The relative effectiveness of Kinesiotape® versus dry needling in patients with myofascial pain syndrome of the Trapezius muscle.

By

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I, Jandré van der Westhuizen, do declare that this dissertation is representative of my own work in both conception and execution

(except where acknowledgements indicate to the contrary)

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Dedication

I dedicate this thesis to all those whom have inspired and encouraged my chiropractic passion, and to God, the Divine Energy, who has given me the courage and skill to complete a dissertation after many years of study.

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I wish to thank all my research participants for their positive attitude towards this study, and for the timely manner in which they came for their visits.

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Abstract:

Background: Therapeutic dry needling is an established modality for the treatment of myofascial pain, whereas limited research on Kinesiotape® exists. Kinesiotaping® is becoming popular, with the main benefit of being non-invasive and long wearing, thereby extending the treatment to the patient. This study aimed to determine the relative effectiveness of these two treatment modalities in patients with myofascial pain syndrome of the Trapezius muscle.

Methods: The study design was a quantitative prospective randomised clinical trial. Fifty patients were equally and randomly allocated into either the dry needling or Kinesiotape® groups. Each patient received two treatments on separate visits to the upper trapezius muscle. Follow-ups were scheduled two to four days after the previous visit. Subjective measures were the Visual Analog Scale (VAS) and the Neck Disability Index (NDI), whilst objective measures were pain pressure threshold (PPT) and cervical range of motion (CROM).

Results: Kinesiotape® demonstrated statistical significant treatments with the VAS ($p < 0.001$), NDI ($p < 0.001$) and PPT ($p= 0.022$) (95% CI). Dry needling showed statistical improvements in VAS ($p= 0.001$) and NDI ($p < 0.001$) only. Also, Kinesiotape® demonstrated a clinically significant improvement with the VAS when compared to the minimal clinically important differences (MCIDs). Trends of a superior treatment effect of Kinesiotape® over dry needling was observed in the VAS and PPT groups ($p= 0.155$; $p= 0.428$). Future studies could repeat the study with larger sample sizes to determine if these trends can be validated.

Conclusion: This study demonstrated that Kinesiotape® was at least as effective as dry needling in the treatment of Myofascial Pain Syndrome. Therefore, Kinesiotaping® is a non-invasive alternative to dry needling.

Kinesiotape® therapy resulted in a greater change in pain and disability scores than did dry-needling trigger point therapy, implying that Kinesiotape® may be a non-invasive alternative to dry needling.

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CHAPTER 1
INTRODUCTION

1.1 THE PROBLEM AND ITS SETTING

With muscles constituting 40-50% of total body mass (Yap, 2007), related pathology is common in clinical practice (Huguenin, 2004; Han and Harrison, 1997; Skootsky, Jaeger and Oye, 1989). In fact, Harden *et al*. (2000) proposed MPS to be a leading diagnosis, with MFTPs being accepted as a fundamental part of the syndrome (Huguenin, 2004). Simons, Travell and Simons (1999) defined trigger points as the presence of exquisite tenderness at a nodule in a palpable taut band of muscle. These trigger points are able to produce referred pain, either spontaneously or on digital compression.

The most common muscle to present with these findings is the trapezius muscle, a large superficial posterior shoulder and neck muscle with the highest noted incidence of MFTPs (Gerwin, 2001; Simons, Travell and Simons, 1999; Sola, Rodenberger and Gettys, 1995).

The effectiveness of dry needling as an intervention in MPS have been confirmed by various systemic reviews (Vernon and Schneider, 2009; Cummings and White, 2001; Karakurum *et al*., 2001). Dry needling was found to be as effective as local anaesthetics, corticosteroids, and coolant spray in the treatment of lower back pain (Garvey *et al*., 1989). More recently Srbely *et al*., (2010) showed that dry needling provides segmental anti-nociceptive effects.

However, limitations to the application of dry needling as an invasive therapy exist. Post-needling soreness is a well documented sequelae (Ferreira, 2006; Hong, 1994), which can delay treatment and recovery as it delays further needling of the same region (Simons, Travell and Simons, 1999). Other contra-indications to dry needling include, but are not limited to, fever, regional skin infections, regional malignancy, pregnancy, severe blood dyscrasias, chronic cardiac failure (Han and

Harrison, 1997), patients prone to convulsions and those hesitant to needle insertion (Rachlin and Rachlin, 2002).

In contrast, the Kinesio Taping® Method with Kinesio® Tex Tape (Kinesiotape®) is an increasingly popular method to treat pain and muscular dysfunction (Hsu *et al*., 2009; Gonzales-Iglesias *et al*., 2009; Thelen, Dauber and Stoneman, 2008; Yoshida and Kahanov, 2007). Kinesiotape® can be comfortably worn for three to four consecutive days after treatment (Kase, Wallis and Kase, 2003). Kinesiotape® is a non-allergenic, elastic tape that elicits elasticity of up to 30-40% from resting length (Terrazas, 2010). It is thus non-invasive and may therefore be applied in instances when dry needling is contra-indicated.

1.2 STATEMENT OF THE PROBLEMS

The aims of this study are to determine whether Kinesiotape® or dry needling is more effective in the treatment of upper trapezius myofascial pain. The research problems are as follows:

1. To determine the effectiveness of Kinesiotape® in terms of subjective and objective findings.
2. To determine the effectiveness of dry needling in terms of subjective and objective findings.
3. To determine the relative effectiveness between Kinesiotape® versus dry needling in terms of the subjective and objective findings.

1.3 HYPOTHESES

1.3.1 The first Hypothesis

H_1 : It was hypothesized that dry needling of trapezius MFTPs in the treatment of MPS would be more effective than published MCIDs in terms of both subjective and objective clinical findings.

H_0 : Dry needling of trapezius MFTPs in the treatment of MPS would have no statistical and clinical significant effect in terms of both subjective and objective clinical findings.

1.3.2 The second Hypothesis

H_1 : It was hypothesized that the application of Kinesiotape® onto trapezius MFTPs in the treatment of MPS would be more effective than published MCIDs in terms of both subjective and objective clinical findings.

H_0 : Application of Kinesiotape® onto the trapezius MFTPs in the treatment of MPS would have no statistical and clinical significant effect in terms of both subjective and objective findings.

1.3.3 The third Hypothesis

H_1 : It was hypothesized that dry needling would be more effective than Kinesiotape® application in terms of both subjective and objective clinical findings.

H_0 : Dry needling would not be more effective than Kinesiotape® application in terms of both subjective and objective clinical findings.

1.4 RATIONALE

- To provide a clinical study regarding the effectiveness of Kinesiotape® as a treatment modality.

- To demonstrate whether the proposed mechanisms of Kinesiotape® was confirmed through response of the patients to the Kinesio Taping® Method.

- Research literature on Kinesiotape® is still limited as a treatment modality and the use of Kinesiotape® is often supported by anecdotal evidence (García-Muro, Rodríguez-Fernández and Herrero-de-Lucas, 2009; Osterhues, 2004).

This study will contribute to evidence-based medicine and, therefore, will increase the ethical value of Kinesiotape® treatment.

1.5 BENEFITS OF THE RESEARCH

Results will indicate the relative effectiveness of Kinesiotape®, a non-invasive therapy, compared to that of an established therapeutic tool such as dry needling. Should the Kinesio Taping® Method be shown to be effective, it would provide both practitioner and patients with an opportunity for a non-invasive treatment option.

1.6 LIMITATIONS OF THE RESEARCH

- It is anticipated that the participants are honest in answering their various feedback forms especially as they was subjective. However the Hawthorne or observer effect cannot be excluded as influencing these results (Mouton, 1996).

- Lack of a blinded assessor during the data capturing process may introduce researcher bias and thus cannot be excluded from this study. Recommendations at the end of this study include the future use of a blinded assessor to increase the rigor of future studies (Mouton, 1996).

- No guarantee exists that the subjective responses of the participants are accurate as all subjective questionnaires include an element perception related to the clinical signs and symptoms which the patient experiences at the time of questionnaire completion and may therefore modify their responses utilized as outcomes in this research (Yeomans, 2000).

1.7 CONCLUSION

This comparative clinical trial will indicate how clinically effective Kinesiotape® is as a non-invasive therapy as compared to dry needling, an acknowledged invasive therapy (Kalichman and Vulfsons, 2010; Dommerholt *et al*., 2006).

Thus, this dissertation will discuss in Chapter Two the related literature on MPS and the various treatment options that exist, including that of dry needling and Kinesiotape®. Thereafter, the design of the study will be explained in Chapter Three (Material and Methods). The processed data will be revealed in Chapter Four (Results), whereafter the data will be discussed further in Chapter Five (Discussion). Finally, Chapter Six (Conclusion and Recommendations) will summarise the research and highlight the most important findings and shortcomings of the study.

CHAPTER 2
REVIEW OF THE LITERATURE

2.1 INTRODUCTION

This chapter highlights muscle anatomy and function, and extends to discuss the literature relating to myofascial pain syndrome (MPS). Thereafter treatment options, with a focus on dry needling and Kinesiotape®, the two treatment interventions used in this research, are reviewed.

2.2 ANATOMY AND PHYSIOLOGY

The understanding of normal anatomy and physiology is imperative to understand the proposed pathophysiology of MPS that follows in 2.4.

2.2.1 Functional anatomy of the trapezius muscle

The trapezius is a large, triangular-shaped, muscle that provides direct attachment from the pectoral girdle to the posterior trunk. The trapezius is flat and located superficially over the deep posterior musculature of the neck and back. It received its name because the muscle forms the shape of a trapezium, an irregular four-sided figure (Moore and Dalley, 2006). The trapezius attaches proximally to the medial third of the superior nuchal line, nuchal ligament and the spinous processes of C7 to T12, and extends distally to the lateral third of the clavicle, and the acromion and spine of the scapula bilaterally. More relevant to this study, the upper fibers of the trapezius muscle attach superiorly to the medial third of the superior nuchal line, inferiorly to the outer third of the clavicle and in the midline to the ligamentum nuchae and to the spinous processes of the first five cervical vertebrae (Simons, Travell and Simons, 1999).

The fibers of the trapezius are divided into superior (upper), middle and inferior (lower) fibers. The superior fibers of the muscle elevate the scapulae, the middle fibers retract the scapulae and the inferior fibers depress the scapulae and lower the

shoulder (Moore and Dalley, 2006). The superior and inferior fibers act together to facilitate rotation of the scapulae (Moore and Dalley, 2006). When the shoulder girdle is fixed the trapezius also acts as a head and neck extensor when contracted bilaterally. In addition, unilateral contraction produces ipsilateral lateral flexion and rotation of the head and neck (Simons, Travell and Simons, 1999).

2.2.2 Muscle Anatomy

The trapezius muscle mass is skeletal muscle tissue which consists of separate muscle fibers bound together by connective tissue to form a singular muscle unit (Martini and Bartholomew, 2003; Vander, Sherman and Luciano, 2001). Within each muscle fiber are numerous myosin and actin myofilaments that are arranged in a specifically organised pattern when viewed in a transverse section. In this arrangement six actin (thin) filaments surrounds one myosin (thick) filament. These myosin and actin filaments are responsible for contraction of a muscle via the sliding filament theory (Guyton and Hall, 2006). This contraction of muscle is regulated by two other proteins – troponin and tropomyosin - that are located on the helical intertwined chain of actin proteins (Vander, Sherman and Luciano, 2001).

2.2.3 Muscle Contraction

The initiation and execution of muscle contraction occurs in the following sequential steps (Guyton and Hall, 2006):

1. An action potential nerve impulse travels along a motor nerve to its endings on muscle fibers.
2. At each ending, the nerve secretes a small amount of the neurotransmitter substance called acetylcholine.
3. The acetylcholine acts on a local area of the muscle fiber membrane to open multiple channels.
4. Opening of the acetylcholine-gated channels allows large quantities of sodium ions to diffuse to the interior of the muscle fiber via its membrane. This initiates an action potential at the membrane.

5. The action potential travels along the muscle fiber membrane and depolarizes the muscle membrane.
6. Much of the action potential electricity flows through the centre of the muscle fiber. Here it causes the sarcoplasmic reticulum, a storage site for calcium, to release large quantities of calcium ions.
7. The calcium ions initiate attractive forces between the actin and myosin filaments, causing them to slide alongside each other, which is the contractile process.
8. After a fraction of a second, the calcium ions are pumped back into the sarcoplasmic reticulum by a calcium membrane pump, and they remain stored in the reticulum until a new muscle action potential comes along; this removal of calcium ions from the myofibrils causes the muscle contraction to cease.
9. Tropomyosin covers the myosin-binding site on each actin molecule, thereby preventing the cross-bridges (the myosin-extension heads) to bind to actin. Each tropomyosin molecule is held in this blocking position by troponin, a smaller protein that is bound to both actin and tropomyosin.

2.2.4 Nerve and Blood Supply of the trapezius muscle

The motor innervation of the trapezius is provided by the spinal root of the accessory nerve (CN XI) and the sensory component i.e. pain and proprioception is supplied by the 3rd and 4th cervical nerves (Moore and Dalley, 2006). Arterial supply to the trapezius occurs through the thyrocervical trunks of the subclavian artery. The thyrocervical trunk has four branches, namely the suprascapular, transverse cervical, ascending cervical and inferior thyroid arteries. It is mainly the suprascapular and transverse cervical arteries bilaterally that are responsible for most of the arterial supply of the upper trapezius muscle (Moore and Dalley, 2006).

2.3 MYOFASCIAL PAIN SYNDROME

2.3.1 Prevalence and Incidence of muscle dysfunction / MPS

In a general medicine clinic, myofascial pain as a primary complaint was as high as 30% (Skootsky, Jaeger and Oye, 1989). However, myofascial pain in pain management centres appear to be even higher, with two independent physicians reporting myofascial pain as a primary diagnosis in 85% of cases (Fishbain *et al*., 1986). Staud (2007) reported that musculoskeletal pain affects 85% of the population at some point in their lives, and that myofascial pain is the main entity of musculoskeletal pain.

Gerwin (1995) examined 96 patients in a pain centre and found myofascial pain to be the primary cause of pain in 74% of patients, whereas 93% of cases had at least a contributing myofascial component. Sola, Rodenberger and Gettys (1995) examined the shoulder girdle muscles of 200 young asymptomatic military personnel and detected MFTPs in nearly 50% of them.

In comparison to other muscles, the trapezius is the muscle with the highest noted incidence of MFTPs (Gerwin, 2001; Simons, Travell and Simons, 1999; Sola, Rodenberger and Gettys, 1995).

2.3.2 Aetiology

Several possible mechanisms are proposed for the development of MFTPs. These include continuous low-level muscle contraction, uneven intra-muscular pressure distribution, direct trauma, proximal nerve compression, eccentric contractions in unconditioned muscles, and maximal or sub-maximal concentric muscle contraction (Dommerholt, Bron and Franssen, 2006; Huguenin, 2004). In addition, Baldry (1993) proposes secondary activating factors for MFTP development. These are compensating synergistic and antagonistic muscles, satellite referral MFTPs, infections, allergies, nutritional deficiencies and low oxygenation of the tissues. Other predisposing factors for MFTP development includes deconditioning, poor posture,

repetitive mechanical stress, mechanical imbalance (e.g. leg length inequality) and joint disorders (Gerwin, 2005; Borg-Stein and Simons, 2002).

Cummings and Baldry (2007) and Simons, Travell and Simons (1999) propose the following primary factors in the development of MFTPs:

Table 2.1 : *Aetiological factors for MPS*	
Trauma	Either direct injury to the muscle, or by sudden or repeated overload. Alternatively, when the muscle is subjected to repeated episodes of microtrauma e.g. repetitive strain injury.
Anxiety	An anxious individual tends to hold a group of muscles in a persistent contracted state.
Muscle wasting	Wasted muscle due to malignant disease or neurological disorders are weakened, predisposing to overload injury.
Muscle ischaemia	Due to arterial obstruction.
Visceral pain referral	Visceral disease often refers pain to the skin and muscles.
Radiculopathic compression of motor nerves	Compression from disc prolapse or spondylosis. Pain may also arise as a result of secondary development of MFTPs in the paraspinal muscles.
Climatic causes	MFTPs may become active when exposed to adverse environmental conditions such as damp, draughts, excessive cold or extreme heat.
Systemic biochemical imbalance	example hormonal imbalances such as thyroid hormone.

In addition, Yap (2007) suggests that mechanical factors such as scoliosis may be precipitating in nature. Yap (2007) also proposed degeneration as a possible cause of MFTPs. According to this author degeneration causes structural degeneration of bones and joints with consequent loss of myofascial flexibility, resulting in myofascial pain and dysfunction.

2.3.3 Perpetuating Factors

Perpetuating factors are responsible for the reoccurrence of myofascial pain after treatment of MFTPs. These factors have thus to be identified and eliminated for the long-term relief of pain (Esenyel, Calgar and Aldemir, 2000). MFTPs can be perpetuated by age, stress or constitutional illness (Yap, 2007; Dommerholt, Bron and Franssen, 2006; Huguenin, 2004). Chen *et al*. (1998) showed that stress had an amplification effect on MFTPs. Using sympathetic antagonists, they demonstrated reduced electromyogram activity in MFTPs. Furthermore, non-restorative sleep, vitamin deficiencies and psychological stressors are proposed to perpetuate MFTPs (Gerwin, 2005).

In addition, Simons, Travell and Simons (1999) advocated many perpetuating factors of myofascial pain:

Table 2.2: *Perpetuating factors for MPS*	
Mechanical stresses	Can be skeletal anomalies such as a short leg, small hemipelvis or a long second metatarsal bone (Morton's foot). Alternatively, non-ergonomic furniture, poor posture, prolonged immobility or abuse of the involved muscle are also classified as mechanical stresses.
Nutritional inadequacies	Low levels of vitamins B1, B6, B12, folic acid and iron aggravate MFTPs. A deficiency of vitamin C results in increased bleeding at the injection site of the MFTP. Inadequate levels of calcium, potassium, and several trace minerals causes abnormal muscle functioning. Dommerholt, Bron and Franssen (2006) also advocate lack of vitamin D, magnesium and zinc as potential perpetuating factors.
Metabolic and endocrine inadequacies	Hypothyroidism, hyperuricemia and hypoglycemia all perpetuate MFTPs.

Table 2.2: *Perpetuating factors continued…*	
Psychological factors	Simons, Travell and Simons (1999) state that anxiety and depression can delay the recovery of MFTPs.
Chronic infection	This infection can be viral, bacterial or parasitic in nature (Yap, 2007).
Miscellaneous factors	Impaired sleep, fatigue, cold damp weather, allergies, chronic visceral disease, and radiculopathy.
Latent MFTPs	LMFTPs can persist for years after apparent injury. Over-stretching, overuse, or chilling of the muscle may cause reactivation of the MFTP, predisposing to development of AMFTPs (Chaitow and DeLany, 2002).

2.4 PATHOLOGY

2.4.1 Current thinking and Theories

Electromyographic studies revealed spontaneous electrical activity (SEA) generated at the MFTP loci only (Hubbard and Berkoff, 1993). This increased SEA is an increase in miniature endplate potentials and excessive acetylcholine (Ach) release (Ge, Fernández-delas-Peñas, Yue, 2011). Mense *et al*., (2003) speculated that excess Ach at the motor endplate stimulates continuous contracture of the associated muscle fibers, resulting in increased metabolic demands. Dommerholt, Bron and Franssen (2006) confirmed this and explained that excessive Ach release affects the voltage-gated sodium channels of the sarcoplasmic reticulum and thereby increases the intracellular calcium level and encourages sustained muscle contraction.

The Integrated Trigger Point Hypothesis is currently the most accepted theory for trigger point formation (Simons, 2008) and describes a possible sequence due to the Ach excess in the synaptic cleft (Srbely, 2010). Due to the excess Ach release from the motor endplate, a state of sustained sarcomere contraction is theorized, resulting in increased metabolic demands and compressed capillary circulation. Lack of adenosine triphosphate (ATP) and reduced blood flow result in the muscle fibers being locked in contracture without sufficient energy to return calcium to the

sarcoplasmic reticulum, thereby encouraging constant contracture between the actin and myosin filaments (Srbely, 2010; Shah and Gilliams, 2008; Simons, Travell and Simons, 1999). Moreover, this local hypoxia and 'energy crisis' may stimulate the release of neuro-reactive substances and metabolic by-products that could potentially sensitize the peripheral nociceptors (Huguenin, 2004).

The Cinderella Hypothesis proposed by Hagg (1988) provides a possible complementary explanation of MFTP development. This hypothesis suggests that smaller Type 1 muscle fibers will be recruited first and de-cruited last during sub-maximal exertion with low-to-moderate physical load (Dommerholt, Bron and Franssen, 2006). This hypothesis is based on Henneman's 'size principle' (Henneman, Somjen and Carpenter, 1964) which suggest that Type 1 muscle fibers are used during static exertions where only a fraction of the motor units are utilized (Shah and Gilliams, 2008). Due to continuous overloading of these fibers, for example postural overloading, muscle microtrauma can occur which may lead to disturbance of calcium homoeostasis and resultant MFTPs (Shah and Gilliams, 2008). Gissell (2000) indicate low-level exertions to cause an increase in calcium release in skeletal muscle cell, muscle membrane damage due to lactate dehydrogenase leakage, energy depletion and myalgia. In addition, Treasters *et al.,* (2006) established that low-level muscle contraction for as little as 30 minutes often resulted in MFTP formation. Otten (1988) used a mathematical model applied to a frog gastrocnemius muscle to conclude that during static low-level muscle contractions, capillary pressures increased dramatically, especially near the muscle insertion, resulting in localised hypoxia and ischaemia. These findings compliment the Integrated Trigger Point Hypothesis.

There is also some evidence to suggest that muscle stretching and hypertonicity itself may encourage Ach release (Grinnell, 2008). Grinnel (2008) suggests that tension on the integrins in the presynaptic membrane at the motor endplate acts as a mechanical trigger for Ach release, with the resultant consequences of the Integrated Trigger Point hypothesis. In addition, Dommerholt, Bron and Franssen (2006) speculated that during MFTP development the myosin filaments may literally get stuck in the Z-band of the sarcomere. According to the authors, the titin structural

filaments are folded into gel-like structures at the Z-band during sarcomere contraction, and may prevent myosin filaments from detaching post-contraction.

2.4.2 Histology

Simons and Stolov (1976) biopsied canine muscle fibers and concluded that the knots featured a combination of severely shortened sarcomeres in the center with lengthened sarcomeres outside the immediate MFTP. Yunus *et al*., (1986) reported either non-specific changes of fibrosis with the absence of inflammatory cells, or negative findings. Windisch *et al.,* (1999) biopsied fresh cadaver muscle and compared the histology to control areas from the same muscle. They found an overall increase in the average diameter of muscle fibers from these nodules compared to the control areas. Electron microscopy by the same authors' indicated an excess of A bands and a lack of the I band configuration, suggesting sarcomere contraction (Windisch *et al*., 1999). Bennett (2007) stated that muscle biopsy in itself is problematic to the histological study of MFTPs. He used light-microscopy examination and indicated 'bulging swelling' in muscles involved with MPS (Bennett, 2007).

2.4.3. Biochemical Markers

An acidic pH has been shown to be associated with pain and lowered nociceptor threshold activity (Issberner *et al*., 1996). Shah and Gilliams (2008) confirmed via micro dialysis investigation that muscles with AMFTPs had an acidic pH. Expanding on the Integrated Trigger Point Hypothesis, Gerwin, Dommerholt and Shah (2004) proposed that Ach esterase, the enzyme responsible for the breakdown of Ach, is inhibited by an acidic pH, thereby encouraging increased amounts of Ach in the synaptic cleft and consequent sustained contraction. The authors also hypothesized that Calcium Gene-related Peptide (CGRP) might intensify the nerve terminal response to excessive Ach by both enhancing Ach receptor activity and receptor synthesis.

Shah and Gilliams (2008) also implicated Substance P, another neuropeptide, as being part of the pathophysiology of MFTPs. Substance P exerts direct actions,

producing nociceptor sensitization, vasodilation, increased vascular permeability and mast cell degranulation (Shah and Gilliams, 2008).

Furthermore, significantly elevated levels of the catecholamines noradrenalin and 5-hydroxytryptamine (5-HT) have been described in AMFTPs (Shah and Gilliams, 2008). In an area of tissue injury, 5-HT is released from platelets, mast cells and basophils. Activation of 5-HT receptors had direct and dose-dependant nociceptive effects on the vascular bed (Giordano and Schultea, 2004). On the other hand, noradrenalin, a sympathetic neurotransmitter, may be associated with amplified sympathetic activity in the motor end plate region of the AMFTP (Shah and Gilliams, 2008).

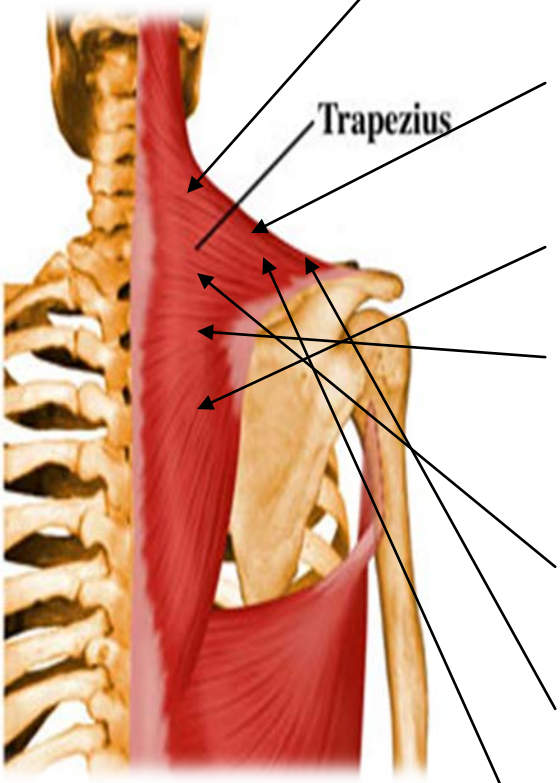
2.5. CLINICAL CHARACTERISTCS AND CONSIDERATIONS

2.5.1. Clinical presentation

MFTPs have motor, sensory and autonomic components (Dommerholt, Bron and Franssen, 2006):

- Motor aspects of active and latent MFTPs may include muscle weakness, muscle stiffness and restricted joint range of motion (Dommerholt, Bron and Franssen, 2006; Alvarez and Rockwell, 2002; Simons, Travell and Simons, 1999).
- Sensory aspects include local tenderness and/or pain referral (Dommerholt, Bron and Franssen, 2006). Referred pain can be experienced either spontaneously or on digital compression. A jump sign by the patient may be seen in response to digital compression of the MFTP (Huguenin, 2004; Simons, Travell and Simons, 1999). Besides local tenderness, Simons, Travell and Simons (1999) mentions that muscular pain is experienced with passive or active stretching in the presence of MFTPs.
- Autonomic phenomena of a MFTP include a twitch response with snapping palpation or with dry needling therapy. Each AMFTP is characterized by their individual referred pain patterns (Simons, Travell and Simons, 1999) (Figure 2.1). These referral patterns may refer spontaneously in AMFTPs, whereas a

LMFTP only exerts pain on manual compression (Hou *et al*., 2002). Other autonomic aspects of MFTPs may include vasoconstriction or dilation, lacrimation and pilo-erection (Simons, Travell and Simons, 1999).



The upper trapezius MFTPs 1 (TP1) has a zone of reference that extends to the ipsilateral sub-occipital and temporal regions.

TP2 refers pain to the neck, but pain may extend to the ipsilateral sub- occipital region.

TP3 refers pain to the neck, mastoid and shoulder regions.

TP4 is characterised by a steady burning pain along the vertebral border of the scapula.

TP5 is characterised as a superficial burning sensation at the C7-T1 junction.

TP6 is situated in the upper Trapezius near the acromion. It refers an aching pain to the top of the shoulder.

TP7 refers a shivery sensation down the ipsilateral arm.

Figure 2.1*: The trapezius muscle with its characteristic MFTPs (Simons, Travell and Simons, 1999).*

2.5.2. Active versus latent Trigger Points

Alvarez and Rockwell (2002) state that LMFTPs may display hypersensitivity and exhibit all the characteristics of AMFTPs (discussed in 2.5.1) except for spontaneous pain. In addition, LMFTPs may also alter muscle activation patterns and contribute to limited range of motion (Lucas *et al*., 2004).

2.5.3. Trigger Points versus Tender Points

Alvarez and Rockwell (2002) also mention that MFTPs should be distinguished from tender points. Tender points are associated with Fibromyalgia Syndrome, when found in particular patterns. Alvarez and Rockwell (2002) tabulate this as follows:

Table 2.3 *MFTPs compared to Tender Points*

MFTPs	**Tender Points**
Local tenderness, taut band, local twitch response, jump sign	Local tenderness
Singular or multiple	Multiple
May occur in any skeletal muscle	Occur in specific locations that are symmetrically located
May cause a specific referred pain pattern	No referred pain, but may cause a total body increase in pain sensitivity

(Adapted from Alvarez and Rockwell, 2002)

2.5.4 Diagnosis

The criteria for an AMFTP are (Huguenin, 2004; Hou *et al*., 2002; Simons, Travell and Simons, 1999):

1. A taut palpable band.
2. A palpable nodule within the palpable band.
3. Patient elicits a jump sign on palpation.
4. The zone of reference of the palpated MFTP is in accordance of that mentioned (described by the patient).
5. The zone of reference of the palpated MFTP is in accordance of that mentioned (achieved on manual compression).
6. Muscle displays weakness.

7. Muscle displays decreased range of motion.
8. Pain with active or passive stretching of the muscle.

Although a patient may present with the above signs and symptoms, in this study the patient will be required to meet ***four*** of the top ***five*** criteria to fulfil the criteria for inclusion into this study.

2.5.5 Differential Diagnosis

MPS has been associated with various pathological conditions (Gerwin, 2004; Borg-Stein and Simons, 2002). These conditions, depending on location, are:

> Radiculopathies, joint dysfunction, disc pathology, tendonitis, cranio-mandibular dysfunction, migraines, tension-type headaches, carpal tunnel syndrome, whiplash-associated disorders, spinal dysfunction, pelvic pain and other urology syndromes, post-herpetic neuralgia, complex regional pain syndromes, drug side-effects, vitamin D or iron-deficiencies, infectious diseases e.g. Lyme Disease, and auto-immune conditions.

2.5.6 Diagnostic Testing

Manual palpation skills and patient feedback are primarily used for MFTP diagnosis (Sciotti *et al.,* 2001). However, routine surface electromyography of AMFTPs tends to show increased motor activity during contraction (Borg-Stein and Simons, 2002). Also, needle electromyography has been demonstrated as being useful in identifying spontaneous electrical activity (SEA). However, the needle has to be very carefully inserted to prevent development of an insertion potential (Bennett, 2007). It is doubtful whether SEA indicates a specific MFTP signal, normal endplate potentials, muscle spindle activity or focal dystonia (Bennett, 2007; Gerwin, Dommerholt and Shah, 2004). Ge, Fernandez-de-las-Penas and Yue (2011) recently stated that SEA represents focal muscle fiber contraction and/or muscle cramp potentials depending on the sensitivity of the MFTP.

Thermography has also demonstrated inconsistency regarding MFTP diagnosis, with both hot and cold spots present in AMFTPs (Han and Harrison, 1997). The authors conclude that the diagnostic value of thermography in all areas of the body remains unclear, and further investigations are needed to clarify the relationship between this thermography and MFTPs.

Pressure algometry is another potential diagnostic tool used to quantify the sensitivity when localized tenderness exists. The pain pressure threshold is measured (i.e. the minimum pressure that induces pain for an individual). Han and Harrison (1997) reports that pressure algometry appears to be a reliable diagnostic tool used for objective readings and testing the relative effectiveness of other treatment modalities.

Moreover, diagnostic ultrasound is has been proposed as a potential diagnostic entity (Simons, Travell and Simons, 1999). Lewis and Tehan (1999) concluded that diagnostic ultrasound could not significantly identify any soft tissue changes in the region of clinically identified MFTPs. However, more recently Sikdar *et al*., (2009) found that ultrasound imaging can be used to distinguish myofascial tissue with and without MFTPs.

In this study we have used manual palpation to identify MFTPs, followed by pressure algometry to measure the pain pressure threshold of the MFTP. These methods are cost-effective and reliable (Sciotti *et al.,* 2001; Han and Harrison, 1997).

2.6 TREATMENT

MFTP therapy is essentially divided into invasive and non-invasive treatment techniques.

2.6.1 Non-Invasive therapies

2.6.1.1 Stretching / Strengthening

Simons, Travell and Simons (1999) are strong advocates of the spray and stretch method. It is suggested that stretching is performed after the application of a vapo-

coolant ethyl chloride spray. In this instance, the vapo-coolant spray may act as a mechanism to inhibit pain by stimulating larger A-beta fibers, which allows the muscle to stretch further, beyond the pain threshold, encouraging normal muscle length and tone. Edwards and Knowles (2003) warned, however, that stretching alone without the prior deactivation of MFTP with dry needling may lead to increased sensitization of MFTPs.

Muscles that contain MFTPs usually become weakened due to pain inhibition (Bennett, 2007). The author recommends that slow progressive strengthening is essential to restore full function, reduce risk of AMFTP recurrence and limit the chance of satellite MFTP perpetuation.

2.6.1.2 Transcutaneous electrical nerve stimulation (TENS)

Graff-Redford *et al.,* (1989) investigated 100Hz, 2Hz and control frequencies of TENS on MFTPs related to chronic pain in the head, neck, or thoracic area. Although low frequency and control TENS had no effect on pain, high frequency TENS resulted in significant myofascial pain relief. The sensitivity of MFTPs, however, remained unaltered after 10 minutes of treatment. Relating to back pain, TENS produces variable literature results (van Tulder *et al.,* 1997; Beurskens *et al.,* 1995). The clinical practice guidelines from the United Kingdom (National Institute for Health and Clinical Excellence, 2009), USA (Chou *et al.,* 2007), Belgium (Nielens *et al.,* 2006), Italy (Negrini *et al.,* 2006) and Europe (Airaksinen *et al.,* 2006) indicate limited evidence for use (Dagenais and Haldeman, 2012), particularly in chronic back and neck pain.

2.6.1.3 Ultrasound

Gam *et al.,* (1998) investigated the therapeutic effect of ultrasound on MFTPs. In this study both intervention groups performed exercise and received additional massage. Both groups showed improvement, with the ultrasound eliciting no additional therapeutic benefits. In contrast, Srbely and Dickey (2007) showed that therapeutic exposures to ultrasound reduced short-term MFTP sensitivity. Draper *et al.,* (2010) demonstrated that thermal ultrasound over LMFTPs was comfortable and could decrease stiffness of a MFTP.

Majlesi and Unalan (2004) studied the effects of a high-power, pain threshold static ultrasound technique. This technique was applied in continuous mode, with the probe placed directly over the MFTP. The probe was held motionless. Pain threshold was reached after the intensity was gradually increased, whereafter the intensity was maintained for 5 seconds, and then reduced to half-intensity for another 15 seconds. This procedure was repeated three times. They found that this technique was significantly better than the conventional stroking technique.

However, there is no agreement on the clinical efficacy and relative effectiveness of ultrasound (Haldeman, 2005; Kitchen and Bazin, 1996). Therefore, when looking at the clinical practice guidelines from the United Kingdom (NICE, 2009), USA (Chou *et al.,* 2007), Belgium (Nielens *et al.,* 2006), Italy (Negrini *et al.,* 2006) and Europe (Airaksinen *et al.,* 2006) limited evidence for general use exist (Dagenais and Haldeman, 2012).

2.6.1.4 Laser

Huguenin (2004) reported that there is no reproducible evidence of the benefit for laser therapy in the treatment of MFTPs. However, Vernon and Schneider (2009) concluded in a systematic review that laser and acupuncture were useful modalities in both short- and long-term relief of MPS. Al-Shenqiti and Oldham (2009) reviewed sixteen articles on laser treatment and determined that the use of Low-Intensity Laser treatment (LILT) for MFTPs produce conflicting results. They proposed that varying symptoms duration, treatment parameters and techniques, non-homogenous populations, and inaccessible and/or poor laser machine specifications to be the main concerns regarding current laser therapy research.

2.6.1.5 Medication

Paracetamol or muscle relaxant medication may be prescribed for mild forms of myofascial pain, whereas non-steroidal anti-inflammatory drugs or cyclooxygenase-2 selective inhibitors may be used if a local inflammatory component is involved (Yap, 2007). However, no evidence exists to suggest that medication eliminates MFTPs (Rudin, 2003).

Tricyclic antidepressant drugs are pain modulating at the central nervous system and were proposed to be of benefit in patients with associated sleep disturbances (Bennett, 2007; Yap, 2007). However, Bennett (2007) mentioned that a particular tricyclic called tizanidine had muscle relaxant and α2-adrenergic receptor activating effects, and was a useful adjunct in challenging cases of myofascial pain.

2.6.2 Invasive Therapies

2.6.2.1 Trigger point injection (TPI)

A variety of fluids had been injected into MFTPs including water, saline, local anaesthetic, vitamin B solutions and long-acting corticosteroids (Scott *et al.,* 2009). Hong (2006) advocated TPI as the most effective means of inactivating a MFTP. Although Hong (1994) recognised the effectiveness of dry needling, the author recommended the use of a local anaesthetic as the patient received instant relief which also confirmed the accuracy of the injection. In addition, the results of a study by Kamanli *et al.,* (2005) also favoured injection with lidocaine, a local anaesthetic, above dry needling and botulinium injection. They stated that lidocaine injection was more practical and rapid. It also caused fewer disturbances than dry needling and was more cost effective than botulinium injection (Kamanli *et al.,* 2005).

Generally there has been no outstanding substance regarding subjective pain relief and most substances had similar outcomes than saline (Huguenin, 2004). One consistent finding, however, was that pain relief outlasts the half-life of the injected substance, suggesting other involved mechanisms of pain relief such as the needle effect (Huguenin, 2004).

Botulinium toxin injections had been proposed for use in TPI based on the concept of excessive Ach release from motor nerve terminals (Huguenin, 2004). The toxin is produced by the bacteria Clostridium botulinium and blocks the release of Ach from the motor nerve terminals (Huguenin, 2004). Botulinium toxin injections, however, for the treatment on MFTPs have not been demonstrated conclusively (Ferrante *et al*., 2005), but may be useful in persistent situations (Kamanli *et al*., 2005).

2.6.2.2 Dry Needling

As early as 1944 Steinbrocker commented on the potential of needle insertion for musculoskeletal pain without the use of an injectable substance (Steinbrocker, 1944). Dry needling has since been shown to be an effective treatment modality for MPS by various authors (Huang *et al*., 2011; Alvarez and Rockwell, 2002; Karakurum *et al*., 2001; Han and Harrison, 1997) and systematic reviews (Vernon and Schneider, 2009; Furlan et al., 2008; Dommerholt, Bron and Franssen, 2006; Cummings and White, 2001). In fact, Garvey, Marks and Wiesel (1989) found dry needling to be as effective as local anaesthetic, corticosteroids or coolant spray in the treatment of low back pain.

Superficial dry needling (SDN) has been advocated by Baldry (1995) as an effective modality for MPS, where the needle is inserted subcutaneously over the indicated MFTP. In addition, Edwards and Knowles (2003) demonstrated that SDN in conjunction with stretching was more effective than stretching alone in the deactivation of MFTPs. However, Lucas *et al*., (2004) also confirmed the effectiveness of deep dry needling (DDN) (i.e. needle insertion into the MFTP) and stretching of LMFTPs of the shoulder girdle musculature (After treatment the muscle activation patterns of these muscles returned to normal). Thus, both SDN and DDN techniques appear to be effective, yet Ceccherelli *et al*., (2002) compared the analgesic effects of SDN to DDN and concluded that the analgesia provided by DDN was superior to that of SDN. These findings were supported by Itoh, Katsumi and Kitakoji (2004) who compared standard acupuncture, SDN and DDN. After 11 weeks (two treatment periods of four weeks each with a three week interval) patients treated with DDN reported less pain intensity with improved quality of life.

A unique feature is of MFTP needling is when a local twitch response (LTR) is elicited. The LTR is an involuntary spinal cord reflex contraction of the muscle fibers within a taut band of muscle (Dommerholt, del Moral and Grobli, 2006). Hong (1994) expressed the importance of eliciting a LTR when treating MFTPs. He stated that in addition to the fact that the treatment outcome is much improved, the LTR confirms the correct insertion of a needle into a taut band of muscle (Hong, 1994). Moreover, Chen *et al.,* (2000) concluded that dry needling of a MFTP is effective in diminishing spontaneous electrical activity (SEA) when LTRs are elicited.

The proposed mechanism of function of dry needling is thought to be through:

- Mechanical disruption, which causes local haemorrhage and an inflammatory reaction, which increases blood flow resulting in the removal of nociceptive substances in the area (Simons, Travell and Simons, 1999). This reduces pain and increases circulation, allowing for resolution of a MFTP (Kalichman and Vulfsons, 2010).
- The above point is also supported by the bio-electric activity of the needle (Hsieh *et al*., 2007; Baldry, 1995), which stimulates blood flow (hyperaemia) to the MFTP and encourages resolution of the MFTP (Kubo *et al*., 2010).
- In addition, the mechanical disruption of the muscle or nerve fibers within the pain-spasm cycle causes the release of potassium into the extracellular fluid with the consequent depolarization of muscle fibers and nerve endings, both increasing relaxation of the muscle and decreasing pain (Srbely *et al*., 2010; Kalichman and Vulfsons, 2010).

2.7 KINESIO TAPING® METHOD

2.7.1 Background

Kase (a Japanese chiropractor) developed Kinesio Tex® Tape in 1979 and is deemed the founder of Kinesio® Tex Tape and the method of its application – the Kinesio Taping® Method (Terrazas, 2011; Illes, 2009). Kase wanted his patients to be able to utilize a 'prescription' that they could take home and use between visits. Unlike normal athletic tape, he wanted to develop something which was similar to the elasticity of the skin and/or muscles. Kinesio Tex® Tape received worldwide exposure when it was used at the Seoul Olympics by Japanese athletes (Illes, 2009). This technique then spread to the United States and was extensively used at the 2004 Olympic Games in Athens (Illes, 2009). Kinesio Tex® Tape is used widely today in many sports including rugby, soccer, NFL football, athletics and cycling (Terrazas, 2010). Lance Armstrong, the seven times Tour de France winner, advocated the use of Kinesio Tex® Tape in his book 'Every Second Counts' (Illes, 2009). However, 85% of applications of Kinesio Tex® Tape remain non-athletic due to the versatility of conditions that are treatable with Kinesio Tex® Tape (Illes, 2009).

2.7.2 Properties of Kinesiotape®

Kinesiotape® has been manufactured to mimic the qualities of the skin. It therefore has the same thickness as the epidermis layer of the skin (Kase, Wallis and Kase, 2003), and has the capacity to longitudinally stretch 130-140% from its static resting length (Osterhues, 2004). This degree of stretch equates to the stretching ability of normal skin. The thickness of Kinesiotape® was intended to limit the body's perception of weight and avoid sensory stimuli when applied properly. After approximately 10 minutes, the patient will generally not perceive any feeling of the tape on the skin (Kase, Wallis and Kase, 2003).

Kinesiotape® is comprised of a polymer elastic strand wrapped by 100% cotton fibers (Kase, Wallis and Kase, 2003). The fibers allow for evaporation of body moisture and enable fast drying of Kinesiotape® after showering, bathing or watersports. Kinesiotape® is latex-free, whilst the adhesive is a 100% acrylic and

heat-activated (Kase, Wallis and Kase, 2003). Heat-activation is achieved by vigorous rubbing of Kinesiotape® after application. The acrylic is designed in a wave-like pattern to mimic the fingerprint of the fingertip. It is proposed that the acrylic becomes more adhesive the longer the application remains on the skin. It can be comfortably worn for 3-5 consecutive days (Kase, Wallis and Kase, 2003). If a person was sensitive to taping previously, it is suggested that a small test application is applied onto the skin before full application (Illes, 2009). In addition, Kinesiotape® is contra-indicated over open wounds, recently irritated skin (e.g. rashes), recently formed scars and irradiated skin (Illes, 2009).

2.7.3 Concepts surrounding Kinesiotape®

Kase based his design on the external assistance of myofascial conditions. He emphasized space, movement and cooling as three important concepts of his taping method (Terrazas, 2010). He argued that painful and / or inflamed muscles lack space, and through the application of Kinesio Tex® Tape space was created with consequent improvement in movement and circulation, allowing for cooling of the involved muscle (Terrazas, 2010). Kinesio Tex® Tape also stimulates proprioceptive A-beta fibers, decreasing the effect of C-pain fibers (Illes, 2009). Besides the reduction of pain, it was also proposed that Kinesio Tex® Tape might normalize muscle ratio and tension, assist in tissue recovery and reduce muscle fatigue.

Kinesiotape® is proposed to exert its physiological effects on skin, circulatory and lymphatic system, fascia, muscles and joints (Illes, 2009; Kinesiotaping Applications Manual, 2005). Kinesiotape® can be applied in different ways to achieve the desired therapeutic effect. However, in all cases, an application forms convolutions of the skin causing microscopic skin lifting, promoting lymphatic drainage from the interstitial spaces and consequently alleviating oedema, inflammation and pain (Terrazas, 2010; Illes, 2009). A ‘space orientation’ technique is a Kinesiotape® application where the aim is solely to create a ‘skin lifting’ effect. This is achieved through stretching the tape 25-50% in the middle of the strip and applying the tape onto stretched tissue. The anchors of Kinesiotape® are always applied with no tension. In addition, the basic principle to promote muscle relaxation or prevent cramping is that the Kinesiotape® is applied from insertion to origin whilst stretching

the tape to 15-25% of its available tension (Kase, Wallis and Kase, 2003). This application is typically used for acute conditions like joint sprains or muscle strains, muscle spasm or in this study, investigating the effect on a myofascial trigger point within the tense over-worked trapezius muscle.

2.7.4 Review of literature on Kinesiotape®

In a case study, Osterhues (2004) reported on the use of Kinesiotape® in conjunction with Interferential Current, ice, rest and pain medication in traumatic patellar dislocation. The case report supported the use of Kinesiotape® in decreasing pain and enhancing quadriceps activity and weight bearing stability during functional activities. In addition, Chen *et al*., (2007) showed via electromyogram testing that, compared to placebo taping and no taping, the onset of the vastus medialis oblique (VMO) muscle activity occurred earlier when Kinesiotape® was applied. No difference between placebo tape and no taping was found. They proposed that earlier activation of VMO should allow for more optimal positioning of the patella during activity. In another study by Vithoulk *et al*., (2010) it was found that application of Kinesiotape® on the anterior surface of the thigh, in the direction of vastus medialis, lateralis and rectus femoris, could increase the eccentric muscle strength (isokinetic eccentric peak torque), in healthy non-athlete females.

In contrast, Janwantanakul and Gaogasigam (2005) found no difference in electromyographic readings between taping and no taping for vastus lateralis and VMO when tested on 30 asymptomatic females between the ages of 18 and 23. These findings were supported in a pilot study by Fu *et al.* (2008). The authors examined the possibility of an immediate and delayed effect of Kinesiotape® on muscle strength in the quadriceps and hamstring muscle groups. Fourteen healthy university athletes (seven males and seven females) free of knee problems were enrolled in the study. Muscle strength was assessed with an isokinetic dynamometer immediately after taping or 12 hours post-taping. The subjects were also assessed without any taping been applied, serving as a control to the results. Results revealed no significant difference in muscle power amongst the three conditions. Kinesiotape®, therefore, did not enhance (nor decrease) performance. Furthermore, Chang *et al*., (2010) demonstrated that Kinesiotape® application does not enhance

maximal grip strength in twenty-one healthy college athletes. The study did, however, find that the sense of 50% maximal force (force sense) as measured by a hand-held dynamometer was improved in the Kinesiotape® group compared to the placebo and no taping groups.

Additionally, Kinesiotape® was shown to significantly increase lower trunk flexion in thirty healthy subjects after assessment of lower trunk flexion, extension and lateral flexion (Yoshida and Kahanov, 2007), indicating possible muscle facilitation. Thelen, Dauber and Stoneman (2008) conducted a randomized double-blinded control trial using Kinesiotape® on shoulder pain and active range of motion. The researchers divided the participants into a sham and therapeutic application of Kinesiotape®. The therapeutic Kinesiotape® group showed immediate improvement in pain-free shoulder abduction after Kinesiotape® application. No other differences between the sham and therapeutic groups regarding range of motion or pain were found. It was concluded that Kinesiotape® may be of some assistance to clinicians in improving pain-free active range of motion immediately after tape application for patients with shoulder pain. However, utilization of Kinesiotape® for decreasing pain intensity or disability for young patients with suspected shoulder tendonitis/impingement was not supported. In addition, García-Muro, Rodríguez-Fernández and Herrero-de-Lucas (2009) demonstrated in a case study that Kinesiotape® may be of assistance in the management of deltoid myofasciitis. They found that pain, joint motion and shoulder function were improved after nine days.

In another study, Gonzales-Iglesias *et al*., (2009) investigated the short-term effects of Kinesiotape® application to the cervical spine following acute whiplash injuries. Cervical pain and range of motion were used to evaluate the treatment efficacy. Statistically significant improvements were found in both pain and range of motion in the Kinesiotape® intervention group. However, the authors concluded that these improvements were small and perhaps not clinically significant. Future longer term studies were suggested to identify possible clinical significant results.

Henry (2010) compared the relative effectiveness of Kinesiotape® versus Ibuprofen (a non-steroidal anti-inflammatory drug) on episodic tension-type headaches. Sixteen subjects were randomly allocated to each group. A significant improvement

was seen in both groups, with no significant difference between the Ibuprofen and Kinesiotape® groups. The authors concluded that either Kinesiotape® or Ibuprofen would be effective in the treatment of episodic tension-type headaches.
Furthermore, Tsai, Chang and Lee (2010) demonstrated that planter fasciitis is better treated with the addition of Kinesiotape® to a physiotherapy programme than with a physiotherapy program alone. Kinesiotape® was applied continuously for one week on the gastrocnemius and plantar fascia. The therapeutic effects were measured with a subjective pain score as well as ultrasonographic assessment of the thickness and structural change of the plantar fascia.

Although the mechanism of action of Kinesiotape® is yet to be shown, it has been hypothesized to be related to the recoil effect of the tape. Recoil causes lifting of the skin, thereby:

- Improving micro-circulation and lymph drainage (Kinesiotape Applications Manual, 2005), which is similar to the increased circulatory effect that is caused by dry needling, but without the inflammatory response (which is thought to be responsible for the post needle soreness).
- Stimulating proprioceptive A-beta fibers, reducing the activity of C-pain fibers thereby reducing pain (Gate Control Theory (Melzack, 2011; Melzack and Wall, 1965)), which is similar to the mechanical stimulation in dry needling that result in nerve depolarization and a reduction in pain.
- In addition, if stretch is applied over the neuromuscular junction of a muscle, the golgi tendon organ (GTO) is activated, causing muscle inhibition (Kinesiotape Applications Manual, 2005), which would be analogous to the inhibition caused by muscle depolarization in dry needling.

2.8 CONCLUSION

With the current research in Kinesiotape® limited to case (Osterhues, 2004) and pilot studies (Fu *et al*., 2008) and only one randomized clinical trial (Thelen, Dauber and Stoneman, 2008), little can be said about its effects on MFTPs compared to dry needling. Kinesiotape® appears to elicit significant therapeutic effects onto the neuromuscular system. As a non-invasive therapy its individual efficacy compared to that of dry needling, a mainstay treatment amongst manual therapists should be assessed.

CHAPTER 3
MATERIALS AND METHODS

3.1 INTRODUCTION

This chapter focuses on the materials used for the study, as well as the research methodology or procedure that was followed. The treatment interventions and process of statistical analysis are also discussed.

This study was conducted at the Chiropractic Day Clinic, Durban University of Technology, Durban, South Africa.

3.2 STUDY DESIGN AND PROTOCOL

3.2.1 Object of the study

This study was designed as a quantitative prospective randomised clinical trial. The aim of this study was to determine whether Kinesiotape® versus dry needling was more effective in treatment of trapezius myofascial pain. On conclusion of the treatment protocol, the two groups were analyzed for inter- and intra-group improvement to determine efficacy of treatment.

This research was approved by the Research Ethics Committee, Faculty of Health Sciences, Durban University of Technology indicating compliance with the Declarations of Helsinki / Nuremberg (Johnson, 2005). (please refer to Annexure E for ethical clearance certificate).

3.2.2 Advertising

Advertisements were distributed around the Durban University of Technology campus (Annexure A). Advertising pamphlets were also distributed in the Glenwood and Musgrave residential areas. The sample of patients was drawn from the greater

Durban area to eliminate the problem of patients not returning to follow-up appointments due to time or distance / transport constraints.

The individuals who responded to the advertisements were telephonically screened, and if eligible for participation in the study, scheduled for an appointment with the researcher. Participants were accepted into the study only after a case history, physical and regional examination were performed to determine if the participant met the inclusion and exclusion criteria for the study (see sections 3.2.6.1 and 3.2.6.2).

3.2.3 Telephonic Interviews

Each patient was telephonically screened with the following questions:

Table 3.1: *Telephonic questions and required answers*

Telephonic Questions:	Required Answers:
Are you currently a patient in this clinic or with any other chiropractor?	No I was part of another research project more than 3 months ago. I was a patient here more than 2 weeks ago.
Do you have pain in your lower neck towards the shoulder region?	Yes
Have you ever had treatment for this pain?	No More than 2 weeks ago
Have you had dry needling in the area recently?	No More than 3 months ago
Are you between the ages of 18 and 50?	Yes
Do you have the time available to be able to make the initial and the follow-up visits, each 2-4 days apart?	Yes
Have you had any surgery to the area?	No
Were you in any accidents recently, or in the past that affected your neck?	No
Do you suffer from any serious systemic illness?	No

Have you taken any painkillers within the last 3 days?	No

3.2.4 Sample Group – size and allocation

A sample size of 50 patients was selected through convenience sampling (Mouton, 1996). No preferences to ethnicity, religion or socio-economic status were used. The sample size was viable to a single researcher project, and allowed for effective statistical analysis (Esterhuizen, 2011).

Patients between the ages of eighteen and fifty years (Thelen, Dauber and Stoneman, 2008) were permitted into the study to maintain homogeneity of the sample group and to avoid the physiological changes associated with puberty and ageing respectively.

3.2.5 Sampling method and process of randomization

All participants were required to read a Letter of Information and give informed consent to the study (Annexure B) before the study commenced. The patients were randomly allocated into either the Kinesiotape® or dry needling group using a randomisation table (Annexure C) designed by the statistician (Esterhuizen, 2011).

3.2.6 Inclusion and Exclusion

3.2.6.1 The inclusion criteria

Each participant had to present with an AMFTP in the upper trapezius region. The criteria for an AMFTPs were (Huguenin, 2004; Alvarez and Rockwell, 2002; Hou *et al*., 2002; Simons, Travell and Simons, 1999):

1. A taut palpable band.
2. A palpable nodule within the palpable band.
3. Patient elicits a jump sign on palpation.
4. The zone of reference of the palpated trigger point is in accordance of that mentioned (described by the patient).

5. The zone of reference of the palpated trigger point is in accordance of that mentioned (achieved on manual compression).
6. Muscle displays weakness.
7. Muscle displays decreased range of motion.
8. Pain with active or passive stretching of the muscle.

Although a patient may present with any of the above signs and symptoms, this study required the participant to meet four of the top five criteria.

3.2.6.2 The exclusion criteria

a) Any patient not 18-50 years of age. In a Kinesiotape® study by Thelen, Dauber and Stoneman (2008) participants between the ages of 18 and 50 were used.
b) Patients with previous surgery that could have affected the trapezius muscle (e.g. cervical vertebral fusion or cervical rib resectomy) as this changes the mechanisms of interaction between the various systems utilised to control neck movement and may lead to aberrant physiological responses as compared to patients who have not had surgery (Murphy, 2000).
c) Severe trauma prior to the consultation with possibility of fracture and other soft tissue injury which is known to alter the biomechanics of the cervical spine and often leads to clinical sequelae that would otherwise not be present in patients without injury (Foreman and Croft, 1995).
d) Signs or symptoms of cervical radiculopathy, brachial plexopathy or other nerve impingement or pathology that often result in changes in the mechanisms of interaction between the various systems utilised to control neck movement and may lead to aberrant physiological responses as compared to patients who do not have these conditions (Murphy, 2000).
e) Patients taking any form of medication that could alter the study results, i.e. analgesics, muscle relaxants, non-steroidal anti-inflammatory drugs or corticosteroids. A three day (72 hour) washout period, as recommend by Poul *et al.,* (1993) and Seth (1999), was applied.

f) People who have received dry needling treatment in the last three months (Ferreira, 2006) in the upper trapezius region, in order to maximise the naivety of patients and increase their memory decay in terms of expected clinical response to dry needling (Mouton, 1996).
g) Research subjects known to have former adverse effects from either dry needling or Kinesiotape®.
h) Fever, regional skin infections or malignancy, pregnancy, severe blood dyscrasias and/or chronic cardiac failure are contra-indicated for treatment with dry needling (Simons, Travell and Simons, 1999; Han and Harrison, 1997).
i) Kinesiotape® application is contra-indicated over malignancy, skin infections, cellulitis, open wounds and deep vein thrombosis (Kase, Wallis, Kase, 2003). Subjects with these conditions were excluded.
j) People with needle phobia or those prone to convulsions e.g. epilepsy patients (Rachlin and Rachlin, 2002).

To maintain homogeneity all the exclusion criteria for dry needling also applied to the Kinesiotape® group, and vice versa. A case history, physical and regional examinations (Annexures F, G and H) was performed to identify subjects that presented with signs that warranted exclusion. Regional examination aimed to exclude cervical spine pathology and identify AMFTPs.

3.3 PROCEDURE

The upper trapezius fibers were used in this study to eliminate risk of variables between the subjects and to maintain homogeneity.

Treatment One with either dry needling or Kinesiotape® commenced within five minutes of assessment. Since Kinesiotape® can be comfortably worn for three to four consecutive days (Kase, Wallis and Kase, 2003), the patient was rescheduled for a follow-up treatment two to four days after treatment One (Table 3.2). On the second visit the post-treatment measurement of Treatment One was performed and Treatment Two commenced. The same reschedule framework applied. At the third

visit post-treatment measurements for Treatment Two were performed. Thereafter, the patients were thanked for their participation in the study.

Table 3.2: *Treatment and Follow-Up Protocol*

	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**
Visits	Visit 1			Visit 2			Visit 3
Follow-ups				Follow-up 1			Follow-up 2
Data Capture (Both Groups)	Visual Analog Scale (VAS) & Neck Disability Index (NDI) baseline Reading			VAS & NDI 2			VAS & NDI 3
	Algometer Baseline Reading			Algometer 2			Algometer 3
	Cervical Range of Motion (CROM) baseline Reading			CROM 2			CROM 3
Treatment	Treatment 1			Treatment 2			

3.3.1 Kinesiotape Group

Kinesiotape® was applied on clean skin with minimal hair (increasing its adhesive quality). If the patient's skin was visibly unclean, it was cleaned with an alcohol wipe. If hair was problematic on the area of application, a hair clipper was used to remove this hair. Kinesiotape® was applied using the correct cutting methods (viz. the corners of the tape was rounded to avoid easy pealing of the tape) and correct handling method (viz. no touching onto the adhesive side of the tape occurred).

A muscle inhibition technique, as well as a space orientation technique was applied to the upper trapezius fibres (Kinesiotape Application Manual, 2005) (Figure 3.1). The Kinesiotape® was measured appropriately according to patient size. The length of the inhibition application was from inferior to the acromion process into the neck, approaching the occiput on the ipsilateral side. Prior to application, the patient was seated and asked to laterally flex their neck and head to the contralateral side, whilst looking down and away from the Kinesiotape® (combined cervical spine flexion and rotation). The anchor was applied inferior to the acromion and the Kinesiotape® was applied with 15-25% stretch towards the occiput. During the 'space orientation'

technique the patient was asked to laterally flex their head to the contralateral side. Three halved strips of Kinesiotape® directly over the MFTP, each applied with 15-25% stretch, were used.

The heat sensitive adhesive was activated through vigorous rubbing of the applied taping after each application. The patient received instructions on how to dry the tape after showering to ensure maximum efficiency of the application. It was advised that the patient do not rub over the Kinesiotape® after showering, but to dab onto it with a towel so that it will dry quicker. The Kinesiotape® for this study was sponsored by the Kinesiotaping Association International (Please refer to Annexure D for contract).

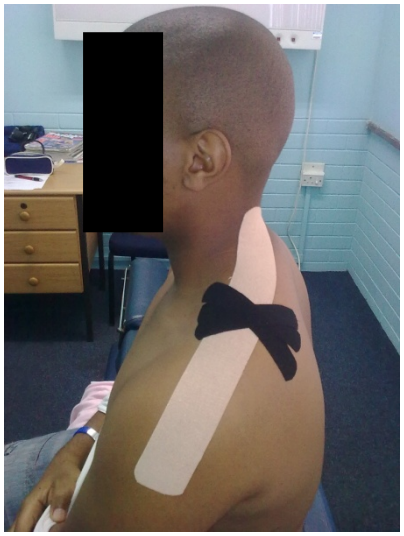


Figure 3.1: *The inhibition technique displayed by the beige Kinesiotape® application, and the space orientation technique displayed by the black Kinesiotape® application.*

3.3.2 Dry Needling Group

The dry needling intervention was done under sterile conditions, using alcohol swabs to clean the participant's area of the body in which the needle was to be inserted. The hands of the researcher were also cleaned prior to opening of the needle from its packaged covering and after the needling procedure. Every needle insertion was done with a new sterile needle (viz. no needle was utilised a second time, even on the same patient).

The MFTP was located by pincer grasp palpation, with the upper trapezius being lifted during needle insertion to eliminate risk of lung puncture. The needle was inserted at an angle of about 30º inferior to superior to further minimise risk. A single insertion with a 25mm 0.25G needle was performed into the core of the trigger point whilst the patient was in prone position. Thus, deep dry needling (DDN) was performed as distinguished from superficial dry needling (SDN) as stated in Chapter Two (Dommerholt, del Moral and Grobli, 2006). The needle was then fanned a few times in the area to elicit any local twitch responses (LTRs). Care was however taken in this study to limit fanning so as to minimise post-needling soreness (Simons, Travell and Simons, 1999). Hereafter, the needle was kept static for a few seconds so that it could exert its analgesic effects (Hong, 1994), particularly as Rowley (2001) found no difference in single needle insertion versus the fanning technique. The needle was then removed and the sterilized with an alcohol swab.

3.4 THE DATA

Three sets of data were collected after treatment at visit one, two and three respectively. Each data set comprised of subjective and objective data. This study included both primary and secondary data.

3.4.1 Primary Data

- Case history (Annexure F)
- Physical examination (Annexure G)
- Cervical spine regional examination (Annexure H)
- Visual Analog Scale / Numerical Pain Rating Scale (Annexure I & J)
- Neck Disability Index (Annexure K & L)
- Algometer readings (Annexure M)
- CROM readings (Annexure N)

3.4.2 Secondary Data

The secondary data was obtained from textbooks and current journals.

3.5 METHODS OF MEASUREMENT

3.5.1 Subjective Data

3.5.1.1 Visual Analog Scale (VAS)

The traditional Visual Analogue Scale (VAS) was used as a subjective measurement of the patient's discomfort / pain. The VAS name is used interchangeably with the numerical pain rating scale (NRS). The traditional VAS is not supplemented with any descriptive terms or numbers along the scale (Mannion *et al*., 2007). The VAS is a questionnaire whereby the subjects estimated their levels of pain prior to the first, second and third treatments. This scale showed the progression or regression of the subjects' pain levels throughout the study. Before each treatment the patient was asked to mark off a point on a 10cm line, between 0 and 100 where the pain intensity presented at that current point in time. 0 indicating no pain whilst 100 indicated the worst pain that the patient experienced. By using a ruler marked in millimeters, the researcher obtained the exact value from the 10cm VAS line.

The VAS was chosen due to the ease at which it can be administered and scored and has been found to be an accurate tool for the measurement of pain intensity in clinical trials (Jenson *et al.*, 1986). Previous studies have demonstrated the reliability of the VAS by strong correlations to other subjective pain measures (Ostelo and de Vet, 2005; Hagg, Fritzell and Nordwall, 2003).

3.5.1.2 Neck Disability Index (NDI)

The Neck Disability Index Questionnaire (NDI) is a questionnaire commonly used for disorders that affects the cervical spine. The questionnaire assisted in understanding to what degree the subjects' pain has affected their ability to manage daily life (Yeomans, 2000).

3.5.2 Objective Data

3.5.2.1 Pressure algometry

The algometer measure pain pressure threshold (PPT) and appears to be a reliable diagnostic tool to quantitatively capture the sensitivity of MFTPs (Han and Harrison, 1997; Kruse *et al.,* 1992). The reliability of the algometer as an index of MFTP sensitivity was reported in studies by Potter, McCarthy and Oldham (2006), Buchanan and Midgley (1987), Fischer (1987) and Reeves *et al*., (1986), who found both high inter- and intra examiner reliability in measuring marked MFTPs.

In this study an analogue algometer was used. The measurements were recorded with the patient in seated position. Steps taken for algometer reading were:

- The dial was set to zero.
- The algometer was placed over the chosen trigger point with the metal rod being perpendicular to the surface of the skin.
- The patient was instructed to express the point at which pain was perceived.
- Pressure was applied with an increasing rate of 1kg/second as recommended by Fischer (1987).
- The procedure was halted once the patient expressed the point at which the pain was perceived (the pain threshold).
- The reading on the algometer was then recorded in kg/cm^2.
- The measurement was repeated directly afterwards.
- The average of the two readings was used in the statistical analysis.

3.5.2.2 CROM (Cervical Range of Motion) Device

This apparatus tests range of motion, including axial rotation. It is portable and has low operational costs. The CROM compares well against other devices used for testing cervical range of motion (Lian *et al*., 2010; Audette *et al.,* 2010). Since the upper trapezius is the primary mover involved in lateral flexion, and trigger points are proposed to decrease range of motion and/or induce weakness (Simons, Travell and Simons, 1999), the CROM device served as an indicator as to whether MFTPs were being resolved through testing increased or decreased range of motion of the neck.

3.5.3 Minimal Clinical Important Difference (MCID)

Although a treatment may not provide statistical significant difference, the purpose of the MCID is to determine whether a significant clinical improvement was achieved with the treatment intervention. The MCID of the visual analogue scale (VAS) has been approximated between 30-35mm in acute subjects and between 20-25mm for sub-acute or chronic subjects (Ostelo and de Vet, 2005, Lee *et al*., 2003). In addition, Farrar *et al.,* (2001) suggested 30% (i.e. 30mm) improvement as a MCID for the VAS and Mesrian, Neubauer and Schiltenwolf (2007) demonstrated a MCID of 25mm for VAS pain intensity, whereas Garner *et al*., (2007) reported a MCID of 2.3cm (i.e. 23mm) on a numeric VAS in a study with 249 subjects.

Relating to algometry (pain pressure threshold) Potter, McCarthy and Oldham (2006) reported the MCID to be 35-40% in the muscles of the spine, whereas O'Leary *et al*. (2007) reported a MCID of 20% in cervical musculature. In addition, Chesterton *et al.,* (2007) proposed an improvement of 1.77kg.cm^2 (i.e. 17.7%) as the MCID for algometry readings.

The MCID for the Neck Disability Index (NDI) has been approximated at 19 percentage points (Cleland, Childs and Whitman, 2008) and for the CROM to be 7.2 degrees (Briem, Huijbregts and Thorsteindottir, 2007).

3.6 STATISTICAL METHODOLOGY

SPSS version 18.0 was used to analyse the data. A p-value <0.05 was considered as statistically significant. Participants' age and gender were compared between the two treatment groups using student's t-test and chi square test respectively to ensure that the two groups were equivalent at baseline. Repeated measures ANOVA tests were used to assess whether the Kinesiotape® was effective at improving outcomes compared with dry needling (Esterhuizen, 2011).

The time x group interaction effect was taken as the effect of the intervention over time. If the time x group effect was statistically significant, post hoc tests comparing time two with baseline and time three with baseline were performed in order to evaluate at which time point the effect was strongest. Profile plots were generated to show graphically the direction and trend of the intervention effect (Esterhuizen, 2011).

CHAPTER 4
RESULTS

4.1 INTRODUCTION

In this chapter, the data collected in the study are presented in tabulated and graphic form. It includes demographic, intra-group and inter-group data to allow for a greater perspective on the study.

4.2 OBJECTIVES OF THE STUDY

4.2.1 The first Hypothesis

H_1 : It was hypothesized that dry needling of trapezius MFTPs in the treatment of MPS would be more effective than published MCIDs in terms of both subjective and objective clinical findings.

H_0 : Dry needling of trapezius MFTPs in the treatment of MPS would have no statistical significant and clinical significant effect in terms of both subjective and objective clinical findings.

4.2.2 The second Hypothesis

H_1 : It was hypothesized that the application of Kinesiotape® onto trapezius MFTPs in the treatment of MPS would be more effective than published MCIDs in terms of both subjective and objective clinical findings.

H_0 : Application of Kinesiotape® onto the trapezius MFTPs in the treatment of MPS would have no statistical and clinical significant effect in terms of both subjective and objective findings.

4.2.3 The third Hypothesis

H_1 : It was hypothesized that dry needling would be more effective than Kinesiotape® application in terms of both subjective and objective clinical findings.

H_0 : Dry needling would not be more effective than Kinesiotape® application in terms of both subjective and objective clinical findings.

4.3 ABBREVIATIONS USED IN TABLES

n	Number of patients
p-value	Probability that the null hypothesis is true
SD	Standard Deviation
SEM	Standard Error Mean
F	Female
M	Male
>	greater than
<	lesser than

4.4 RESULTS

4.4.1 Demographics

4.4.1.1 Age

The mean age of all participants was 27.7 years with a standard deviation of 6.1 years and a range of 19 to 49 years. Although the dry needling group was slightly older than the Kinesiotape® group, there was no significant difference between the ages of the two treatment groups (*p*= 0.496) (Esterhuizen, 2011).

***Table 4.1**: T-test comparison of mean age between the two treatment groups*

Group Statistics					***p*-value**
Group	N	Mean	SD	SEM	
Dry needling	25	28.2800	6.16117	1.23223	0.496
Kinesiotape®	25	27.0800	6.19758	1.23952	

4.4.1.2 Gender

There was also no difference in gender distribution between the two groups (*p*= 0.544) with the overall gender ratio being 32% males to 68% females.

Table 4.2: *Group*Gender cross-tabulation*					
Group * gender Cross tabulation					
			Gender		Total
			F	M	
Group	Dry needling	Count	16	9	25
		% within group	64.0%	36.0%	100.0%
	Kinesiotape®	Count	18	7	25
		% within group	72.0%	28.0%	100.0%
Total		Count	34	16	50
		% within group	68.0%	32.0%	100.0%

Pearson's chi square = 0.368, *p*= 0.544

4.4.2 Subjective outcomes

4.4.2.1 Visual Analog Scale (VAS) / Numerical Pain Rating Scale (NRS)

Table 4.3: *Within and between subjects effects for NRS*		
Effect	**Statistic**	***p*-value**
Time	Wilk's Lambda = 0.407	<0.001
Time x group	Wilk's Lambda = 0.924	0.155
Group	F = 0.074	0.787

Profile plot of mean NRS by group and time

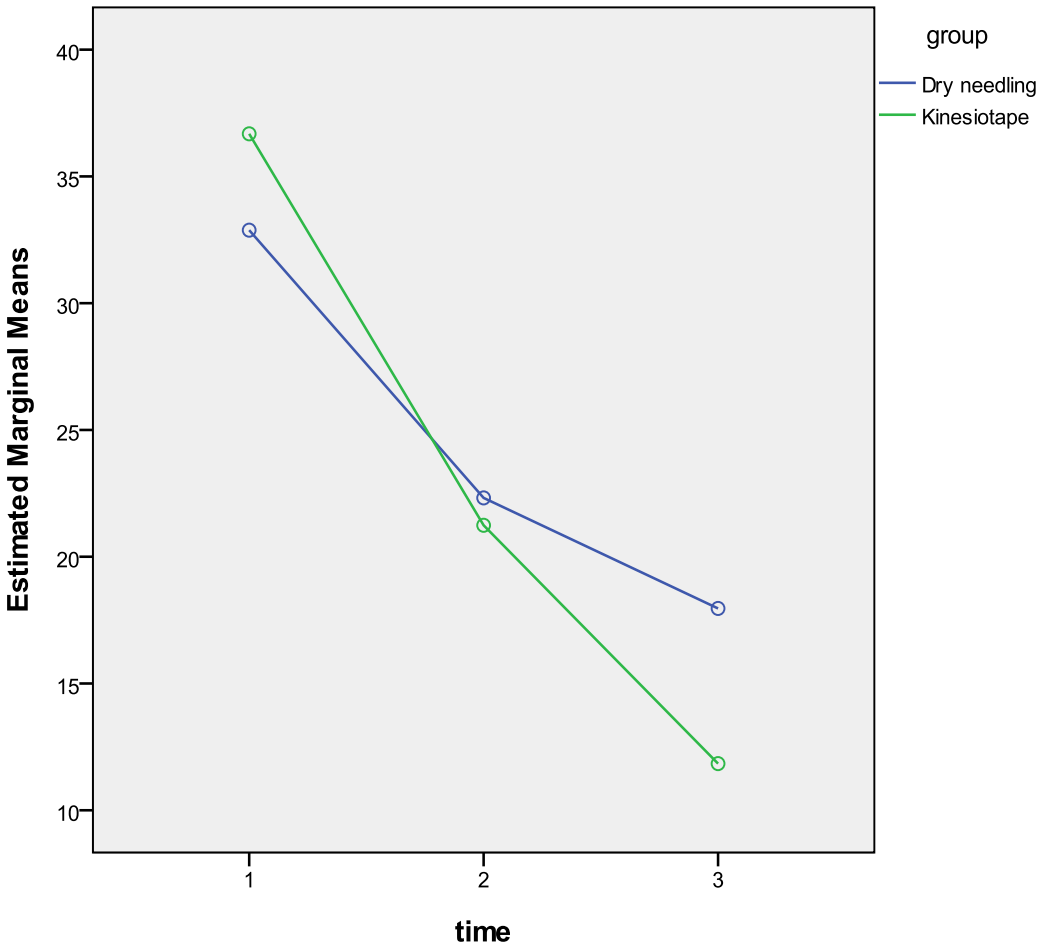


Figure 4.1: *Profile plot of mean NRS by group and time*

Both intervention groups had statistically significant improvements relating to NRS (Dry needling p= 0.001; Kinesiotape® $p < 0.001$). Figure 4.1 shows that there was a slight trend towards the NRS values decreasing faster in the Kinesiotape® group compared to the dry needling group. However, this was not statistically significant (p= 0.155).

4.4.2.2 Neck Disability Index (NDI)

***Table 4.4**: Within and between subjects effects for NDI*		
Effect	**Statistic**	***p*-value**
Time	Wilk's Lambda = 0.315	<0.001
Time x group	Wilk's Lambda = 0.970	0.491
Group	F = 0.079	0.779

Profile plot of mean NDI by group and time

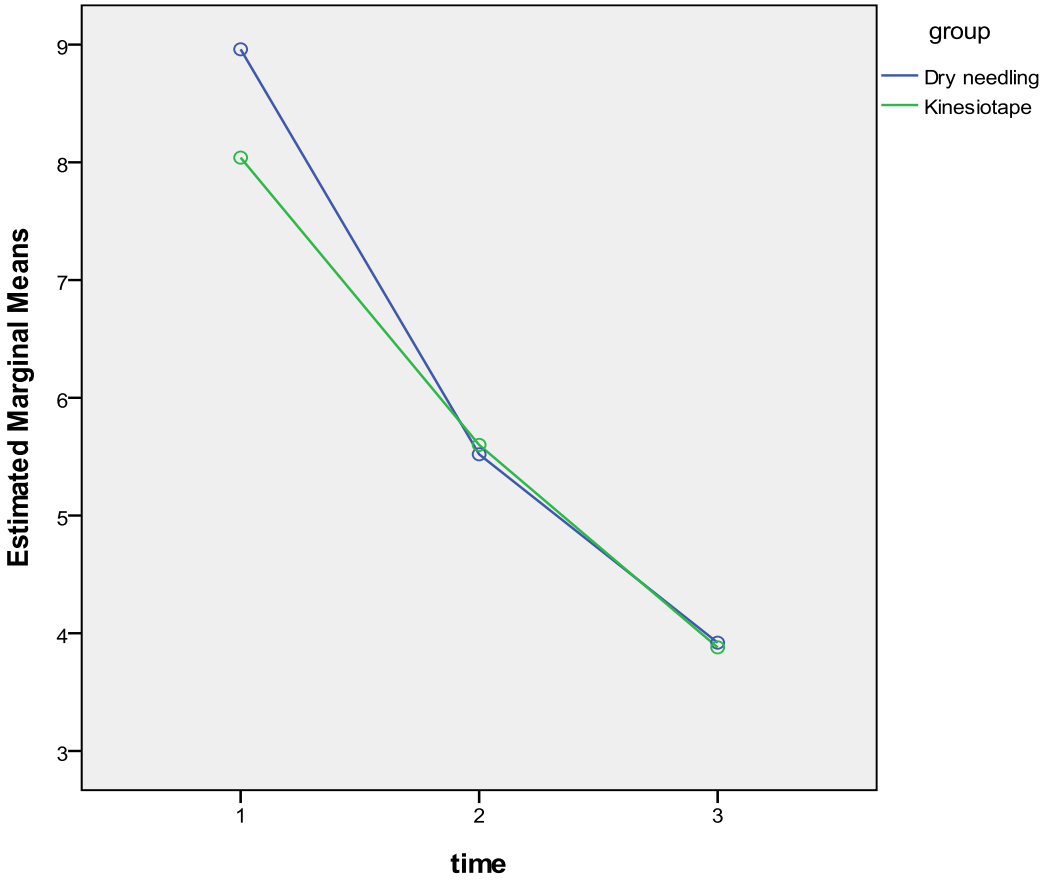


***Figure 4.2**: Profile plot of mean NDI by group and time*

Both groups showed statistical significant ($p < 0.001$) improvement regarding NDI scores. However, there was no difference between effect of the interventions on NDI scores ($p= 0.491$). Figure 4.2 demonstrates that both treatment groups showed the same rate of improvement over time.

4.4.3 Objective Outcomes

4.4.3.1 Pressure Algometry / Pain Pressure Threshold (PPT)

Table 4.5: *Within and between subjects' effects for algometer*		
Effect	**Statistic**	***p*- value**
Time	Wilk's Lambda = 0.805	0.006
Time x group	Wilk's Lambda = 0.965	0.428
Group	F = 0.209	0.650

Profile plot of mean algometer by group and time

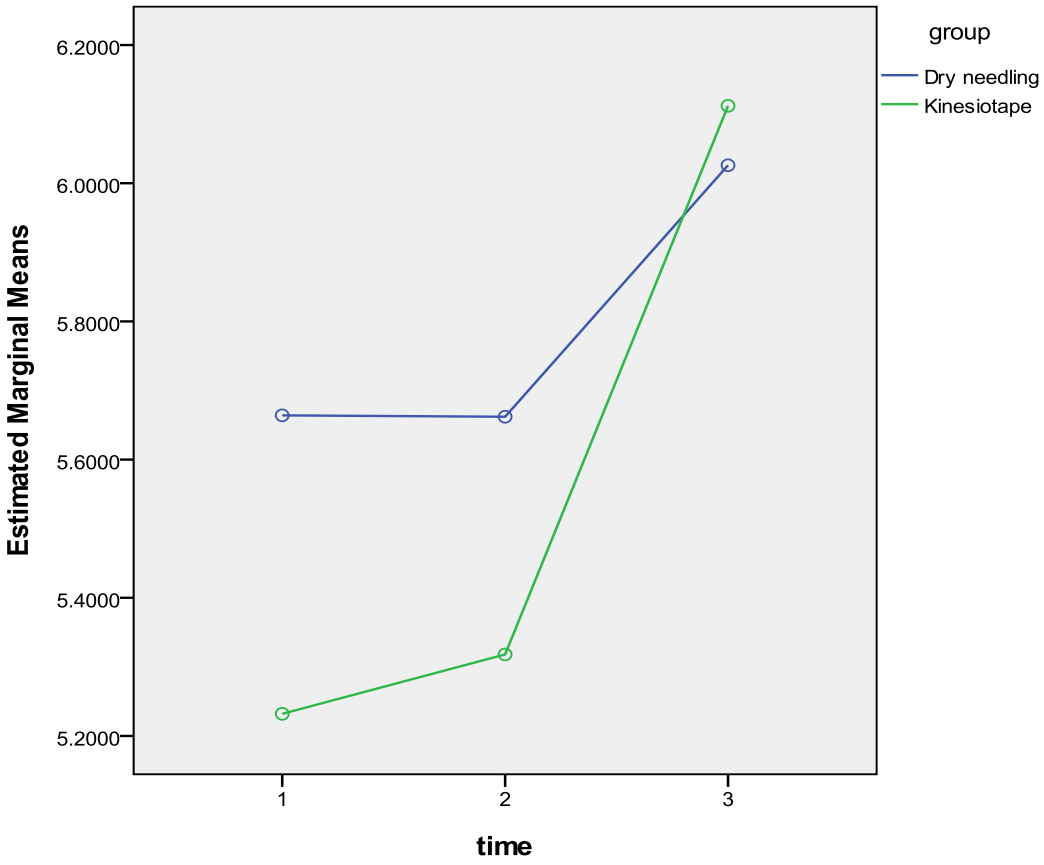


Figure 4.3*: Profile plot of mean algometer by group and time*

Dry needling demonstrated no statistical improvement in algometer readings (*p*= 0.258). On the other hand, Kinesiotape® intervention did reveal a statistical significant improvement (*p*= 0.022). Although Figure 4.3 shows that there was a

trend towards the Kinesiotape® group showing a faster rate of improvement than the dry needling group, this was not statistically significant (*p*= 0.428).

4.4.3.2 CROM

4.4.3.2.1 Right lateral flexion (RLF)

***Table 4.6**: Within and between subjects effects for RLF*		
Effect	**Statistic**	***p*-value**
Time	Wilk's Lambda = 0.965	0.345
Time x group	Wilk's Lambda = 0.963	0.410
Group	F = 1.805	0.185

Profile plot of mean right lateral flexion by group and time

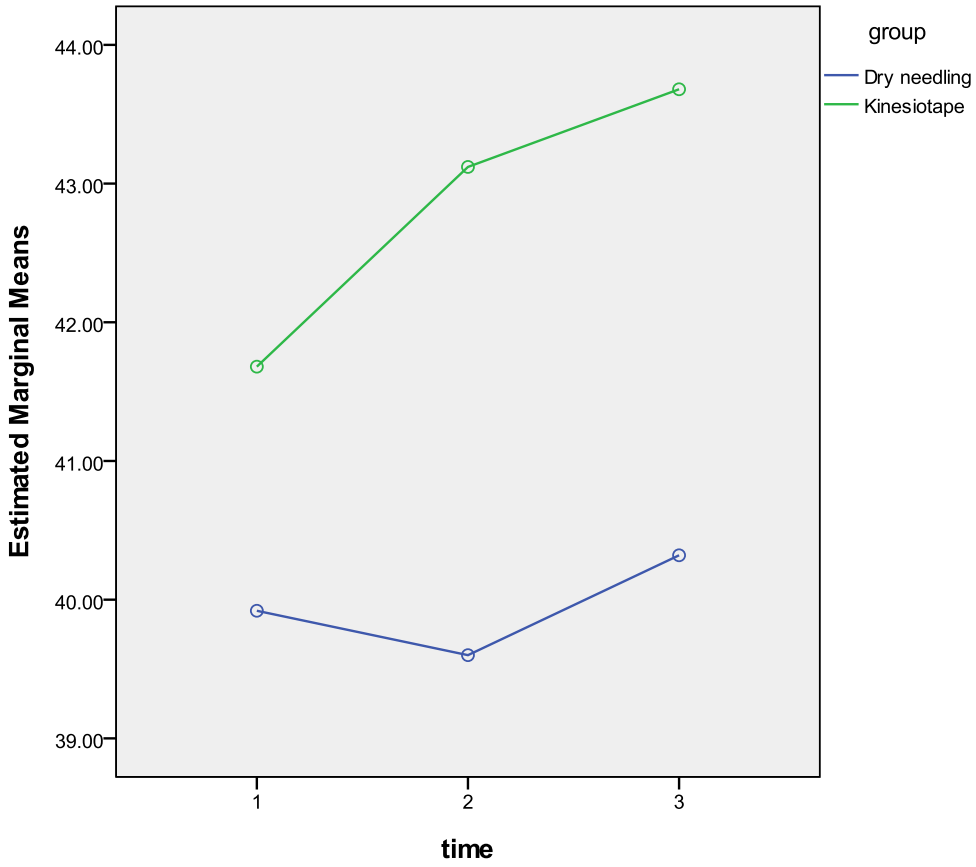


***Figure 4.4:** Profile plot of mean right lateral flexion by group and time*

In terms of right lateral flexion, neither dry needling (*p*= 0.804) nor Kinesiotape® (*p*= 0.169) confirmed a statistical significant treatment effect. There was also no statistical evidence of a treatment effect (*p*= 0.410) between the interventions, but the Kinesiotape® group did reveal a slight increase in range of motion over time while the dry needling group did not.

4.4.3.2.2 Left lateral flexion (LLF)

***Table 4.7**: Within and between subjects effects for LLF*		
Effect	**Statistic**	***p*-value**
Time	Wilk's Lambda = 0.941	0.242
Time x group	Wilk's Lambda = 0.971	0.497
Group	F = 0.860	0.358

Profile plot of mean left lateral flexion by group and time

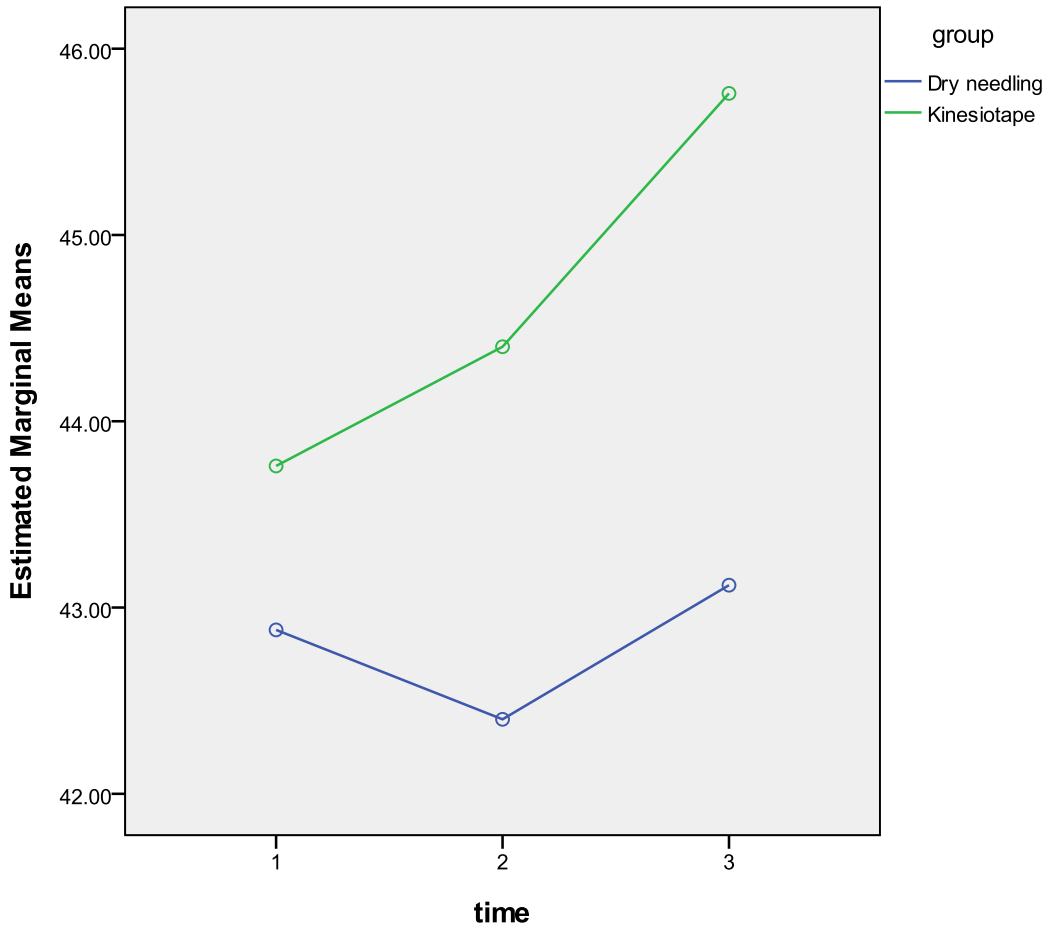


***Figure 4.5:** Profile plot of mean left lateral flexion by group and time*

Individual comparison indicated no statistical difference in either the dry needling (*p*= 0.844) or Kinesiotape® (*p*= 0.116) groups. There was also no evidence that Kinesiotape® is more beneficial than dry needling in terms of the outcome of left lateral flexion (*p*= 0.497). Once again, the Kinesiotape® group demonstrated a slight increase over time while the dry needling group did not.

4.4.3.2.3 Right sided treatment with dry needling

There was no change in right lateral flexion with right sided dry needling intervention (*p*= 1.000). There was also no left lateral flexion improvement (*p*= 0.581) (n= 15).

4.4.3.2.4 Left sided treatment with dry needling

Right and left lateral flexion demonstrated no difference created by the intervention (*p*= 0.230; *p*= 0.728) (n= 10).

4.4.3.2.5 Right sided treatment with Kinesiotape®

Right lateral flexion showed no improvement made by Kinesiotape® (*p*= 0.520), whilst left lateral flexion also did not shown any significant improvement (*p*= 0.647) over the treatment period (n= 12). However, trends of improvement were observed (Figure 4.6 and Figure 4.7).

Right sided treatment with Kinesiotape® and the corresponding trends with CROM

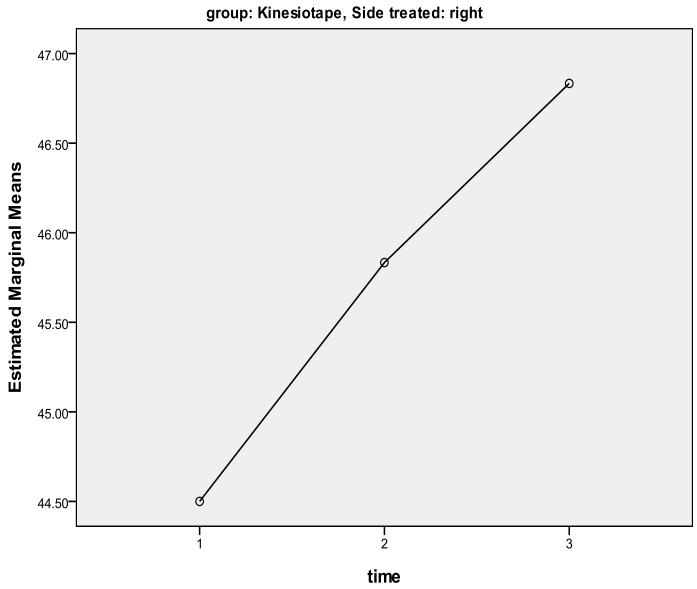


Figure 4.6: *CROM values indicating a trend of increased right lateral flexion with right sided treatment*

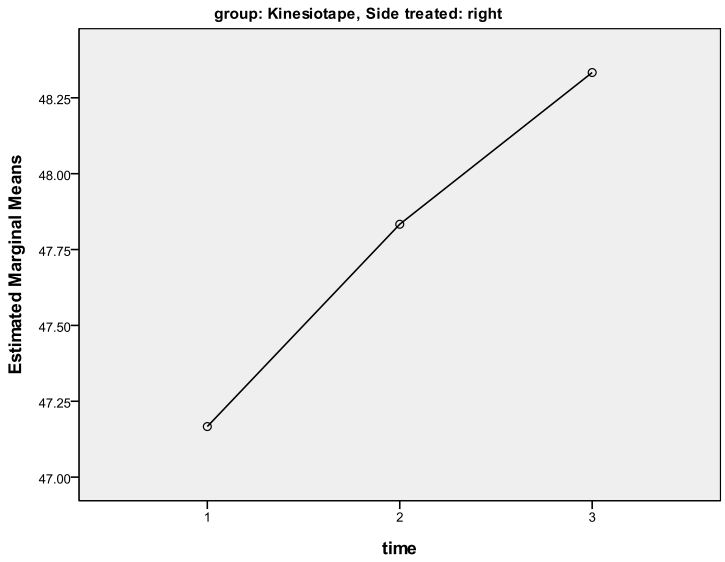


Figure 4.7: *CROM values indicating a trend of increased left lateral flexion with right sided treatment*

4.4.3.2.6 Left sided treatment with Kinesiotape®

Left lateral flexion showed no statistical difference from Kinesiotape® intervention (*p*= 0.154). Also, right lateral flexion did not reveal any significant change (*p*= 0.328) (n= 13). Once again, bilateral trends of increase range of motion were observed (Figure 4.8 and 4.9).

Left sided treatment with Kinesiotape® and the corresponding trends with CROM

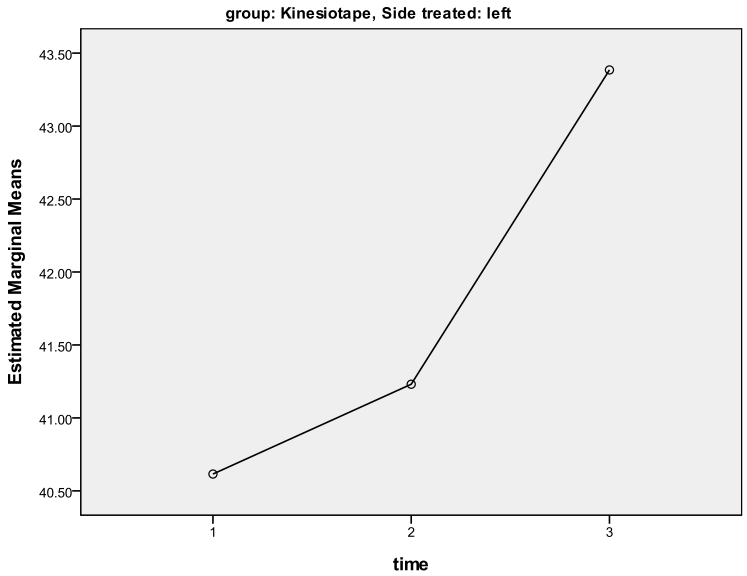


Figure 4.8: *CROM values indicating a trend of increased left lateral flexion with left sided treatment*

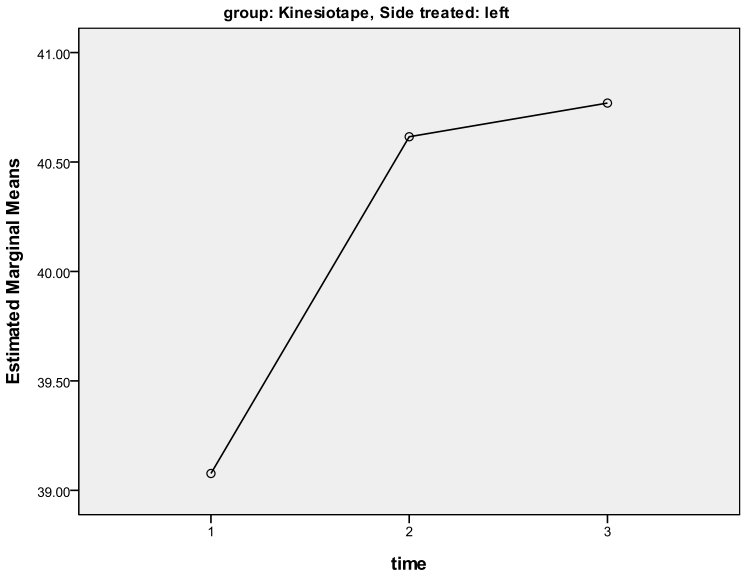


Figure 4.9: *CROM values indicating a trend of increased right lateral flexion with left sided treatment*

4.5 SUMMARY AND CONCLUSION

According to the above statistics, dry needling significantly improved the NRS (p= 0.001) and NDI (p < 0.001), whereas Kinesiotape® significantly improved the NRS (p < 0.001), NDI (p < 0.001) and PPT (p= 0.022). However, none of the outcomes measured in this study showed a significant differential treatment effect between the two treatments. NRS (p= 0.155), NDI (p= 0.491) and PPT (p= 0.428) all showed improvements over time in both groups with no statistical significant treatment between interventions. In terms of CROM the Kinesiotape® group demonstrated a slight non-statistical increase in both right and left lateral flexion over time while the dry needling group did not. When the specific side of treatment where analyzed relating to CROM, there was also no significance, but once again trends of improvement in the Kinesiotape® group were observed.

However, for NRS and PPT, there was a non-significant treatment effect in the Kinesiotape® group. This may mean that the study was underpowered to show the effect as statistically significant since a larger sample size might have resulted in achieving statistical significance. The study should be repeated in a larger sample in order to demonstrate whether this effect was real or due to chance alone (Esterhuizen, 2011).

CHAPTER 5
DISCUSSION

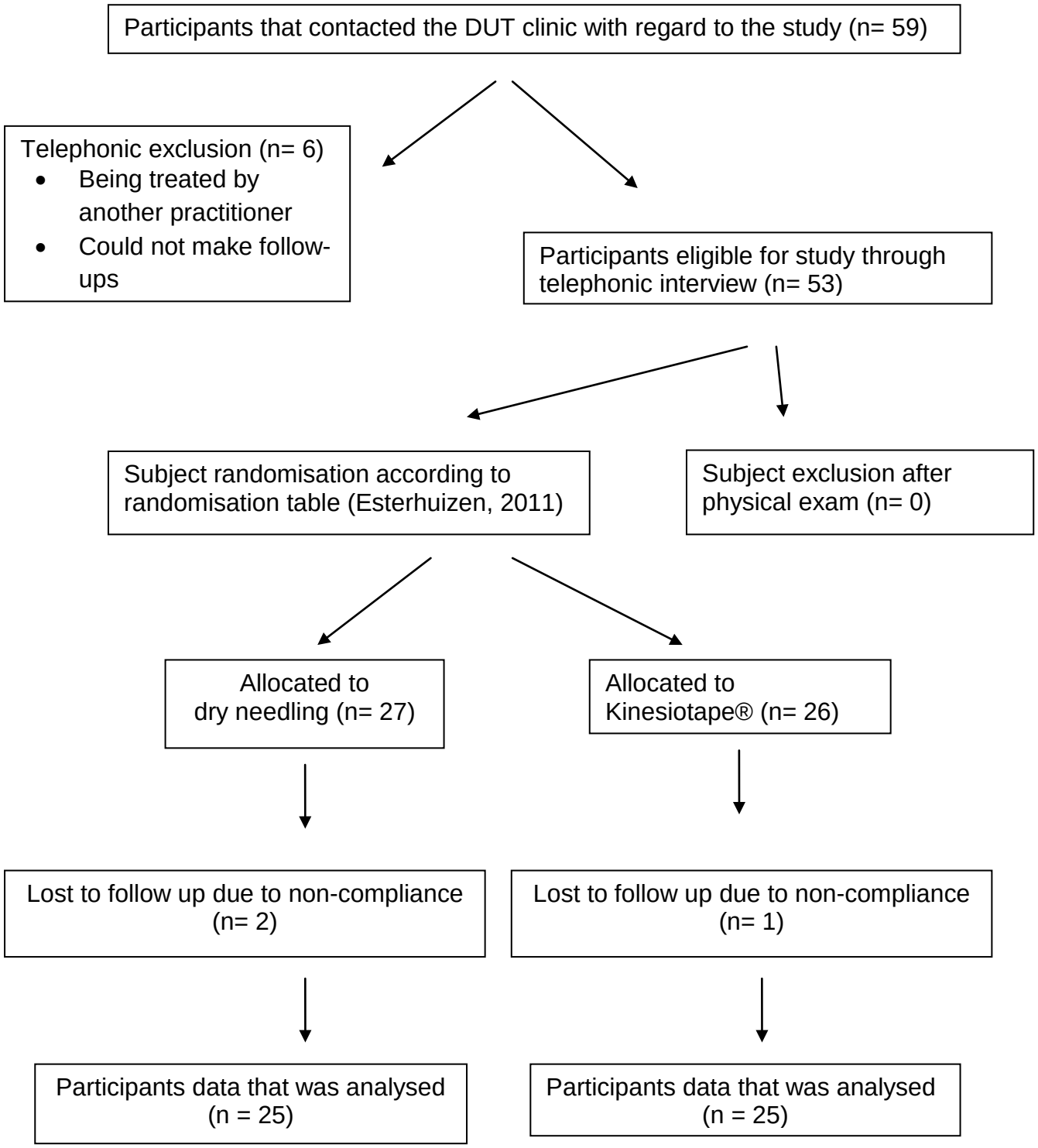
5.1 INTRODUCTION

All results that were presented in Chapter Four will be discussed in greater detail in this portion of the dissertation. Demographic data and baseline data measurements will be discussed in this chapter to indicate the level of homogeneity between the two groups at the onset of the study. The main focus, however, is to present the findings of the study and to compare these findings to present literature. Any similarities and/or differences that are in line with present literature will be noted.

The data from intra-group analysis with respect to both subjective and objective measurements at the visits will be discussed and indications will be made to statistical and clinically significant findings and the proposed theories of these findings.

In addition, the data from inter-group analysis with respect to both subjective and objective measurements at the first, second and third visits will be discussed and indications will be made to statistical and clinically significant findings and the proposed theories of these findings.

5.2 CONSORT DIAGRAM



From this consort diagram it must be noted that of the three participants that dropped out of the treatment protocol (2x dry needling; 1x Kinesiotape®), one participant was not honest about her age, the second could not attend her last visit due to strike

action on campus and the third participant undertook an unexpected work-related flight. This data is of value because it indicates that the dropouts were due to external factors and not related to the treatment (Mouton, 1996). The data of these patients were ignored and not used in the statistical and analytical processes.

In terms of the ***sample size***, Thelen, Dauber and Stoneman (2008) indicated a study sample of 21 subjects per group. This compares favourably with Srbely *et al*., (2010) who indicated 20 subjects per group in their study. These were both based on the power analysis data completed and reported by Srbely and Dickey (2007), where it was indicated that a sample size of 20 subjects per group provided a minimum of 90% power to detect an effect magnitude of 1.6 (SD) at a p= 0.05 level. Therefore, this study with 25 patients per group complied with the power values and, therefore, had the ability to confidently assess statistical outcomes with a high degree or accuracy for significance. Nevertheless, Esterhuizen (2011) proposed that a larger sample size might have contributed statistically more towards differentiating between VAS and PPT treatment effects between the two groups (see section 4.6). In addition, to determine the effect of CROM on MFTP therapy, it will also be beneficial for future studies to use more participants.

5.3 DISCUSSION

5.3.1 Demographic data

This study's age inclusion was 18- 50 years of age based on the study by Thelen, Dauber and Stoneman (2008) and it was found that the mean ***age*** of the participants was 27.7 years with a standard deviation of 6.1 years and a range of 19 to 49 years. The study thus complied with the inclusion criteria. A mean of 27.7 ± 6.1 years indicates a study population that is relatively young.

The dry needling group averaged one year older than the Kinesiotape® group. The SD and SEM for both groups were similar. Esterhuizen (2011) concluded that there was no significant difference between the ages of the two treatment groups (p=

0.496). From this can be concluded that age difference between the two groups would not have influenced the results of the study.

In a study by Skootsky, Jaeger and Oye (1989), the mean age of the patients was 53.5 ± 18.2 years, which was older than Srbely *et al*., (2010) where an average age of 48.2 ± 15.2 (55% females) was found in the test group and 45.4 ± 17.8 (40% females) was found in the control group. Both where higher than Esenyel, Caglar and Aldemir (2000), who found a mean age of 31 ± 6.7 years, which concurs with Gonzalez-Iglesias *et al*., (2009) who had an average age of 33 ± 7 years. Thus, this study had an age group significantly younger than the average age of studies previously completed, but compares with Chang *et al*., (2010), who noted an age range of 20.86 ± 2.59 years. The comparative values of age both in this study and the study by Chang *et al*., (2010) is most likely related to the fact that both studies where likely to have had larger student populations involved, as compared to other similar studies. Therefore, it is recognized that the outcomes of this study may be limited in applicability to older patients and it is suggested that a study with more generalized inclusion be done to ensure applicability. For example, chronicity of MFTPs and other concomitant cervical spine syndromes were potentially low in this study (Simons, Travell and Simons, 1999) and may, therefore, explain the low NDI baseline values found in this study.

In terms of ***gender***, the dry needling group had 16 females and 9 males, compared to the 18 females and 7 males of the Kinesiotape® group. Gender distribution was, therefore, equally represented (p= 0.544). However, females were predominant in the study, with a total of 68% patients being females.

In a study by Skootsky, Jaeger and Oye (1989) 69% were females. Sixty patients (45 females (75%) and 15 males (25%)) partook in a study by Graff-Radford *et al*., (1989) when the effects of TENS on myofascial pain was investigated. Furthermore, Sciotti *et al*., (2001) recruited 20 volunteer subjects of whom 12 were females (60%) and 8 males (40%). Esenyel, Caglar and Aldemir (2000) examined the effectiveness of ultrasound and trigger point injection on MFTPs and used a sample size of 102 patients (64 females (63%) and 38 males (37%)). Additionally, in a study that assessed the effect of Kinesiotape® on cervical range of motion after acute whiplash

injury 41 patients were recruited. Females contributed 52% of the sample size (Gonzalez-Iglesias *et al*., 2009). More recently, Srbely *et al*., (2010) who investigated segmental anti-nociceptive effects of dry needling found that 55% of participants in the test group and 40% in the control group were female. Therefore, the ratio of male : female of this study (32% : 68%) is in accordance with the literature, irrespective of age.

5.3.2 Subjective data

5.3.2.1 Visual Analogue Scale (VAS)

Kinesiotape®, compared to dry needling, demonstrated a non-significant trend (p= 0.155) towards the NRS values decreasing faster in the Kinesiotape® group. However, both treatments produced a statistically significant change in NRS scores that implies some improvement in both groups (Dry needling = 0.001; Kinesiotape® < 0.001).

Tashjian *et al*., (2009) suggests that after statistical significant difference has been determined, it is important to evaluate the possibility of a clinical significant difference. Interpreting the dry needling data, average improvements from 32.88 at visit one, to 22.32 at visit two, to 17.96 at visit three were noted. These improvements were statistically different (p= 0.001). A difference of 14.92 between visit one and three were noted. Comparing this to the MCIDs of 20-30mm for the VAS (Mesrian, Neubauer and Schiltenwolf, 2007; Garner *et al*., 2007; Farrar *et al*., 2001), no clinically significant improvements between visit one, visit two and visit three were observed.

Interpreting the Kinesiotape® data, average improvements from 36.68 at visit one, to 21.24 at visit two to 11.84 at visit 3 were noted. These improvements were statistically significant (p < 0.001). Between visit one and visit three there was an improvement of 24.84, which is within the range of the proposed VAS MCIDs (Garner *et al*., 2007; Ostelo and de Vet, 2005, Lee *et al*., 2003). Thus, Kinesiotape® made a clinical significant difference on the subjective VAS pain scores after two treatments. These treatments were performed two to four days after the previous visit (see Chapter Two). It can, therefore, be concluded that Kinesiotape® also made

a VAS *clinical* significant difference after two treatments with the Kinesiotape® application being applied between four and eight days duration.

It was mentioned in Chapter Two (section 2.7.3) that the recoil effect of Kinesiotape® may cause lifting of the skin, and through this mechanism improves micro-circulation and lymphatic drainage (Kinesiotape Applications Manual, 2005). This may be similar to the increased circulatory effect that is caused by dry needling, but without the inflammatory response, which is thought to be responsible for the post needle soreness (Ferreira, 2006; Hong, 1994). Thus, in this context, the treatment of Kinesiotape® with the consequent exclusion of post-needling soreness was favourable in the VAS. Additionally, prolonged stimulation of the proprioceptive A-beta fibers (inhibiting the C-pain fibers) (Melzack and Wall, 1965) and the muscle inhibition technique use with Kinesiotape® can possibly have influenced this clinically significant difference. When stretch is applied over the neuromuscular junction of a muscle, the golgi tendon organ (GTO) is activated, causing muscle inhibition (Kinesiotape Applications Manual, 2005). Although this may be analogous to the inhibition caused by muscle depolarization in dry needling, the prolonged therapeutic application of Kinesiotape®, as well as the absence of post-needling soreness after dry needling is possible explanations of superior mechanisms that caused a favourable VAS outcome. More in-depth research is required to determine if these proposed effects are in fact legitimate.

5.3.2.2 Neck Disability Index (NDI)

In Chapter Four it was mentioned that both groups showed statistical significant improvement ($p < 0.001$) regarding NDI scores. However, there was no difference between the interventions on NDI scores ($p= 0.491$).

Relating to the dry needling group, the NDI averaged 8.96 at visit one, 5.52 at visit two and 3.92 at visit three, whereas with the Kinesiotape® group, the NDI averaged 8.04 at visit one, 5.6 at visit two and 3.88 at visit three. Since these were only the values (out of 50), the percentage points (out of 100) were calculated by multiplication by two (x2):

***Table 5.1**: Conversion of NDI scores (out of 50) to percentages (out of 100)*		
	Out of 50	Out of 100 (%)
Dry Needle Visit 1	8.96	17.92
Dry Needle Visit 2	5.52	11.04
Dry Needle Visit 3	3.92	7.84
Kinesiotape® Visit 1	8.04	16.08
Kinesiotape® Visit 2	5.6	11.2
Kinesiotape® Visit 3	3.88	7.76

Cleland, Childs and Whitman (2008) proposed a MCID of 19 percentage points for the NDI. Comparing this value to that in Table 5.1, we find that there were no clinical significant improvements made by either dry needling or Kinesiotape®. The NDI was designed to indicate if a treatment intervention has an effect on the lifestyle functions of the patient (Yeomans, 2000). However, since the baseline percentages were low in this study, it can be concluded that the patients were reasonably functional at the time of visit one and therefore limited improvement with this questionnaire would be expected. It can be speculated that the younger average age of 27 ± 6.1 in this study might have resulted in lower baseline NDI scores due to less chronicity of MFTPs (Simons, Travell and Simons, 1999).

In fact, since the first (baseline) readings for NDI in both groups were below 19, these calculations were not mathematically possible. A possible future inclusion criterion might be for patients to have a NDI above 20 before the onset of the study so that it can be determined mathematically if a clinical significant difference was made with the treatment intervention. Nonetheless, both treatment interventions showed statistical significant improvements ($p < 0.001$), indicating the both treatments improved the daily living of the research participants.

5.3.3 Objective data

5.3.3.1 Algometer / Pain Pressure Threshold (PPT)

Algometry showed that there was no statistically significant effect of the Kinesiotape® over the dry needling treatment (p= 0.428). However, Figure 4.2 showed that there was a trend towards the Kinesiotape® group showing a faster rate of improvement than the dry needling group. Also, Kinesiotape® demonstrated a statistical significant improvement in algometer readings (p= 0.022), whereas dry needling did not (p= 0.258).

Dry needling averaged 5.66 at visit one, 5.66 at visit two and 6.03 at visit three, whereas Kinesiotape® averaged 5.23 at visit one, 5.32 at visit two and 6.11 at visit three. The algometer readings of the dry needling group, therefore, improved 0.37 or 3.7% from visit one to visit three, whereas Kinesiotape® improved 0.88 or 8.8% from visit one to visit three.

The lowest proposed MCID for pain pressure threshold (PPT) is 17.7% (Chesterton *et al*., 2007). Thus, algometry measurements indicated that neither dry needling nor Kinesiotape® made any clinically significant difference in this study.

Nonetheless, Kinesiotape® displayed a statistically significant improvement over dry needling with regards to algometry. Once again this supports (section 5.3.2.1) the potential superiority of a prolonged constant therapeutic application by Kinesiotape® versus dry needling with its post-needling soreness phenomenon (Ferreira, 2006; Hong, 1994). It can be proposed that the ‘space orientation’ technique used with Kinesiotape® has a specific localised effect either through continuous A-beta fiber stimulation and/or facilitation of noxious chemical by-products away from the MFTP area. In addition, the proposed stretch over the golgi tendon organ might cause a spinal feedback that encourages a decrease in central sensitization and subsequent decreased release of Acetylcholine (Ach) into the synaptic cleft. More in-depth biochemical research is needed to determine these proposed phenomena.

5.3.3.2 Cervical Range of Motion

Simons, Travell and Simons (1999) mentioned that AMFTPs may limit range of motion and/or induce weakness of the involved muscle. Since the upper trapezius is a primary mover of lateral flexion of the cervical spine, the CROM device was used to identify possible MFTP resolution of either dry needling or Kinesiotape®.

Esterhuizen (2011) reported no significant changes in left lateral flexion (dry needling *p*= 0.844; Kinesiotape® *p*= 0.116) or right lateral flexion (dry needling *p*= 0.804; Kinesiotape® *p*= 0.169) in both dry needling and Kinesiotape® groups over the three visits (Figure 4.4 and 4.5). However, Kinesiotape® did reveal trends of increase range of motion towards right and left lateral flexion. The averaged values were:

Table 5.2: *Right and left lateral flexion in both groups*

	Dry Needling Group (n= 25)		
	Visit 1	Visit 2	Visit 3
Right lateral flexion	39.92	39.6	40.32
Left lateral flexion	42.88	42.4	43.12
	Kinesiotape® Group (n= 25)		
	Visit 1	Visit 2	Visit 3
Right lateral flexion	41.68	43.12	43.68
Left lateral flexion	43.76	44.4	45.76

However, in this analysis no differentiation of the side of treatment was made, which might have influenced the results. For example, if the right side was treated, an improvement to the left would mean improved range of motion, whereas improvement to the right would mean improved strength of the muscle. Therefore, the statistical analysis was modified to include the sidedness of the treatment in both the dry needling and Kinesiotape® groups.

Right sided treatment with dry needling revealed no change in right lateral flexion (*p*= 1.000) or left lateral flexion (*p*= 0.581) (n= 15), indicating no visible effect on either improved muscle strength or increased range of motion due to treatment. Left sided treatment with dry needling (n= 10) also provided no improvement in either right or left lateral flexion respectively (*p*= 0.230; *p*= 0.728). The averaged values were:

Table 5.3: *The effect of dry needling values as measured by CROM (values in degrees)*			
	Dry Needling Group		
	Right side treated (n= 15)		
	Visit 1	Visit 2	Visit 3
Right lateral flexion	39.7	39.7	39.7
Left lateral flexion	43.2	42.9	44.5
	Left side treated (n= 10)		
	Visit 1	Visit 2	Visit 3
Right lateral flexion	40.2	39.4	41.2
Left lateral flexion	42.4	41.6	41.0

Right sided treatment with Kinesiotape® (n= 12) indicated no statistical significant improvement regarding CROM measurement. Neither right lateral flexion (*p*= 0.520) nor left lateral flexion (*p*= 0.647) showed significant improvement over the treatment period. Left sided treatment demonstrated that neither left lateral flexion (*p*= 0.154) nor right lateral flexion (*p*= 0.328) showed any statistical difference from Kinesiotape® intervention (n= 13). However, Chapter Four indicated via graphical display (Figures 4.6, 4.7, 4.8, 4.9) that increased range of motion trends were observed.

The averaged values were:

Table 5.4: *The effect of Kinesiotape® values as measured by CROM (values in degrees)*			
	Kinesiotape® Group		
	Right side treated (n= 12)		
	Visit 1	Visit 2	Visit 3
Right lateral flexion	44.5	45.8	46.8
Left lateral flexion	47.2	47.8	48.3
	Left side treated (n= 13)		
	Visit 1	Visit 2	Visit 3
Right lateral flexion	39.1	40.6	40.8
Left lateral flexion	40.6	41.2	43.4

Regarding clinical significance, the proposed MCID for CROM is 7.2 degrees (Briem, Huijbregts and Thorsteindottir, 2007). It can be observed that no improvement in range of motion occurred with dry needling treatment (Table 5.3). However, small improvements are noticed in the Kinesiotape® group (Table 5.4).

When Kinesiotape® was used on right sided MFTPs, an improvement of 2.3 degrees towards right lateral fexion, and an improvement of 1.1 degrees towards left lateral flexion were observed between visit one and visit three. These values, however, are smaller than the proposed MCIDs of 7.2 degrees (Briem, Huijbregts and Thorsteindottir, 2007). When Kinesiotape® was used on left sided MFTPs, improvements of 1.7 degrees towards the right and 2.8 degrees towards the left were noted. Also, these values do not indicate a clinically significant difference.

Thus, due to small sample size with these groups it will be beneficial for future studies to focus on a specific side of treatment (to increase each subset to a minimum of 20 patients treated on a particular side), and could potentially be used as an inclusion criterion for future studies. The trends of Kinesiotape® on CROM should be further explored to indicate if Kinesiotape® has an impact either on muscle strength (increased CROM towards the treated side) or on increased range of motion away from the treated muscle (increase CROM away from the treated side). Either finding will indicate resolution of the MFTP, but would differentiate potentially different mechanisms of action involved. For example, it is proposed that Kinesiotape® activates the GTO in the neuromuscular junction of the upper trapezius and causes subsequent muscle relaxation (Illes, 2009; Kase, Wallis and Kase, 2003). However, this particular effect would be questioned if an increased range of motion towards the side of treatment is observed, indicating increased muscle strength, and not muscle relaxation.

5.4 REVISION OF HYPOTHESES

5.4.1 The first Hypothesis

H_1 : It was hypothesized that dry needling of trapezius MFTPs in the treatment of MPS would be more effective than published MCIDs in terms of both subjective and objective clinical findings.

H_0 : Dry needling of trapezius MFTPs in the treatment of MPS would have no statistical and clinical significant effect in terms of both subjective and objective clinical findings.

- Intra-group:
    - This study showed that according to the VAS and NDI, dry needling produced statistically significant improvements in the treatment of MPS (p= 0.001; $p < 0.001$).
    - Therefore, the H_0 hypothesis can be rejected for VAS and NDI (the subjective outcomes) and can conversely be accepted for PPT and CROM (the objective outcomes).

- MCIDs:
    - Dry needling improvement was not clinically significant according to the VAS, NDI, PPT and CROM.
    - Thus, dry needling was *not* more effective than published MCIDs in the treatment of MPS and, therefore, the H_0 hypothesis cannot be rejected.

- Conclusion:
    - Although some statistical significant improvements were seen in VAS and NDI, the majority of the H_0 cannot be rejected.

5.4.2 The second Hypothesis

H_1 : It was hypothesized that the application of Kinesiotape® onto trapezius MFTPs in the treatment of MPS would be more effective than published MCIDs in terms of both subjective and objective clinical findings.

H_0 : Application of Kinesiotape® onto the trapezius MFTPs in the treatment of MPS would have no statistical and clinical significant effect in terms of both subjective and objective findings.

- Intra-group:
    - Kinesiotape® showed statistical significant improvement with the VAS, NDI and PPT.
    - The CROM sample sizes were too small / underpowered for specific outcomes measurements that made statistical analysis inconclusive.
    - Therefore, the H_0 hypothesis can be rejected for VAS, NDI and PPT.

- MCIDs:
    - Kinesiotape® PPT and CROM scores were not clinically significant.
    - It was mathematically impossible to achieve a clinical significant difference with the NDI scores that were recorded.
    - Kinesiotape® VAS scores were in the range of the published MCIDs.
    - Thus, Kinesiotape® was clinically significant only in regards to subjective outcomes and, therefore, the H_0 hypothesis cannot be rejected.

- Conclusion:
    - Kinesiotape® statistically and clinically improved VAS.
    - Kinesiotape® statistically improved NDI, and clinical significance was mathematically impossible.
    - Kinesiotape® statistically improved PPT, but not clinically.
    - Kinesiotape® did not statistically or clinically improve CROM outcomes, although specific measurement groups were smaller.

- Thus, H_0 cannot be rejected since no clinical effect regarding subjective measures were demonstrated.

5.4.3 The third Hypothesis

H_1 : It was hypothesized that dry needling would be more effective than Kinesiotape® application in terms of both subjective and objective clinical findings.

H_0 : Dry needling would not be more effective than Kinesiotape® application in terms of both subjective and objective clinical findings.

- Inter-group:
  - According to all the outcome measures, there were no statistical significant improvements of dry needling over Kinesiotape® in the treatment of MPS.
  - Kinesiotape® showed a trend of a significant treatment effect compared to dry needling with both NRS and PPT scores.
  - Therefore, H_0 cannot be rejected.

- MCIDs:
  - Kinesiotape® showed clinical significance with the VAS.
  - Thus, H_0 cannot be rejected.

- Conclusion:
  - H_0 cannot be rejected, suggesting that Kinesiotape® is at least as effective as dry needling in the treatment of MPS within a younger patient population.

5.5 SUMMARY AND CONCLUSION

Table 5.5 summarises the main statistical and clinical findings in this study:

Table 5.5: *Comparison of the main findings between dry needling and Kinesiotape® with regards to the outcome measures for this study.*

	Dry needling	**Kinesiotape®**	**Dry Needling versus Kinesiotape®**
VAS	Statistical (p= 0.001)	Statistical and Clinical (p < 0.001)	Non-statistical (p= 0.155)
NDI	Statistical (p < 0.001)	Statistical (p < 0.001)	Non-statistical (p= 0.491)
PPT	Non-statistical (p= 0.258)	Statistical (p= 0.022)	Non-statistical (p= 0.428)
CROM	Non-statistical (RLF p= 0.804) (LLF p= 0.844)	Non-statistical (RLF p= 0.169) (LLF p= 0.116)	Non-statistical (RLF p= 0.410) (LLF p= 0.497)

VAS – Visual Analog Scale; NDI – Neck Disability Index; PPT – Pain Pressure Threshold; CROM – Cervical Range of Motion; RLF – Right lateral flexion; LLF – left lateral flexion.

In comparing the relative effectiveness of Kinesiotape® versus dry needling it can be concluded that by rejecting hypothesis three in this chapter that Kinesiotape® is at least as effective as dry needling in the treatment of MPS. In addition Table 5.5 shows that Kinesiotape® was clinically significant with regards to VAS, whereas dry needling was not. Also, Kinesiotape® showed statistical significance with PPT whereas dry needling did not.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

In conclusion, this study demonstrated that the relative effectiveness of Kinesiotape® was at least equal to that of dry needling in the treatment of MPS. Kinesiotape® showed clinical significance with the VAS and statistical significance with PPT whereas dry needling did not. Although there was no statistically significant outcome when the two groups were directly compared for treatment effects, Kinesiotape® did show a trend of a significant treatment effect compared to dry needling with regards to NRS, PPT and CROM.

The findings of this study supported the proposed therapeutic mechanisms of Kinesiotape® application, although further studies are required to convincingly support or refute the proposed underlying physiological mechanisms of the Kinesio Taping® Method.

Nevertheless, this study contributed to the research literature and the field of evidence-based medicine through supporting the use of Kinesiotape® in the treatment of MPS in younger populations, especially in cases where the patient is hesitant to needle insertion.

6.2 RECOMMENDATIONS

- According to Esterhuizen (2011) the study may have been underpowered especially with regards to the treatment effect of Kinesiotape® compared to dry needling in relation to NRS, algometer scores and CROM (sidedness). This may mean that the study was underpowered to show the effect as statistically significant since a larger sample size might have resulted in the same effect size as achieving statistical significance. It was recommended that this study should be repeated with a larger sample in order to

demonstrate whether this effect was real or due to chance alone (Esterhuizen, 2011).

- To determine the effects of treatment on cervical right and left lateral flexion, either a larger sample size is required, or the study design should focus on treating one-sided MFTPs (i.e. MFTPs that is located on either the left or right side).

- In terms of the sample, a further additional suggestion, in order to prevent sampling bias, would be to include either an age stratification or recruit from a greater age range of population, as the results of this study are particularly limited to a younger age group (section 5.3.1). This may have had an impact on the NDI.

- Since the NDI scores were lower at baseline than the proposed MCID improvement, it could be beneficial for future studies to have a NDI > 20% (10 out of 50) value as part of the inclusion criteria. This will allow for the possibility to calculate a clinical significant improvement if present.

- The use of a blinded assessor would have added more scientific validity. However, limited funds and the lack of a reliable blinded assessor resulted in a choice to not employ such a person. The researcher did the assessments himself and vows for non-biased measurements.

- Ultrasound investigation might have been used in identification or assessment of MFTPs pre- and post-intervention. However, Sciotti *et al*., (2001) reported that clinical palpation of trapezius MFTPs are a reliable method for detection of MFTPS. Measurement tools used in this study also compares well with studies that involve myofascial pain, dry needling and Kinesiotape® (Srbely *et al*., 2010; Gonzalez-Iglesias *et al*., 2009; Esenyel *et al*., 2007; Hsieh *et al*., 2007; Edwards and Knowles, 2003).

- The timeframe in this study was used to comply with the suggested duration that Kinesiotape® can be worn and for the post-needling soreness to be minimised. Additionally, only two treatments were performed. To achieve the published MCIDs, especially regarding pain pressure threshold (PPT), a third treatment or longer treatment protocol may have been appropriate.

6.3 CLINICAL APPLICATION

This study demonstrated that Kinesiotape® is a valuable adjunct to practitioners and therapist dealing with MPS. With the VAS, Kinesiotape® demonstrated both statistical and clinical significant measurements, whereas with the NDI and PPT Kinesiotape® displayed statistical significant differences. The clinical significant difference relating to the VAS was found after two treatments with Kinesiotape® over a four to eight day period.

In addition, trends of a greater relative effectiveness compared to dry needling were seen with the NRS, PPT and CROM. Kinesiotape® can, therefore, be used as a substitute for dry needling in cases where the patient is hesitant to needle insertion.

6.4 FUTURE STUDIES

- The same study methodology with a larger sample size can be used to explore the possibility of a statistically significant treatment effect of Kinesiotape® over dry needling in relation to NRS and PPT.

- Future studies could also improve on the time-interval used in this study. In this study a two-to-four day interval was set, because the clinical setting did not allow for follow-up of patients over weekends. A possible future improvement would be to set a specific time interval of four days so that no possible of post-needling soreness exist.

- A combination Kinesiotape® application has been used in this study (muscle inhibition and space orientation). Since the VAS showed that this application

was clinically better than dry needling, it would be interesting to see how only one method of application (e.g. ‘space orientation’ technique) will compare to 1) dry needling, or 2) against the other method of Kinesiotape® used in this study (‘muscle inhibition’ technique). This will further help to elucidate what mechanisms of Kinesiotape® are mainly responsible for its favourable effects.

- Another potential future study could focus on a combination therapy of dry needling and Kinesiotape® versus dry needling or Kinesiotape® alone in the treatment of MPS. Kinesiotape® may potentially relieve the post-needling soreness of dry needling, causing an increase in subjective and objective measurements.

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Abbreviations and Definitions:

MCID = Minimal Clinically Important Difference

This clinically important difference is unrelated to statistical significant difference (95% Confidence Interval), and refers to an improvement by the patient (or research subject) that is clinically significant (Hutchinson, 2007).

MFTPs = Myofascial Trigger Points

Simons, Travell and Simons (1999) define a MFTP as the presence of exquisite tenderness at a nodule in a palpable taut band of muscle. MFTPs are accepted as a fundamental part of myofascial pain syndrome (Huguenin, 2004; Simons, Travell and Simons, 1999).

AMFTPs = Active Myofascial Trigger Points

AMFTPs refer pain spontaneously or on digital compression, and each AMFTP is characterized by its specific pain referral pattern (Simons, Travell and Simons, 1999).

LMFTPs = Latent Myofascial Trigger Points

LMFTPs may be clinically very similar to AMFTPs. However, LMTPs do not refer pain spontaneously, only on manual compression (Alvarez and Rockwell, 2002; Hou *et al*., 2002).

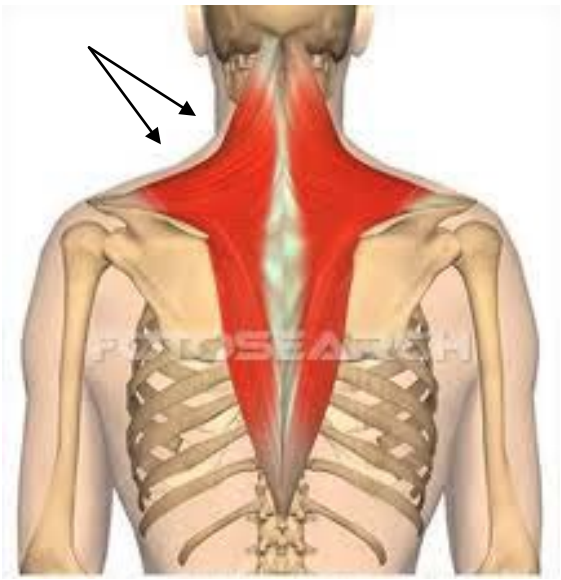
MPS = Myofascial Pain Syndrome

MPS is a syndrome of non-visceral pain originating from either muscle or its related fascia (Kalichman and Vulfsons, 2010). MPS is defined as the sensory, motor and autonomic symptoms that is caused by MFTP and, therefore, presents the clinical manifestation of MFTPs (Simons, Travell and Simons, 1999).

Annexure A - Advertisement

FREE TREATMENT

Do you have muscle pain in your lower neck and/or upper back region??



Research is being conducted that tests the effectiveness of two treatment modalities on Trapezius muscle pain.

If you are interested and between the ages of 18 and 50,

Please contact Jandré
or the DUT Chiropractic Day Clinic
084 240 7296 / 031 373 2205

Annexure B - Information & Informed Consent

Title of Research:	The relative effectiveness of Kinesiotape® versus dry needling in patients with myofascial pain syndrome of the trapezius.
Researcher:	Jandré van der Westhuizen
Supervisor:	Dr. Charmaine Korporaal

Dear Participant

Please read the following regarding the research topic:

What is Dry Needling??

Dry needling implies the insertion of needles into areas of pain without injecting any liquid into the area.

What is Kinesio® taping??

Kinesiotape® is a hypo-allergenic cotton tape that is the same thickness as the outer layer of your skin and assists the muscles from the outside of the body. Kinesiotape® can stretch 30-40% of its original length, and through this mechanism it is able to impact the muscle in certain beneficial ways.

Purpose of Research

This research project will focus on the effects of dry needling compared to Kinesio® taping. Whereas dry needling is a very commonly used and established therapeutic modality for myofascial pain, Kinesiotape® is a less common therapy that is becoming more popular. The main benefit of Kinesiotape® is that the tape can be worn for 3-4 days, therefore extending its therapeutic input outside of the practitioner's room. This study wants to determine which treatment modality is more effective as a single therapeutic modality.

Outline of procedure

There are 2 treatment groups. One group will receive dry needling, whereas the other will receive a Kinesiotape® application. You, as participant, will be randomly assigned to one of these groups. You will receive your first treatment on the day of the first consultation after you have agreed to partake in this study (i.e. signing at the

bottom of this document). Hereafter you will receive the same treatment within 3-4 days, and the final measurement will be done 3-4 days thereafter. The duration of this study is thus 6-8 days from start to finish.

Possible risks and discomforts / Research-related injury

If you are included in the dry needling group, you may experience slight discomfort during the treatment procedure and/or after treatment. It is possible that a transient stiffness of the treated muscle may be felt after treatment, but this does not mean that the treatment is not effective. The researcher and supervisor will not take any responsibility for any severe adverse reactions that may occur during either of the treatment modalities.

Benefits of the research for you

The study will determine which treatment modality works best. This will be of benefit for future chiropractors planning treatment for their patients. The research will also help to confirm / refute the scientific claims behind the functioning of Kinesiotaping®. The treatment, in whatever group you are, should be of benefit for you.

You may withdraw

The participant may decide to stop participating in this study at any time, for any reason whatsoever. Your decision will not affect your relationship with the researcher, Durban University of Technology or any other affiliations associated with this research.

Remuneration and costs for study

No financial award will be awarded to the research participant. Also, no financial fees will be charged for the consumables (tape and needles) as well as for the services provided by the researcher.

Confidentiality

All information supplied by you throughout the research process will be regarded as confidential. Your name will not appear in the research publication or any derivative thereof. The research data will be safely stored for a period of 5 years. Hereafter it will be terminated.

Persons to contact for any queries

Researcher: Jandré van der Westhuizen 084 240 7296

Supervisor: Dr. Charmaine Korporaal 031 373 2094

Statement of agreement

I, ... (Full name and ID number) hereby acknowledge that I have read this document in its entirety and understand the research procedure. Any queries have been fully explained to me by ....., the researcher. I also understand that I may withdraw from the research at any time without any consequences. I hereby voluntarily agree to participate in this study.

Name of participant: _____

Participant signature: _____

Date: _____

Researcher name: _____

Researcher signature: _____

Date: _____

Witness name: _____

Witness signature: _____

Date: _____

Supervisor's name: _____

Supervisor's signature: _____

Date: _____

ANNEXURE C – Randomisation Table

patient number	group
1	2
2	1
3	2
4	2
5	2
6	2
7	1
8	2
9	2
10	2
11	2
12	2
13	1
14	2
15	1
16	2
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
25	2
26	1
27	2
28	2
29	1
30	1
31	1
32	1
33	1
34	1
35	1
36	2
37	2
38	1
39	2
40	1
41	1
42	2
43	2
44	2
45	2
46	2
47	2
48	1
49	1
50	2

Annexure D – Kinesiotape® Contract

Kinesio Taping® Standard Clinical Trial Agreement

CLINICAL STUDY AGREEMENT TITLE

THE KINESIO TAPING ASSOCIATION INTERNATIONAL, (hereinafter referred to as "KTAI"), and **Department of Chiropractic and Somatology at the Durban University of Technology**, as represented by **Jan Hendrik van der Westhuizen (student and principle investigator) and Charmaine Korporaal (research supervisor)** (hereinafter referred to as "Principal Investigator") agree that Principal Investigator will provide for KTAI a clinical study (hereinafter referred to as "the Study") in return for complimentary use of Kinesio® Tex Gold™, (hereinafter referred to as Product).

1. INVESTIGATOR. Principal Investigator, **Jan Hendrik van der Westhuizen (student and principle investigator)**, will be responsible for conducting the Study.

2. TERM. This Agreement begins upon signing and ends **March 2012**. At this time the Principal Investigator will provide KTAI, the final study in its completion. KTAI shall not have rights over study and may not suggest, imply, or demand recommendations to favor the outcome within said study.

3. SPONSORED PRODUCT(S). KTAI shall provide Principal Investigator the necessary agreed upon amount **(35 meters of beige and 35 meters of black)** of Product for performance of the Study, to be delivered immediately upon signed Kinesio Taping® Standard Trial Agreement.

4. TERMINATION. Either party may terminate this Agreement upon thirty (30) days written notice to the other party. Primary Investigator shall reimburse and/or return KTAI for all Products that were provided for said study. If Principal Investigator is unable to complete said study to the best of its efforts, for whatever reasons, KTAI has the option to collect MSRP ($14.95 per roll) of the amount provided for said study.

5. CONFIDENTIALITY. KTAI shall not disclose confidential information unless it is necessary to the Study. Any confidential information provided by KTAI to the Principal Investigator will be clearly marked by KTAI, in writing, as "Confidential" or if disclosed orally, written notice will be provided within thirty (30) days of disclosure. Principal Investigator shall protect KTAI's confidential information with the same degree of care as Principal Investigator's own confidential information. The Principals Investigator's obligation of confidentiality will exist during the performance of this Agreement and for three (3) years following termination or expiration of this Agreement, unless disclosure is required by law or regulation, or such information (i) is known by the Principal Investigator without restriction prior to disclosure under this Agreement; (ii) is disclosed to the Principal Investigator by a third party without an obligation of confidentiality; (iii) is available to the public through no fault of the Principal Investigator; or (iv) is independently developed by Principal Investigator without knowledge or use of confidential information disclosed by KTAI under this Agreement.

6. PUBLICATION. Principal Investigator **(Jan Hendrik van der Westhuizen (student and principle investigator)** may disseminate Study results through either publication or presentation, but will not disclose KTAI's confidential information without permission. Principal Investigator will provide manuscripts or presentation materials for review thirty (30) days before publication. KTAI shall not have editorial rights over manuscripts or presentations, but may comment on implications of publication timing for multiple site studies or request deletion of KTAI's confidential or proprietary information.

7. PATENTS AND INVENTIONS. To the extent that KTAI is providing Confidential Information to the Principal Investigator, and to the extent that the KTAI has authored the Protocol to be conducted under this Agreement, and has designed and structured the manner in which the work is to be conducted, all inventions made in the direct performance of the Protocol and that necessarily incorporates KTAI's device, including new uses, shall be the sole

property of KTAI. In instances in which the KTAI desires to secure protection on such inventions, the Principal Investigator will cooperate with the KTAI, for the purpose of filing and prosecuting patent applications, the cooperation to include the execution of any and all lawful papers which may be deemed necessary or desirable by KTAI for the filing and prosecution of applications and for assignment of the same to the KTAI.

8. PRINCIPAL INVESTIGATOR NAME. KTAI shall not use Principal Investigator's name(s), for any advertising or promotional purposes without prior written approval from Principal Investigator.

9. MARKS AND USAGE OF TRADEMARKED AND COPYRIGHTED INFORMATION. Principal Investigator understands that the use of the name Kinesio®, Kinesio Taping®, Kinesio Taping® Method, Kinesio® Tex Gold™, is protected under international copyright and trademark laws, and will place the proper marks to insure the protection of its identity. The use of Kinesiotaping, Kinesiotape, KT, etc. is prohibited.

9. APPLICABLE LAW. The laws of the State of New Mexico will govern this Agreement.

By signing this agreement both parties agree to the terms mentioned.

<table>
<tr><td>THE KINESIO TAPING ASSOCIATION INTERNATIONAL</td><td colspan="2">DURBAN UNIVERSITY OF TECHNOLOGY
Jan Hendrik van der Westhuizen (student and principle investigator) and Dr. Charmaine Korporaal (research supervisor)</td></tr>
<tr><td>_____
(signature)
By_____
Title_____
Date_____</td><td>_____
(signature)
By_____
Title_____
Date_____</td><td>_____
(signature)
By_____
Title_____
Date_____</td></tr>
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Annexure E – Ethical Clearance Certificate

DURBAN UNIVERSITY of TECHNOLOGY

Faculty of Health Sciences

ETHICS CLEARANCE CERTIFICATE

Student Name	Jawoké v/d Westhuizen	Student No	20407643
Ethics Reference Number	FHSEC 010/11	Date of FRC Approval	16/05/11
Qualification	M. Tech: Chiropractic		
Research Title:	The relative effectiveness of Kinesiotape® versus dry needling in patients with myofascial pain syndrome of the trapezius muscle.		

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

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

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

[redacted]

24/5/2011
DATE

25/5/2011
DATE

27/05/2011
DATE

30/05/2011
DATE

Annexure F – Case History

DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: _____ Date: _____

File # : _____ Age: _____

Sex : _____ Occupation: _____

Intern : _____ Signature: _____

FOR CLINICIANS USE ONLY:

Initial visit

Clinician: Signature :

Case History:

Examination:

Previous: Current:

X-Ray Studies:

Previous: Current:

Clinical Path. lab:

Previous: Current:

CASE STATUS:

PTT: Signature: Date:

CONDITIONAL:

Reason for Conditional:

Signature: Date:

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

Case Summary signed off: Date:

Intern's Case History:

1. Source of History:

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

3. Present Illness:

	Complaint 1	**Complaint 2**
< Location < Onset : Initial: Recent: < Cause: < Duration < Frequency < Pain (Character) < Progression < Aggravating Factors < Relieving Factors < Associated S & S < Previous Occurrences < Past Treatment < Outcome:		

4. Other Complaints:

5. Past Medical History:

< General Health Status

< Childhood Illnesses

< Adult Illnesses

< Psychiatric Illnesses

< Accidents/Injuries

< Surgery

< Hospitalizations

6. Current health status and life-style:

< Allergies

< Immunizations

< Screening Tests incl. x-rays

< Environmental Hazards (Home, School, Work)

< Exercise and Leisure

< Sleep Patterns

< Diet

< Current Medication
Analgesics/week:
< Tobacco

< Alcohol

< Social Drugs

7. Immediate Family Medical History:

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

8. Psychosocial history:

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

9. Review of Systems:

< General

< Skin

< Head

< Eyes

< Ears

< Nose/Sinuses

< Mouth/Throat

< Neck

< Breasts

< Respiratory

< Cardiac

< Gastro-intestinal

< Urinary

< Genital

< Vascular

< Musculoskeletal

< Neurologic

< Haematologic

< Endocrine

< Psychiatric

Annexure G – Physical Examination

Patient Name : _____ File no :_____ Date :_____
Student : Signature :

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

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

SYSTEM SPECIFIC EXAMINATION:
CARDIOVASCULAR EXAMINATION
RESPIRATORY EXAMINATION
ABDOMINAL EXAMINATION
NEUROLOGICAL EXAMINATION
COMMENTS

Clinician: Signature :

Annexure H – Cervical Spine Regional Examination

DURBAN UNIVERSITY OF TECHNOLOGY
REGIONAL EXAMINATION - CERVICAL SPINE

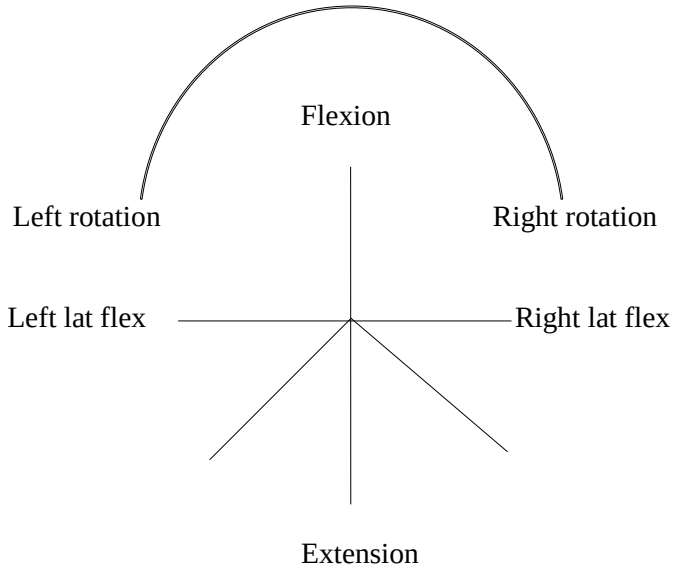
Patient: _____ File No: _____

Date: _____ Student: _____

Clinician: _____ Sign: _____

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

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



RANGE OF MOTION:
Extension (70º):
L/R Rotation (70º):
L/R Lat flex (45º):
Flexion (45º):

PALPATION:
Lymph nodes
Thyroid Gland
Trachea

ORTHOPAEDIC EXAMINATION:

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

	Right	Left		Right	Left
Doorbell sign			Cervical compression		
Kemp's test			Lateral compression		
Cervical distraction			Adson's test		
Halstead's test			Costoclavicular test		
Hyper-abduction test			Eden's test		

Shoulder abduction test			Shoulder compression test		
Dizziness rotation test			Lhermitte's sign		
Brachial plexus test					

NEUROLOGICAL EXAMINATION:

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				
Disdiadochokinesis								

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

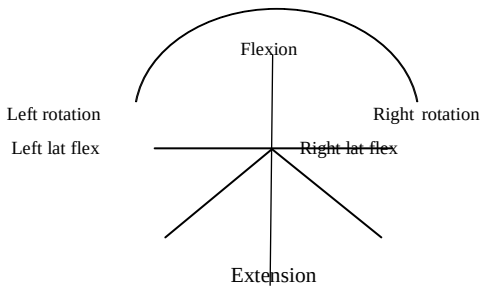
MOTION PALPATION & JOINT PLAY:
Left: Motion Palpation:
Joint Play:
Right: Motion Palpation:
Joint Play:

BASIC EXAM: SHOULDER:
Case History:

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

BASIC EXAM: THORACIC SPINE:
Case History:

ROM:



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

Annexure I – Numerical Pain Rating Scale (NRS)

Numerical Pain Rating Scale Questionnaire

Date: _____

File No: _____

Visit No:_____

Patient Name: _____

Please indicate using a mark or line that crosses the scale below, best indicating the number between 0 and 100 that describes the pain you experience at this point in time.

0 100

_____

Annexure J - VAS / NRS values

	DRY NEEDLE				KINESIOTAPE		
Patient 1	17	16	10	Patient 1	16	11	6
Patient 2	28	3	4	Patient 2	13	15	19
Patient 3	61	33	63	Patient 3	34	14	11
Patient 4	3	3	3	Patient 4	74	40	8
Patient 5	43	6	4	Patient 5	34	23	18
Patient 6	69	57	49	Patient 6	41	20	9
Patient 7	38	37	25	Patient 7	57	29	2
Patient 8	64	58	59	Patient 8	73	72	72
Patient 9	74	37	4	Patient 9	26	17	10
Patient 10	21	16	36	Patient 10	47	4	3
Patient 11	4	7	3	Patient 11	24	24	7
Patient 12	26	16	7	Patient 12	39	16	9
Patient 13	20	9	6	Patient 13	41	8	4
Patient 14	38	28	24	Patient 14	30	11	7
Patient 15	36	21	32	Patient 15	9	5	3
Patient 16	58	40	12	Patient 16	49	24	16
Patient 17	21	24	19	Patient 17	58	34	14
Patient 18	10	9	3	Patient 18	36	20	9
Patient 19	29	22	6	Patient 19	26	0	0
Patient 20	41	18	2	Patient 20	34	12	8
Patient 21	19	20	10	Patient 21	56	43	19
Patient 22	19	20	17	Patient 22	44	55	12
Patient 23	17	9	18	Patient 23	17	9	6
Patient 24	38	37	25	Patient 24	13	7	8
Patient 25	28	12	8	Patient 25	26	18	16
AVERAGE	**32.88**	**22.32**	**17.96**	**AVERAGE**	**36.68**	**21.24**	**11.84**

Annexure K - Neck Disability Index (NDI) Questionnaire

Patient name: _____ File #:_____ Date:_____

This questionnaire has been designed to give the doctor information as to how your neck pain has affected your ability to manage everyday life. Please answer every section and mark in each section only the ONE box that applies to you. We realize that you may consider that two of the statements in any one section relate to you, but please just mark the box that most closely describes your problem.

Section 1 – Pain Intensity • **I have no pain at the moment** • **The pain is very mild at the moment** • **The pain is moderate at the moment** • **The pain is fairly severe at the moment** • **The pain is very severe at the moment** • **The pain is worst imaginable at the moment**	**Section 6 – Concentration** • **I can concentrate fully when I want to, with no difficulty.** • **I can concentrate fully when I want to, with slight difficulty.** • **I have a fair degree of difficulty in concentrating when I want to.** • **I have a lot of difficulty in concentrating when I want to.** • **I have a great deal of difficulty in concentrating when I want to.** • **I cannot concentrate at all.**
Section 2 – Personal Care (Washing, drying etc.) • **I can look after myself normally, without causing extra pain.** • **I can look after myself normally, but it causes extra pain.** • **It is painful to look after myself and I am slow and careful.** • **I need some help, but manage most of my personal care.** • **I need help every day in most aspects of self care.** • **I do not get dressed; I wash with difficulty and stay in bed.**	**Section 7 – Work** • **I can do as much work as I want to.** • **I can do my usual work, but no more.** • **I can do most of my usual work, but no more.** • **I cannot do my usual work.** • **I can hardly do any work at all.** • **I can't do any work at all.**

Section 3 – Lifting • I can lift heavy weights without extra pain. • I can lift heavy weights, but it gives extra pain. • Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, for example, on a table. • Pain prevents me from lifting heavy weights off the floor, but I can manage light to medium weights if they are conveniently positioned. • I can lift very light weights. • I cannot lift or carry anything at all.	**Section 8 – Driving** • I can drive my car without any neck pain. • I can drive my car as long as I want, with slight pain in my neck. • I can drive my car as long as I want, with moderate pain in my neck. • I can't drive my car as long as I want, because of moderate pain in my neck. • I can hardly drive at all, because of severe pain in my neck. • I can't drive my car at all.
Section 4 – Reading • I can read as much as I want to, with no pain in my neck. • I can read as much as I want to, with slight pain in my neck. • I can read as much as I want to, with moderate pain in my neck. • I can't read as much as I want, because of moderate pain in my neck. • I can hardly read at all, because of severe pain in my neck. • I cannot read at all.	**Section 9 – Sleeping** • I have no trouble sleeping. • My sleep is slightly disturbed (less than 1 hr sleepless). • My sleep is mildly disturbed (1-2 hrs sleepless). • My sleep is moderately disturbed (2-3 hrs sleepless). • My sleep is greatly disturbed (3-5 hrs sleepless). • My sleep is completely disturbed (5-7 hrs sleepless).
Section 5 – Headaches • I have no headaches at all. • I have slight headaches that come infrequently. • I have moderate headaches that come infrequently. • I have moderate headaches that come frequently.	**Section 10 – Recreation** • I am able to engage in all my recreation activities, with no neck pain at all. • I am able to engage in all my recreation activities, with some neck pain at all. • I am able to engage in most, but not all, of my usual recreation

• **I have severe headaches that come frequently.** • **I have headaches almost all the time.**	**activities, because of pain in my neck.** • **I am able to engage in few of my recreation activities, because of pain in my neck.** • **I can hardly do any recreation activities, because of pain in my neck.** • **I can't do any recreation activities at all.**

Vernon, H., Mior, S. 1991. The Neck Disability Index: A study of reliability and validity. Journal of Manipulative and Physiological Therapeutics. 14: 409-415.

Annexure L - NDI values

DRY NEEDLE				KINESIOTAPE			
Patient 1	4	4	5	Patient 1	6	6	2
Patient 2	7	0	0	Patient 2	15	13	15
Patient 3	18	9	14	Patient 3	18	16	18
Patient 4	7	4	2	Patient 4	13	4	2
Patient 5	8	0	0	Patient 5	10	7	4
Patient 6	13	12	12	Patient 6	6	2	3
Patient 7	13	13	8	Patient 7	7	2	3
Patient 8	12	11	5	Patient 8	14	16	10
Patient 9	6	2	0	Patient 9	5	5	0
Patient 10	13	9	10	Patient 10	8	3	1
Patient 11	4	3	0	Patient 11	6	6	3
Patient 12	7	4	3	Patient 12	10	3	1
Patient 13	3	4	0	Patient 13	6	2	0
Patient 14	6	6	4	Patient 14	4	0	0
Patient 15	10	7	9	Patient 15	7	2	0
Patient 16	19	9	7	Patient 16	9	5	7
Patient 17	9	3	3	Patient 17	10	7	5
Patient 18	6	2	0	Patient 18	4	7	4
Patient 19	11	5	1	Patient 19	8	5	2
Patient 20	11	5	3	Patient 20	7	3	0
Patient 21	8	7	5	Patient 21	5	5	0
Patient 22	5	3	3	Patient 22	6	8	3
Patient 23	8	2	2	Patient 23	7	3	4
Patient 24	13	11	0	Patient 24	5	4	4
Patient 25	3	3	2	Patient 25	5	6	6
AVERAGE	**8.96**	**5.52**	**3.92**	**AVERAGE**	**8.04**	**5.6**	**3.88**

Annexure M - Algometer / Pain Pressure Threshold (PPT) readings

	Dry Needling					Kinesiotape®		
	Visit 1	Visit 2	Visit 3			Visit 1	Visit 2	Visit 3
Patient 1	6.65	4.70	7.6		Patient 1	5.35	5.30	7.50
Patient 2	6.35	8.35	7.9		Patient 2	5.35	5.55	6.10
Patient 3	4.15	4.50	5.3		Patient 3	3.85	6.60	7.40
Patient 4	4.60	3.45	4.9		Patient 4	6.10	7.80	8.25
Patient 5	5.15	6.70	5.7		Patient 5	9.25	10.00	8.70
Patient 6	5.55	4.65	6.4		Patient 6	5.10	4.50	4.75
Patient 7	3.45	2.85	3.5		Patient 7	6.30	4.10	5.30
Patient 8	3.20	3.55	4.0		Patient 8	2.55	3.00	3.70
Patient 9	4.70	4.90	5.9		Patient 9	7.70	7.95	5.50
Patient 10	9.25	10.05	9.3		Patient 10	4.40	3.15	3.25
Patient 11	5.90	6.20	7.5		Patient 11	3.50	4.65	5.30
Patient 12	5.05	4.20	5.1		Patient 12	2.85	3.80	6.80
Patient 13	4.65	4.35	4.6		Patient 13	7.95	6.00	6.90
Patient 14	3.75	3.50	4.2		Patient 14	5.95	7.00	8.50
Patient 15	3.70	5.15	3.9		Patient 15	3.15	4.20	3.75
Patient 16	4.50	5.05	4.0		Patient 16	3.20	2.35	3.70
Patient 17	7.25	6.85	9.2		Patient 17	4.15	2.60	4.25
Patient 18	4.85	6.60	7.7		Patient 18	4.85	4.40	5.75
Patient 19	6.00	5.40	4.0		Patient 19	8.30	10.85	11.50
Patient 20	10.85	9.05	8.1		Patient 20	4.30	5.35	5.00
Patient 21	8.10	7.00	6.6		Patient 21	1.05	3.35	6.25
Patient 22	5.70	7.95	7.2		Patient 22	7.00	5.50	9.00
Patient 23	4.75	6.40	5.2		Patient 23	6.50	6.00	5.60
Patient 24	4.65	3.70	4.8		Patient 24	5.45	4.25	4.25
Patient 25	8.85	6.45	8.6		Patient 25	6.65	4.70	5.80
AVERAGE	**5.66**	**5.66**	**6.03**		**AVERAGE**	**5.23**	**5.32**	**6.11**

Annexure N - CROM readings

Dry Needling						
	Right lateral flexion	Left lateral flexion	Right lateral flexion	Left lateral flexion	Right lateral flexion	Left lateral flexion
Patient 1	50	48	48	50	46	48
Patient 2	38	48	42	44	44	44
Patient 3	38	36	34	28	40	30
Patient 4	42	32	42	40	42	38
Patient 5	32	40	42	42	40	42
Patient 6	44	52	32	40	42	50
Patient 7	38	48	44	44	36	40
Patient 8	38	36	38	36	38	38
Patient 9	50	52	50	60	32	46
Patient 10	46	44	42	42	42	46
Patient 11	46	42	44	46	48	46
Patient 12	32	42	36	42	38	46
Patient 13	36	38	36	40	42	46
Patient 14	34	32	32	28	32	34
Patient 15	36	40	40	36	44	38
Patient 16	22	30	26	38	24	32
Patient 17	32	46	26	40	28	38
Patient 18	46	46	50	50	50	46
Patient 19	38	42	34	44	40	32
Patient 20	46	50	52	58	50	54
Patient 21	36	40	32	32	36	40
Patient 22	42	44	44	42	46	46
Patient 23	40	50	40	48	42	50
Patient 24	48	48	46	48	50	60
Patient 25	48	46	38	42	36	48
AVERAGE	**39.92**	**42.88**	**39.6**	**42.4**	**40.32**	**43.12**

Kinesiotape®						
	Right lateral flexion	Left lateral flexion	Right lateral flexion	Left lateral flexion	Right lateral flexion	Left lateral flexion
Patient 1	24	26	26	26	26	26
Patient 2	38	40	36	38	42	44
Patient 3	38	48	40	38	36	46
Patient 4	44	44	46	46	42	44
Patient 5	46	44	50	52	52	50
Patient 6	30	28	34	36	38	32
Patient 7	48	58	40	42	42	50
Patient 8	36	44	32	42	30	40
Patient 9	42	44	52	50	58	52
Patient 10	42	48	52	44	44	52
Patient 11	46	50	44	46	42	44
Patient 12	46	38	46	46	52	52
Patient 13	46	46	42	44	42	48
Patient 14	38	38	38	40	42	40
Patient 15	42	42	48	46	44	50
Patient 16	28	32	28	38	32	34
Patient 17	36	34	46	36	38	42
Patient 18	32	48	34	46	36	42
Patient 19	48	50	48	46	48	52
Patient 20	40	40	44	46	42	42
Patient 21	42	52	40	52	54	54
Patient 22	66	56	68	62	62	60
Patient 23	52	52	52	54	52	52
Patient 24	60	60	58	58	56	56
Patient 25	32	32	34	36	40	40
AVERAGE	**41.68**	**43.76**	**43.12**	**44.4**	**43.68**	**45.76**