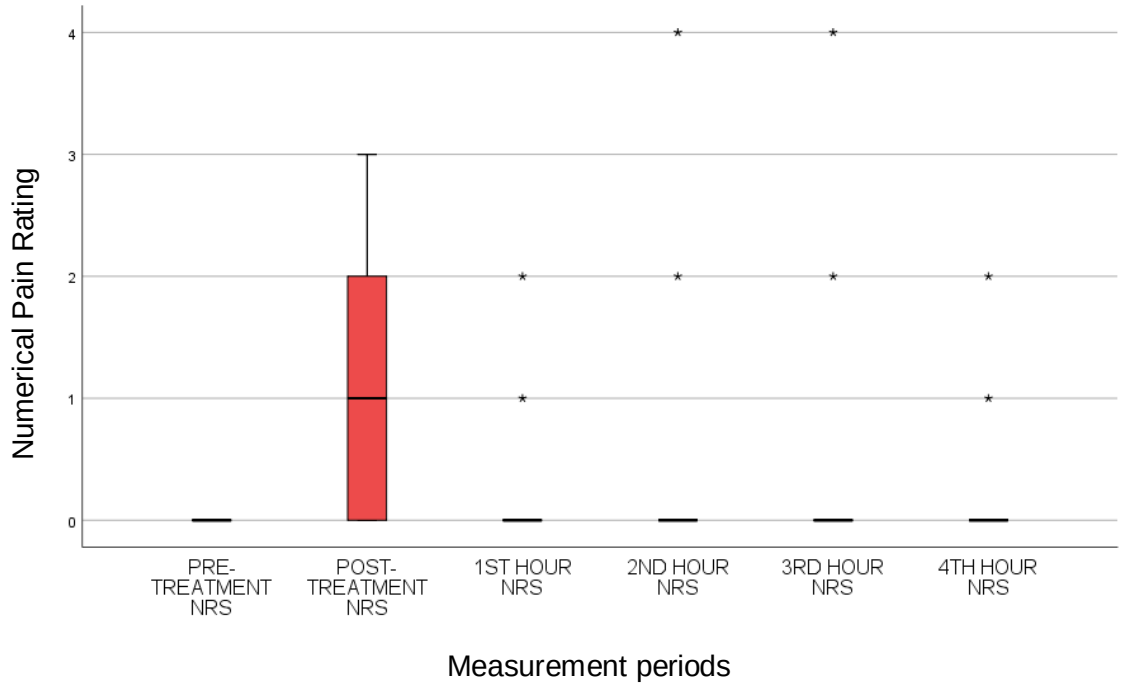

Figure 4.3.1 NRS data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.1.

4.4 Algometer (PPT)

There was no significant difference in algometer measurements over time (p = 0.321)

Table 4.4.1 Algometer hypothesis test summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment Algometer, Post-Treatment Algometer, 1st Hour Algometer, 2nd Hour Algometer, 3rd Hour Algometer and 4th Hour Algometer are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.321	Retain Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

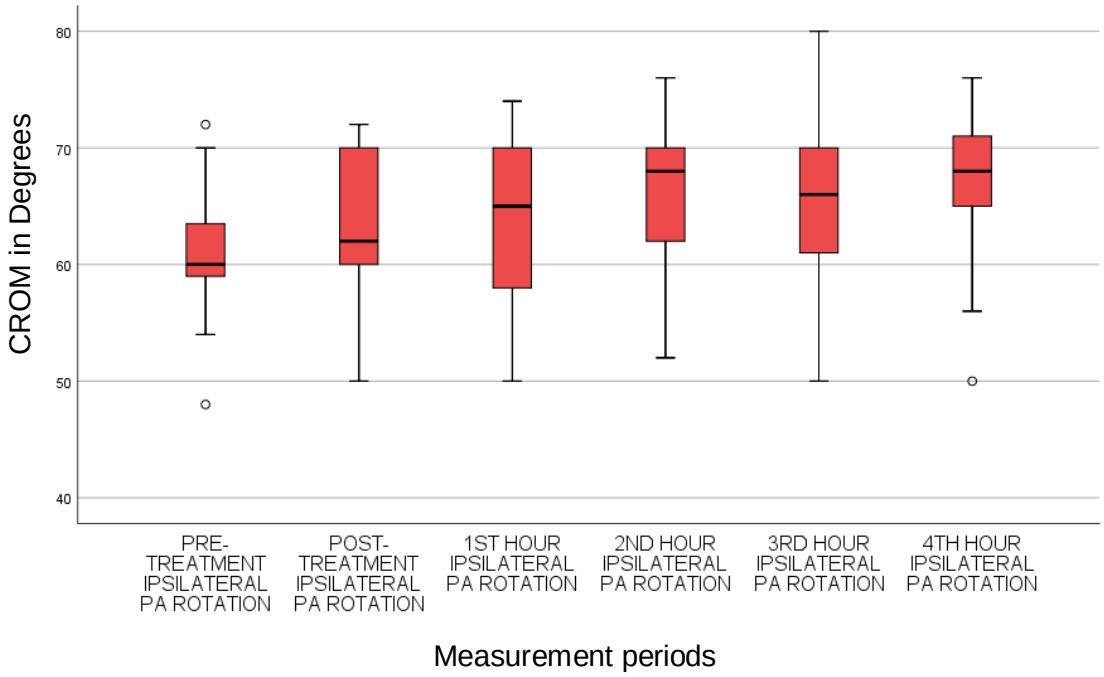

Figure 4.4.1 Algometer data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.2.

4.5 IPA Rotation

There was a statistically significant overall difference between the time points for this outcome ($p < 0.001$). The post hoc tests showed that the difference lay between the pre- and 2nd, 3rd and 4th hours. This shows a statistically significant increase in ipsilateral PA rotation after DN from the 2nd hour.

Table 4.5.1 Ipsilateral PA rotation hypothesis test summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment Ipsilateral PA Rotation, Post-Treatment Ipsilateral PA Rotation, 1st Hour Ipsilateral PA Rotation, 2nd Hour Ipsilateral PA Rotation, 3rd Hour Ipsilateral PA Rotation and 4th Hour Ipsilateral PA Rotation are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.000	Reject Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

Table 4.5.2 Ipsilateral PA rotation pairwise comparison

Sample 1 – Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Pre-Treatment Ipsilateral PA Rotation - 1st Hour Ipsilateral PA Rotation	-.900	.683	-1.317	.188	1.000
Pre-Treatment Ipsilateral PA Rotation - Post-Treatment Ipsilateral PA Rotation	-1.067	.683	-1.561	.118	1.000
Pre-Treatment Ipsilateral PA Rotation - 2nd Hour Ipsilateral PA Rotation	-2.067	.683	-3.025	.002	.037
Pre-Treatment Ipsilateral PA Rotation - 3rd Hour Ipsilateral PA Rotation	-2.233	.683	-3.269	.001	.016
Pre-Treatment Ipsilateral PA Rotation - 4th Hour Ipsilateral PA Rotation	-2.733	.683	-4.001	.000	.001
1st Hour Ipsilateral PA Rotation - Post-Treatment Ipsilateral PA Rotation	.167	.683	.244	.807	1.000
1st Hour Ipsilateral PA Rotation - 2nd Hour Ipsilateral PA Rotation	-1.167	.683	-1.708	.088	1.000
1st Hour Ipsilateral PA Rotation - 3rd Hour Ipsilateral PA Rotation	-1.333	.683	-1.952	.051	.764
1st Hour Ipsilateral PA Rotation - 4th Hour Ipsilateral PA Rotation	-1.833	.683	-2.684	.007	.109
Post-Treatment Ipsilateral PA Rotation - 2nd Hour Ipsilateral PA Rotation	-1.000	.683	-1.464	.143	1.000
Post-Treatment Ipsilateral PA Rotation - 3rd Hour Ipsilateral PA Rotation	-1.167	.683	-1.708	.088	1.000
Post-Treatment Ipsilateral PA Rotation - 4th Hour Ipsilateral PA Rotation	-1.667	.683	-2.440	.015	.220
2nd Hour Ipsilateral PA Rotation - 3rd Hour Ipsilateral PA Rotation	-.167	.683	-.244	.807	1.000
2nd Hour Ipsilateral PA Rotation - 4th Hour Ipsilateral PA Rotation	-.667	.683	-.976	.329	1.000
3rd Hour Ipsilateral PA Rotation - 4th Hour Ipsilateral PA Rotation	-.500	.683	-.732	.464	1.000

Each row tests the null hypothesis that Sample 1 and Sample 2 are the same. Asymptomatic significances (2-sided tests) are displayed. The significance is .05. Significance values have been adjusted by the Bonferroni correction for multiple tests.

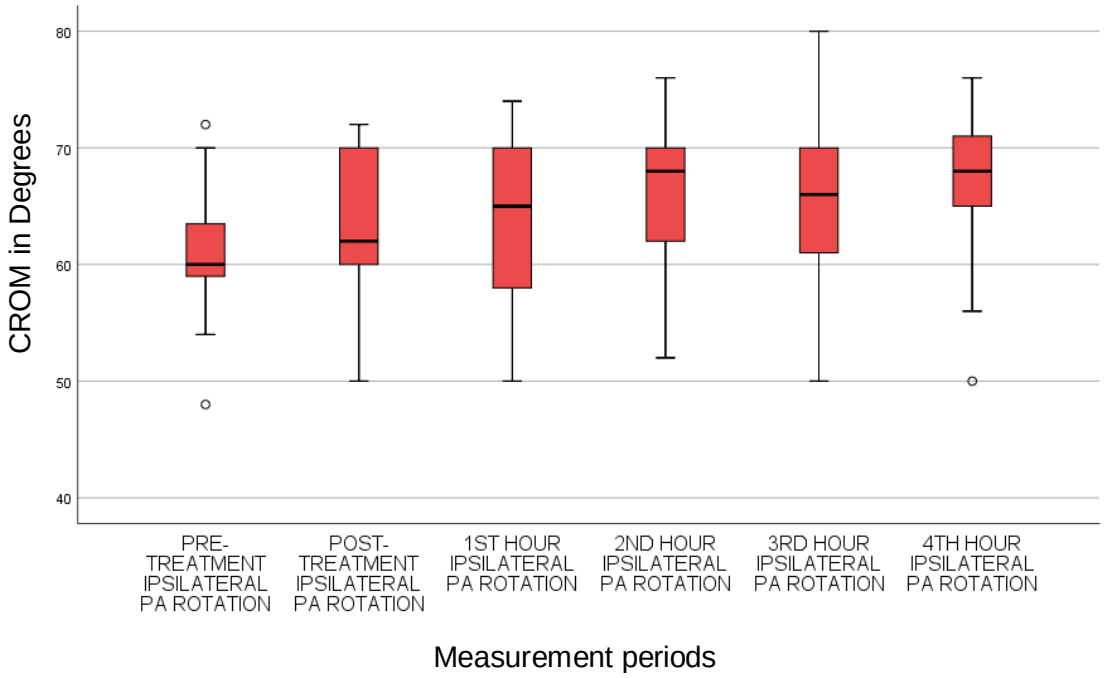

Figure 4.5.1 Ipsilateral PA rotation data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.3.

4.6 Contralateral PA Rotation

There was an overall highly significant difference between the time points for this outcome ($p < 0.001$). The post hoc tests showed the difference lay between pre- and 3rd and post- and 3rd. This shows a statically significant increase in contralateral PA rotation at the 3rd hour after DN.

Table 4.6.1 Contralateral PA rotation hypothesis test summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment Contralateral PA Rotation, Post-Treatment Contralateral PA Rotation, 1st Hour Contralateral PA Rotation, 2nd Hour Contralateral PA Rotation, 3rd Hour Contralateral PA Rotation and 4th Hour Contralateral PA Rotation are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.000	Reject Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

Table 4.6.2 Contralateral PA rotation Pairwise comparison

Sample 1 – Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Pre-Treatment Contralateral PA Rotation - Post-Treatment Contralateral PA Rotation	-.900	.683	-1.317	.188	1.000
Pre-Treatment Contralateral PA Rotation - 1st Hour Contralateral PA Rotation	-1.733	.683	-2.537	.011	.168
Pre-Treatment Contralateral PA Rotation - 2nd Hour Contralateral PA Rotation	-1.900	.683	-2.781	.005	.081
Pre-Treatment Contralateral PA Rotation - 4th Hour Contralateral PA Rotation	-1.900	.683	-2.781	.005	.081
Pre-Treatment Contralateral PA Rotation - 3rd Hour Contralateral PA Rotation	-2.967	.683	-4.343	.000	.000
Post-Treatment Contralateral PA Rotation - 1st Hour Contralateral PA Rotation	-.833	.683	-1.220	.223	1.000
Post-Treatment Contralateral PA Rotation - 2nd Hour Contralateral PA Rotation	-1.000	.683	-1.464	.143	1.000
Post-Treatment Contralateral PA Rotation - 4th Hour Contralateral PA Rotation	-1.000	.683	-1.464	.143	1.000
Post-Treatment Contralateral PA Rotation - 3rd Hour Contralateral PA Rotation	-2.067	.683	-3.025	.002	.037
1st Hour Contralateral PA Rotation - 2nd Hour Contralateral PA Rotation	-.167	.683	-.244	.807	1.000
1st Hour Contralateral PA Rotation - 4th Hour Contralateral PA Rotation	-.167	.683	-.244	.807	1.000
1st Hour Contralateral PA Rotation - 3rd Hour Contralateral PA Rotation	-1.233	.683	-1.805	.071	1.000
2nd Hour Contralateral PA Rotation - 4th Hour Contralateral PA Rotation	.000	.683	.000	1.000	1.000
2nd Hour Contralateral PA Rotation - 3rd Hour Contralateral PA Rotation	-1.067	.683	-1.561	.118	1.000
4th Hour Contralateral PA Rotation - 3rd Hour Contralateral PA Rotation	1.067	.683	1.561	.118	1.000

Each row tests the null hypothesis that Sample 1 and Sample 2 are the same. Asymptomatic significances (2-sided tests) are displayed. The significance is .05. Significance values have been adjusted by the Bonferroni correction for multiple tests.

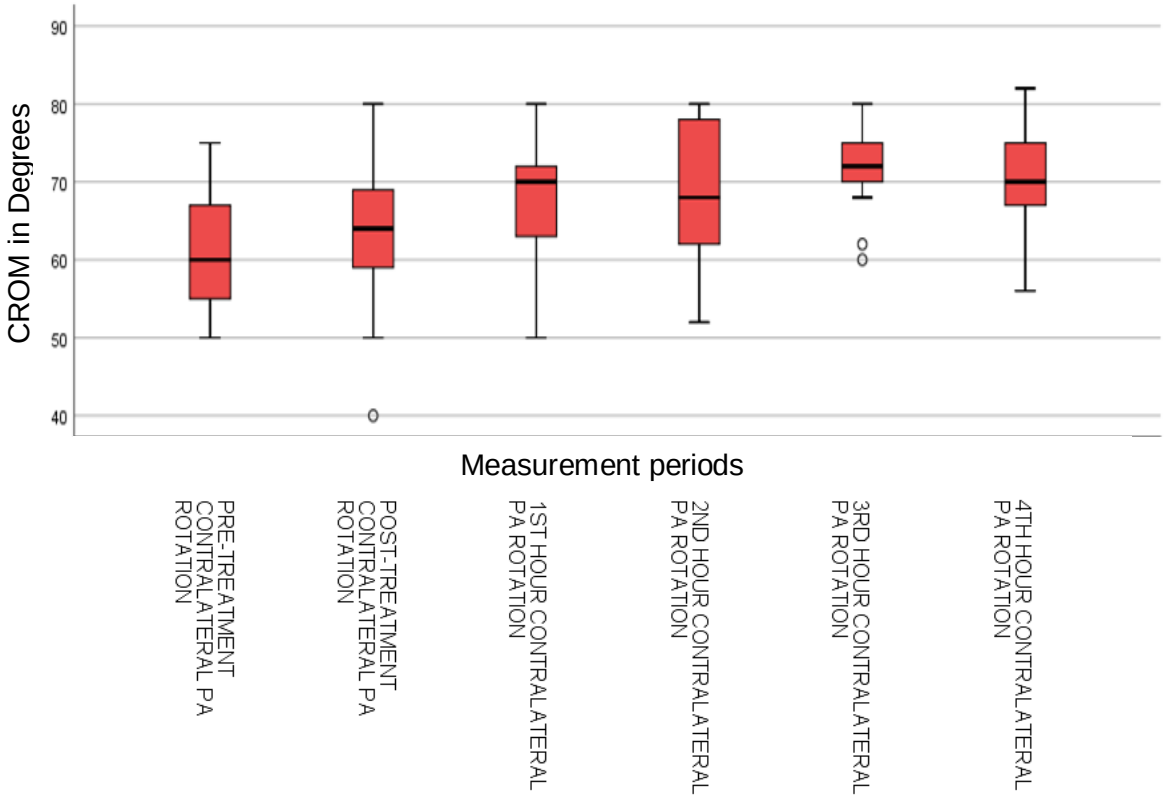

Figure 4.6.1 Contralateral PA rotation data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.4.

4.7 Ipsilateral lateral flexion

There was a statistically significant overall difference between the time points for this outcome (p = 0.001). The post hoc tests showed the difference lay between pre- and 4th hour. This shows a statically significant increase in ipsilateral lateral flexion at the 4th hour after DN.

Table 4.7.1 Ipsilateral lateral flexion hypothesis test summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment Ipsilateral Lateral Flexion, Post-Treatment Ipsilateral Lateral Flexion, 1st Hour Ipsilateral Lateral Flexion, 2nd Hour Ipsilateral Lateral Flexion, 3rd Hour Ipsilateral Lateral Flexion and 4th Hour Ipsilateral Lateral Flexion are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.001	Reject Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

Table 4.7.2 Ipsilateral lateral flexion pairwise comparisons

Sample 1 – Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Pre-Treatment Ipsilateral Lateral Flexion - Post-Treatment Ipsilateral Lateral Flexion	-.433	.683	-.634	.526	1.000
Pre-Treatment Ipsilateral Lateral Flexion - 1st Hour Ipsilateral Lateral Flexion	-.500	.683	-.732	.464	1.000
Pre-Treatment Ipsilateral Lateral Flexion - 2nd Hour Ipsilateral Lateral Flexion	-1.267	.683	-1.854	.064	.956
Pre-Treatment Ipsilateral Lateral Flexion - 3rd Hour Ipsilateral Lateral Flexion	-1.967	.683	-2.879	.004	.060
Pre-Treatment Ipsilateral Lateral Flexion - 4th Hour Ipsilateral Lateral Flexion	-2.433	.683	-3.562	.000	.006
Post-Treatment Ipsilateral Lateral Flexion - 1st Hour Ipsilateral Lateral Flexion	-.067	.683	-.098	.922	1.000
Post-Treatment Ipsilateral Lateral Flexion - 2nd Hour Ipsilateral Lateral Flexion	-.833	.683	-1.220	.223	1.000
Post-Treatment Ipsilateral Lateral Flexion - 3rd Hour Ipsilateral Lateral Flexion	-1.533	.683	-2.245	.025	.372
Post-Treatment Ipsilateral Lateral Flexion - 4th Hour Ipsilateral Lateral Flexion	-.2000	.683	-2.928	.003	.051
1st Hour Ipsilateral Lateral Flexion - 2nd Hour Ipsilateral Lateral Flexion	-.767	.683	-1.122	.262	1.000
1st Hour Ipsilateral Lateral Flexion - 3rd Hour Ipsilateral Lateral Flexion	-1.467	.683	-2.147	.032	.477
1st Hour Ipsilateral Lateral Flexion - 4th Hour Ipsilateral Lateral Flexion	-1.933	.683	-2.830	.005	.070
2nd Hour Ipsilateral Lateral Flexion - 3rd Hour Ipsilateral Lateral Flexion	-.700	.683	-1.025	.306	1.000
2nd Hour Ipsilateral Lateral Flexion - 4th Hour Ipsilateral Lateral Flexion	-1.167	.683	-1.708	.088	1.000
3rd Hour Ipsilateral Lateral Flexion - 4th Hour Ipsilateral Lateral Flexion	-.467	.683	-.683	.495	1.000

Each row tests the null hypothesis that Sample 1 and Sample 2 are the same. Asymptomatic significances (2-sided tests) are displayed. The significance is .05. Significance values have been adjusted by the Bonferroni correction for multiple tests.

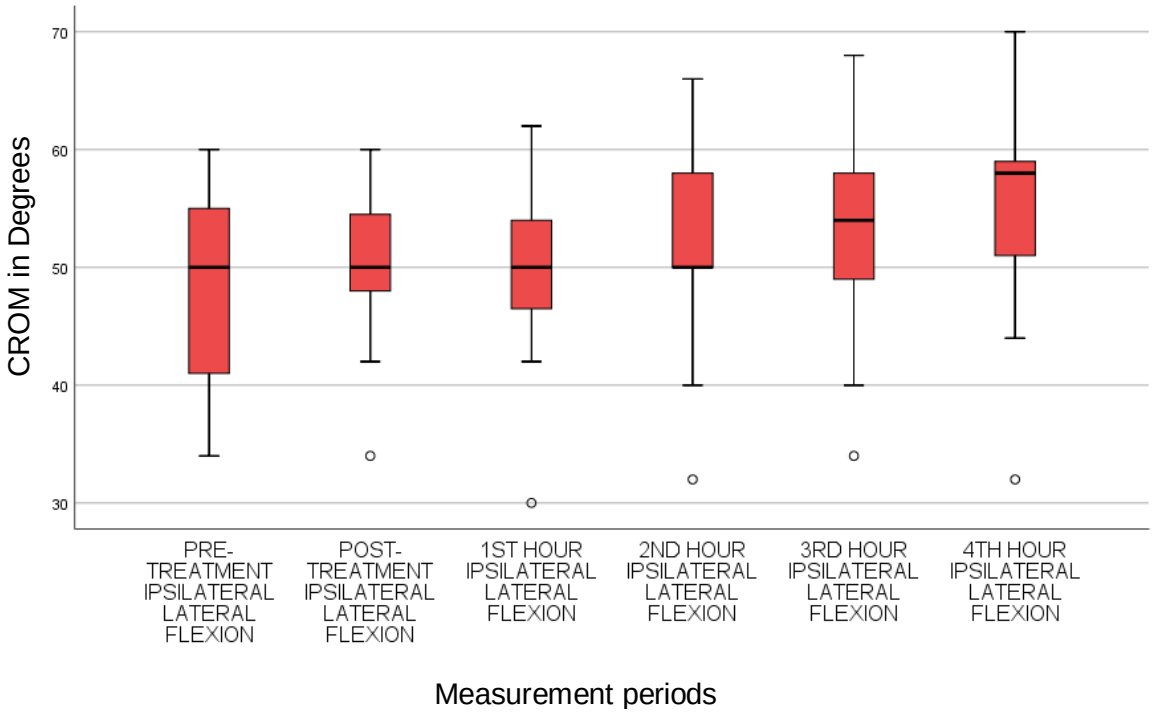

Figure 4.7.1 Ipsilateral lateral flexion data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.5.

4.8 Contralateral lateral flexion

There was an overall highly statistically significant difference between the time points for this outcome ($p < 0.001$). Post hoc tests showed that the differences lay between pre- and 3rd, pre- and 4th, 1st and 4th, and post- and 4th. This shows a statically significant increase in contralateral lateral flexion from the 3rd hour after DN.

Table 4.8.1 Contralateral lateral flexion hypothesis summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment Contralateral Lateral Flexion, Post-Treatment Contralateral Lateral Flexion, 1st Hour Contralateral Lateral Flexion, 2nd Hour Contralateral Lateral Flexion, 3rd Hour Contralateral Lateral Flexion and 4th Hour Contralateral Lateral Flexion are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.000	Reject Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

Table 4.8.1 Contralateral lateral flexion pairwise comparisons

Sample 1 – Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Pre-Treatment Contralateral Lateral Flexion - 1st Hour Contralateral Lateral Flexion	-1.433	.683	-2.098	.036	.538
Pre-Treatment Contralateral Lateral Flexion - Post-Treatment Contralateral Lateral Flexion	-1.667	.683	-2.440	.015	.220
Pre-Treatment Contralateral Lateral Flexion - 2nd Hour Contralateral Lateral Flexion	-1.967	.683	-2.879	.004	.060
Pre-Treatment Contralateral Lateral Flexion - 3rd Hour Contralateral Lateral Flexion	-2.467	.683	-3.611	.000	.005
Pre-Treatment Contralateral Lateral Flexion - 4th Hour Contralateral Lateral Flexion	-3.867	.683	-5.660	.000	.000
1st Hour Contralateral Lateral Flexion - Post-Treatment Contralateral Lateral Flexion	.233	.683	.342	.733	1.000
1st Hour Contralateral Lateral Flexion - 2nd Hour Contralateral Lateral Flexion	-.533	.683	-.781	.435	1.000
1st Hour Contralateral Lateral Flexion - 3rd Hour Contralateral Lateral Flexion	-1.033	.683	-1.513	.130	1.000
1st Hour Contralateral Lateral Flexion - 4th Hour Contralateral Lateral Flexion	-2.433	.683	-3.562	.000	.006
Post-Treatment Contralateral Lateral Flexion - 2nd Hour Contralateral Lateral Flexion	-.300	.683	-.439	.661	1.000
Post-Treatment Contralateral Lateral Flexion - 3rd Hour Contralateral Lateral Flexion	-.800	.683	-1.171	.242	1.000
Post-Treatment Contralateral Lateral Flexion - 4th Hour Contralateral Lateral Flexion	-2.200	.683	-3.220	.001	.019
2nd Hour Contralateral Lateral Flexion - 3rd Hour Contralateral Lateral Flexion	-.500	.683	-.732	.464	1.000
2nd Hour Contralateral Lateral Flexion - 4th Hour Contralateral Lateral Flexion	-1.900	.683	-2.781	.005	.081
3rd Hour Contralateral Lateral Flexion - 4th Hour Contralateral Lateral Flexion	-1.400	.683	-2.049	.040	.606

Each row tests the null hypothesis that Sample 1 and Sample 2 are the same. Asymptomatic significances (2-sided tests) are displayed. The significance is .05. Significance values have been adjusted by the Bonferroni correction for multiple tests.

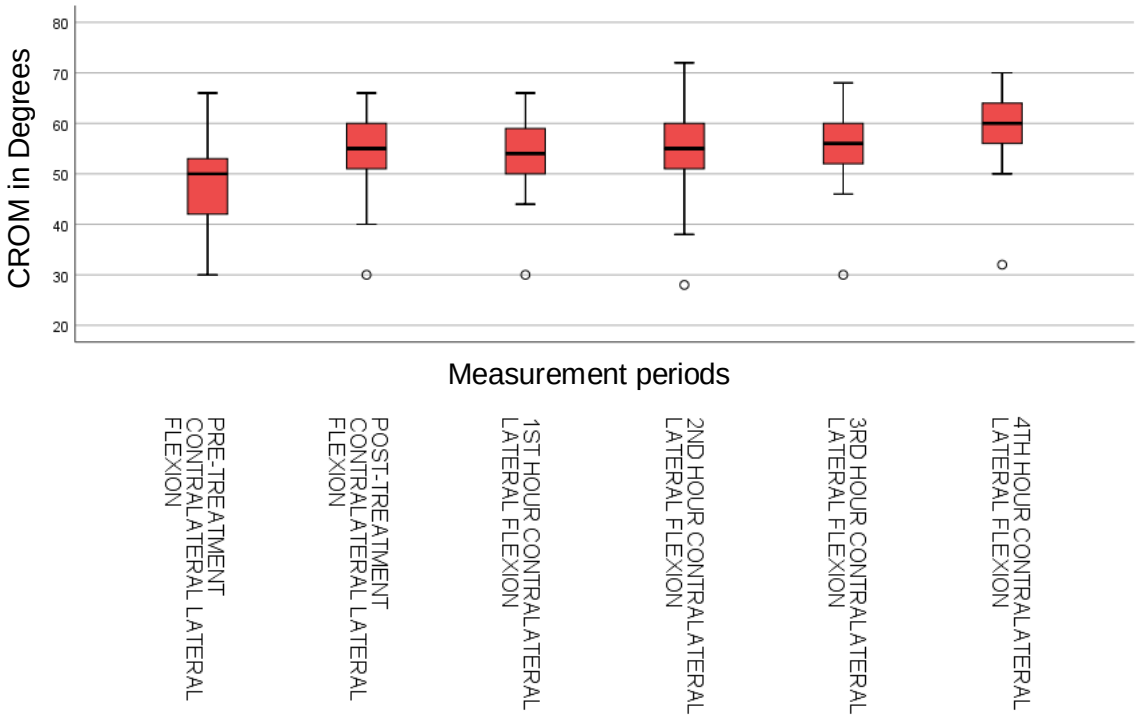

Figure 4.8.1 Contralateral lateral flexion data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.6.

4.9 One-minute rest

There was no difference between the time points for this outcome (p=0.452).

Table 4.9.1 1-minute rest sEMG summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment One-Minute Rest, Post-Treatment One-Minute Rest, 1st Hour One-Minute Rest, 2nd Hour One-Minute Rest, 3rd Hour One-Minute Rest and 4th Hour One-Minute Rest are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.452	Retain Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

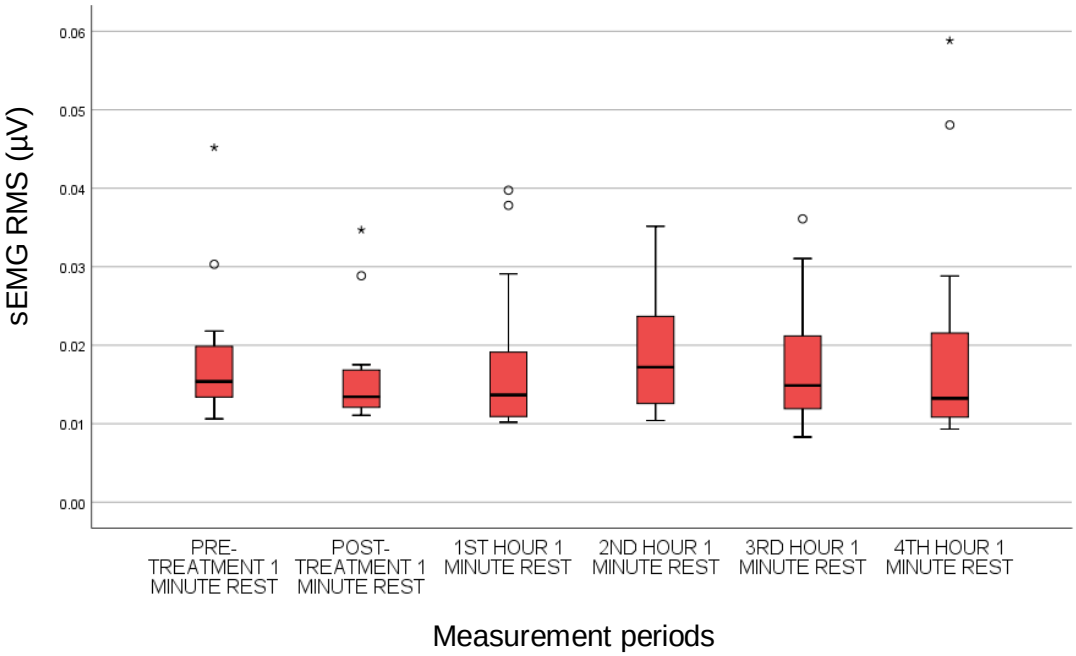

Figure 4.9.1 1-minute rest data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.7.

4.10 First Contraction

There was no difference between the time points (p = 0.212).

Table 4.10.1 1st Contraction sEMG summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment 1st Contraction, Post-Treatment 1st Contraction, 1st Hour 1st Contraction, 2nd Hour 1st Contraction, 3rd Hour 1st Contraction and 4th Hour 1st Contraction are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.212	Retain Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

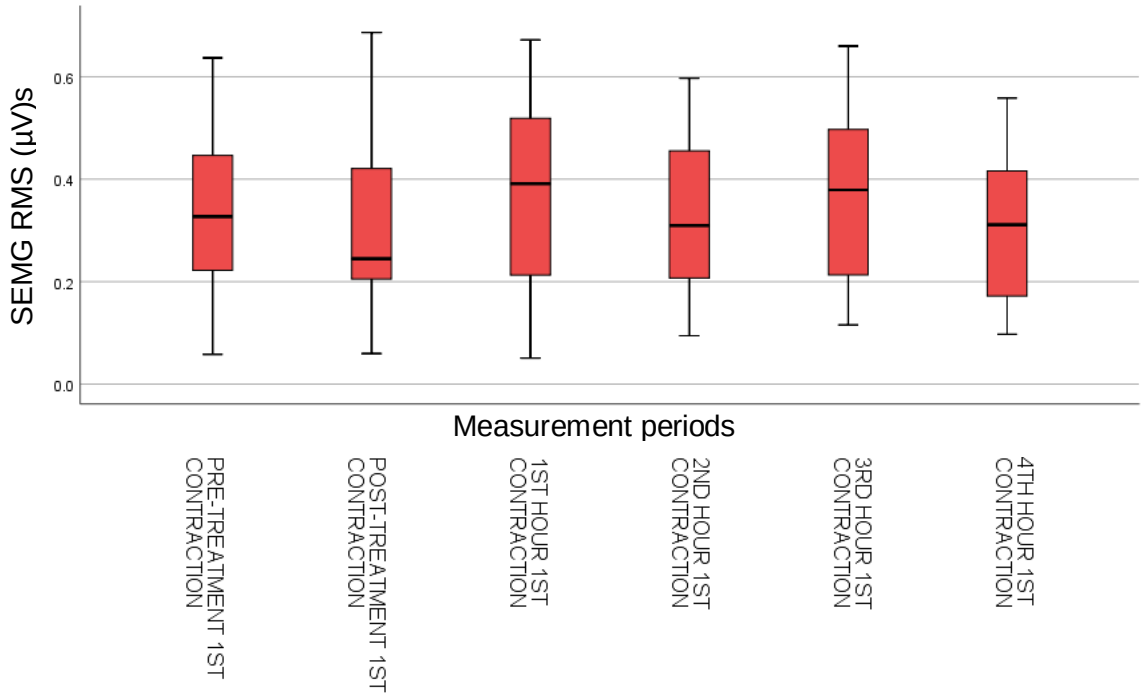

Figure 4.10.1 1st Contraction data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.8.

4.11 Second Contraction

There was no difference between the time points (p = 0.546)

Table 4.11.1 2nd Contraction sEMG summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment 2nd Contraction, Post-Treatment 2nd Contraction, 1st Hour 2nd Contraction, 2nd Hour 2nd Contraction, 3rd Hour 2nd Contraction and 4th Hour 2nd Contraction are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.546	Retain Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

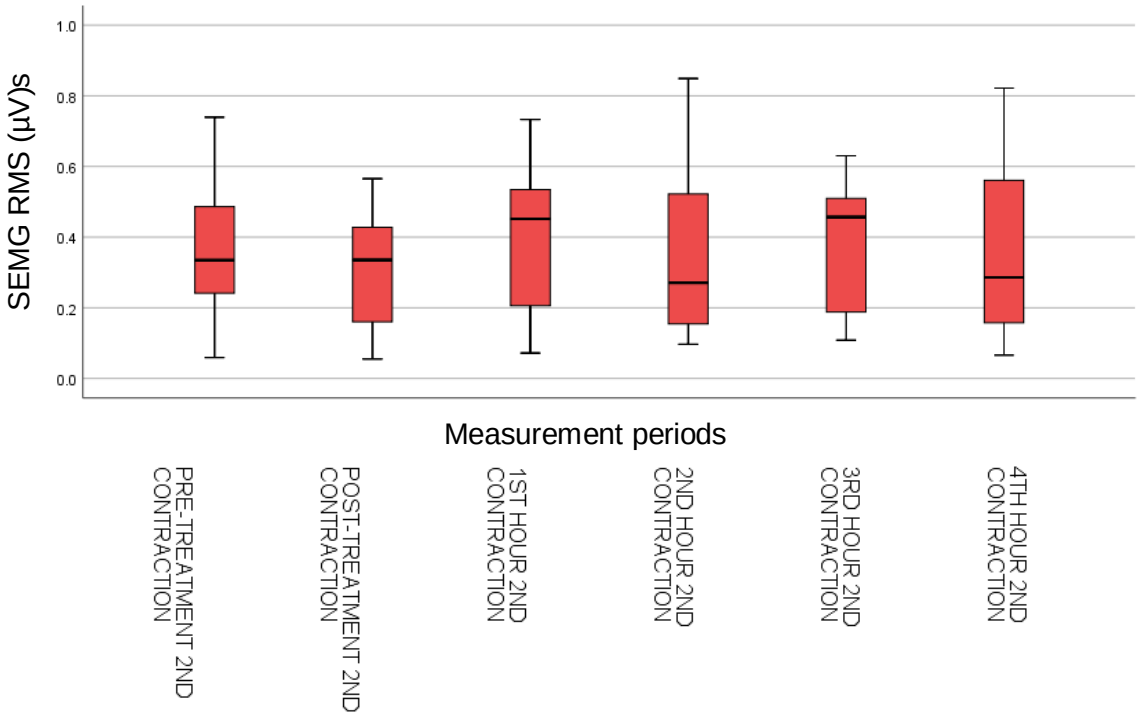

Figure 4.11.1 2nd Contraction data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.9.

4.12 Third Contraction

There was no difference between the time points (p = 0.573).

Table 4.12.1 3rd Contraction sEMG summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment 3rd Contraction, Post-Treatment 3rd Contraction, 1st Hour 3rd Contraction, 2nd Hour 3rd Contraction, 3rd Hour 3rd Contraction and 4th Hour 3rd Contraction are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.573	Retain Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

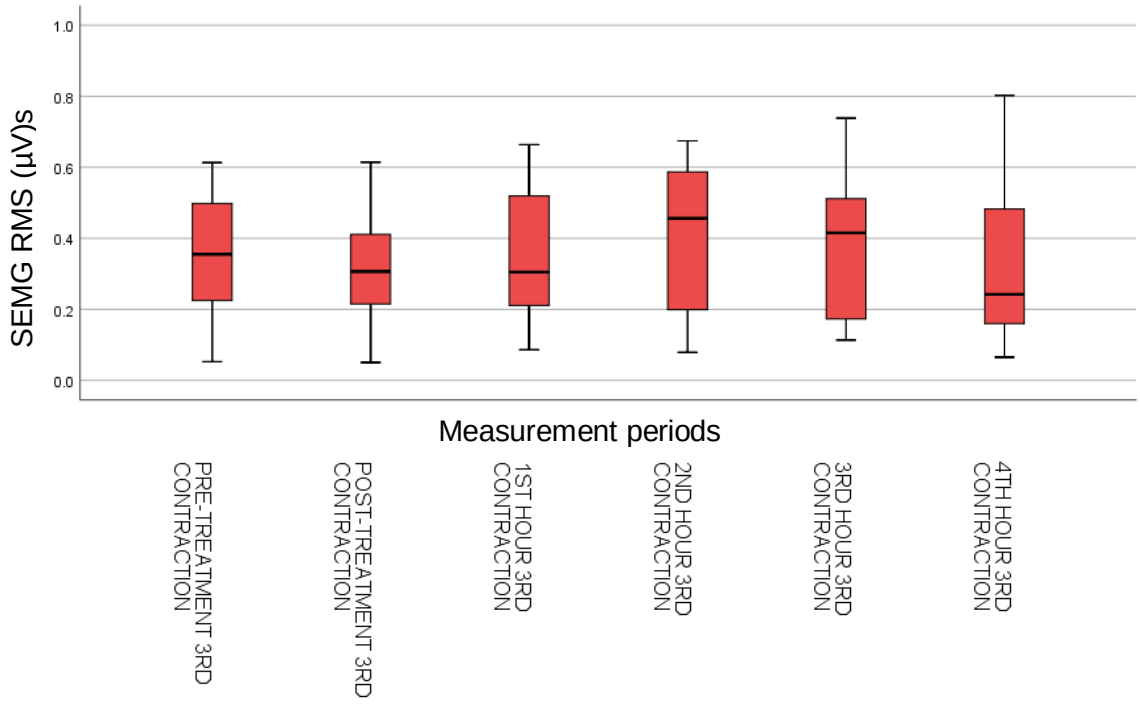

Figure 4.12.1 3rd Contraction data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.10.

4.13 Mean of the three contractions

There was no difference between the time points (p = 0. 534).

Table 4.13.1 Mean of the 3 contractions sEMG summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment Mean of Contractions, Post-Treatment Mean of Contractions, 1st Hour Mean of Contractions, 2nd Hour Mean of Contractions, 3rd Hour Mean of Contractions and 4th Hour Mean of Contractions are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.534	Retain Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

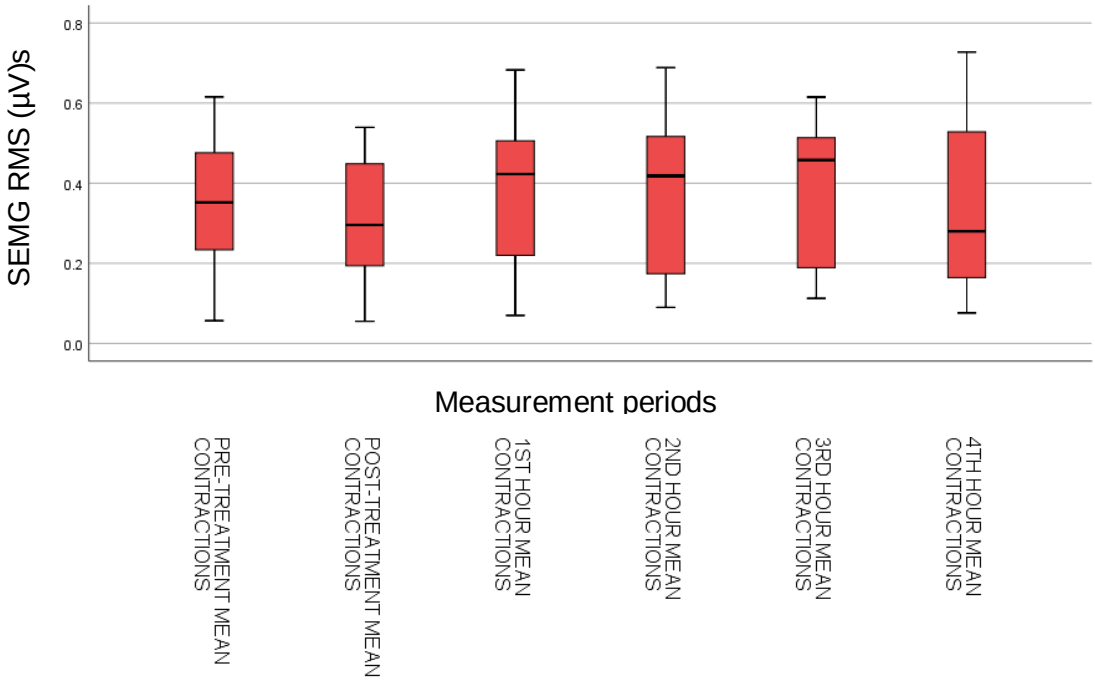

Figure 4.13.1 Mean of the 3 contractions data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.11.

4.14 Three-minute rest

There was no difference between the time points (p = 0.879)

Table 4.14.1 3-minute rest sEMG summary

Null Hypothesis	Test	Significance	Decision
The distributions of Pre-Treatment Three Minute Rest, Post-Treatment Three Minute Rest, 1st Hour Three Minute Rest, 2nd Hour Three Minute Rest, 3rd Hour Three Minute Rest and 4th Hour Three Minute Rest are the same	Related-Samples Friedmans Two-Way Analysis of Variance by Ranks	.879	Retain Null Hypothesis

Asymptomatic significances are displayed. The significance level is 0.5.

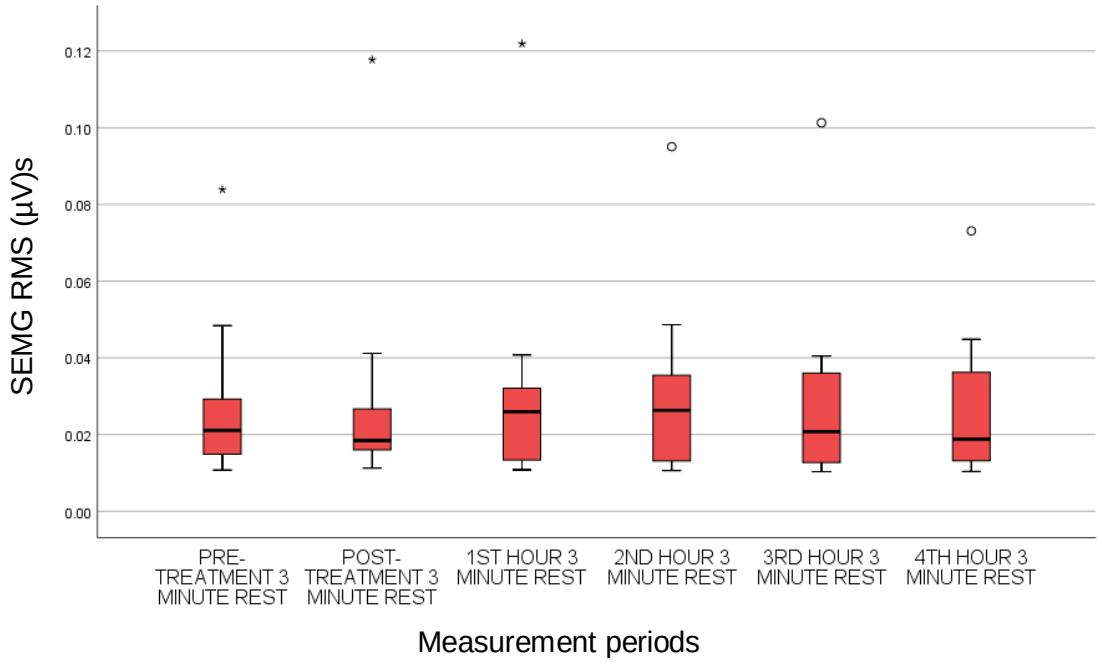

Figure 4.14.1 3-minute rest data distribution using box and whisker plots at the different measurement periods. For tabular form see table 4.16.12.

4.15 Comparing the findings of the different measures against one another

Change in CP and change in IP rotation were strongly positively correlated together (rho = 0.711).

Change in IP rotation was negatively correlated with change in 1-minute rest (rho = -0.569).

Change in CP rotation was positively correlated with change in mean contraction (rho = 0.527).

Table 4.14.1 Nonparametric Correlations

			Change NRS	Change Algometer	Change IP Rotation	Change CP Rotation	Change IL Flex	Change CL Flex	Change 1-minute rest	Change 3-minute rest	Change in mean contractions
Spearman's rho	Change NRS	Correlation Coefficient	1.000	.139	.031	-.034	-.457	-.104	-.157	.278	-.205
		Sig. (2-tailed)	.	.621	.914	.905	.087	.713	.576	.316	.463
	Change Algometer	Correlation Coefficient	.139	1.000	.204	.182	.018	.157	-.036	-.363	-.274
		Sig. (2-tailed)	.621	.	.466	.516	.948	.576	.899	.183	.323
	Change IP Rotation	Correlation Coefficient	.031	.204	1.000	.711**	.122	.438	-.569*	-.435	.096
		Sig. (2-tailed)	.914	.466	.	.003	.665	.103	.027	.105	.734
	Change CP Rotation	Correlation Coefficient	-.034	.182	.711**	1.000	.224	.352	-.413	-.128	.527*
		Sig. (2-tailed)	.905	.516	.003	.	.421	.199	.126	.649	.043
	Change IL Flex	Correlation Coefficient	-.457	.018	.122	.224	1.000	.279	.325	-.099	.411
		Sig. (2-tailed)	.087	.948	.665	.421	.	.313	.237	.726	.128

	Change CL Flex	Correlation Coefficient	-.104	.157	.438	.352	.279	1.000	-.499	-.303	.123
		Sig. (2-tailed)	.713	.576	.103	.199	.313	.	.058	.273	.664
	Change 1-minute rest	Correlation Coefficient	-.157	-.036	-.569*	-.413	.325	-.499	1.000	.057	-.268
		Sig. (2-tailed)	.576	.899	.027	.126	.237	.058	.	.840	.334
	Change 3-minute rest	Correlation Coefficient	.278	-.363	-.435	-.128	-.099	-.303	.057	1.000	.504
		Sig. (2-tailed)	.316	.183	.105	.649	.726	.273	.840	.	.056
	Change in mean contractions	Correlation Coefficient	-.205	-.274	.096	.527*	.411	.123	-.268	.504	1.000
		Sig. (2-tailed)	.463	.323	.734	.043	.128	.664	.334	.056	.

CHAPTER 5

DISCUSSION OF RESULTS

5.1 Introduction

This chapter includes the discussion of both subjective (NRS) and objective (PPT, sEMG and CROM) results.

5.2 NRS

The increase in NRS, which indicates a rise in perceived pain at the post-needling measurement, coincided with the research available on the effect of dry needling LMFTPs (Martin-Pintado Zugasti *et al.* 2014; Martin-Pintado-Zugasti *et al.* 2015; Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero 2016; Martin-Pintado-Zugasti *et al.* 2017). However, the drop-back to pre-treatment measures at the first hour follow up measurement does not coincide with what one may expect. Martin-Pintado Zugasti *et al.* (2014) and Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero (2016) found elevated VAS levels at the 6-hour mark. This may be accounted for by the number of needle insertions used in this study. According to Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero (2016), there is a strong correlation between the number of needle insertions and the amount of PNS experienced. This is thought to be due to the extent of tissue and local capillary damage caused by the needling (Simons, Travell and Simons 1999) and is partially supported by a study on mice by Domingo *et al.* (2013) which showed a transient inflammatory response and tissue damage after dry needling. Only ten fanning actions were performed for this research where other studies have performed as many as 60 (Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero 2016). Less tissue damage may have been incurred, resulting in a smaller PNS response.

Reject null hypothesis: DN LMFTPs, in the upper trapezius muscle, will have no effect on NRS in the first four hours after treatment**.**

5.3 PPT

While there were no statistically significant changes in PPT, there was a decrease in PPT (reduced tolerance to pressure) at the post-treatment measurement and a steady increase from the 1st to the 3rd hour measurements, and a decrease again in the 4th hour. The post-needling decrease in PPT is consistent with current research on LMFTPs (Martin-Pintado Zugasti *et al.* 2014; Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero 2016).

To the author's knowledge no previous study has investigated PPT in the first four hours after DN LMFTPs. Previous studies investigating the short-term effects of DN have taken measurements pre-post, 24 hours and 48 hours, showing a decline at the 24-hour mark and a rise by the 48-hour mark. One of the studies, Martin-Pintado Zugasti *et al.* (2014), investigated the effect of DN + spray and stretch on PNS versus a control group of just DN. They used VAS (post-DN, post-treatment, 6, 12, 24, 48 and 72 hours after DN) PPT (pre-DN, post-DN, 24 and 48 hours after DN) and psychological distress to measure outcomes. The other study, Martin-Pintado-Zugasti, Rodriguez-Fernandez and Fernandez-Carnero (2016), investigated PNS after DN a LMFTP in the upper trapezius with regard to characteristics of PNS with possible differences between genders, using the same outcomes as Martin-Pintado Zugasti *et al.* (2014), minus the psychological distress assessment.

Studies that may show the longer-term effects of DN on PPT in LMFTPs differ in their methodologies which make comparing data difficult. A study by Takla, Atwa and El-Latif (2017) investigated the effects of PPR versus DN over eight weeks, but included three treatments a week, and included a stretch for each group. They found that both groups were effective at increasing PPT, lateral flexion and rotation of the neck. A study by Yeganeh Lari *et al.* (2016), investigated the effects of DN versus MET versus DN+MET in a one week period but included three treatments and one final measurement session. Only pre-treatment measurements were recorded until the last session. They found that all three groups were effective as treatment but that the DN+ MET group was superior.

Retain null hypothesis: DN LMFTPs, in the upper trapezius muscle, will have no effect on PPT in the first four hours after treatment.

5.4 ROM

While there was a statistically significant improvement across all ranges of motion tested (ipsilateral PA rotation $p < 0.001$, contralateral PA rotation $p < 0.001$, ipsilateral lateral flexion $p = 0.001$ and contralateral lateral flexion $p < 0.001$), these changes did not become significant until the 2nd hour measurement at soonest. This ties in with what was shown by Martin-Pintado-Zugasti *et al.* (2015), where the effect of ischemic compression (IC) on PNS of a LMFTP was investigated using three groups with VAS and CROM as measures. The groups consisted of IC, placebo and control (DN only). With regards to the DN group and CROM, there was improvement in the post-intervention measurements, but only contralateral lateral flexion statistically significantly improved ($P < .05$).

Reject null hypothesis: DN LMFTPs, in the upper trapezius muscle, will have no effect on CROM in the first four hours after treatment.

5.5 sEMG

While there were no statistically significant findings with regards to the sEMG readings, it can be noted that the pre-treatment readings for the one minute of rest are slightly higher than the 1-minute rest readings of the subsequent measurements. This can also be noted in the 3-minute rest readings with the exception that the post-treatment 3-minute rest reading is higher. The following studies may explain these findings. Wytrazek *et al.* (2015) found that LMFTPs have greater resting and lower maximum voluntary contraction sEMG reading than muscle free of MFTPs. DN has been shown to decrease SEA and ACH levels of MFTPs (Chen *et al.* 2001; Liu *et al.* 2017).

Retain null hypothesis: DN LMFTPs, in the upper trapezius muscle, will have no effect on muscle activity (sEMG) during treatment and in the first four hours after treatment.

5.6 Correlations

Statistical analysis revealed three correlations from the data.

Change in contralateral and ipsilateral PA rotation were strongly positively correlated together (rho = 0.711). This showed a strong correlation between the improvement of contralateral and ipsilateral rotation.

Change in IP rotation was negatively correlated with change in 1-minute rest (rho = -0.569). This showed a correlation between improvement in ipsilateral Pa rotation and a decreased sEMG with the 1-minute rest.

Change in CP rotation was positively correlated with change in mean contraction (rho = 0.527). This showed a correlation between improved contralateral PA rotation and an increase in sEMG with mean contraction.

Reject null hypothesis: No correlations will be found comparing the findings of the different measures against one another and to pre-treatment measures.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The aim of this study was to investigate the effect of DN LMFTPs in the upper trapezius muscle with regards to NRS, PPT, CROM and sEMG in the first four hours after treatment to compare the findings of the different measures against one another, and to pre-treatment measures. The methodology, measurement tools and statistical analysis chosen for this study provided accurate and relevant data, while a larger sample size would have provided more accurate data, it was sufficient for this study.

The results of this study show that while NRS did rise at post-treatment measurement it did not stay elevated as one could assume from the current literature. This, however, is most likely due to study design differences with regards to needling technique and time between follow up measurements (Martin-Pintado-Zugasti *et al.* 2018).

Algometer readings showed a small and statistically insignificant decrease in pressure tolerance post-treatment. However, this was not maintained. Previous studies that took measurements at the 24-hour mark still found a decrease in PPT.

ROM improved significantly in all ranges by the second hour mark, showing that DN LMFTPs may be more effective at increasing CROM in the short term than previously thought. This is in keeping with the results from other studies where ROM always increased post-treatment with varying significance.

sEMG readings did not yield any statistically significant results, and there are no previous studies on the short-term effects of DN LMFTPs where sEMG has been used.

Change in contralateral and ipsilateral rotation were positively correlated. This means that DN of LMFTPs may have more widespread effects/benefits than just a local effect on the structures pierced.

The negatively correlated changes in ipsilateral PA rotation and sEMG in 1-minute rest (increase in ROM and decrease in resting sEMG readings), and the positive

correlation in changes of contralateral PA rotation and sEMG in mean contraction (increase in ROM and increase in contraction sEMG readings) may indicate a return to normal function.

In conclusion, the results of this study show that DN of LMFTPs in the upper trapezius muscle may be effective at improving CROM without eliciting a strong PNS effect or a significant drop in PPT. A possible practical application of these results is that treating LMFTPs before they become AMFTPs could be of benefit to patients, however further research may be needed with regards to preventative/proactive treatment of MPS as opposed to reactive treatment. It is important to note that as this is one of the few studies that exist to test objective and subjective results in the 1st four hours after needling, it is difficult to draw strong conclusions.

6.2 Recommendations

- More studies are needed to look at the post-needling results in the first couple of hours after intervention.

- In a dissertation setting, reduce the number of follow up measurements as this complicates participant recruiting due to the time commitment required. This is supported by the outcomes of this study as most of the change was seen by the 2-hour post-needling mark.

- Add extra electrode placements to allow for a complete reading of the whole trapezius, not just the upper trapezius.

- If patient recruitment is not hindered by time constraints, an increased sample size will increase the statistical relevance of the study.

- An endurance measure could be used together with, or instead of, maximum voluntary contraction with sEMG.

- Studies should also look at AMFTPs as this is what is clinically encountered and typically needled.

- A similar study is needed to compare AMFTPs and LMFTPs in the early stages of post-intervention.

- Adding in a placebo group and double blinding the study using research assistants to take measurements would add significant value to the study.

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APPENDICES

Appendix A:

Advertisement

RESEARCH PARTICIPANTS WANTED!

ARE YOU BETWEEN 18 TO 25 YEARS OLD?

ARE YOU FREE FROM

HEAD/NECK/SHOULDER PAIN?

INTERESTED IN PARTICIPATING IN RESEARCH THAT LOOKS INTO THE PREVENTATIVE TREATMENT OF NECK PAIN?

AT

THE DURBAN UNIVERSITY OF TECHNOLOGY

CHIROPRACTIC DAY CLINIC

(IF YOU FIT THE RESEARCH CRITERIA)

THE PURPOSE OF THIS STUDY IS TO DETERMINE HOW DRY NEEDLING EFFECTS THE MUSCLE OVER A SHORT PERIOD OF TIME

CONTACT: STEVEN

(031) 373 2205 / 061 148 6019

Appendix B

ACTIVITY DIARY **Date:**
Patient Code:_____

Dear patient.

Kindly complete this activity diary, documenting your activities between measurement sessions

For the duration of this study, please:

- Do not apply ice to the needled area,
- Do not take any medication (e.g. pain medication, anti-inflammatory drugs)
- Do not apply any topical pain-relieving creams or ointments on the treated area.
- Do not participate in any strenuous activity

Please fill in the following diary according to the allocated timeframes.

Timeframe:	**Activity:**
First hour	
Second hour	
Third hour	
Fourth hour	

Should you have any questions regarding the research, if you require aid or if the pain becomes intense, kindly contact:

- Steven Peter (researcher) on (031) 373 2205 or 061 148 6019
- Dr Kretzmann (research supervisor) on 072 601 4405

Please note that if (and only if) the pain becomes intense, it is advised that you ice the area and rest.

Patient Code:_____ Signature:_____

Research Student Name:_____ Signature:_____

Appendix C

Data Sheet

Date:_____ Patient code:_____

Visit: Pre-treatment / Post-treatment / 1st Hour / 2nd Hour / 3rd Hour / 4th Hour

- **Numerical Rating Scale – (NRS-11):**

Please indicate on the line below, the number between 0 and 10 that best describes the pain you experience **when it is at its worst**. A zero (0) would mean “no pain at all”, and ten (10) would mean “pain as bad as it could be”.

Please circle only one number.

0_1_2_3_4_5_6_7_8_9_10

- **Algometer Reading:**

- **Cervical Range of Motion:**

Ipsilateral PA Rotation	Contralateral PA Rotation	Ipsilateral Lateral Flexion	Contralateral Lateral Flexion

Appendix D

Appendix D

LETTER OF INFORMATION

Title of the Research Study: The effect of dry needling on trapezius muscle activity and post needling soreness in participants with latent trapezius myofascial trigger points.

Principal Investigator/s/researcher: Steven Peter, BTech Chiropractic

Co-Investigator/s/supervisor/s: Dr H. Kretzmann

Brief Introduction and Purpose of the Study:

Outline of the Procedures: This research will take place at the Durban University of Technology Chiropractic Day Clinic. At the first consultation, I will examine you to see whether you can take part in this study. Once accepted into the study, you will receive one treatment involving a full neck examination and dry needling of the trapezius muscle.

Dry needling involves the insertion of a solid (non-hollow) needle into a muscle. The needle is then partially withdrawn and re-inserted several times (this is called fanning). Before and after insertion, the area is cleaned using alcohol. Dry needling is used to treat muscular pain and tightness as well as a few other conditions.

Measurements will be taken before and after the treatment and then every hour for 4 hours. **The total time commitment required for this research will be around 5 hours**. Between measurement sessions you must avoid any strenuous activity.

Measurement tools:

The small device (algometer) will be placed on your muscle and some pressure applied to find out how you respond to pain. The pressure will be small enough not to hurt you but find out when you will start feeling some pain.

Electrical activity of your muscles will be measured by placing small round discs on each muscle to be tested (Surface Electromyography (sEMG)It is a safe way to measure the electrical energy in muscles.

The movement of the neck (CROM (cervical range of motion) will be measured using a small instrument placed on your neck (goniometer).

The pain will be rated using a paper scale. The Numerical Rating Scale (NRS) will be used to Check how you feel pain during this project. The NRS requires the participant to rate their pain on a scale of 0 – 10 with 0 being no pain and 10 being the most pain.

Activity diary: each participant will be given a small book in which to record your activities between measurement sessions.

This research will have approximately 15 participants

Risks or Discomforts to the Participant: You may experience soreness in the area that the needle was inserted. This is commonly called Post Needling Soreness

Benefits: This study will provide a better understanding as to what happens in the first few hours after dry needling, enabling further research into preventative treatments for pain and post needling soreness.

Reason/s why the Participant May Be Withdrawn from the Study:

- If you are unable to commit to the follow-up readings.
- If you have changed any lifestyle habits during your participation in this study that may affect the outcome of this research (e.g. medication, strenuous activity, supplements or treatment).
- If you suspect that you are pregnant.

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

Remuneration: One free treatment will be provided after completion of the study.

Costs of the Study: None

Confidentiality: we will insert a special code against your name so that nobody can identify you and your information will be secret. Only the researcher and supervisor will have access to who each code refers to. The code will be used for labeling the data collected. The results from this study will be used for research purposes only, and the coding ensures anonymity. Only the researcher and supervisor (Dr Kretzmann) will be allowed access to these records. All data will be securely destroyed after study (+5 years).

Research-related Injury: Should a participant experience unbearable post needling soreness, the clinician on duty would be informed and you will be treated accordingly to reduce your discomfort.

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

(Supervisor and details) Please contact the researcher (tel no. 061 148 6019), my supervisor (tel no. 072 601 4405) or the Institutional Research Ethics Administrator on 031 373 2900. Complaints can be reported to the Director: Research and Postgraduate Support, Prof S Moyo on 031 373 2577 or moyos@dut.ac.za

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, _____ (name of researcher), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature / Right Thumbprint**

I, _____ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**
_____	_____	_____
Full Name of Witness (If applicable)	**Date**	**Signature**
_____	_____	_____
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Appendix E

Appendix E

CHIROPRACTIC PROGRAMME

CHIROPRACTIC DAY CLINIC

CASE HISTORY

Patient: _____ Date: _____

File #: _____ Age: _____

Sex: _____ Occupation: _____

Student: _____ 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:

Student's Case History:

1. Source of History:

2. Chief Complaint: (patient's own words):

3. Present Illness:

	Complaint 1(principle complaint)	**Complaint 2 (additional or secondary complaint)**
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:
Other (please list):

Tobacco Alcohol Social Drugs

7. Immediate Family Medical History:

Age of all family members Health of all family members Cause of Death of any family members

	Noted	Family member		Noted	Family member
Alcoholism			Headaches		
Anaemia			Heart Disease		
Arthritis			Kidney Disease		
CA			Mental Illness		
DM			Stroke		
Drug Addiction			Thyroid Disease		
Epilepsy			TB		
Other (list)					

8. Psychosocial history:

Home Situation and daily life Important experiences Religious Beliefs

9. Review of Systems (please highlight with an asterisk those areas that are a problem for the patient and require further investigation)

General

Skin

Head

Eyes

Ears

Nose/Sinuses

Mouth/Throat

Neck

Breasts

Respiratory

Cardiac

Gastro-intestinal

Urinary

Genital

Vascular

Musculoskeletal

Neurologic

Haematological

Endocrine

Psychiatric

Appendix F

Appendix F

DUT DURBAN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

CHIROPRACTIC PROGRAMME

PHYSICAL EXAMINATION: SENIOR

Patient Name:			File no:	Date:
Student:			Signature:	
VITALS:				
Pulse rate:			Respiratory rate:	
Blood pressure:			Medication if hypertensive:	
Temperature:			Height:	
Weight:	Any recent change?		If Yes: How much gain/loss	Over what period
GENERAL EXAMINATION:				
General Impression				
Skin				
Jaundice				
Pallor				
Clubbing				
Cyanosis (Central/Peripheral)				
Oedema				
Lymph nodes	Head and neck			
	Axillary			
	Epitrochlear			
	Inguinal			
Pulses				
Urinalysis				
SYSTEM SPECIFIC EXAMINATION:				
CARDIOVASCULAR EXAMINATION				
RESPIRATORY EXAMINATION				
ABDOMINAL EXAMINATION				
NEUROLOGICAL EXAMINATION				
COMMENTS				
Clinician:			Signature:	

Appendix G

Appendix G

CHIROPRACTIC PROGRAMME

REGIONAL EXAMINATION – CERVICAL SPINE

Patient: ..... File No: .....

Date: ..... Student: .....

Clinician: ..... Sign: .....

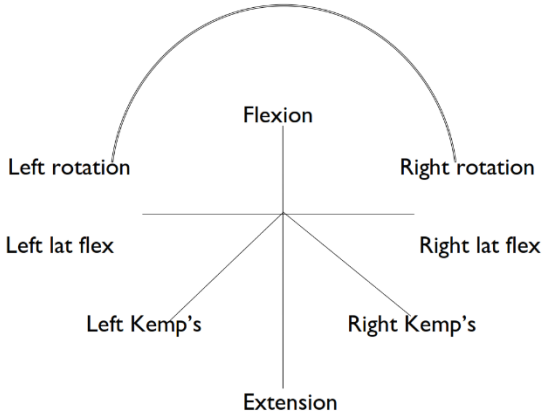
OBSERVATION:

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

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

RANGE OF MOTION:

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



PALPATION:

Lymph nodes
Thyroid Gland
Trachea

MYOFASCIAL ASSESSMENT

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

ORTHOPAEDIC EXAMINATION:

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

NEUROLOGICAL EXAMINATION:

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

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

MOTION PALPATION & JOINT PLAY:

Left: Motion Palpation:
Joint Play:
Right: Motion Palpation:
Joint Play:

BASIC EXAM: SHOULDER:

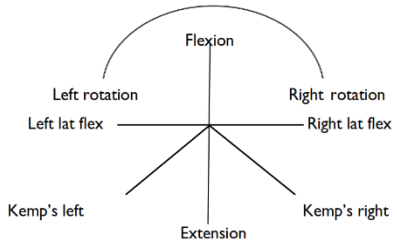
Case History:

ROM: Active:
Passive:
RIM:
Orthopaedic:
Neuro:
Vascular:

BASIC EXAM: THORACIC SPINE:

Case History:

ROM:



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

Appendix H

CHIROPRACTIC PROGRAMME Appendix H

Patient Name:			***File number:***	***Page:***
Date:	***Visit:***	***Student:***		
Attending Clinician:			***Signature:***	
S: ***Numerical Pain Rating Scale (Patient)*** ***Least 0 1 2 3 4 5 6 7 8 9 10 Worst***		***Student Rating*** ☐	***A:***	
0:			***P:***	
			E:	
Special attention to:			***Next appointment:***	
Date:	***Visit:***	***Student:***		
Attending Clinician:			***Signature:***	
S: ***Numerical Pain Rating Scale (Patient)*** ***Least 0 1 2 3 4 5 6 7 8 9 10 Worst***		***Student Rating*** ☐	***A:***	
O:			***P:***	
			E:	
Special attention to:			***Next appointment:***	
Date:	***Visit:***	***Student:***		
Attending Clinician:			***Signature***	
S: ***Numerical Pain Rating Scale (Patient)*** ***Least 0 1 2 3 4 5 6 7 8 9 10 Worst***		***Student Rating*** ☐	***A:***	
O:			***P:***	
			E:	
Special attention to:			***Next appointment:***	

Appendix I

Appendix I

Patient Code:

Questions	Answers
"Would you mind answering some questions to see if you meet the requirements to participate in the study?"	
"Are you able to fluently understand English?"	
"How old are you?"	
"Do you have any head, neck or shoulder pain?"	
"Do you have a recent history of trauma, such as a motor vehicle accident or suffered any injury to your head and neck?"	
"Are you currently taking any painkillers and/or anti-inflammatory medications?"	
"Are you on any blood thinning medication?"	
"Are you pregnant, or do you suspect that you may be pregnant i.e. missed menstrual cycle/sexual activity"? **(For females)**	
"Have you had acupuncture or dry needling in the last three months?"	
"Do you have a phobia of needles?"	
"Do you have, or have you had any malignant diseases?"	
"Have you had any surgery done to your neck, back or shoulder(s)?"	

Appendix Chapter 4: 4.16 Tabular Data

Table 4.16.1 NRS

	Median	Percentile 25	Percentile 75
PRE-TREATMENT NRS	.0	0	0
POST-TREATMENT NRS	1.0	0	2
1ST HOUR NRS	.0	0	0
2ND HOUR NRS	.0	0	0
3RD HOUR NRS	.0	0	0
4TH HOUR NRS	.0	0	0

Table 4.16.2 Algometer

	Median	Percentile 25	Percentile 75
PRE-TREATMENT ALGOMETER	5.5	3.4	6.1
POST-TREATMENT ALGOMETER	4.3	3.6	5.6
1ST HOUR ALGOMETER	4.7	4.0	6.0
2ND HOUR ALGOMETER	5.0	4.3	6.2
3RD HOUR ALGOMETER	5.4	4.2	6.8
4TH HOUR ALGOMETER	5.1	3.9	6.0

Table 4.16.3 Ipsilateral PA rotation

	Median	Percentile 25	Percentile 75
PRE-TREATMENT IPSILATERAL PA ROTATION	60.0	58	65
POST-TREATMENT IPSILATERAL PA ROTATION	62.0	60	70
1ST HOUR IPSILATERAL PA ROTATION	65.0	56	70
2ND HOUR IPSILATERAL PA ROTATION	68.0	62	70
3RD HOUR IPSILATERAL PA ROTATION	66.0	60	70
4TH HOUR IPSILATERAL PA ROTATION	68.0	64	72

Table 4.16.4 Contralateral PA rotation

	Median	Percentile 25	Percentile 75
PRE-TREATMENT CONTRALATERAL PA ROTATION	60.0	52	70
POST-TREATMENT CONTRALATERAL PA ROTATION	64.0	58	70
1ST HOUR CONTRALATERAL PA ROTATION	70.0	60	72
2ND HOUR CONTRALATERAL PA ROTATION	68.0	60	80
3RD HOUR CONTRALATERAL PA ROTATION	72.0	70	76
4TH HOUR CONTRALATERAL PA ROTATION	70.0	66	76

Table 4.16.5 Ipsilateral lateral flexion

	Median	Percentile 25	Percentile 75
PRE-TREATMENT IPSILATERAL LATERAL FLEXION	50.0	40	56
POST-TREATMENT IPSILATERAL LATERAL FLEXION	50.0	46	56
1ST HOUR IPSILATERAL LATERAL FLEXION	50.0	45	54
2ND HOUR IPSILATERAL LATERAL FLEXION	50.0	50	60
3RD HOUR IPSILATERAL LATERAL FLEXION	54.0	48	60
4TH HOUR IPSILATERAL LATERAL FLEXION	58.0	50	60

Table 4.16.6 Contralateral lateral flexion

	Median	Percentile 25	Percentile 75
PRE-TREATMENT CONTRALATERAL LATERAL FLEXION	50.0	40	54
POST-TREATMENT CONTRALATERAL LATERAL FLEXION	55.0	50	60
1ST HOUR CONTRALATERAL LATERAL FLEXION	54.0	50	60
2ND HOUR CONTRALATERAL LATERAL FLEXION	55.0	50	60
3RD HOUR CONTRALATERAL LATERAL FLEXION	56.0	52	60
4TH HOUR CONTRALATERAL LATERAL FLEXION	60.0	54	66

Table 4.16.7 One-minute rest

	Median	Percentile 25	Percentile 75
PRE-TREATMENT 1 MINUTE REST	.0	.01311	.02058
POST-TREATMENT 1 MINUTE REST	.0	.01193	.01719
1ST HOUR 1 MINUTE REST	.0	.01075	.02141
2ND HOUR 1 MINUTE REST	.0	.01194	.02442
3RD HOUR 1 MINUTE REST	.0	.01104	.02184
4TH HOUR 1 MINUTE REST	.0	.01066	.02198

Table 4.16.8 First Contraction

	Median	Percentile 25	Percentile 75
PRE-TREATMENT 1ST CONTRACTION	.3	.20933	.49114
POST-TREATMENT 1ST CONTRACTION	.2	.19720	.43936
1ST HOUR 1ST CONTRACTION	.4	.20626	.52023
2ND HOUR 1ST CONTRACTION	.3	.19477	.47379
3RD HOUR 1ST CONTRACTION	.4	.20286	.51750
4TH HOUR 1ST CONTRACTION	.3	.15728	.42639

Table 4.16.9 Second Contraction

	Median	Percentile 25	Percentile 75
PRE-TREATMENT 2ND CONTRACTION	.3	.23916	.49161
POST-TREATMENT 2ND CONTRACTION	.3	.15643	.44437
1ST HOUR 2ND CONTRACTION	.5	.18382	.55397
2ND HOUR 2ND CONTRACTION	.3	.14565	.54079
3RD HOUR 2ND CONTRACTION	.5	.17843	.53498
4TH HOUR 2ND CONTRACTION	.3	.14945	.57995

Table 4.16.10 Third Contraction

	Median	Percentile 25	Percentile 75
PRE-TREATMENT 3RD CONTRACTION	.4	.20441	.50607
POST-TREATMENT 3RD CONTRACTION	.3	.18219	.41623
1ST HOUR 3RD CONTRACTION	.3	.20121	.53757
2ND HOUR 3RD CONTRACTION	.5	.19870	.60621
3RD HOUR 3RD CONTRACTION	.4	.15106	.51835
4TH HOUR 3RD CONTRACTION	.2	.15315	.48557

Table 4.16.11 Mean contractions

	Median	Percentile 25	Percentile 75
PRE-MEAN CONTRACTIONS	0.4	0.2	0.5
POST-MEAN CONTRACTIONS	0.3	0.2	0.5
1ST HR MEAN CONTRACTIONS	0.4	0.2	0.5
2ND HR MEAN CONTRACTIONS	0.4	0.2	0.5
3RD HR MEAN CONTRACTIONS	0.5	0.2	0.5
4TH HR MEAN CONTRACTIONS	0.3	0.2	0.6

Table 4.16.12 Three-minute rest

	Median	Percentile 25	Percentile 75
PRE-TREATMENT 3 MINUTE REST	.0	.01346	.03212
POST-TREATMENT 3 MINUTE REST	.0	.01555	.02697
1ST HOUR 3 MINUTE REST	.0	.01274	.03355
2ND HOUR 3 MINUTE REST	.0	.01261	.03736
3RD HOUR 3 MINUTE REST	.0	.01204	.03610
4TH HOUR 3 MINUTE REST	.0	.01211	.04016