MUSCLE ENERGY TECHNIQUE VERSUS DRY NEEDLING OF QUADRATUS LUMBORUM IN THE TREATMENT OF MYOFASCIAL TRIGGER POINTS

A research dissertation presented to the Faculty of Health Sciences, University of Johannesburg, as partial fulfilment for the Masters Degree in Technology, Chiropractic by:

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DECLARATION

I, Joshua Greenberg, declare that this dissertation is my own, unaided work. It is being submitted as partial fulfillment for the Master's degree in Technology, in the program of Chiropractic, at the University of Johannesburg. It has not been submitted before for any degree or examination in any other University or Technikon.

_____

Joshua Greenberg

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ABSTRACT

Purpose: The aim of this comparative study was to compare the effects of Muscle Energy Technique (MET) versus myofascial dry needling of quadratus lumborum in the treatment of myofascial trigger points (TrPs), with regards to pain, disability and lumbar spine range of motion.

Method: Thirty participants, male and female between the ages of eighteen and forty-five years, with an active quadratus lumborum TrP were used in this study. The thirty participants were randomly divided into two groups consisting of fifteen individuals each, ensuring equal male to female and age ratios. Group 1 received treatment in the form of MET. Group 2 received treatment in the form of myofascial dry needling. The trial consisted of five visits over a treatment period of two weeks, of which the first four visits the participants received treatment and the fifth visit served the purpose of obtaining the final data. The data was gathered on the first, third and fifth visits. The data was gathered before the treatment was performed. Objective data consisted of measuring lumbar spine range of motion with a digital inclinometer and pain pressure threshold using an algometer. Subjective data was obtained by using the Numerical Pain Rating Scale (NPRS) and Oswestry Disablity Index for Lower Back Pain (ODI).

Results: The results were interpreted by STATKON at the University of Johannesburg. Both groups improved significantly in both the objective and subjective measurements over the two week trial period. This indicted that both treatment interventions were effective in the treatment of active quadratus lumborum TrPs. The results also indicated that group 2 (myofascial dry needling) was statistically superior to group 1 (MET) with regards to the subjective and lumbar spine range of motion measurements obtained during the study. There was no statistical superiority between the two treatment interventions with regards to the pain pressure threshold values obtained. These results indicate that dry needling is more effective than MET in decreasing pain and disability, while increasing lumbar spine range motion due to active quadratus lumborum TrPs.

Conclusion: It was concluded, based on the results, that myofascial dry needling was more effective than MET with regards to the subjective pain, disability and lumbar spine

range of motion. However with regards to pain pressure threshold values, there was no superiority of either treatment. This study suggests that myofascial dry needling is a preferential treatment option than MET in the case of active quadratus lumborum TrPs as it is possible that dry needling alone is more effective in reducing pain, disability and increasing lumbar spine range of motion. However this does not rule out MET as treatment for active TrPs as objectively MET reduces objective pain as effectively as dry needling.

DEDICATIONS

This research dissertation is dedicated to my family and girlfriend, who have supported me throughout my studies. I thank you for all your patience and belief in me.

To my mom looking down from heaven, I know this would make you proud. I love and miss you every day.

ACKNOWLEDGEMENTS

I would like to thank Dr Yelverton for all his assistance and understanding throughout this research dissertation and my studies.

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CHAPTER ONE: INTRODUCTION

1.1. The Problem and its Setting

Back strains disable more people than serious pathological spinal diseases put together (Waddell, 1998). According to Davidson (2006), sixty to eighty percent of people will at some time in their lives encounter lower back pain episodes and ninety percent of the time lower back pain will be mechanical in nature. Mechanical lower back pain is non-specific and is usually associated with lifting, bending and poor posture which often results hypertonic musculature, lower back pain and decreased range of motion. Myofascial trigger points (TrPs) are often found in this setting (Huguenin, 2004).

Soft tissues may become shortened, contracted, weakened, lengthened or painful. The human body compensates for what is being demanded of it. These adaptive demands relate to a combination of processes including daily activities, trauma, repetitive habits, and emotional states as well as the ageing process. Musculoskeletal dysfunction can be shown to be as a result of the body's adaptive capabilities. Our bodies compensate until the adaptive capacity of the tissues are exhausted. At this stage symptoms manifest which include an increase in pain and limited range of motion (Chaitow, 2006).

TrPs form part, or occasionally the major contributing part, of pain suffered by people with musculoskeletal dysfunction (Chaitow, 2006). TrPs are thought to form in response to increased or altered muscle demands and acute or chronic stresses (Huguenin, 2004). TrPs are hyperirritable foci lying within taut bands of hypertonic musculature (Dommerholt and Huijbregts, 2011). Although TrPs are widely recognized in the clinical environment, there is still much to be discussed with regards to their pathophysiology, mechanisms of pain referral and treatment of choice (Huguenin, 2004). According to Chaitow (2006), many ways of treating TrPs have been hypothesized, the most common being acupuncture, procaine injections and myofascial dry needling.

Recommended treatment for TrPs includes dry needling (Travell and Simons, 1999) and Muscle Energy Technique (MET) (Chaitow, 2006). However there is no consensus in clinical practice to the most appropriate treatment and management of TrPs (Huguenin, 2004).

TrP dry needling, also known as intramuscular stimulation, is an invasive procedure in which an acupuncture needle is inserted into the skin and muscle (Dommerholt and Huijbregts, 2011). Needling of TrPs is very effective for myofascial pain release and deactivation if it is performed correctly by the practitioner (Hong, 2006). The insertion of needles into TrPs, for the relief of pain produced by them, is a common practise (Baldry, 2001). Dry needling involves solid acupuncture needle insertions (in a controlled manner through the skin) into the TrP lying within the muscle aiming to reproduce the patients symptoms, elicit an involuntary spinal reflex (known as a local twitch response), and achieving relief of muscle tension and pain (Dommerholt and Huijbregts, 2011 and Huguenin, 2004).

MET is a form of soft tissue osteopathic manipulation methods which were designed to help restore musculoskeletal function and reduce pain. MET has been hypothesised to decrease pain of agonist and antagonist muscle groups to restore musculoskeletal function and restore joint range of motion especially in restricted joints. The techniques incorporate precisely directed and controlled, patient initiated isometric and/or isotonic muscle contractions (Chaitow, 2006). The outlook for people with TrPs is excellent since TrPs usually respond quickly to manipulative techniques which include stretching. MET is shown to be a safe, easy and effective means of decreasing TrPs in a muscle. Most TrPs treatments offer temporary relief however MET offers a useful means of treatment since normal muscle resting length is restored and TrPs do not re-activate. It is understood that a TrPs will re-activate if the muscle in which it lies, cannot easily reach its normal resting length (Chaitow, 2006).

1.2. Aim of the Study

The aim of this comparative study was to compare the effects of MET versus myofascial dry needling of quadratus lumborum in the treatment of TrPs, with regards to pain, disability and lumbar spine range of motion.

1.3. Benefits of the Study

This study was performed to determine which of the treatment protocols is more effective and to determine possible benefits for patients as well as for the practitioners. This study could determine which treatment protocol in the form of MET or myofascial dry needling would be better suited in the treatment of active quadratus lumborum TrPs.

As mentioned, there is a lack of consensus in clinical practice to the most appropriate treatment and management of TrPs (Huguenin, 2004). Therefore this study may be beneficial in illustrating the most beneficial treatment protocol for TrPs when looking at this study alone.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Relevant anatomy of skeletal muscle, and the quadratus lumborum muscle, is discussed in the literature review that follows. The review will then define the etiology of myofascial trigger points (TrPs), and investigate the use of Muscle Energy Technique (MET), as well as the use of myofascial dry needling in the treatment of quadratus lumborum TrPs.

2.2 Anatomy

2.2.1 Skeletal muscle

Skeletal muscle is a form of muscle in the human body which converts chemical energy into mechanical work. A muscle's most important property is having specialised muscle cells which have the ability to change shape. According to Guyton and Hall (1997), approximately forty percent of the body is skeletal muscle. Powerful muscular contractions, due to the arrangement of muscle fibers, can be produced by skeletal muscle. Large range of motion can be achieved as skeletal muscle attaches to bone, aided by lever systems. Somatic motor neurons innervate skeletal muscle (Standring, 2008).

a) Functional organization of skeletal muscle

Skeletal muscle is an organised structure comprising of various components and is illustrated in Figure 2.1. Each Skeletal muscle is completely enclosed in a sheath of connective tissue called fascia. Beneath the fascia lies a delicate membrane called epimysium which covers the muscle and forms their immediate external environment. Each muscle contains muscle fascicles which are bundles of muscle fibres. Perimysium, a connective tissue membrane, separates the muscle fascicles. Blood vessels and nerves can be found within this layer. Each muscle fascicle contains muscle fibers which are covered by a connective tissue membrane called endomysium (Thibodeau and Patton, 2003).

The cellular unit of a muscle is called a muscle fiber. They are long cylindrical structures which can vary in size from ten to one hundred nanometres in diameter and from millimetres to many centimetres in length. The cytoplasm surrounding each muscle fiber is a plasma membrane called sarcolemma. The contractile components within the fibers are called myofibrils (one to two nanometres in diameter) and are composed of myofilaments. Myofilaments are made up of contractile proteins called actin, myosin, troponin and tromyosin (Standring, 2008).

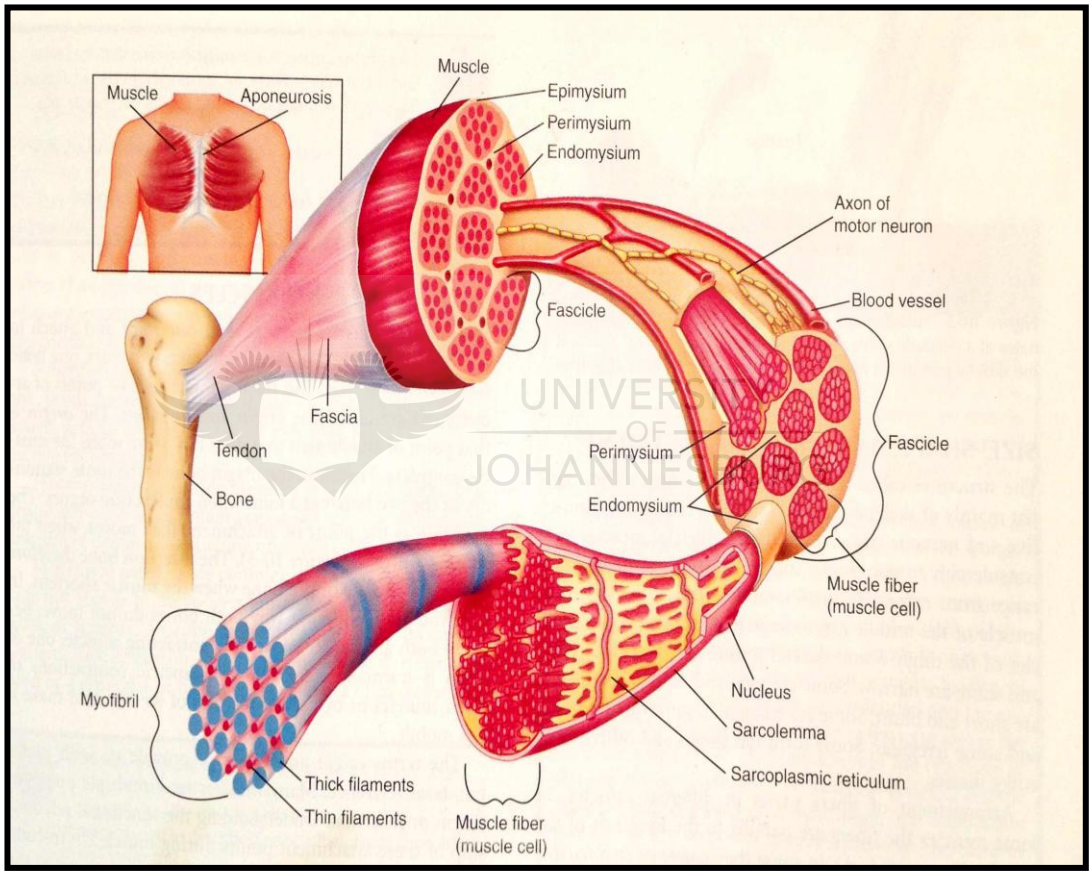

Figure 2.1: The functional organisation of skeletal muscle (Thibodeau and Patton, 2003)

b) Structure of the sarcomere

Sarcomeres are the contractile units of skeletal muscle. The sarcomere consists of thick filaments (myosin) and thin filaments (actin, troponin and tropomyosin). The thick filaments

form the dark 'A' band. The thin filaments extend in each direction from the 'Z' disk, and they create the light 'I' band. The 'H' zone is the portion of the 'A' band where the thick and thin filaments do not overlap. The 'M' line runs through the exact centre of the sarcomere. Molecules of series elastic proteins (titin), which anchor the ends of the thick filaments to the 'Z' disk, provide a scaffold for the assembly of a precise number of myosin molecules in the thick filament. They may also dictate the number of actin molecules in the thin filaments (Thibodeau and Patton, 2003). Figure 2.2 illustrates the structure of the sarcomere.

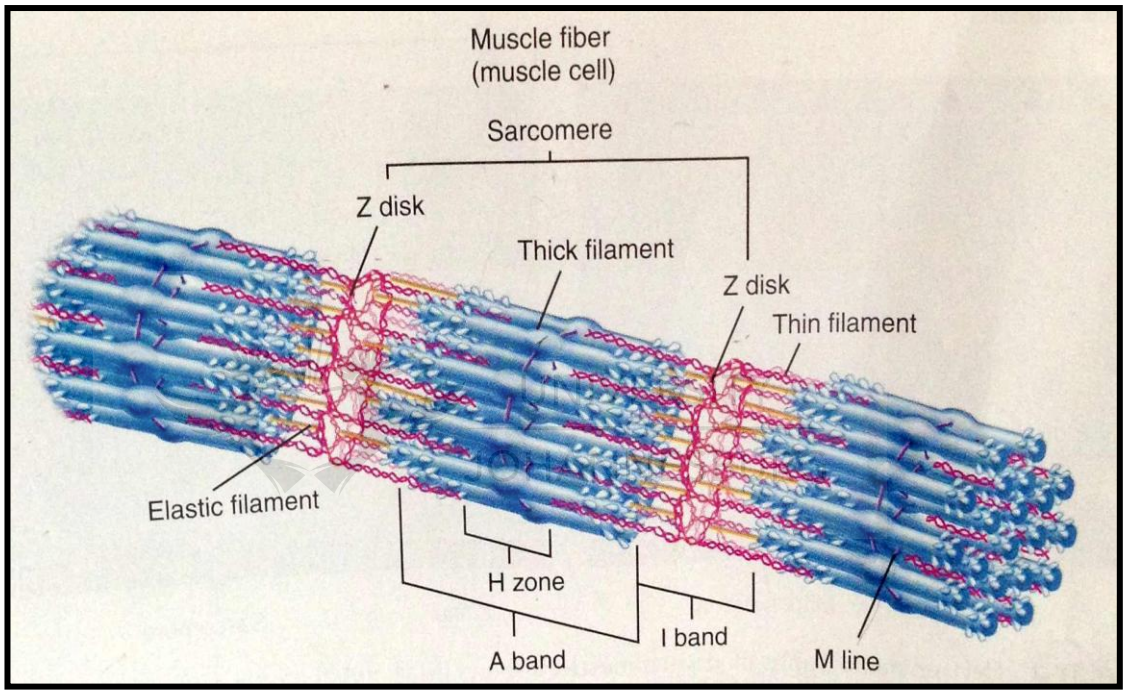

Figure 2.2: The functional organisation of a sarcomere (Thibodeau and Patton, 2003).

c) The neuromuscular junction

The distal end of a motor neuron forms a synapse or 'chemical junction' with an adjacent muscle fiber (refer to Figure 2.3). These synapses enable nerve impulses to be transferred from a neuron to a muscle fibre (Thibodeau and Patton, 2003). The neuromuscular junction depends on acetylcholine (Ach) as the neurotransmitter. The nerve terminal produces Ach by means of an energy dependent process supplied by mitochondria located in the nerve terminal (Travell and Simons, 1999).

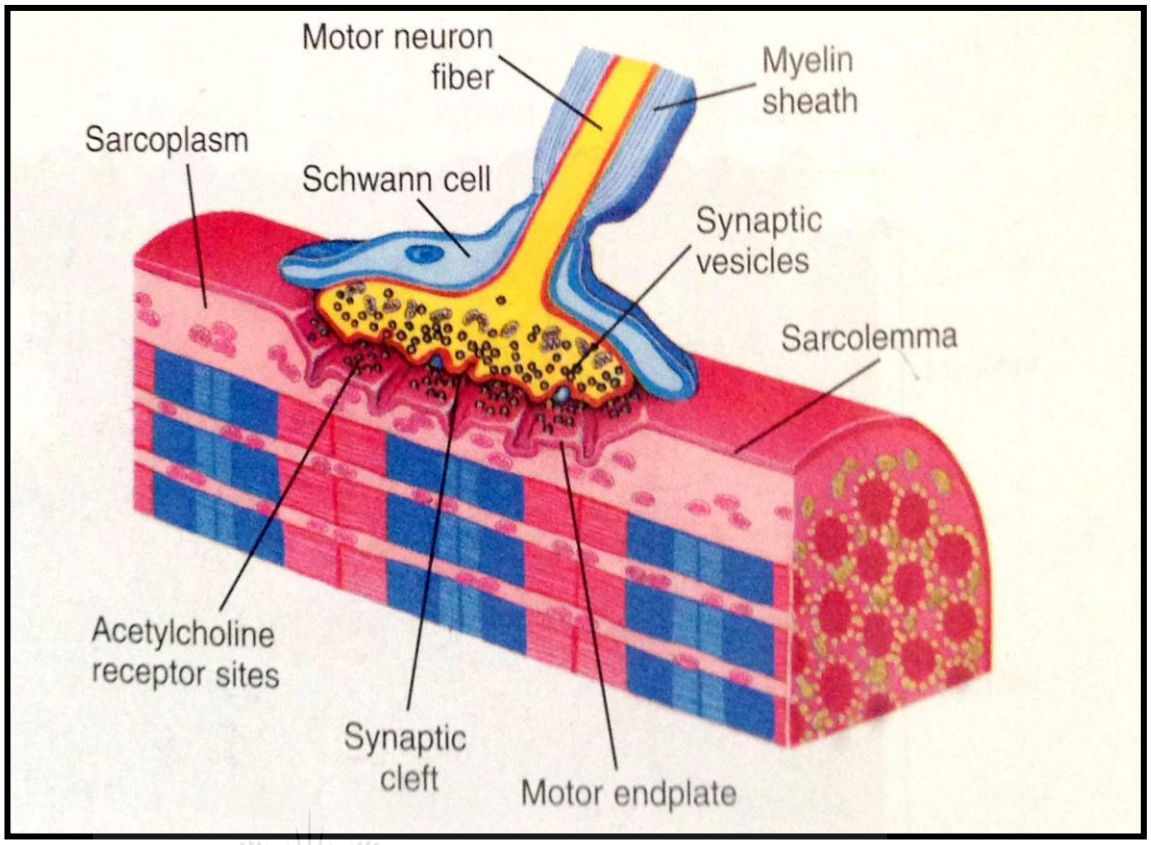

Figure 2.3: The neuromuscular junction (Thibodeau and Patton, 2003)

Travell and Simons (1999) state that a nerve impulse can be transmitted across the neuromuscular junction according to the following steps:

- An action potential travels along a motor neuron and reaches the nerve terminal.
- The nerve terminal responds by opening voltage-gated calcium channels.
- These channels calcium to move from the synaptic cleft into the nerve terminal.
- The channels are located on both sides of the specialized nerve membrane which release Ach in response to the influx of calcium ions.
- Ach overwhelms the barrier of cholinesterase in the synaptic cleft.
- Ach reaches the post synaptic membrane of the muscle fibre where Ach receptors are located
- Sodium channels open and the action potential is transferred to the muscle fibre.
- Cholinesterase decomposes any remaining Ach in the synaptic cleft, limiting its time of action.
- The synapse can now respond to another action potential.

d) Golgi tendon organs

The Golgi tendon organ is a receptor found at the junction of tendons and muscle fibers. These receptors respond primarily to the tension within a muscle during an isometric contraction. The response causes a relaxation reflex. Golgi tendon organs comprise of free nerve endings that wind between collagen fibers inside a connective tissue capsule (Silverthorn, 2004).

When a muscle contracts (isometrically) collagen fibers within the Golgi tendon organ are pulled tight. This activates sensory endings of afferent neurons causing them to fire. Inhibitory interneurons in the spinal cord are then activated which in turn inhibits alpha motor neurons innervating the muscle. The muscle contraction deceases or stops completely. This reflex slows muscle contraction as the force of muscle contraction increases. The Golgi tendon organs may also prevent excessive contraction that might injure the muscle (Silverthorn, 2004).

e) Muscle spindles

Muscle spindles are stretch receptors that send information to the spinal cord and brain regarding muscle length or any changes in muscle length. They are small, elongated structures which lie among and are arranged in a parallel configuration to contractile muscle fibers (Silverthorn, 2004).

Each muscle spindle consists of a connective tissue capsule that encloses a group of small muscle fibers known as intrafusal fibers. Intrafusal fibers are modified so that the ends are contractile but the central portion lacks myofibrils. The contractile ends of the intrafusal fibers are innervated by gamma motor neurons. The non contractile central portion of the intrafusal fiber is enveloped by sensory nerve endings that are stimulated by stretch. Any movement that increases muscle length stretches the muscle spindle which results in excitation of the sensory nerve fibers. This creates a reflex contraction of the muscle which prevents damage from overstretching. This reflex pathway is known as a stretch reflex (Silverthorn, 2004).

2.2.2 Physiology of skeletal muscle

The general and most important function of skeletal muscle is to provide movement to the body as a whole or its parts however skeletal muscle has two other important functions to mention. Skeletal muscle increases heat production for the homeostasis of body temperature with contractions producing most of the body's total heat. The other vital function is the maintenance of posture. Continuous contraction of skeletal muscle is vital for posture when standing and sitting. Postural skeletal muscle contraction is also needed when undertaking activities such as running, walking or performing other movements (Tortora and Derrickson, 2007)

Skeletal muscle cells have several characteristics that permit them to perform their function. They display excitability (the ability to be stimulated by nerves signals), contractility (the ability to shorten or contact and produce movement), and extensibility (the ability to extend or stretch which allows muscle to return to its normal resting length) (Thibodeau and Patton, 2003).

a) Types of muscle contractions

There are four types of skeletal muscle contractions according to Mense and Gerwin (2010):

- Concentric contractions are defined as a reduction in muscle length produce by a generation of muscle force. These contractions are characterized by simultaneous length and force changes.
- Isotonic contractions are defined as a length change without a change in the force exerted. Pure isotonic contractions can be performed when a constant resistance through the range of motion is provided.
- Isometric contractions are defined as an increase in force without length change. The developed force is not used to shorten the muscle but rather for putting tension on the insertion points and for stretching the elastic components of the muscle. The sacrcomeres shorten but the muscle as a whole does not.

- Eccentric contractions are defined as a lengthening of muscle by external forces, with the muscle resisting the lengthening. The force developed by the muscle is smaller than that causing the lengthening. The muscle contracts to slow the lengthening.

b) The mechanism of contraction

According to Thibodeau and Patton (2003), a skeletal muscle must undergo several processes that need to be coordinated step by step in order to produce a desirable and powerful muscle contraction:

The process begins with excitation followed by a muscle contraction:

- Nerve impulses travel along a motor neuron reaching the neuromuscular junction where the neurotransmitter Ach is released.
- Ach binds to receptors on the motor end plate of the muscle fibre.
- An impulse is created which travels along the sarcolemma, through the 'T' tubules, to the sarcoplasmic reticulum.
- Sarcoplasmic reticulum releases calcium ions into the sarcoplasm where it binds to troponin within the thin myofilaments.
- Tromyosin molecules in the thin filaments then shift and actin's binding sites are exposed.
- Myosin cross bridges, of the thick myofilaments, bind to actin and use their energy to pull the thin myofilaments to the centre of the sarcomere as depicted in Figure 2.4.
- This cycle can occur many times per second however adenosine-triphosphate (ATP), an energy molecule, has to be available.

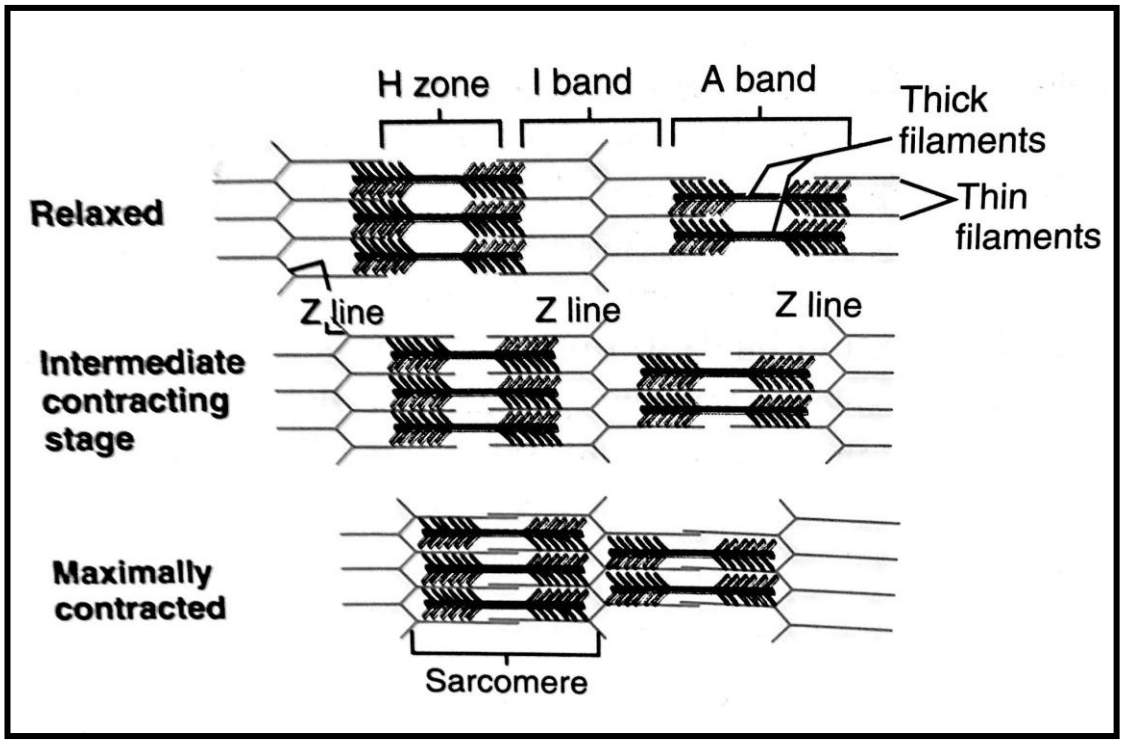

Figure 2.4: The sliding filament theory during relaxation and contraction of sarcomeres (Thibodeau and Patton, 2003)

The process ends as muscle undergoes relaxation:

- As the impulse ceases, calcium ions are actively pumped back into the sarcoplasmic reticulum.
- Tropomyosin returns into its original position and actin's binding sites are blocked.
- Myosin cross-bridges can no longer bind to the actin.
- The contraction can no longer be sustained.
- The thin and thick myofilaments are no longer connected and the muscle's normal resting length is restored as illustrated in Figure 2.4.

2.3. Myofascial Trigger Points

2.3.1 Introduction

According to Dommerholt and Huijbregts (2011), myofascial pain is one of the most common clinical findings in patients presenting with musculoskeletal pain. Travell and Simons (1999), state that TrPs become a painful part of nearly everyone's life at one time or another. Almost every person will experience some type of muscle pain over a life time (Rachlin, 2002).

Untreated myofascial pain can manifest into chronic pain conditions. Chronic pain can cause disability due to pain and related conditions including depression, physical reconditioning, sleep disturbances, and other psychological and behavioural disturbances (Rachlin, 2002). Although TrPs are widely recognised in clinical practice, their pathophysiology, mechanisms of pain referral, and treatment of choice requires further investigation (Huguenin, 2004). According to Chaitow (2007), dysfunction postural patterns are sustained unless TrPs are de activated. Furthermore TrPs will continue to evolve if the etiological factors that created and maintained them are not corrected.

2.3.2 Definition of a myofascial trigger point

Travell and Simons (1999), define a TrP as "A hyperirritable spot in skeletal muscle that is associated with a hypersensitive palpable nodule in a taut band. The spot is painful on compression and can give rise to characteristic referred pain, referred tenderness, motor dysfunction, and autonomic phenomena". Figure 2.5 illustrates TrPs within skeletal muscle.

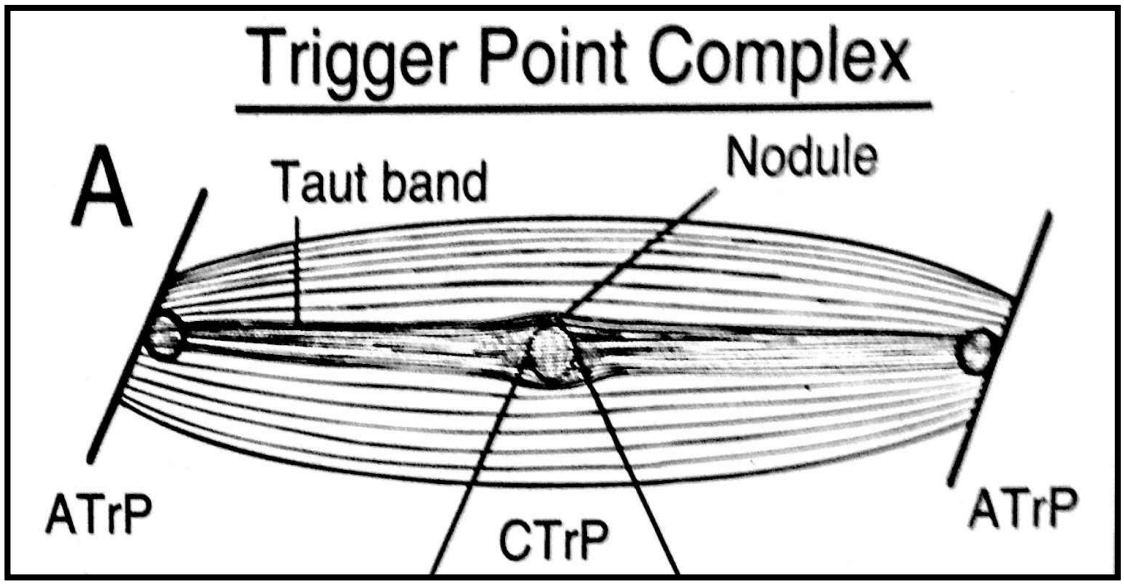

Figure 2.5: A schematic representation of a TrP complex of a muscle in longitudinal section. A central TrP (CTrP) is found in the endplate zone and two TrPs (ATrP) are found in the muscle attachment sites (Travell and Simons, 1999)

Huguenin (2004), states that TrPs can be categorized into two groups. A TrP may either be active or latent. Active TrPs produces pain, refer pain at rest or upon movement, exhibit tenderness on palpation, prevent the muscle from lengthening and weakens muscle (Travell and Simons, 1999). Compression of an active TrP causes local pain as well as referred pain and symptoms at a distant site (Rachlin, 2002).

According to Travell and Simons (1999), latent TrPs are clinically quiescent with respect to spontaneous pain. Latent TrPs can cause stiffness, decreased range of motion and are present in a shortened muscle. Local pain is only produced when a latent TrP is palpated (Huguenin, 2004).

2.3.3 Activation of myofascial trigger points

According to Travell and Simons (1999) muscles are most likely to acquire TrPs from an acute overload, chronic overload or repetitive movements, direct trauma and muscle chilling. The most common cause of TrP formation is occupational and recreational activity that results in repetitive stress on one or more muscles or muscle groups (Alvarez and

Rockwell, 2002). TrPs can also be activated indirectly by other TrPs, nutritional deficiencies, emotional states, chronic infections and infestations (Travell and Simons, 1999).

TrPs may be activated by acute events and chronic stresses according to Travell and Simons (1999*)*:

- Acute events such as: wrenching movements, accidents, falls, fractures, sprains, strains, dislocations, direct trauma and excessive or unusual exercise can all cause primary active TrPs. TrPs associated with an acute origin are easily inactivated as soon and the healing process has taken place. However, they may also persist for many years unless treated.
- Chronic stress perpetuates a gradual onset of active TrPs. Chronic stresses such as: sustained postural overload, poor work habits, slouched posture, repetitive daily activities, chronic immobilization of a muscle, nerve compression (radiculopathy), and emotional tension or stress.

TrPs may have many other causes and are listed below:

- Secondary activation occurs when a muscle is overloaded as a synergist or an antagonist of the muscle that is housing the primary active TrP (Baldry, 2001).
- Satellite TrPs can occur in muscles that are located in the referral zone of another muscle (Baldry, 2001).
- Systemic pathology (Baldry, 2001).
- Nutritional deficiencies (vitamin C, B complex, and iron) (Chaitow, 2006).
- Hormonal imbalances – hypothyroidism, menopausal or premenstrual situations (Chaitow, 2006).
- Infections bacteria, viruses and yeast (Chaitow, 2006).
- Infestations (Travell and Simons, 1999).
- Psycological factors (hopelessness, depression, anxiety and tension) (Travell and Simons, 1999).
- Allergies to wheat and dairy (Chaitow, 2006).
- Low oxygenation of tissues, tension stress inactivity and poor respiration (Chaitow, 2006).

- Postural imbalances (Chaitow, 2006).
- Congenital problems (short leg or small hemi pelvis) (Chaitow, 2006).
- Visceral pain referrel (Chaitow, 2006).
- Hypermobility (Chaitow, 2007).

2.3.4 Myofascial trigger point examination

Patient comfort is vital for accurate assessment of a TrP. The patient should be comfortable, relaxed and warm during the examination. If the patient is cold or tense, distinction between tense bands and adjacent slack muscle fibers is lost. A palpable band feels like a taut 'rope like' cord of muscle fibers among normally slack fibers. The examiner palpates along the taut band to locate the point of maximal tenderness. Firm digital pressure is applied to this spot and referral patterns of pain are elicited (Travell and Simons, 1999).

According to Travell and Simons (1999), TrP palpation can be done in three ways:

1. Flat palpation is used when a muscle can be pressed onto underlying bone. A fingertip can be used to slide the patient's skin across the underlying muscle fibers. Any taut band within the muscle is felt as it is rolled under the fingertip. Transverse snapping palpation can be applied to the taut band. This can be compared to plucking a violin or guitar string.
2. Pincer palpation is used when opposite aspects of a muscle can be held between the examiners digits. The technique is performed by grasping the belly of the muscle between the thumb and fingers and squeezing the fibers between them in a rolling motion to locate the taut bands. As the taut band is located, the examiner explores it in its entirety and the point of maximal tenderness is noted.
3. Deep palpation is used when intervening tissue makes it impossible to use flat or pincer palpation. The technique is performed by placing a fingertip over an area of skin that overlies the motor point region or the attachment of a muscle suspected of housing TrPs.

2.3.5 The local twitch response

The local twitch response, as illustrated in Figure 2.6, is a transient contraction of the muscle fibers in the tense or taut band that is associated with a TrP. Sudden changes of pressure on the TrP usually elicit this response. The techniques of palpation described above can elicit this response especially transverse snapping palpation. Dry needling, which will be discussed later in the chapter, may elicit this response when the needle comes into contact with the TrP. This objective sign is most useful in indentifying a TrP clinically. The local twitch response has been studied electromyographically and was found to last 12-76ms in response to needle stimulation (Travell and Simons, 1999). The local twitch response during dry needling causes the increase of various chemicals at the TrP to be corrected. Tissue oxygen tension increases as the needle approaches the TrP. After reaching a peak, the tissue oxygen tension returns to almost zero, indicating hypoxia in the central region where the needle was inserted (Osborne and Gatt, 2010). This may decrease the amount of vaso-reactive substances and relieve the energy crisis in the TrP (Travell and Simons, 1999).

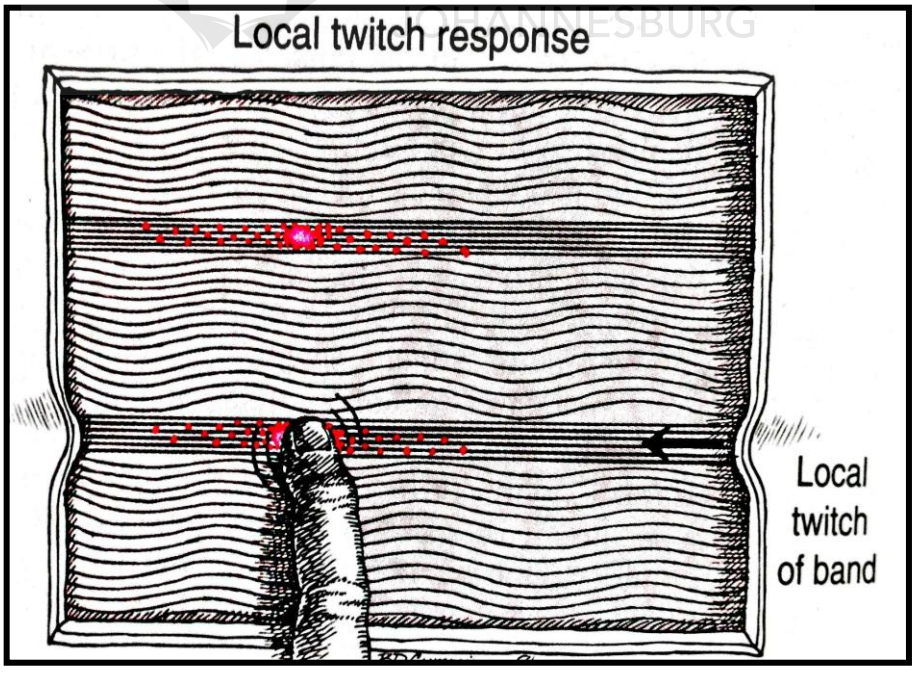

Figure 2.6: A schematic drawing of a local twitch response upon palpation of a TrP (red zones) (Travell and Simons, 1999)

2.3.6 Diagnostic criteria

TrPs exhibit several characteristics that the practitioner looks for in order to reach a diagnosis according to Travell and Simons (1999):

- An examination for spot tenderness or Jump sign.
- Pain recognition, indicating that if a patient recognizes the pain produce by the pressure, the tender spot can be considered a source contributing to at least part of the patient's pain problem.
- Finding of a palpable taut band.
- Recognized referred pain that reproduces the patient's pain complaint.
- Local twitch responses are strongly associated with the presence of TrPs.
- Pain-restricted range of motion.

2.3.7 Histopathological characteristics of myofascial trigger points

According to Cummings and Baldry (2007), contraction knots may be a specific histological marker for a TrP. A large number of contraction knots are present within a TrP. Contracted sarcomeres within these knots give the taut band and TrPs within it, a palpable ropiness and nodularity (Baldry, 2001). Histological studies of muscle cross sections reveal dark staining, large, round fibers. Longitudinal sections reveal central bulges within some muscle fibers where there is a highly contracted portion. On either side of the bulge the fiber was narrowed and elongated to compensate for the central knot of contracted sarcomeres (Cummings and Baldry, 2007).

2.3.8 Pathogenesis of myofascial trigger points

There are several theories which describe the pathogenesis of TrPs. According to Huguenin (2004) the energy crisis theory and the motor end plate hypothesis are the most widely accepted theories. The integrated hypothesis was also accepted and was compiled by Travell and Simons (1999).

a) Energy crisis theory

The energy crisis theory is the earliest explanation of TrP formation (Huguenin, 2004). It was developed in 1981 and has been evolving ever since (Travell and Simons, 1999). Figure 2.7 illustrates the energy crisis theory schematically.

Travell and Simons (1999) stated that the energy crisis theory was developed to provide a pathophysiological explanation to account for the following:

- The absence of motor unit action potentials in the palpable taut bands of the TrP when the muscle was at rest.
- TrPs are often activated by muscle overload.
- Sensitisation of nociceptors in the TrP.
- The effectiveness almost any therapeutic technique that restores the muscles full stretch length.

This theory postulates that through acute injury or chronic microtrauma, a muscle will result in a release of calcium ions from extracellular fluid or the sarcoplasmic reticulum. Free calcium ions in the presence of ATP, the main energy source for any muscle, stimulates the sarcomere to undergo a sustained contraction and the metabolic demand increases. Blood flow within the TrP is compromised due to the sustained muscle contraction resulting in oxygen debt. The combination between increased metabolic demand and decreased blood flow results in an energy crisis (Rachlin, 2002).

Adenosine Tri-Phosphate (ATP) is needed at the neuromuscular junction to inhibit Ach, however due to depleted ATP reserves Ach is free to be released into the neuromuscular junction in excessive amounts and allows for action potentials to be distributed across the sarcolemma resulting in a sustained contractile state. Compromised oxygenated blood does not allow for cells to produce ATP which would normally start the muscle relaxation process. The calcium pump, an energy dependent pump which returns calcium into the sarcoplasmic reticulum, is also impaired due to the ischemia and intracellular calcium accumulates causing excessive binding of the thick and thin filaments within the sarcomere. This completes the vicious cycle (Rachlin, 2002).

Nocicceptors in the region are sensitized by various chemicals and ischaemic by-products of metabolism which cause TrP tenderness and pain and the perception of referred pain. These substances include bradykinins, serotonin, histamine and prostaglandins (Rachlin, 2002).

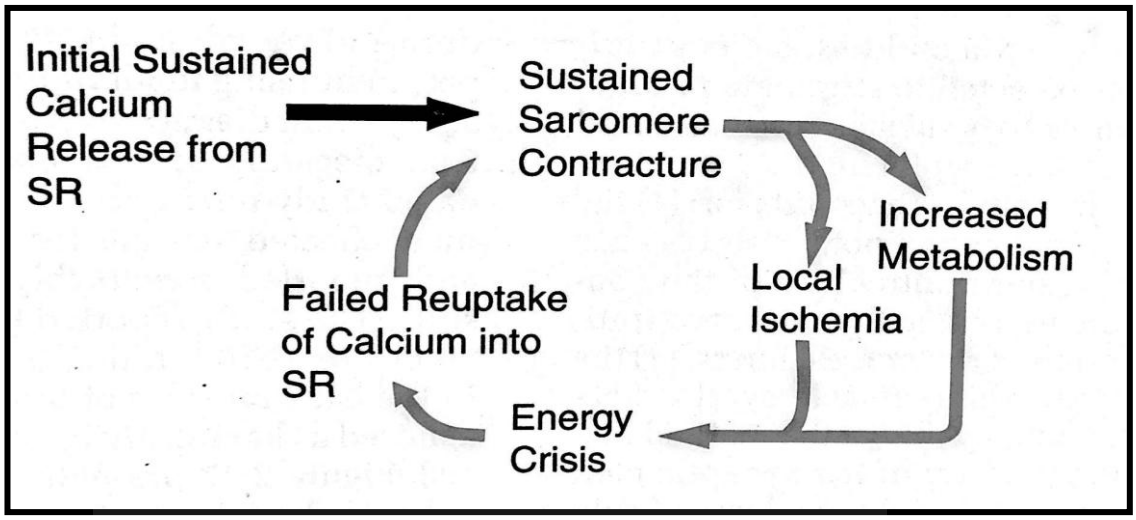

Figure 2.7: A schematic representation of the energy crisis hypothesis which postulates the cycle that appears to contribute to the formation of TrPs (Travell and Simons, 1999)

b) Motor endplate hypothesis

The motor end plates of a muscle are found at the distal end of a motor neuron fiber and form the post synaptic membrane of a synapse (Thibodeau and Patton, 2003). End plates in nearly all skeletal muscle are located near the middle of each fiber at the midway between its attachments (Travell and Simons, 1999). The terms neuromuscular junction and motor end plate are synonymous and are used with regards to structure and function (Dommerholt and Huijbregts, 2011).

The motor endplate hypothesis also called the dysfunctional endplate hypothesis describes that the foundation for all TrP formation occurs at the motor end plate of a muscle (Travell and Simons, 1999).

According to Huguenin (2004), the motor endplate hypothesis and the energy crisis theory could possibly co exist. Needle electromyogram (EMG) studies have found that a TrP contains a locus that produces characteristic electrical activity (Hubbard and Berkhoff, 1993). The endplate noise or spontaneous electrical activity (SEA) seen on EMG is thought to represent an increased rate of release of Ach from the nerve terminal. Small amounts of activity at the motor endplate can result in action potentials being propagated small distances along the muscle cell membrane. This small amount of activity and propagation may cause local sarcomere contraction and hence the formation of TrPs in close proximity to the motor endplates (Huguenin, 2004).

c) The intergrated hypothesis

The integrated hypothesis has evolved since its first introduction as the 'energy crisis hypothesis' in 1981 and is illustrated in Figure 2.8. It is based on a combination electrodiagnostic and histopathological evidence (Dommerholt and Huijbregts, 2011). According to Travell and Simons (1999), the integrated hypothesis indicates that a TrP is a region of many dysfunctional end plates and each dysfunctional end plate is associated with a section of muscle fiber that is maximally contracted. This region is called a contraction knot. The integrated hypothesis proposes a likely relationship between the dysfunctional end plates and the contraction knot.

The hypothesis is based on excessive Ach release from a dysfunctional motor nerve terminal into its synaptic cleft. Cholinestrase's function is impaired and this accentuates the effect. Ach activates Ach receptors in the post synaptic membrane to produce greatly increased numbers of miniature endplate potentials. These potentials occur so frequently that they produce end plate noise and sustained depolarization of the post synaptic membrane. Abnormal mitochondria in the nerve terminal indicate that there is an increased energy demand due to the excessive demand of Ach. The increased activity of the post synaptic membrane as well its sustained depolarization causes a further increased energy demand. Increases in sub-sarcolemmal mitochondria and abnormal mitochondria have also been reported (Travell and Simons, 1999).

The sustained depolarization of the post synaptic membrane might account for the release of calcium from the sarcoplasmic reticulum to produce the local sarcomere contractions of the contraction knots. This sustained release of calcium increases the energy demand of the calcium pumps in the sarcoplasmic membrane which return the calcium into the sarcoplasmic reticulum. The sustained contraction of the sarcomeres in the contraction knot depletes oxygen reserves and depletes local energy supplies (Travell and Simons, 1999).

The energy crisis in the region of the motor endplate releases neuro-active substances which sensitise sensory and autonomic nerves in the region. Sensitisation of nociceptors results in pain and tenderness of the TrP. There is evidence to suggest that autonomic nervous system activity can contribute to the excessive released of Ach from the nerve terminal which again fuels this self sustaining vicious cycle (Travell and Simons, 1999).

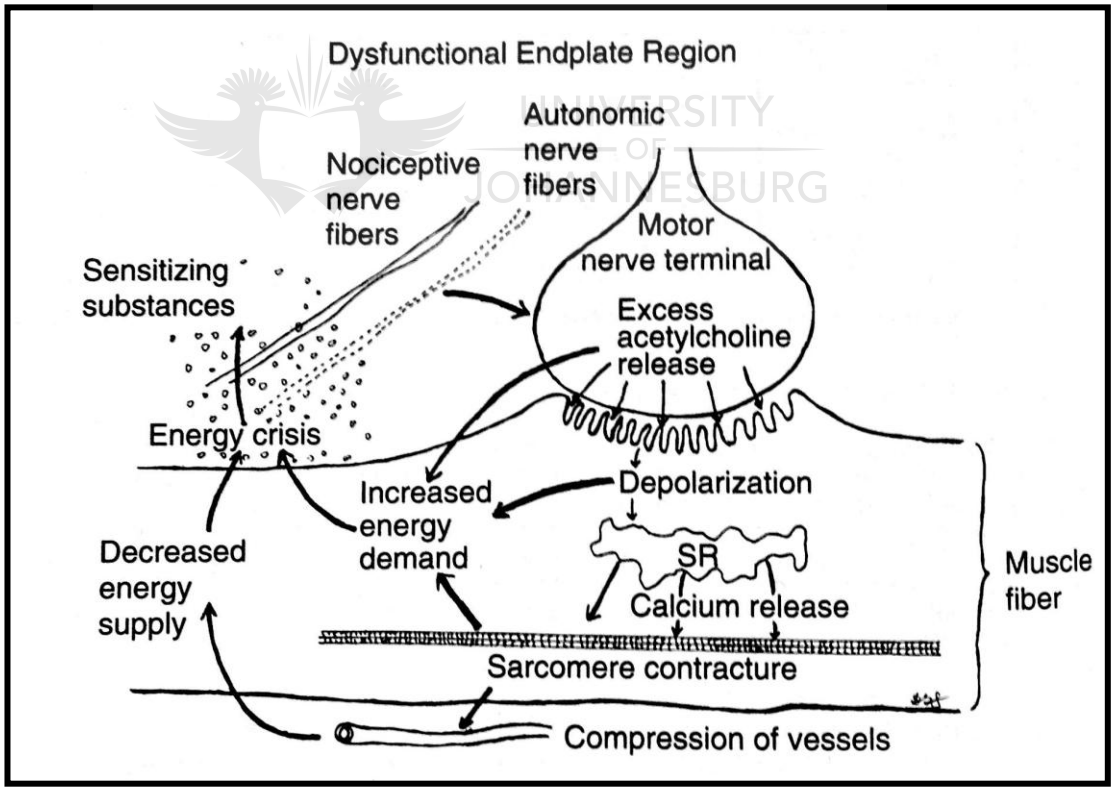

Figure 2.8: A schematic representation of the intergrated hypothesis (Travell and Simons, 1999)

2.3.9 Referral pain from myofascial trigger points

Travell and Simons (1999) defines referred TrP pain as “pain that arises in a trigger point, but is felt at a distance, often entirely remote from its source. The pattern of referred pain is reproducibly related to its site of origin”. Referral of pain is a common and typical feature of muscle pain, and TrPs in muscles are a well known source of referred pain. The location of the pain referral is usually constant therefore pain referral patterns were constructed. Occasionally there are exceptions to this rule and not all pain referral patterns follow the published patterns (Mense and Gerwin, 2010).

2.4 The Quadratus Lumborum Muscle

2.4.1 Anatomy

The quadratus lumborum muscle originates from the inferior border of the twelfth rib and transverse processes of first to the fourth lumbar vertebrae and inserts onto the posterior aspect of the iliac crest and iliolumbar ligament (Visniak, 2010). Figure 2.9 illustrates the quadratus lumborum muscle.

Three orientations of muscle fibres exist in the quadratus lumborum muscle according to Travell and Simons (1999):

- The iliocostal fibres run vertically from the inferior border of the twelfth rib to the iliac crest and iliolumber ligaments.
- The iliolumbar fibres run medially from the iliac crest and iliolumber ligaments to the transverse processes of the upper four lumbar vertebrae.
- The lumbocostal fibres contain the fewest number of fibres of the three quadratus muscle fibre orientations. They run diagonally and the span the space between the second to fourth lumbar transverse processes, inferiorly, and twelfth rib ,superiorly.

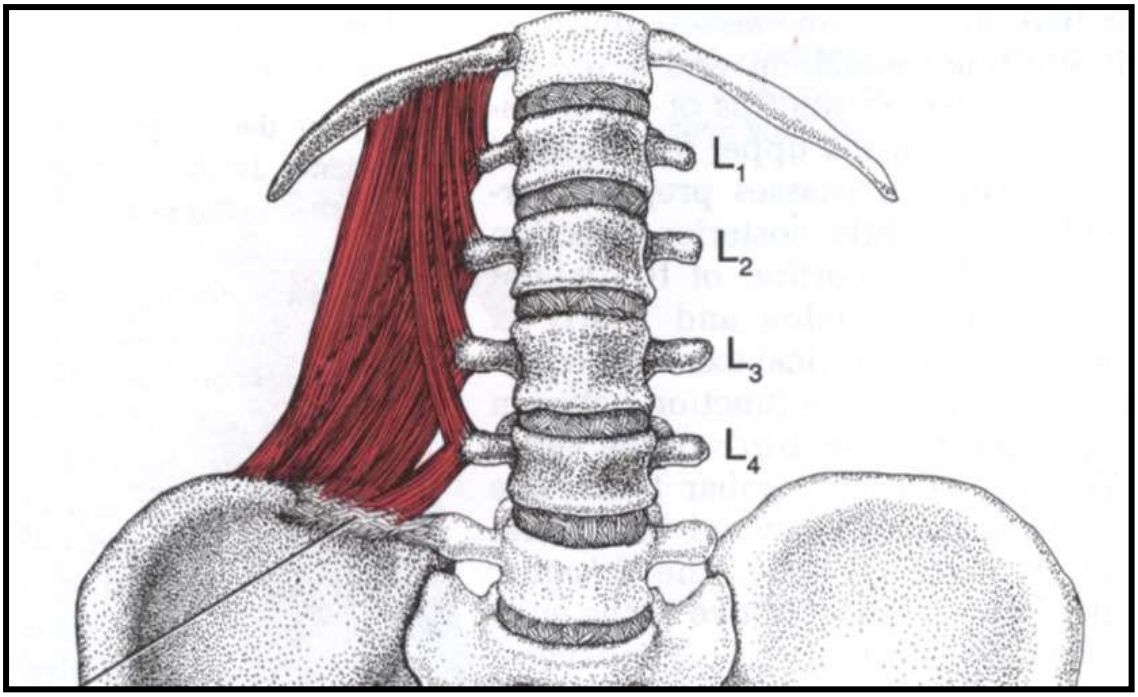

Figure 2.9: The quadratus lumborum and its attachments (Travell and Simons, 1999)

The quadratus lumborum muscle receives its nerve innervation from thoracolumbar spinal nerves specifically branches of the lumbar plexus arising from spinal nerves T12 and L1 to L4 (Travell and Simons, 1999).

During standing, the quadratus lumborums function is to regulate lateral flexion to the opposite side by a lengthening (isotonic) muscle contraction. It is a strong stabilizer of the lumbar spine onto the pelvis and paralysis of this muscle would make ambulation impossible. The unilateral action of the quadratus lumborum when the pelvis is fixed is lateral flexion of the spine and trunk to the homolateral side. With the spine fixed, unilateral contraction elevates (hikes) the pelvis on the homolateral side. The twelfth rib is also depressed during unilateral contractions. Acting bilaterally, extension is produced in the lumbosacral spine. Coughing and sneezing produces forceful contractions of the muscle which stabilize the rib cage (Travell and Simons, 1999 and Visniak, 2010).

2.4.2 Quadratus lumborum myofascial trigger points

Quadratus lumborum muscle is one of the most commonly affected muscles by TrPs. The quadratus lumborum has four TrPs: two superficial TrPs (refer to Figure 2.10), and two deep TrPs (refer to Figure 2.11) in a caudal and cephalad location. The superficial cephalad TrP is located directly underneath the twelfth rib. The deep cephalad TrP is located lateral to the transverse process of the third lumbar vertebra. The superficial caudal TrP is located above the iliac crest and the deep caudal TrP is located lateral to the transverse process of the fifth lumbar vertebra (Travell and Simons, 1999).

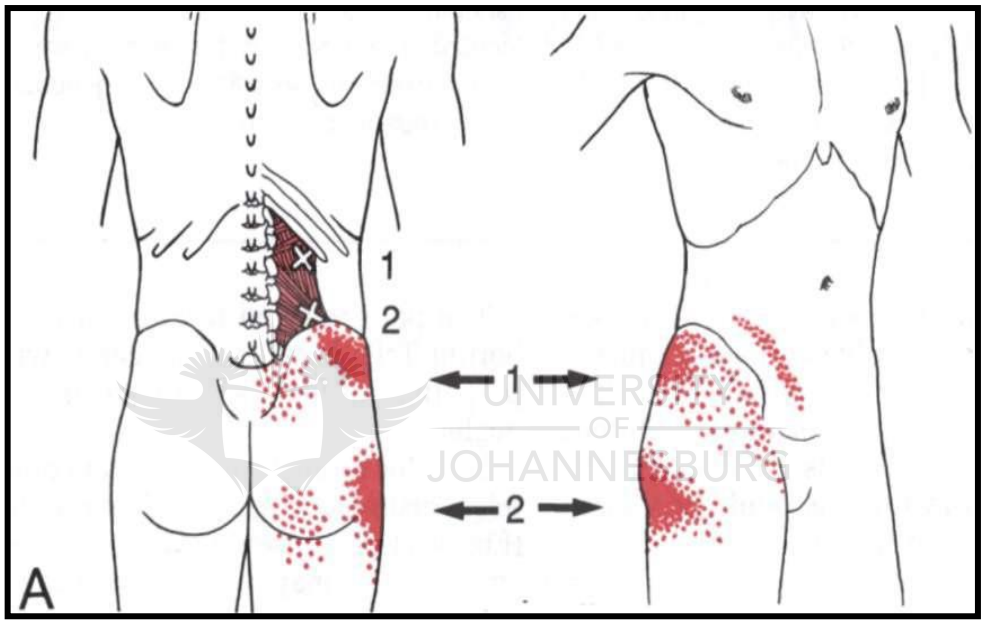

Figure 2.10: Superficial quadratus lumborum TrPs and their referred pain patterns (Travell and Simons, 1999)

According to Travel and Simons (1999), the quadratus lumborum muscle has four locations that refer pain unilaterally. The pain usually has a dull, deep and aching character but maybe sharp during movement. The superficial cephalad TrP refers pain along the iliac crest and occasionally to the adjacent lower abdominal quadrant. The pain may also extend to the lateral and upper aspect of the groin. The superficial caudal TrP refers pain to the greater trochanter of the femur and upper thigh regions. The deep cephalad TrP refer pain unilaterally to the sacroiliac joint. Pain that extends across the upper sacral area as a band is usually caused by bilateral involvement of this TrP. The deep caudal TrP refers pain to the lower buttock.

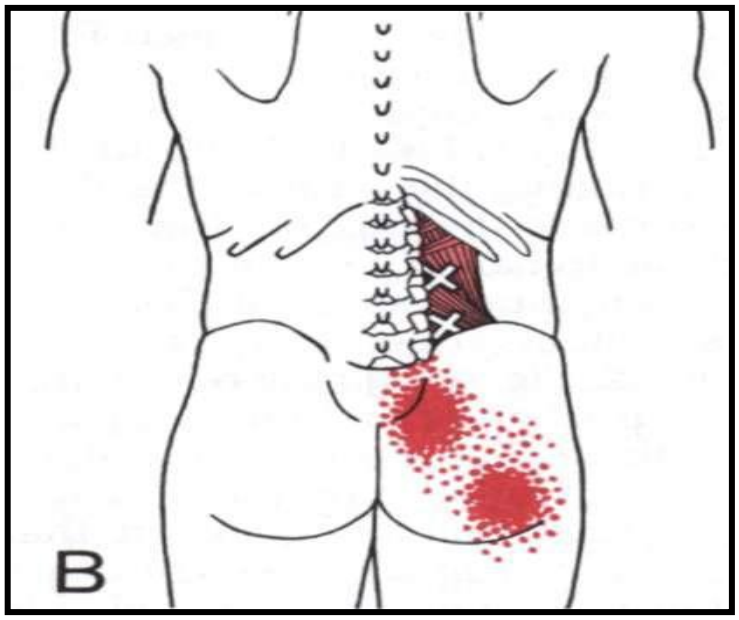

Figure 2.11: Deep quadratus lumborum TrPs and their referred pain patterns (Travell and Simons, 1999)

a) Symptoms of active quadratus lumborum myofascial trigger points

The quadratus lumborum muscle is one of the most commonly overlooked sources of lower back pain and often mimics more serious lower back pathology. It is called the "Joker of Low Back Pain". Symptoms resulting from active quadratus lumborum TrPs usually include: Severe lower back pain with a deep, dull and aching characteristic. It can present during rest or in any body position. Pain can become extreme during unsupported standing positions and in sitting or standing that increases weight bearing or require stabilization of the lumbar spine. Lower torso movement can cause a knifelike, cutting pain. Forward flexion may be restricted. Patients describe difficulty turning and leaning to the opposite side and climbing stairs can be painful. Coughing can enhance the pain. Getting out of a chair may be very difficult and upper limb assistance is usually needed.

Pain may extend into the referral zones of the TrP involved especially in the sacroiliac joint area and over greater trochanter and can be mistaken for local pathology. A patient with chronic TrPs may have loss of vitality and endurance due to energy required to suppress pain consciously and subconsciously and remain active in spite of it. Heaviness of the hips, calf cramps and burning sensation in the legs and feet has been reported. Quadratus

lumborum TrPs may cause additional pain by activating satellite TrPs in other muscles (Travell and Simons, 1999).

b) Activation and perpetuation

Due to the role the quadratus lumborum muscle plays in lumbar spine, pelvis and rib cage stabilisation, the muscle is commonly overloaded by: leg-length inequality, hemipelvis, short upper arms, soft bedding, leaning forward over a desk, standing or leaning over a low work surface and poorly conditioned abdominal muscles (Travell and Simons, 1999).

Quadratus lumborum TrPs are activated acutely by awkward movements and by sudden trauma. Awkward movements include: lifting a heavy load, bending coupled with rotation, to pick something up of the floor. Side or lateral bending can also cause these acute TrPs (Travell and Simons, 1999).

Quadratus lumborum TrPs can also be activated by repetitive movements. Activities such as gardening, lifting up heavy boxes, walking or jogging on slated surfaces all involve chronic repetitive movements which lead to repetitive microtrauma of the muscle. TrPs can become activated when agonist or antagonist muscles undergo shortening (eccentric) or lengthening (isotonic) contractions (Travell and Simons, 1999). Systemic factors such as vitamin and other nutritional deficiencies, metabolic disorders chronic infections and infestations, and emotional stress can all perpetuate quadratus lumborum TrPs (Travell and Simons, 1999).

2.5 Dry Needling Therapy

2.5.1 Introduction

TrP dry needling, also known as intramuscular stimulation, is an invasive procedure in which an acupuncture needle is inserted into the skin and muscle (Dommerholt and Huijbregts, 2011). Dry needling was first introduced by Lewit in the late 1970s. He had noticed that the pain relieving effect, previously thought to be the result of a local anaesthetic, may be due to needling (Baldry, 2001).

According to Dommerholt and Huijbregts (2011), Travell first described the use TrP injections in the treatment of myofascial pain in 1942. She further developed her work and it led to formulating the myofascial trigger point technique which used no intramuscular injection of solution. Both Travell and Lewit agreed that the mechanical stimulus of the needle results in the beneficial therapeutic benefits.

Cummings and Baldry (2007), suggests that there is no therapeutic difference between injection of a solution into a TrP and dry needling. The therapeutic effect is caused by the needle itself and not the solution within the injection. When comparing injection therapy with dry needling many authors suggest that dry needling provides as much pain relief as injection of lidocaine but causes more post-needling soreness (Dommerhalt, del Moral and Grobli, 2006). Kamanli, Kaya and Ardicoglu (2005), demonstrated in a study that dry needling yielded better results than injections with lidocaine and botulinium toxin in the treatment of myofascial pain.

According to Chaitow (2006), many ways of treating TrPs have been hypothesised, the most common being acupuncture, procaine injections and myofascial dry needling.

According to Dommerholt and Huijbregts (2011), superficial and deep dry needling techniques are used in treating TrPs. Research compiled by Ceccherelli, Rigoni, Gagliardi, and Ruzzante (2002), compared deep dry needling to superficial dry needling resulted in deep dry needling yielding significantly better analgesia than superficial dry needling.

2.5.2 Deep dry needling

The insertion of needles into TrPs for the relief of pain produced by them is a common practise (Baldry, 2001). Deactivation of a TrP may require deep dry needling. After palpating and locating an active TrP, the patient is positioned appropriately and a solid acupuncture needle is inserted in a controlled manner through the skin into the TrP lying within the muscle. As the needle enters the TrP an involuntary spinal reflex known as a local twitch response may be elicited (Dommerholt and Huijbregts, 2011).

TrP deep dry needling is an invasive technique aiming to "release" TrPs. The treatment utilizes acupuncture needles however it differs completely from traditional Chinese acupuncture (Dommerholt and Huijbregts, 2011).

Deep dry needling involves insertion of an acupuncture needle into a TrP within a muscle aiming to cause a reproduction in the patient's symptoms, visualisation of a local twitch response, deactivation of the TrP thereby reducing muscular pain and tension (Huguenin, 2004).

According to Rachlin (2002), deep dry needling causes a mechanical disruption of the TrP. Pain produced at the TrP zone and the exact placement of the needle into the point of maximal tenderness determines the efficacy of the treatment. The immediate analgesia produced is called the "needle effect". Although dry needling is effective in deactivating TrPs it can be painful for the patient and post injection soreness has been reported. Lewit stated "the effectiveness of treatment is related to the intensity of pain produced at the TrP and to the precision with which the site of maximal tenderness is located by the needle" (Baldry, 2001).

According to Dommerholt and Huijbregts (2011), a medical diagnosis, a medical examination, needle insertions into TrPs according to a myofascial examination and knowledge of anatomy is imperative to administer effective dry needling techniques.

2.5.3 Mechanism of myofascial dry needling

The therapeutic effect of myofascial dry needling is mechanical disruption of the TrP and the motor endplates are either damaged or destroyed which causes distal axon denervation when the needle comes into contact with the TrP. This triggers changes in the endplate cholinesterase and Ach receptors and the muscle regeneration process can commence. Satellite cells migrate from other area in the muscle and respond to the muscle damage and aid in the regeneration process by repairing or replacing damaged myofibrils (Dommerholt and Huijbregts, 2011).

According to Rachlin (2002), the possible mechanisms of pain relief following myofascial dry needling are as follows:

- The TrP including its muscular elements and nerve endings are mechanically disrupted by the needle.
- Nerve fibres are depolarized due to the release of intracellular potassium.
- An increase in endogenous opioids (neurohormonal beta-endorphins or somatospecific dorsal horn enkephalins).
- Central opiod release is thought to reduce pain perception by gating the spinal cord pain impulse transmission. This is known as diffuse noxious inhibitory control (Huguenin, 2004).
- Immediate analgesia known as the 'needle effect" is produced by needling a TrP (Dommerholt and Huijbregts, 2011 and Rachlin, 2002).
- Dry needling mechanically disrupts a TrP, releases endorphins, inhibits nociception and provides pain relief by spinal cord pathway modulation (Yap, 2007).
- Local twitch response elicitation is needed in achieving an immediate effect for pain relief (Cummings and Baldry, 2007). The presence of a local twitch response during dry needling should be as effective as botulinium toxen type 'A' injections (Dommerholt and Huijbregts (2011).

TrP dry needling comprises of the following mechanisms according to Dommerholt and Huijbregts (2011):

- A needle may provide a localised stretch to the contracted cytoskeletal structures, which allows for the sarcomeres to return to their normal resting length. The degree of overlap between the protein filaments, actin and myosin, are now reduced.
- The needle may electrically polarise the muscle and connective tissues.
- The 'needle grasp' is a phenomenon caused by muscle fibres contracting around the needle and holding it tightly in place.
- Rotation of the needle can facilitate the eliciting of typical pain referral patterns.
- Stimulation of sensory afferent nerve fibres may activate enkephalinergic, serotonergic and noradrenergic inhibitory systems during superficial dry needling. Acupuncture studies have reported changes in various parts of the brain with needling of acupuncture points in comparison with control points. It is likely that myofascial deep dry needling causes similar changes as well as activation of the descending inhibitory pathway.
- The natural response of dry needling includes the migration of satellite cells from other areas in the muscle when activated following muscle damage which aids in muscle regeneration (Dommerhalt, del Moral and Grobli, 2006).
- Dry needling has been shown to be effective in improving range of motion by the mechanical action of the needle which ultimately provides the energy in the form of ATP needed to unlock the actin-myosin cross bridges and reabsorb the calcium ions to allow for full lengthening of the effected muscle. Dry needling provides the necessary energy (ATP) to unlock actin-myosin cross bridge formations and the energy to reuptake calcium ions (Travell and Simons, 1983).

The neurological mechanisms of deep dry needling are as follows (Baldry, 2001):

1. Insertion of a needle into an active pain-producing TrP activates the pain-suppressing endogenous opioid system.

2. Repeated insertions of the needle into the TrP results in local twitch responses with lead to the following:

I. Alternations in muscle fibre length.
II. Mechanoreceptive large diameter sensory afferent input to dorsal horn.
III. Blockade of intra-dorsal horn passage of the TrP's nociceptive information.
IV. Alleviation of the TrP.

2.6 Muscle Energy Technique

2.6.1 Introduction

According to Chaitow (2006), the original developers of Muscle Energy Techniques (MET) were Mitchell (1967) and T.J Ruddy (1961). T.J. Ruddy developed a treatment method involving patient-induced, rapid, pulsating contractions against resistance termed 'rapid resistive duction'. Mitchell used this work as the basis for the evolution of MET. Stretching methods compiled by Travell and Simons (1983) were derived from muscle energy procedures, who had accepted earlier methods described by Lewit (1984) who had studied with Mitchell. MET has evolved and been refined and now crosses all interdisciplinary boundaries. MET is being widely adopted in the clinical setting because it appears to be gentle, safe and effective.

MET have a number of clinical uses according to Greenman (1996) and Fryer (2011):

- It can be used to lengthen a shortened muscle, contractured, or spastic muscles.
- Strengthen a weakened group of muscles.
- Reduce edema and relieve passive congestion.
- Lymphatic drainage.
- Mobilization of a restricted joint.

MET is shown to be a safe, easy and effective means of decreasing TrPs in a muscle, since TrPs usually respond quickly to stretching techniques. A number of researchers, including Lewit (1984), have reported that MET is an excellent method of treating TrPs. TrPs will re-activate if the muscle in which it lies, cannot easily reach its normal resting length (Chaitow, 2006).

2.6.2 Definition of Muscle Energy Technique

MET are forms of soft tissue osteopathic manipulation methods and were designed to help restore musculoskeletal function and reduce pain (Chaitow, 2006).

Methods are used in which the patient actively contracts a muscle or various muscles from a controlled position, in a specific direction, with the appropriate effort against a precise counterforce given by the practitioner. Contractions can be isometric, isotonic or isolytic

depending on the therapeutic effect required. The practitioner ascertains how contractions should be administered and can begin from or before the barrier of resistance, depending on acute or chronic conditions (Chaitow and DeLany, 2008). Clinical experience has shown that three to five repetitions of muscle effort for three - seven seconds each are required to produce a therapeutic effect (Greenman, 1996).

2.6.3 Force of isometric contraction used in Muscle Energy Technique

Light contractions enable the practitioner to control the forces involved. The patient experiences greater comfort and reduced pain when contractions are not strong. Contractions are kept light in MET methodology. The force of contractions can either be twenty or thirty percent of the patient's available strength, depending on acute or chronic settings. It has been suggested that when a contraction exceeds thirty to thirty-five percent of strength available, phasic muscles are activated. In most instances the postural fibres require stretching therefore introducing post isometric relaxation to the phasic fibres would have little advantage (Chaitow, 2006).

2.6.4 Physiological mechanisms of Muscle Energy Technique

There are two physiological mechanisms, post-isometric relaxation and reciprocal inhibition, which can take place in order to reduce muscle tone within a muscle or group of muscles according to Chaitow (2006):

Post-isometric relaxation is the term referring to when a muscle or group of muscles experiences reduced muscle tone following an isometric contraction (refer to Figure 2.12). Passive stretching can now be accomplished during this relaxed refractory period. Golgi tendon organ proprioceptors experience an increased tension during muscle contraction and a reflex neurological loop is activated causing inhibition or a post-isometric relaxation effect in that muscle. Ward (2003), states that the goal of post isometric relaxation is to accomplish muscle relaxation.

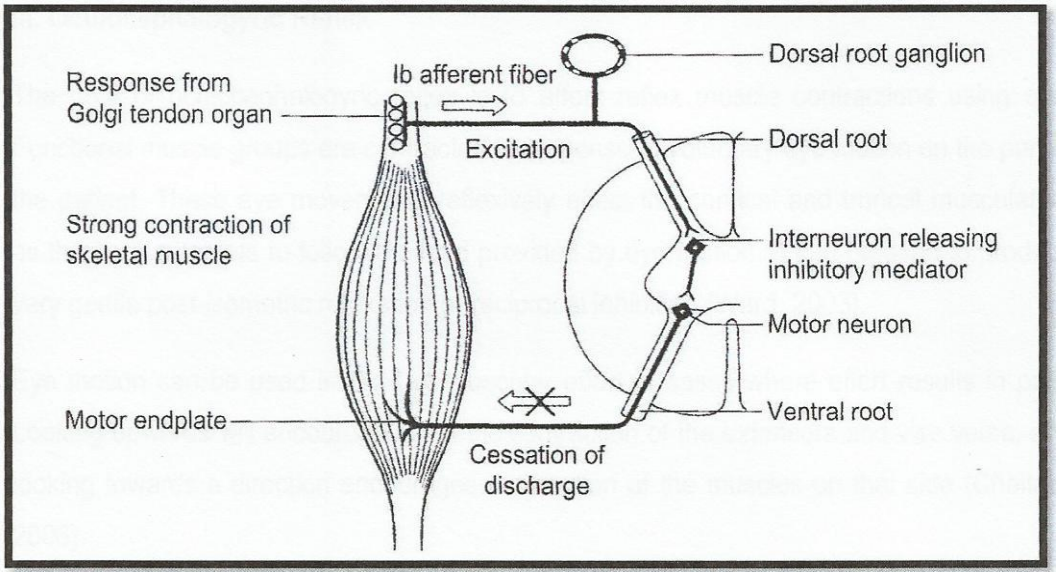

Figure 2.12: Neurophysiological mechanism during post-isometric relaxation (Chaitow, 2006)

Reciprocal inhibition involves lengthening or decreasing muscle tone of an antagonist muscle or muscle group by isometrically contracting the agonist muscle which initiates the neurological reflex (refer to Figure 2.13). Ward (2003), states that the goal of reciprocal inhibition is to lengthen a muscle shortened by cramp or acute spasm.

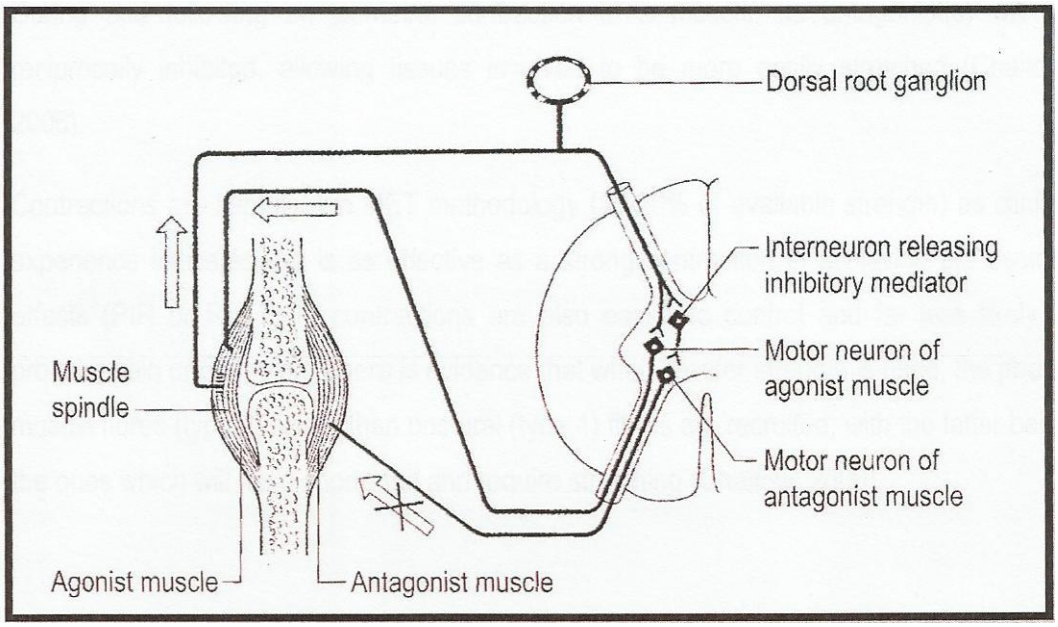

Figure 2.13: Neurophysiological mechanism during reciprocal inhibition (Chaitow, 2006)

2.6.5 Mechanisms of the therapeutic effect of Muscle Energy Technique

a) Muscle Energy Technique and pain

MET may have an influence on pain mechanisms and promote hypoalgesia. MET and other techniques that incorporate post-isometric relaxation reduce pain and discomfort when applied to muscles. Central and peripheral modulatory mechanisms may be involved such as activation of mechanoreceptors that involve centrally mediated pathways, like the periaqeductal gray matter in the midbrain or non opioid seratonergic and noradrenergic descending inhibitory pathways (Fryer, 2011).

Fluid drainage may also be increased by MET and promote hypoalgesia. Muscle contractions increase blood blow and lymphatic drainage. Mechanical forces change interstitial pressure and increase capillary blood flow. MET may reduce pro inflammatory cytokines and desensitize peripheral nociceptors (Fryer, 2011).

MET has been proposed to improve lymphatic flow and reduce oedema. Muscle contractions increases interstitial tissue fluid collection and lymphatic flow. Physical activity increases lymphatic flow through the collecting ducts, thoracic duct and within muscle during concentric and isometric muscle contraction. Thus, MET may assist lymphatic flow and remove excess tissue fluid to promote hypoalgesia (Fryer, 2011).

Several clinical trials investigating osteopathic management of spinal pain, have included MET as a treatment component. The trials provided support for MET's effectiveness as treatments significantly reduced pain and disalility (Fryer, 2011). Lamberth, Hansen, Bloch-Thomson, Silbye and Remvig (2005), reported a decrease in pain following MET in the treatment of acute lower back pain.

b) Myofascial extensibility

The physiological mechanisms behind myofascial extensibility produced by MET remain controversial. There are three mechanisms which are thought to account for the short and medium term changes in myofascial extensibility: Reflex relaxation, viscoelastic or muscle property change and changes to stretch intolerance. The change to stretch intolerance is the most supported mechanism by the scientific literature (Chaitow, 2006).

- Reflex relaxation, facilitated by MET techniques, is caused by a neurological reflex which follows an isometric muscle contraction. Muscle relaxation following an isometric contraction has been proposed to occur by activation of the golgi tendon organs and their inhibitory influence on the α-motor neuron pool or due to reciprocal inhibition produced by an antagonist muscle contraction. There is evidence to suggest that MET may produce reflex inhibition of the a-motor neuron pool and is consistent with many protocols which recommend five to ten second isometric muscle contractions followed by stretching. Several studies support the concept of neurological muscle relaxation in MET. Moore and Kukulka (1991), examined H-reflexes (an indicator of a-motor neuron pool excitability) of the soleus muscle where by 16 subjects performed isometric plantar flexion contractions. The researchers found that a strong brief suppression of the soleus H-reflex occurred in all the subjects and lasted for 10 seconds (Chaitow, 2006).
- Viscoelasticity is the term used to describe connective tissues as having mechanical properties relating to their fluid or gel components and their elastic properties. Tissue responds with slow elongation or 'creep' when a constant stretching force is applied to the tissue. The tissue 'creep' results in a loss of energy (hysteresis) and repetition of loading will result in greater deformation. Isometric muscle contractions and stretching have been found to produce similar reductions in tissue tension. Contractions and stretching techniques (as used in MET) may be more affective for producing viscoelastic change than passive stretching alone. The combined forces could produce greater viscoelastic change and passive extensibility. Stretch and isometric contractions may affect water content and produce an alteration to the length and stiffness of the tissue involved. Therefore MET may help realign maturing connective tissues along the lines of force, and break poorly aligned cross linkages (Chaitow, 2006).
- Stretch tolerance has been shown to improve after MET (Ballantyne, Fryer and McLaughlin, 2003). Range of motion gains following passive stretching or MET have been reported in many studies. It is also reported that MET methods may produce a greater change in stretch tolerance than passive stretching. Stretching and isometric contraction stimulate muscle and joint mechanoreceptors and proprioceptors. Large diameter mechanorepectors produces inhibition of pain at the dorsal horn of the spinal

cord. The application of MET may decrease the patient's perception of muscle pain and appear to produce lasting changes in stretch tolerance. The mechanism may therefore be more complex than just gating the spinal cord. Changes in the higher centres of the central nervous system may be involved (Chaitow, 2006).

c) Muscle Energy Technique and myofascial trigger points

The prognosis for patients with TrPs is excellent since TrPs usually respond quickly to manipulative techniques which include stretching (Chaitow 2006). MET is shown to be a safe, easy and effective means of decreasing TrPs in a muscle (Chaitow, 2006). Most TrP treatments offer temporary relief however MET offers a useful means of treatment since normal muscle resting length is restored and TrPs do not re-activate. It is understood that a TrP will re-activate if the muscle in which it lies, cannot easily reach its normal resting length (Chaitow, 2006).

Treatment methods involving stretching alter the dynamics of the circulatory imbalance affecting the TrPs and appear to deactivate them. Stretching of a muscle using either active or passive stretching methods, as used in MET, is useful in treating both the shortness of the muscle and the TrP since this can reduce the taut band as well as increase circulation to the area. The MET sequence (contraction-relax-stretch) lends itself to reducing pain, muscle tenderness and TrPs (Chaitow, 2006).

Post isometric relaxation is the essence of many effective TrP release techniques. Gentle muscle contraction tends to equalize sarcomere length in fibers affected by TrPs. Sarcomeres within contraction knots can no longer exert any contractile forces because they are already maximally shortened. However the sarcomeres between the TrP and the muscle fiber attachments are in an optimal state for muscle contraction. Therefore gentle voluntary contraction allows the lengthened sarcomeres to exert an effective elongation force on the shortened sarcomeres of the TrP (Simons, 2002).

d) Muscle Energy Technique and range of motion

According to Chaitow (2006), MET can be used to increase spinal range of motion as the technique focuses on restoring dysfunctional soft tissue which may be the reason for the limited range of motion. A few studies have reported spinal range of motion gains following

MET. MET has been demonstrated to produce increases in spinal range of motion when applied to a single motion segment. Shenk, Adelman and Rousselle (1994) examined the effects of MET on range of motion for the cervical region over a four week period involving multiple MET sessions and noted that cervical range of motion significantly increased. Shenk *et al* (1994), applied MET to the thoracic spine in the direction of the restricted rotation significantly produced increased range of active trunk rotation. Lenehan, Fryer and McLaughlin (2003), showed an increased in thoracic rotation following one MET isometric contraction. A study by Prachi, Basavaraj, Santosh and Subhash (2010), concluded that MET on the quadratus lumborum showed significant statistically difference in reduction in disability and increase in spinal range of motion. Research conducted in Stockholm by Brodin (1987), investigated the effects of MET on low back pain sufferers. The group receiving treatment, in the form of MET, showed significant pain reduction as well as an increase in mobility of the lumbar spine.

2.7 Conclusion

This chapter served as a literature review pertinent to this study. The following topics were discussed; the anatomy and physiology of skeletal muscle; myofascial TrPs; the anatomy of the quadratus lumborum muscle; the location and referral patterns of quadratus lumborum TrPs; dry needling therapy and MET. The following chapter will provide a detailed explanation of the methods in which the study was conducted.

CHAPTER THREE: METHODOLOGY

3.1. Introduction

A systematic description of the study design, the participant recruitment procedure and the treatment protocol that followed, will be discussed in this chapter. It further describes the assessments performed and type of measurements recorded. The chapter concludes with ethical considerations.

3.2. Study Design

This is a comparative study, as the outcomes and efficacy of two treatment interventions namely Muscle Energy Technique (MET) and myofascial dry needling, were compared. The study is a randomised controlled study to eliminate selection bias.

3.3. Participant Recruitment

Advertisements were placed on notice boards throughout the University of Johannesburg Doorfontein Campus and Chiropractic Day Clinic to recruit possible participants (Appendix A). Any individuals, between the ages of eighteen and forty five, who presented to the University of Johannesburg Chiropractic Day Clinic with localised lower back, or other areas, of pain referred by an active TrP in either quadratus lumborum muscle, were considered as a potential candidate for the study.

3.4. Sample Selection and Size

Thirty participants were informed of the nature of the study, and screened to ensure that they adhered to the inclusion and exclusion criteria. The participants were randomly divided into two groups of fifteen each. Every participant was required to read and sign the information and consent form specific to this study (Appendix B).

3.4.1. Participant criteria

The inclusion and exclusion criteria for this study determined which participants were accepted or rejected.

a) Inclusion criteria

Inclusion criteria for prospective participants included:

- Males and females between the ages of eighteen to forty-five years old. Kalichman and Vulfsons (2010) state myofacial pain may affect up to ten percent of the adult population at any given time.
- Localised lower back pain, or other areas of pain referred by an active TrPs in either quadratus lumborum muscle, confirmed by palpation.
- At least one active TrP. Active TrPs produce pain, refer pain at rest or upon movement, exhibit tenderness on palpation, prevent the muscle from lengthening and weakens muscle (Travell and Simons, 1999). Compression of an active TrP causes local pain as well as referred pain and symptoms at a distant site (Rachlin, 2002). The TrP could present on the left and right hand side, unilaterally or bilaterally. The most severe TrP was treated, if more than one TrP was found.

b) Exclusion criteria

Exclusion criteria for prospective participants included:

- Participants should not have taken any analgesics, non-steroidal anti-inflammatory drugs or muscle relaxants for the duration of the study as well as two days prior to the study.
- Participants should not have received any other form of treatment that may have interfered with the results of the study, prior to commencement and for the duration of the study.
- Contra-indications to myofascial dry needling (Appendix C).

- Contra-indications to MET: Chaitow (2006) states that if pathology is suspected, MET should not be used until an accurate diagnosis is made. The force of contraction, stretching and repetitions can be adjusted accordingly once a correct diagnosis has been made.

3.5. Group Randomisation

The random group allocation process was done by drawing from a container which group the participants would be assigned to. Fifteen folded cards with the letters "MET" printed on them indicated participants would be in the MET group, group 1. Fifteen folded cards with the word "Needling" printed on them indicated participants would be placed in the myofascial dry needling group, group 2.

3.6. Treatment Approach

3.6.1. First visit

This visit involved the following:

- Signing an informed consent form (Appendix B).
- Completion of a thorough case history (Appendix D).
- Completion of a physical examination (Appendix E).
- Completion of a lumbar spine regional examination (Appendix F).
- A SOAP note was completed prior to treatment (Appendix G).
- Palpation for the most active quadratus lumborum TrP.
- Completion of a Numerical Pain Rating Scale (Appendix H) and Oswestry Disability Index for Lower Back Pain (Appendix I), done by the participant.
- All lumbar spine ranges of motion (flexion, extension, lateral flexion and rotation) were measured with the digital inclinometer by the researcher and recorded on the participants data sheet (Appendix J).
- The most active quadratus lumborum TrP was measured using a pain pressure algometer (Appendix K).

- Participants received treatment in the form of myofascial dry needling or MET (Appendix L) depending on their allocated group.

3.6.2. Follow-up visits

- Participants were treated twice a week over a maximum of two weeks; they then attended a fifth follow-up visit where no treatment was administered, only readings of subjective and objective data were taken.
- Participants received treatment in the form of myofascial dry needling of the most active TrP in the quadratus lumborum muscle or MET repeated three to five times to the quadratus lumborum muscle with the most active TrP, depending on their allocated group.
- Participants were requested again before the third visit and at the fifth visit to complete the Numerical Pain Rating Scale (NPRS), as well as the Oswestry Disability Index for Lower Back Pain (ODI).
- Lumbar spine range of motion was assessed again before the third visit and the fifth visit using the digital inclinometer machine.
- The most active myofascial quadratus lumborum TrP was assessed before the third and fifth visits using the pain pressure algometer.
- A SOAP note was completed prior to treatment.
- No treatment was administered on the fifth visit and only readings were taken.
- No chiropractic adjustments were included in any of the visits.
- No post needling protocol was used in this study.

3.7. Myofascial Trigger Point Location

During the lumbar spine regional exam all participants underwent a TrP examination of the quadratus lumborum muscles. There are four TrPs in the quadratus lumborum muscle, specifically two superficial and two deep in a caudal and cephalad location:

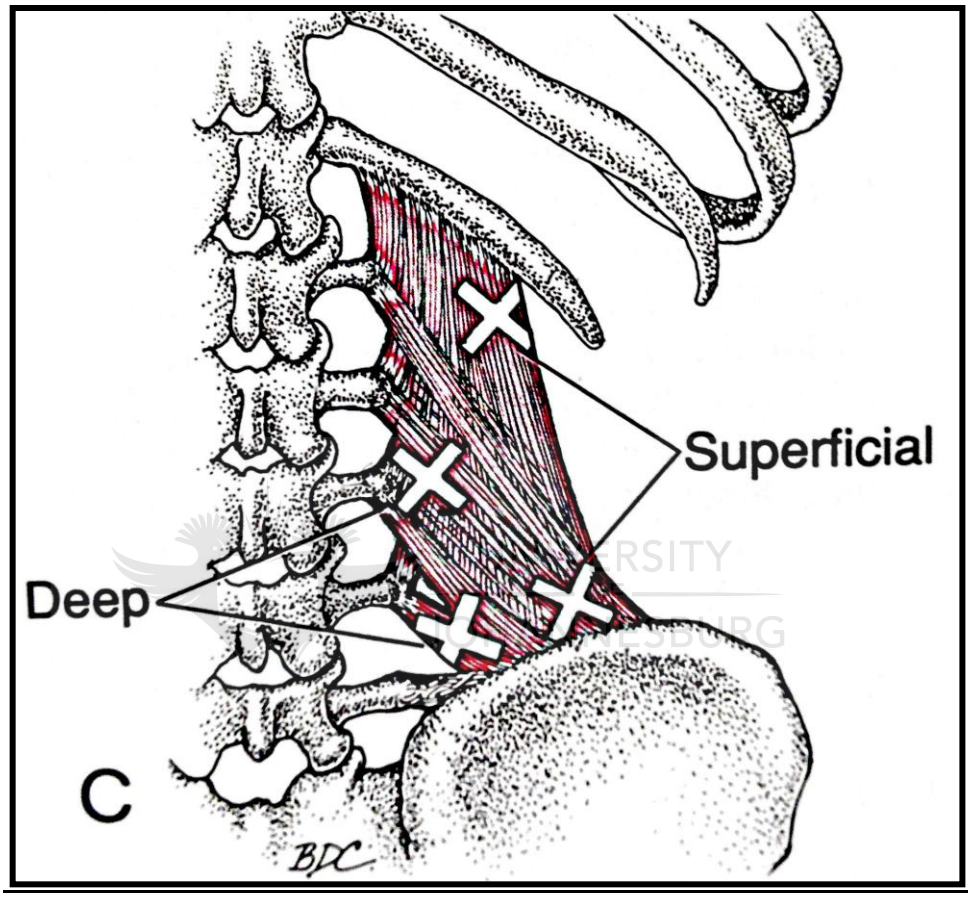

Figure 3.1: Location of the TrPs in the quadratus lumborum muscle (Travell and Simons, 1999)

When assessing the TrPs of the quadratus lumborum, the participant was side lying. The chest was elevated by the participant reaching upward with the uppermost arm behind the head to grasp the end of the examination table. The knee of the participants' uppermost limb was placed on the examination table, behind the other knee. Three regions were examined in this position for TrPs.

The first region was deep and in the angle where the crest of the ilium and paraspinal muscles meet, near the level of the L4 transverse process. The muscle was then palpated by applying deep finger tip pressure superior to the crest of the ilium and anterior to the paraspinal muscles. The second region extends along the inner crest of the ilium where the iliocostal fibres attach. Fingertip pressure was applied to these fibres. The third region lies in the angle where the paraspinal muscles and the twelfth rib meet. Deep finger tip pressure was applied to the cephalad iliocostal and lumbocostal fibres.

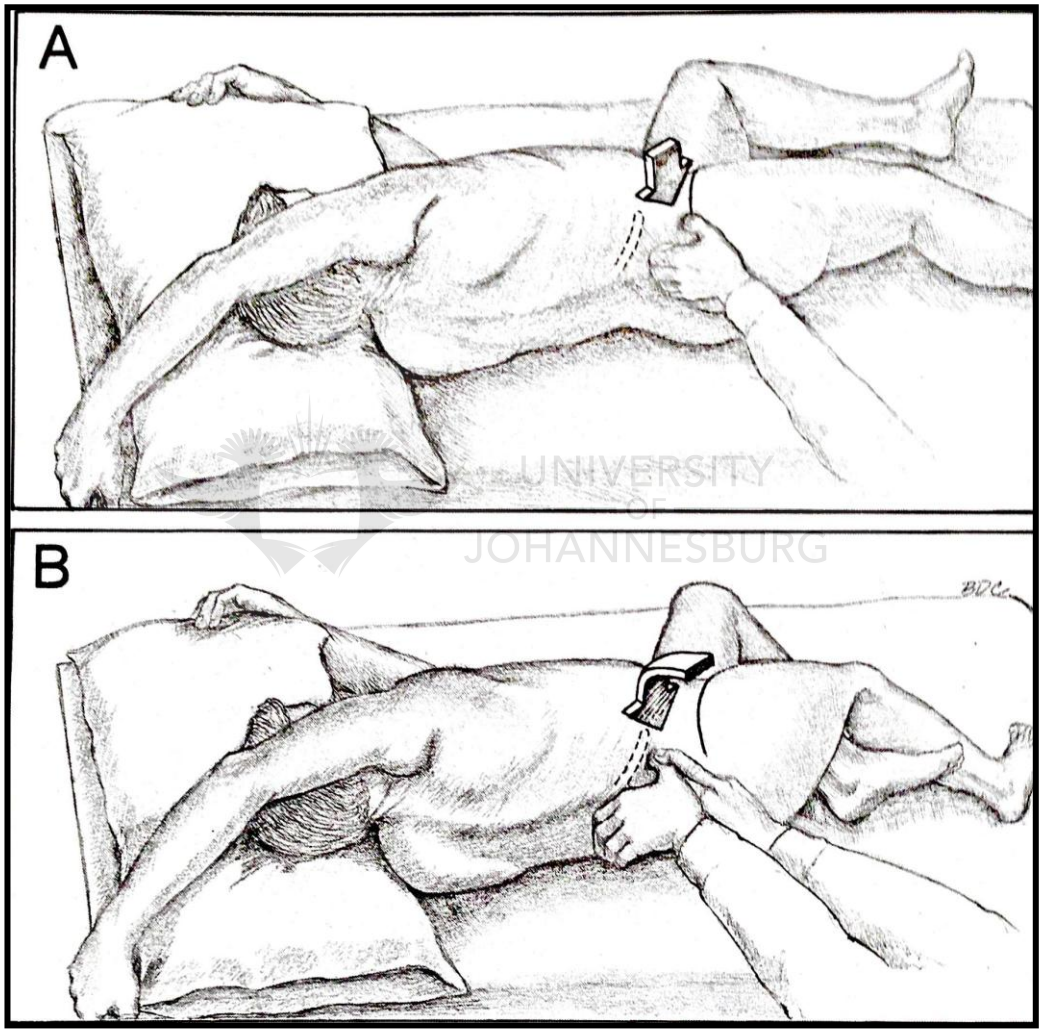

Figure 3.2: A schematic representation of examination of the quadratus lumborum muscle for TrPs. A, the examiner is palpating for superficial quadratus lumborum TrPs just above the iliac crest and anterior to the paraspinal muscles. B, the examiner is palpating with deeper pressure to locate deeper quadratus lumborum TrPs (Travel and Simons, 1999)

With the participant in this position the examiner applied pressure, in a caudad direction, towards the lumbar transverse processes between regions one and three (Travell and Simons, 1999).

3.8. Treatment Interventions

3.8.1. Myofascial dry needling technique

TrP dry needling, also known as intramuscular stimulation, is an invasive procedure in which an acupuncture needle is inserted into the skin and muscle (Dommerholt and Huijbregts, 2011). As the needle enters the TrP an involuntary spinal reflex known as a local twitch response may be elicited (Dommerholt and Huijbregts, 2011). Deep dry needling aims to cause a reproduction in the patient's symptoms, visualisation of a local twitch response, deactivation of the TrP thereby reducing muscular pain and tension (Huguenin, 2004). The needle is left in the TrP for seven to ten minutes (Travell and Simons, 1999).

Figure 3.3: A schematic diagram illustrating dry needling of the deep TrPs of the quadratus lumborum muscle (Travell and Simons, 1999)

Dry needling of the quadratus lumborum was performed in the examination position. Dry needling of the deep TrPs required the participants' lumbar spine to be perpendicular to the

treatment table. The direction to approach the spot of tenderness was confirmed and pressure was applied to depress the skin over the muscle. The needle was aimed straight downward toward the tender spot in the direction of a transverse process. The more anterior fibers of the iliocostal portion of the quadratus lumborum, near the iliac crest were dry needled under palpatory control. Dry needling cephalad of the L1 spinous process was avoided as there is a risk of piercing the lung. The reason for this is that the quadratus lumborum and the diaphragm attach to the twelfth rib (Travell and Simons, 1999).

3.8.2. Muscle Energy Technique

The participant was lying supine with the feet crossed (the side treated was crossed under the non treated-side leg) at the ankle. The participant was arranged in a light side-bend, away from the side which was treated, so that the pelvis was towards that side, and the feet and head away from that side ('banana shaped'). When this side-bend was achieved, the affected quadratus lumborum was palpated for bind so that the barrier was correctly identified. The participant's heels were placed just off the side of the table, anchoring the lower extremities and pelvis. The participant placed the arm of the side to be treated behind his/her neck as the practitioner, stood on the side opposite which was treated, slid his cephalad hand under the participants shoulders and grasped the treated-side axilla. The participant grasped the practitioner's cephalad arm at the elbow, with the treated side hand making the contact more secure. The participant's non-treated side hand was interlocked with the practitioner's cephalad hand. The participant's treated side elbow at this stage was pointing superiorly. The practitioner's cauded hand was placed firmly but carefully on the anterior superior iliac spine, on the side which was treated. This produced an isometric contraction in quadratus lumborum on the side which was treated. After 7 seconds the patient was asked to relax completely and then to side bend towards the non-treated side, as the practitioner simultaneously transferred his body weight from the cephalad leg to the caudad leg and leant backwards slightly, in order to side-bend the participant. This effectively stretched the quadratus lumborum muscle. The stretch was held for thirty seconds, allowing for the lengthening of shortened musculature in the region. The treatment was repeated if it was deemed necessary (Chaitow, 2006).

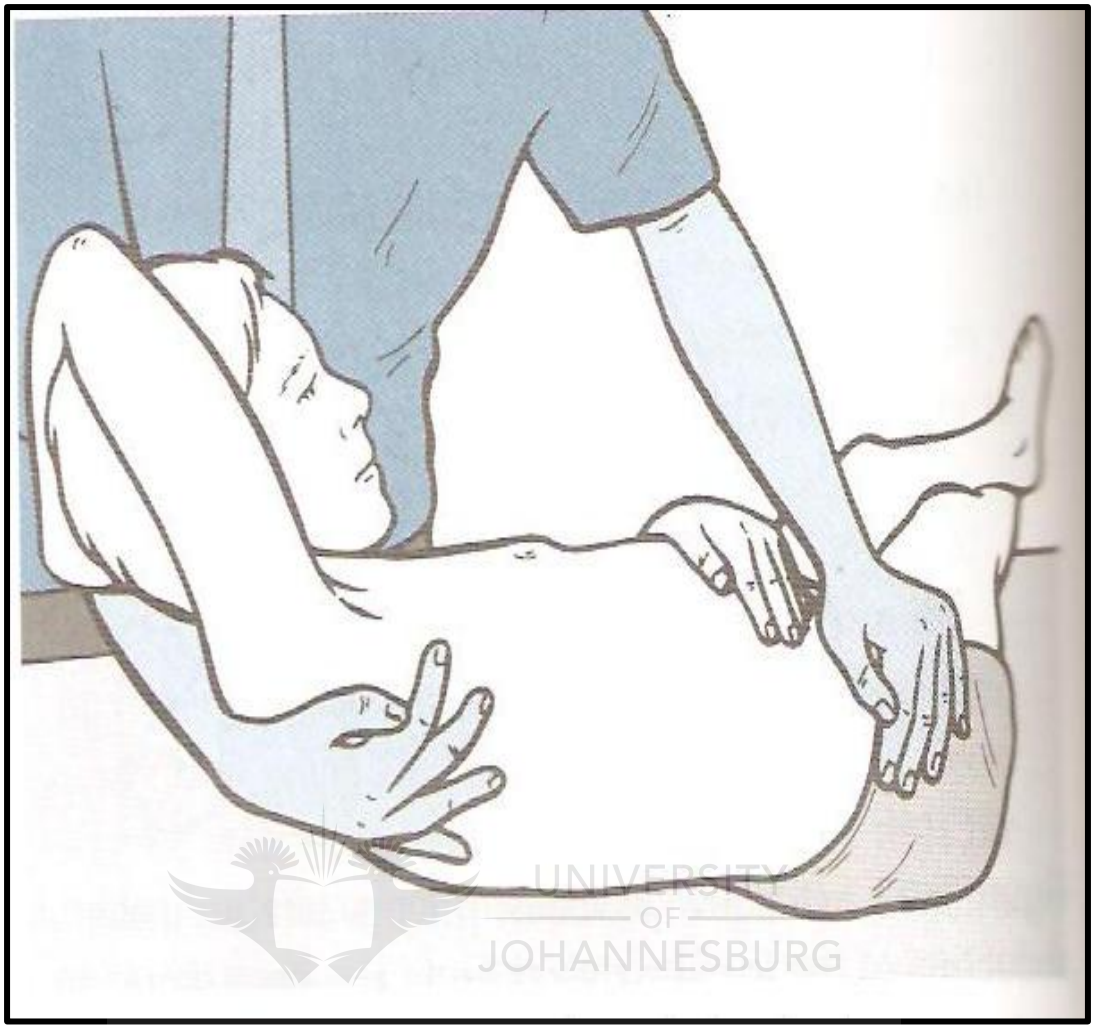

Figure 3.4: MET of the quadratus lumborum muscle (Chaitow, 2006)

3.9. Subjective Data

Participants were required to complete a Numerical Pain Rating Scale and an Oswestry Disability Index for Lower Back Pain questionnaire. On the first, third and fifth visits, prior to the relative treatment, the questionnaires were completed.

3.9.1. Numerical Pain Rating Scale

The Numerical Pain Rating Scale (NPRS) is a patient-completed 11-point pain scale and was completed on the first, third and fifth visits. Participants were asked to indicate the severity of their pain at that particular moment using a scale marked from zero to ten. Zero represents 'no pain' and ten represents 'worst imaginable pain' the participant had experienced. A two or three rating would indicate "mild pain" and a rating of seven or higher "severe pain" (McCaffery and Pasero, 1999). The numerical pain rating scale is commonly used to acquire subjective measurement of pain in the research and practice settings (Haneline, 2007).

The NPRS has been shown to be reliable and valid by Marquie, Duarte, Marine, Lauque, and Sorum (2008). The NPRS is the preferred scale for research trials involving pain rating due to its ease of use and responsiveness and sensitivity to fluctuating pain intensities (Bolton and Wilkinson, 1998).

3.9.2. Oswestry Disability Index for Lower Back Pain

The Oswestry Disability Index for Lower Back Pain (ODI) is a lower back specific questionnaire compiled by Fairbank and Pynsent (2000). Participants completed the ODI on the first, third and fifth visits. There are a total of ten questions, with six possible answers per question. Each question has a maximum score of five and a minimum score of zero. The points per section are then added up to get a final score out of a possible fifty points (Fairbank and Pynsent, 2000).

If more than one option per section was selected, the highest score was selected for calculation. Nine out of ten sections were calculated if any section was left out.

Score interpretation for the ODI (Fairbank and Pynsent, 2000):

Table 3.1: Score and interpretation of the Oswestry Disability Index for Lower Back Pain (Fairbank and Pynsent, 2000)

Score:	Interpretation:
0 – 10	Minimal disability
11 – 20	Moderate disability
21 – 30	Severe disability
31 – 40	Crippled
41 – 50	Bed-bound or exaggerating symptoms.

The validity and reliability of the ODI has been proven and well established in subjectively measuring low back pain. It was used to attain subjective data regarding the participant's lower back pain and activities of daily living (Haneline, 2007).

Davidson and Keating (2002) compared the reliability and responsiveness of five low back disability questionnaires, it was concluded that the ODI was the most reliable. Another study compared nine self-administered questionnaires designed to evaluate disability caused by back pain, determined that the ODI was one of three questionnaires that best assessed the level of disability caused by back pain (Rocchi, Sisti, Benedetti, Valentini, Bellagamba and Federici, 2005). In a recent study, Astfalck, O'Sullivan, Straker, Smith, Burnett, Caneiro and Dankaerts (2010) showed that the ODI is both reliable and valid in the evaluation of chronic low back pain and disability in both adults as well as adolescents.

3.10. Objective Data

The range of motion of the participant's lumbar spine was measured using the digital inclinometer instrument. The measurements were recorded on the LROM digital

inclinometer data sheet (appendix J). Pain was measured using the pain pressure algometer. Readings were taken on the first third and fifth visits. The measurements were recorded on the algometer measurement table (Appendix K). Readings were taken on the first third and fifth visits.

3.10.1. Digital inclinometer

A digital inclinometer was used to assess active lumbar spine ranges of motion (ROM) in flexion, extension, lateral flexion, and rotation. The portable, hand held inclinometer has a LCD display of its position. Lumbar spine range of motion was recorded in degrees and tabulated for comparison and statistical analysis. Measurements for all ranges of motion were recorded at the T12-L1 interspace and the L5-S1 interspace (Saunders, 1997). The degrees of motion were noted and recorded on the participants' data sheet (Appendix J). Objective measurements with the digital inclinometer were taken at the first, third and fifth consultations.

A study conducted by Saur, Ensink, Frese, Seeger and Hildebrandt (1996) measured the reliability and validity of measuring lumbar spine range of motion with an inclinometer. The inclinometer was concluded to be a highly reliable and valid useful clinical tool for measuring lumbar spine range of motion.

a) Lumbar spine flexion and extension

1. The participant was asked to stand erect
2. The researcher identified the T12-L1 interspace
3. The digital inclinometer was placed at the T12-L1 interspace (Saunders, 1997) and zeroed before range of motion was tested
4. The participant was instructed to flex forward maximally, and then extend backward maximally, whilst maintaining knee extension
5. Measurements were recorded at maximal flexion and extension

6. The digital inclinometer was then placed at the L5-S1 interspace (Saunders, 1997) and zeroed before range of motion was tested
7. The participant was instructed to flex forward maximally, and then extend backward maximally, whilst maintaining knee extension
8. Measurements were recorded at maximal flexion and extension

To determine end range of lumbar spine flexion, the value at the L5-S1 interspace was subtracted from the value at the T12-L1 interspace. To determine end range of lumbar extension, the value at the L5-S1 interspace was subtracted from the value at the T12-L1 interspace.

b) Lumbar spine lateral flexion

1. The participant was asked to stand erect
2. The researcher identified the T12-L1 interspace
3. The digital inclinometer was placed at the T12-L1 interspace (Saunders, 1997) and zeroed before range of motion was tested
4. The participant was instructed to laterally flex maximally to the left or right, whilst maintaining knee extension
5. Measurements were recorded at maximal lateral flexion, bilaterally
6. The digital inclinometer was then placed at the L5-S1 interspace (Saunders, 1997) and zeroed before range of motion was tested
7. The participant was instructed to laterally flex maximally to the left or right, whilst maintaining knee extension
8. Measurements were recorded at maximal lateral flexion, bilaterally

To determine end range of lumbar spine lateral flexion, the values at the L5-S1 interspace were subtracted from the values at the T12-L1 interspace.

c) Lumbar spine rotation

1. The participant was instructed to stand erect. To isolate lumbar spine rotation and exclude rotation at the hips, the participant was instructed to flex forward at the hips, ensuring the lumbar spine was as horizontal as possible.
2. In this forward flexed position the researcher identified the T12-L1 interspace.
3. The digital inclinometer was placed at the T12-L1 interspace (Saunders, 1997) and zeroed before range of motion was tested.
4. The participant was instructed to rotate maximally to the left or right, whilst maintaining knee extension
5. Measurements were recorded at maximal rotation, bilaterally
6. The digital inclinometer was then placed at the L5-S1 interspace (Saunders, 1997) and zeroed before range of motion was tested
7. The participant was instructed to rotate maximally to the left or right, whilst maintaining knee extension.
8. Measurements were recorded at maximal rotation, bilaterally

To determine end range of lumbar spine rotation, the values at the L5-S1 interspace were subtracted from the values at the T12-L1 interspace.

3.10.2. Pain pressure algometer

Pain pressure threshold is defined as the minimal amount of pressure applied that produces pain (Ylinen, 2007). The algometer, also known as a pressure threshold meter, consists of a rubber disc attached to the pole of a pressure (force) gauge. The gauge is calibrated in kilograms and pounds. The kilogram scale is used for clinical purposes. The surface of the rubber disc is one centimetre hence the readings are expressed in kg/cm2 (Rachlin, 2002). The practitioner will ascertain how much pressure is required to produce symptoms and hence monitor any improvement after treatment has commenced (Chaitow, 2010). Hong (1998), Pontinen (1998) and Reeves, Jaeger and Graff-Radford, (1986) have all independently proved the validity, reliability and reproducibility of pain pressure algometer measurements.

Pain pressure threshold was objectively measured using a pain pressure algometer on the most active quadratus lumborum TrP with the participants positioned in a lateral recumbent position. Prior to using the pain pressure algometer digital deep palpation was applied to the active TrP in order to elicit a pain referral pattern in the referral zone of the quadratus lumborum muscle. The pain pressure algometer was placed over the same TrP at a 90 degree angle to the skin. Pressure was then applied in a downward direction until the participant indicated the pressure began causing a painful stimulus. This was done three times and the mean algometer reading in kg/cm2 was then recorded on the algometer readings form (appendix J) and compared with values obtained from the previous visits.

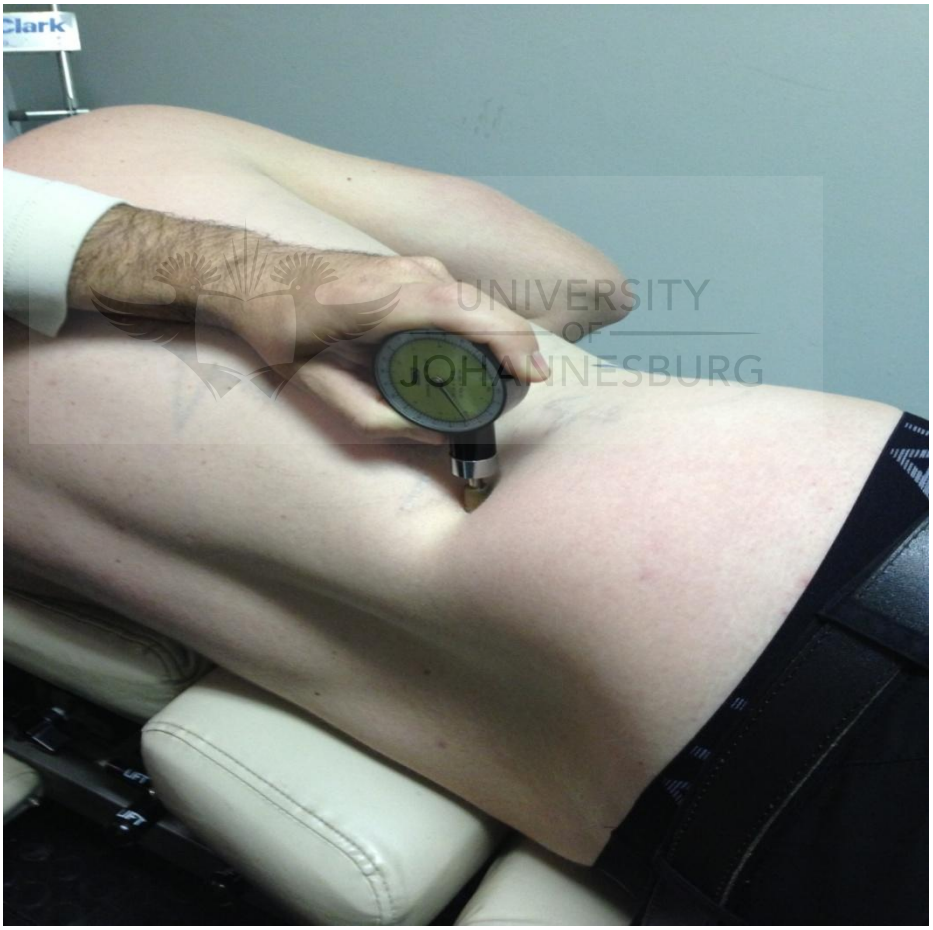

Figure 3.5: The algometer being applied to a deep quadratus lumborum TrP

Figure 3.6: The pressure algometer (http://wagner.securesites.com)

3.11. Data Analysis

The researcher collected the subjective and objective data from the clinical trials. All the data was analysed by STATKON. The results were based on lumbar spine range of motion and pain pressure algometer readings taken by the researcher, and the Numerical Pain Rating Scales and the Oswestry Disability Index for Lower Back Pain questionnaire completed by the participants.

Data analysis included a comparison of mean lumbar spine range of motion, pain pressure algometry, Numerical Pain Rating Scale and Oswestry Disability Index for Lower Back Pain values taken on the first, third and fifth visits.

The following tests were used to analyse the data collected from this study. The Shapiro Wilk Test was used to analyse normality. Intergroup analysis involved the use of the Mann-Whitney test (non-parametric), to determine if there was a statistically significant change in recorded data between group one and group two recorded on the first, the third, and the fifth visits. This will allow us to determine if either treatment protocol was preferential. If differences between the two groups are found, the Wilcoxon Signed Ranks test (non-parametric) will be applied as well as the Friedman Test (non-parametric) to find if changes occurred during the research over time or only one point in treatment.

3.12. Ethical Considerations

A proposal outlining the research study was passed by the Higher Degrees and Ethics Committees prior to the study being conducted. All participants that qualified for this particular study were requested to read and sign the information and consent form specific to the study. The information and consent form outlined the names of the researcher, purpose of the study, participant assessment and treatment procedure; any risks, benefits and discomforts pertaining to the treatments involved were also explained and that the participants safety would be ensured (prevention of harm). The information and consent form also explained that the participant's privacy (only the researcher, participant and clinician will be in a private room during treatment) would be protected by ensuring their anonymity (all the participant's details will be converted to data and therefore cannot be traced back to the participant) and standard doctor-patient confidentiality during treatment, whilst compiling treatment files, and when compiling the research dissertation. The participants were informed that their participation was on a voluntary basis, and that they were free to withdraw from the study at any stage. Contact details of the researcher were made available should the participant have had any further questions. The participants were then required to sign the information and consent form, signifying that they understood all that was required of them for the study. Results of the study would be made available on request.

With regards to this particular study, normal post needling soreness may have been experienced for a day or two. A minor stretching pain or discomfort during or after the MET treatment used may have also been a normal response, however the benefits of this study may have involved a reduction in lower back pain due to deactivation of an active TrP in the quadratus lumborum and an increase in the range of motion of the lumbar spine.

An increase in pain however should not have been present with MET and myofascial dry needling treatments and the researcher should have been contacted if an increase in pain was noted by the participant.

Participants were referred when necessary.

CHAPTER FOUR: RESULTS

4.1. Introduction

The results obtained during the course of the clinical trial are presented in this chapter. All participants presented with an active quadratus lumborum myofascial trigger point (TrP) and were divided into two groups of fifteen participants each. The first group received treatment in the form of Muscle Energy Technique (MET). The second group received treatment in the form of myofascial dry needling. The results obtained from both groups were compared. Due to the small sample groups which the statistical data represents, no assumptions can be made about the population as a whole. The probability level (p-value) was set at 0.05 and represents the level of significance of the results.

The following analyses were performed:

1. Demographic data: Age and gender.
2. Subjective measurements: Numerical Pain Rating Scale and Oswestry Disability Index for Lower Back Pain.
3. Objective measurements: Lumbar spine range of motion (ROM) and pain pressure algometer measurements.

4.2. Demographic Data

4.2.1. Age distribution

Group 1 represents MET, whilst Group 2 represents myofascial dry needling.

Table 4.1: Demographic data within the sample of thirty participants

	MEAN AGE	FEMALE	MALE
Group 1	25.27	8	7
Group 2	26.20	7	8

The participants recruited for this study were aged between eighteen and forty-five years of age. Group 1 had a mean age of **25.27** and group 2 participants had a mean age of **26.20**. A total of thirty participants were recruited for this study. Group 1 consisted of **8** female and **7** male participants, whilst group 2 consisted of **7** female and **8** male participants.

4.3. Subjective Data Analysis

The Shapiro-Wilks test was used to determine if data was normally distributed across the entire group. Intragroup analysis was performed using the Friedman test. If statistically significant values were revealed, further intragroup analysis was performed using the Wilcoxon Signed Ranks test. Intergroup analysis was performed using the Mann-Whitney test.

4.3.1. Numerical Pain Rating Scale

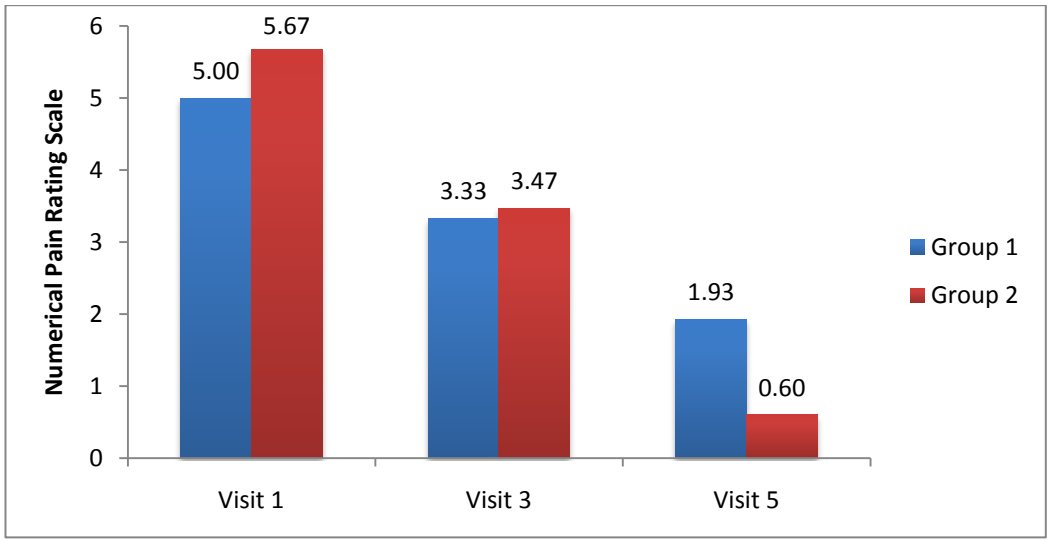

Figure 4.1: Bar graph comparing mean Numerical Pain Rating Scale values

Figure 4.1 shows a bar graph comparing the mean Numerical Pain Rating Scale (NPRS) values of group 1 and group 2 measured at the first, third and fifth visits. From the bar graph it may be seen that the mean NPRS value for group 1 was **5.00** at the first visit, **3.33** at the third visit and **1.93** at the fifth visit. Group 1 showed an improvement of **61.4**% at the fifth visit compared to that of the first. The mean NPRS value for group 2 was **5.67** at the first visit, **3.37** at the third visit and **1.93** at the fifth visit. Group 2 showed an improvement of **89.4**% at the fifth visit compared to that of the first.

The Shapiro-Wilks test was used to determine if data was normally distributed across both groups: with regards to the Numerical Pain Rating Scale. Group 1 was not statistically significant ($p > 0.05$) for visit one as **(p=0.10)** and visit three **(p=0.07)**, and was statistically significant ($p \leq 0.05$) for visit five **(p=0.00)**. Group 2 was found not to be statistically significant ($p > 0.05$) for visit one **(p=0.19)**, and was statistically significant ($p \leq 0.05$) for visit three **(p=0.01)** and visit five **(p=0.00)**.

Intragroup analysis of Numerical Pain Rating Scale

Comparative intragroup analysis was performed using the Friedman test and Wilcoxon Signed Ranks test.

The Friedman test revealed a statistically significant difference ($p \leq 0.05$) over time in group 1 as **(p=0.00)**, and a statistically significant difference ($p \leq 0.05$) over time was also found in group 2 **(p=0.00)**.

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the third visit with those recorded at the first visit. A statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**. A comparison was made of the values recorded at the fifth visit with those recorded at the first visit and a statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**.

Intergroup analysis of Numerical Pain Rating Scale

The Mann–Whitney test was used to compare group 1 and group 2 throughout the sampled data. The Mann-Whitney test revealed that the groups were not statistically significant ($p > 0.05$) at visit one **(p=0.20)**, were not statistically significant ($p > 0.05$) at visit three **(p=0.88)**, but were statistically significant ($p \leq 0.05$) at visit five **(p=0.00)**.

4.3.2. Oswestry Disability Index for Lower Back Pain

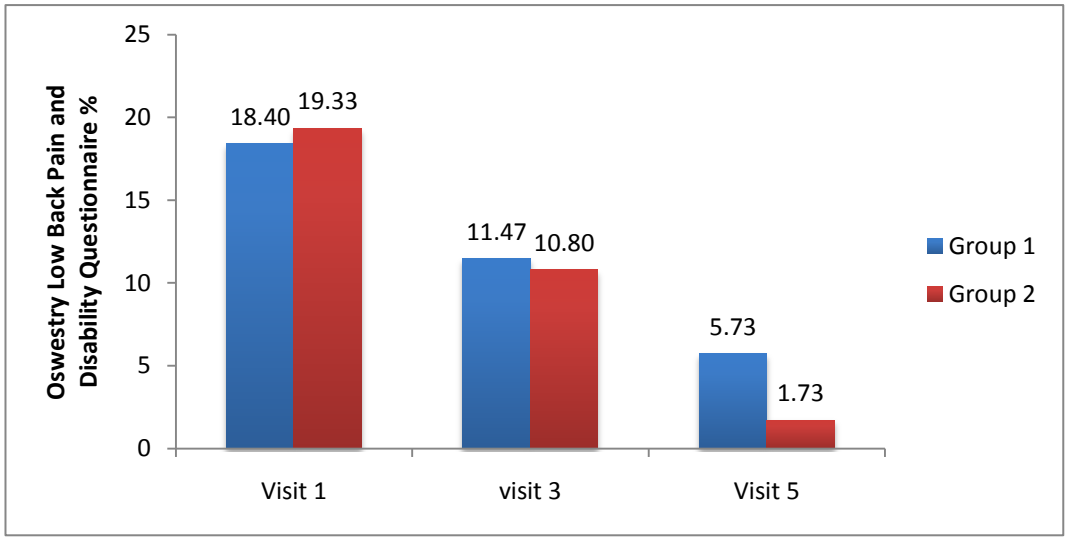

Figure 4.2: Bar graph comparing mean Oswestry Disability Index for Lower Back Pain

Figure 4.2 shows a bar graph comparing mean Oswestry Disability Index for Lower Back Pain values of group 1 and group 2 measured at the first, third and fifth visits. From the bar graph above it may be seen that the mean Oswestry Disability Index for Lower Back Pain values for group 1 was **18.40%** at the first visit, **11.47%** at the third visit and **5.73%** at the fifth visit, indicating an overall decrease in Oswestry Disability Index for Lower Back Pain values by **68.9%.** The mean Oswestry Low Back Pain and Disability Questionnaire value for group 2 was **19.33%** at the first visit, **10.80%** at the third visit and **1.73%** at the fifth visit, indicating an overall decrease in Oswestry Disability Index for Lower Back Pain values by **91.0%**.

The Shapiro-Wilks test was used to determine if data was normally distributed across both groups: with regards to the Oswestry Disability Index for Lower Back Pain. Group 1 was not statistically significant ($p > 0.05$) for visit one **(p=0.64)**, and was statistically significant ($p \leq 0.05$) for visit three **(p=0.00)** and visit five **(p=0.02)**. Group 2 was found not to be statistically significant ($p > 0.05$) for visit one **(p=0.62)** and visit three **(p=0.42)**, and was statistically significant ($p \leq 0.05$) for visit five **(p=0.01)**.

Intragroup analysis of Oswestry Disability Index for Lower Back Pain

Comparative intragroup analysis was performed using the Friedman test and Wilcoxon Signed Ranks test.

The Friedman test revealed a statistically significant difference ($p \leq 0.05$) over time in group 1 **(p=0.00)**, and a statistically significant difference ($p \leq 0.05$) over time was also found in group 2 **(p=0.00)**.

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the third visit with those recorded at the first. A statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**. A comparison was made of the values recorded at the fifth visit with those recorded at the first visit and a statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**.

Intergroup analysis of Oswestry Disability Index for Lower Back Pain

The Mann–Whitney test was used to compare group 1 and group 2 throughout the sampled data. The Mann-Whitney test revealed that the groups were not statistically significant ($p > 0.05$) at visit one **(p=0.77)**, were not statistically significant ($p > 0.05$) at visit three **(p=0.71)**, but were statistically significant ($p \leq 0.05$) at visit five **(p=0.00)**.

4.4. Objective Data Analysis

The Shapiro-Wilks test was used to determine if data was normally distributed across both groups. Intragroup analysis was performed using the Friedman test. If statistically significant values were revealed, further intragroup analysis was performed using the Wilcoxon Signed Ranks test. Intergroup analysis was performed using the Mann-Whitney test.

4.4.1. Lumbar spine range of motion

a) Lumbar spine flexion

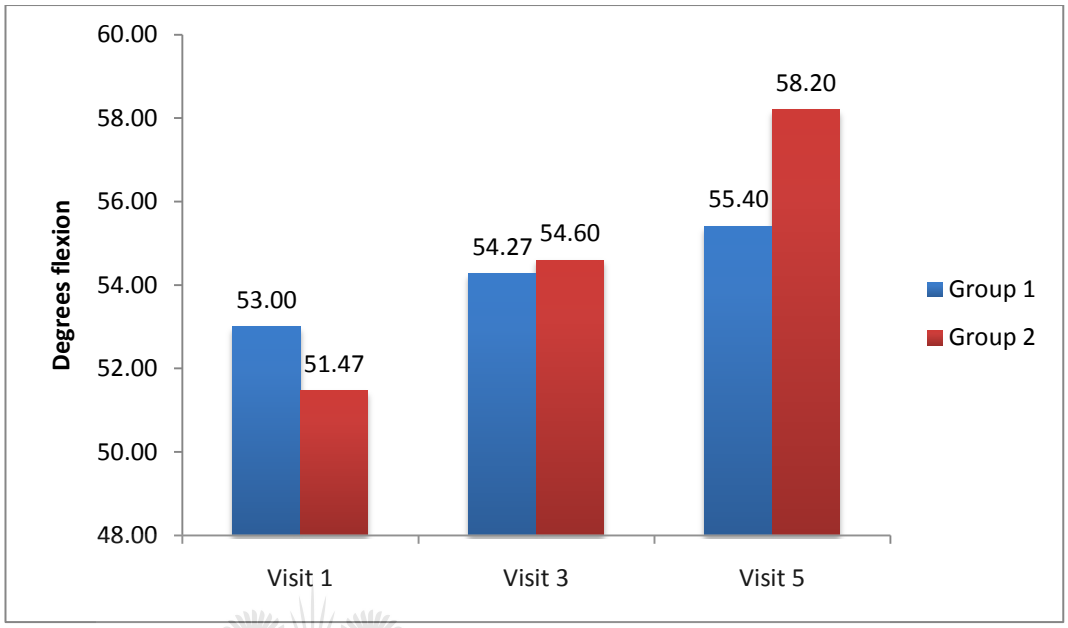

Figure 4.3: Bar graph comparing mean flexion values of the lumbar spine

Figure 4.3 shows a bar graph comparing mean lumbar spine flexion values for group 1 and group 2 measured at the first, third and fifth visits. From the bar graph it may be seen that the mean lumbar spine flexion value for group 1 was **53.00°** at the first visit, **54.27°** at the third visit and **55.40°** at the fifth visit. In group 1, an improvement in range of motion, totalling **4.52%**, was noted at the fifth visit compared to that of the first visit. The mean lumbar spine flexion value for group 2 was **51.47°** at the first visit, **54.60°** at the third visit and **58.20°** at the fifth visit. An improvement in range of motion was noted in group 2 totalling **13.07%** when the fifth visit was compared to that of the first.

The Shapiro-Wilks test was used to determine if data was normally distributed across both groups: with regards to lumbar spine flexion. Group 1 was not statistically significant ($p > 0.05$) for visit one **(p=0.10)**, visit three **(p=0.64)** and visit five **(p=0.46)**. Group 2 was found not to be statistically significant ($p > 0.05$) for visit one **(p=0.35)**, visit three **(p=0.46)** and visit five **(p=0.74)**.

Intragroup analysis of lumbar spine flexion

Comparative intragroup analysis was performed using the Friedman test and Wilcoxon Signed Ranks test.

The Friedman test revealed a statistically significant difference ($p \leq 0.05$) over time in group 1 **(p=0.00)**, and a statistically significant difference ($p \leq 0.05$) over time was also found in group 2 **(p=0.00)**.

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the third visit with those recorded at the third visit. A statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**. A comparison was made of the values recorded at the fifth visit with those recorded at the first visit and a statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**.

Intergroup analysis of lumbar spine flexion

The Mann–Whitney test was used to compare group 1 and group 2 throughout the sampled data. The Mann-Whitney test revealed that the groups were not statistically significant ($p > 0.05$) at visit one **(p=0.50)** and visit three **(p=0.51)**, but were statistically significant ($p \leq 0.05$) at visit five **(p=0.01)**.

b) Lumbar spine extension

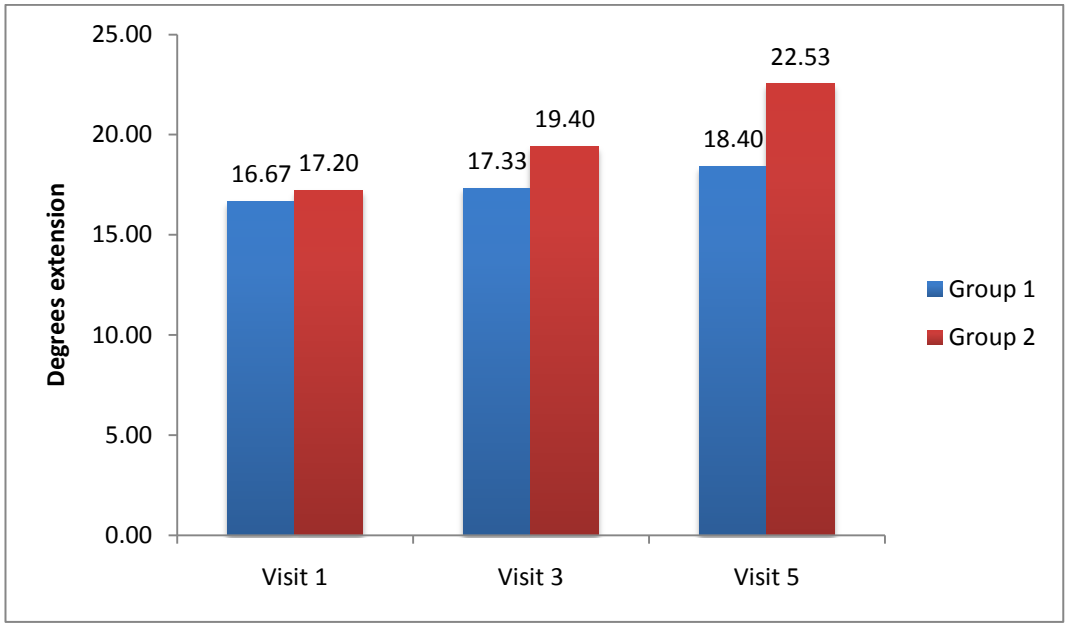

Figure 4.4: Bar graph comparing mean extension values of the lumbar spine

Figure 4.4 shows a bar graph comparing mean lumbar spine extension values of group 1 and group 2 measured at the first, third and fifth visits. From the bar graph it may be seen that the mean lumbar spine extension value for group 1 was **16.67°** at the first visit, **17.33°** at the third visit and **18.40°** at the fifth visit. In group 1 an improvement in range of motion, totalling **10.4%** was noted at the fifth visit compared to the first. The mean lumbar spine extension value for group 2 was **17.20°** at the first visit, **19.40°** at the third visit and **22.53°** at the fifth visit. In group 2 an improvement in range of motion, totalling **30.9%** was noted at the fifth visit compared to that of the first.

The Shapiro-Wilks test was used to determine if data was normally distributed across both groups: with regards to lumbar spine extension. Group 1 was not statistically significant ($p > 0.05$) for visit one **(p=0.15)** and visit three **(p=0.20)**, but was statistically significant ($p \leq 0.05$) for visit five **(p=0.04)**. Group 2 was found not to be statistically significant ($p > 0.05$) for visit one **(p=0.14)**, visit three **(p=0.07)** and visit five **(p=0.07)**.

Intragroup analysis of lumbar spine extension

Comparative intragroup analysis was performed using the Friedman test and Wilcoxon Signed Ranks test.

The Friedman test revealed a statistically significant difference ($p \leq 0.05$) over time in group 1 **(p=0.00)**, and a statistically significant difference ($p \leq 0.05$) over time was also found in group 2 **(p=0.00)**.

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the third visit with those recorded at the third visit. A statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.01)** and group 2 **(p=0.00)**. A comparison was made of the values recorded at the fifth visit with those recorded at the first visit and a statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**.

Intergroup analysis of lumbar spine extension

The Mann–Whitney test was used to compare group 1 and group 2 throughout the sampled data. The Mann-Whitney test revealed that the groups were not statistically significant ($p > 0.05$) at visit one **(p=0.51)**, but were statistically significant ($p \leq 0.05$) at visit three **(p=0.04)** and visit five **(p=0.00)**.

c) Lumbar spine left lateral flexion

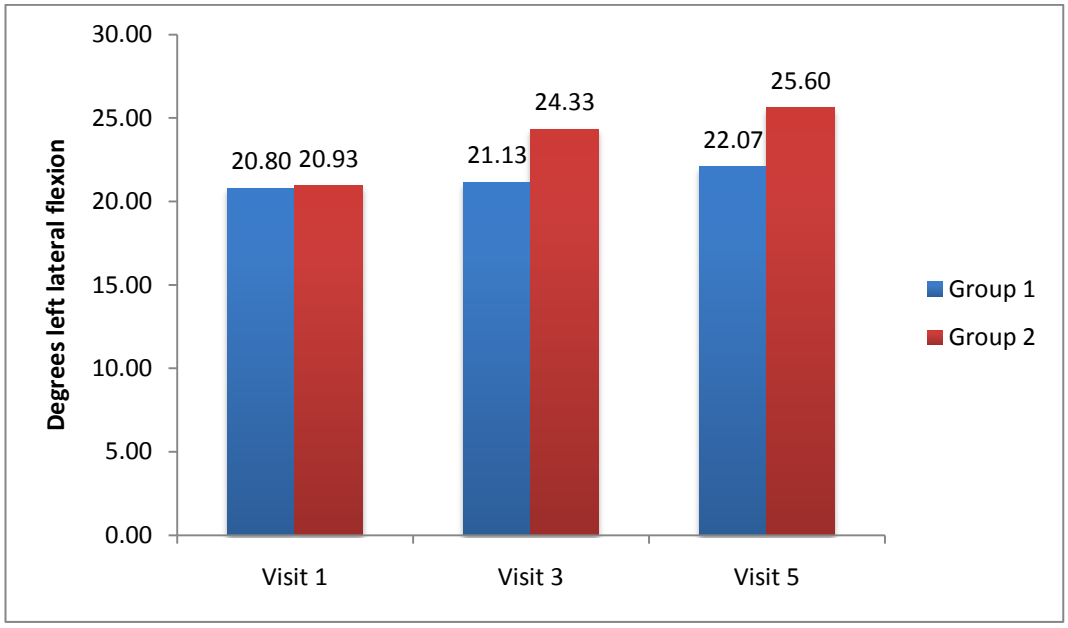

Figure 4.5: Bar graph comparing mean left lateral flexion values of the lumbar spine

Figure 4.5 shows a bar graph comparing mean left lateral flexion values of group 1 and group 2 measured at the first, third and fifth visits. From the bar graph it may be seen that the mean lumbar spine left lateral flexion value for group 1 was **20.80°** at the first visit, **21.13°** at the third visit and **22.07°** at the fifth visit. In group 1 an improvement in range of motion, totalling **6.1%** was noted at the fifth visit compared to the first. The mean lumbar spine left lateral flexion value for group 2 was **20.93°** at the first visit, **24.33°** at the third visit and **25.60°** at the fifth visit. In group 2, an improvement in range of motion totalling **22.3%**, was noted at the fifth visit compared to the first.

The Shapiro-Wilks test was used to determine if data was normally distributed across both groups: with regards to lumbar spine left lateral flexion. Group 1 was not statistically significant ($p > 0.05$) for visit one **(p=0.13)**, visit three **(p=0.25)** and visit five **(p=0.59)**. Group 2 was found to be statistically significant ($p \leq 0.05$) for visit one **(p=0.01)**, visit three **(p=0.05)** and visit five **(p=0.01)**.

Intragroup analysis of lumbar spine left lateral flexion

Comparative intragroup analysis was performed using the Friedman test and Wilcoxon Signed Ranks test.

The Friedman test revealed a statistically significant difference ($p > 0.05$) over time in group 1 **(p=0.00)**, and a statistically significant difference ($p > 0.05$) over time was also found in group 2 **(p=0.00)**.

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the third visit with those recorded at the third visit. A statistically significant difference ($p > 0.05$) was not found in group 1 **(p=0.06)** and a statistically significant difference ($p \leq 0.05$) was found in group 2 **(p=0.00)**. A comparison was made of the values recorded at the fifth visit with those recorded at the first visit and a statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**.

Intergroup analysis of lumbar spine left lateral flexion

The Mann–Whitney test was used to compare group 1 and group 2 throughout the sampled data. The Mann-Whitney test revealed that the groups were not statistically significant ($p > 0.05$) at visit one **(p=0.64)**, but were statistically significant ($p \leq 0.05$) at visit three **(p=0.00)** and visit five **(p=0.00)**.

d) Lumbar spine right lateral flexion

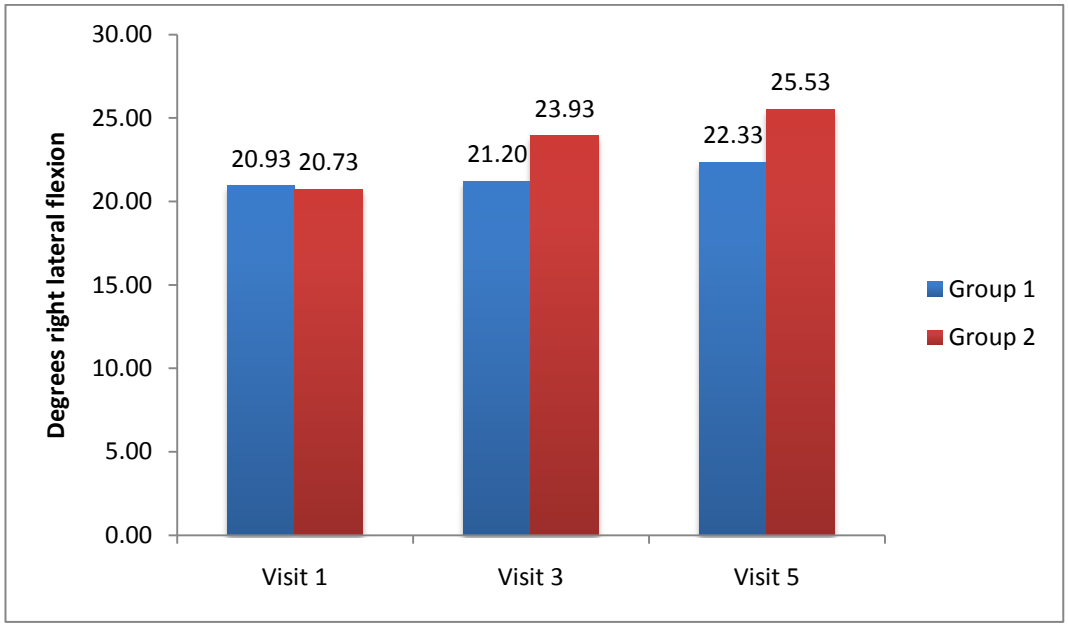

Figure 4.6: Bar graph comparing mean right lateral flexion values of the lumbar spine

Figure 4.6 shows a bar graph comparing mean lumbar spine right lateral flexion values of group 1 and group 2 measured at the first, third and fifth visits. From the bar graph it may be seen that the mean lumbar spine right lateral flexion value for group 1 was **20.93°** at the first visit, **21.20°** at the third visit and **22.33°** at the fifth visit. In group 1 an improvement in range of motion, totalling **6.7%** was noted at the fifth visit compared to the first. The mean lumbar spine extension value for group 2 was **20.93°** at the first visit, **23.93°** at the third visit and **25.53°** at the fifth visit. In group 2 an improvement in range of motion, totalling **23.2%** was noted at the fifth visit compared to the first.

The Shapiro-Wilks test was used to determine if data was normally distributed across both groups: with regards to lumbar spine right lateral flexion. Group 1 was not statistically significant ($p > 0.05$) for visit one **(p=0.08)**, visit three **(p=0.08)** and visit five **(p=0.08)**. Group 2 was found to be statistically significant ($p \leq 0.05$) for visit one **(p=0.01)** and not statistically significant ($p > 0.05$) for visit three **(p=0.29)** and visit five **(p=0.39)**.

Intragroup analysis of lumbar spine right lateral flexion

Comparative intragroup analysis was performed using the Friedman test and Wilcoxon Signed Ranks test.

The Friedman test revealed a statistically significant difference ($p \leq 0.05$) over time in group 1 **(p=0.00)**, and a statistically significant difference ($p \leq 0.05$) over time was also found in group 2 **(p=0.00)**.

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the third visit with those recorded at the third visit. No statistically significant difference ($p > 0.05$) was found in group 1 **(p=0.21)** and a statistically significant difference ($p \leq 0.05$) was found in group 2 **(p=0.00)**. A comparison was made of the values recorded at the fifth visit with those recorded at the first visit and a statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**.

Intergroup analysis of lumbar spine right lateral flexion

The Mann–Whitney test was used to compare group 1 and group 2 throughout the sampled data. The Mann-Whitney test revealed that the groups were not statistically significant ($p > 0.05$) at visit one **(p=0.76)**, but were statistically significant ($p \leq 0.05$) at visit three **(p=0.00)** and visit five **(p=0.00)**.

e) Lumbar spine left rotation

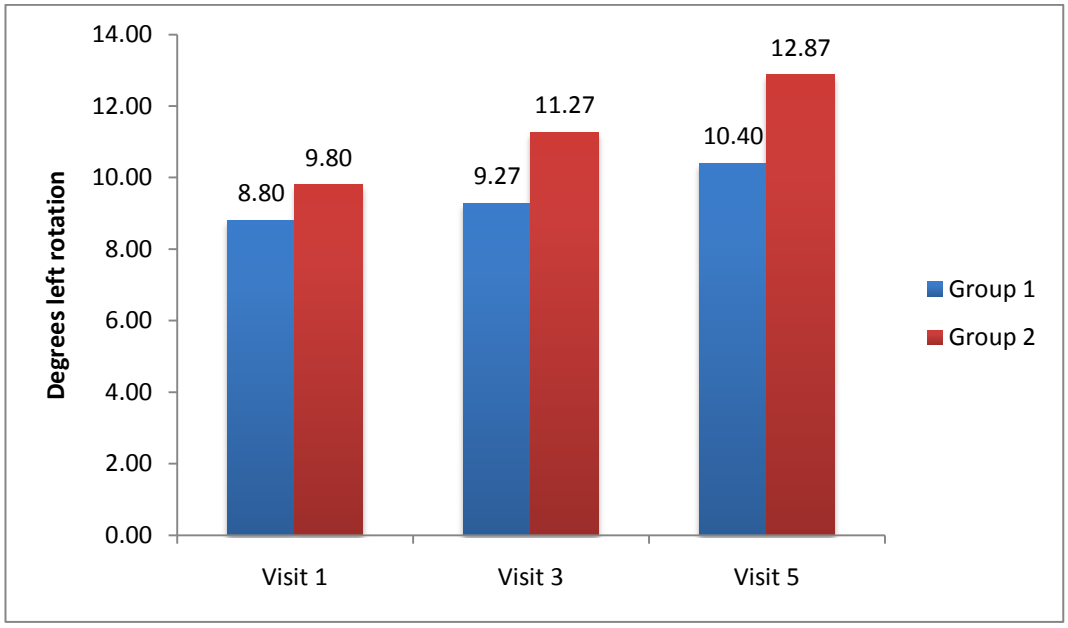

Figure 4.7: Bar graph comparing mean left rotation values of the lumbar spine

Figure 4.7 shows a bar graph comparing mean lumbar spine left rotation values of group 1 and group 2 measured at the first, third and fifth visits. From the bar graph it may be seen that the mean lumbar spine left rotation value for group 1 was **8.80°** at the first visit**, 9.27°** at the third visit and **10.40°** at the fifth visit. In group 1 an improvement in range of motion, totalling **18.2%** was noted at the fifth visit compared to the first. The mean lumbar spine left rotation value for group 2 was **9.80°** at the first visit, **11.27°** at the third visit and **12.87°** at the fifth visit. In group 2 an improvement in range of motion, totalling **31.3%** was not at the fifth visit compared to the first.

The Shapiro-Wilks test was used to determine if data was normally distributed across the entire group: with regards to lumbar left rotation. Group 1 was statistically significant ($p \leq 0.05$) for visit one **(p=0.03)**, was not statistically significant ($p > 0.05$) for visit three **(p=0.25)** and was statistically significant ($p \leq 0.05$) for visit five **(p=0.03)**. Group 2 was statistically significant ($p \leq 0.05$) for visit one **(p=0.01)**, was not statistically significant ($p > 0.05$) for visit three **(p=0.06)** and was statistically significant ($p \leq 0.05$) for visit five **(p=0.01)**.

Intragroup analysis of lumbar spine left rotation

Comparative intragroup analysis was performed using the Friedman test and Wilcoxon Signed Ranks test.

The Friedman test revealed a statistically significant difference ($p \leq 0.05$) over time in group 1 **(p=0.00)** and a statistically significant difference ($p \leq 0.05$) over time was also found in group 2 **(p=0.00)**.

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the third visit with those recorded at the third visit. A statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.04)** and group 2 **(p=0.00)**. A comparison was made of the values recorded at the fifth visit with those recorded at the first visit and a statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**.

Intergroup analysis of lumbar spine left rotation

The Mann–Whitney test was used to compare group 1 and group 2 throughout the sampled data. The Mann-Whitney test revealed that the groups were not statistically significant ($p > 0.05$) at visit one **(p=0.06)**, but were statistically significant ($p \leq 0.05$) at visit three **(p=0.00)** and visit five **(p=0.00)**.

f) Lumbar spine right rotation

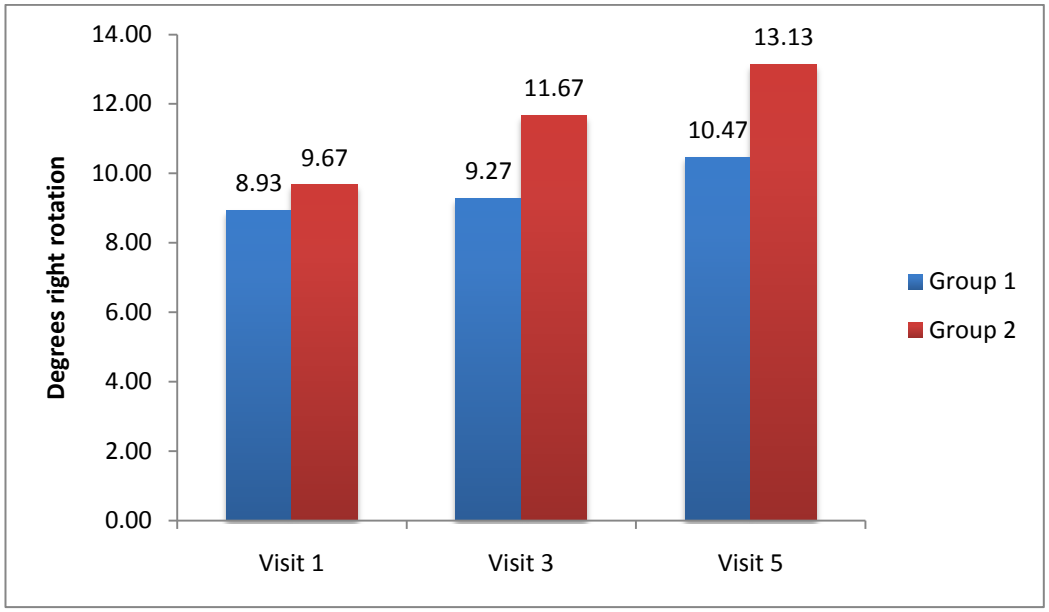

Figure 4.8: Bar graph comparing mean right rotation values of the lumbar spine

Figure 4.8 shows a bar graph comparing mean lumbar spine right rotation values of group 1 and group 2 measured at the first, third and fifth visits. From the bar graph it may be seen that the mean lumbar spine right rotation value for group 1 was **8.93°** at the first visit, **9.27°** at the third visit and **10.47°** at the fifth visit. In group 1 an improvement in range of motion, totalling **17.2%** was not at the fifth visit compared to the first. The mean lumbar spine extension value for group 2 was **9.67** at the first visit, **11.67°** at the third visit and **13.13°** at the fifth visit. In group 2 an improvement in range of motion, totalling **35.8%** was not at the fifth visit compared to the first.

The Shapiro-Wilks test was used to determine if data was normally distributed across both groups: with regards to lumbar spine right rotation. Group 1 was not statistically significant ($p > 0.05$) for visit one **(p=0.24)** and was statistically significant ($p \leq 0.05$) for visit three **(p=0.04)** and visit five **(p=0.04)**. Group 2 was found not to be statistically significant ($p > 0.05$) for visit one **(p=0.26)** and was statistically significant ($p \leq 0.05$) for visit three **(p=0.01)** and visit five **(p=0.01)**

Intragroup analysis of lumbar spine right rotation

Comparative intragroup analysis was performed using the Friedman test and Wilcoxon Signed Ranks test.

The Friedman test revealed a statistically significant difference ($p \leq 0.05$) over time in group 1 **(p=0.00)**, and a statistically significant difference ($p \leq 0.05$) over time was also found in group 2 **(p=0.00)**.

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the third visit with those recorded at the third visit. A statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.03)** and group 2 **(p=0.00).** A comparison was made of the values recorded at the fifth visit with those recorded at the first visit and a statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**.

Intergroup analysis of lumbar spine right rotation

The Mann–Whitney test was used to compare group 1 and group 2 throughout the sampled data. The Mann-Whitney test revealed that the groups were not statistically significant ($p > 0.05$) at visit one **(p=0.11)**, but were statistically significant ($p \leq 0.05$) at visit three **(p=0.00)** visit five **(p=0.00)**.

4.4.2. Algometer data analysis

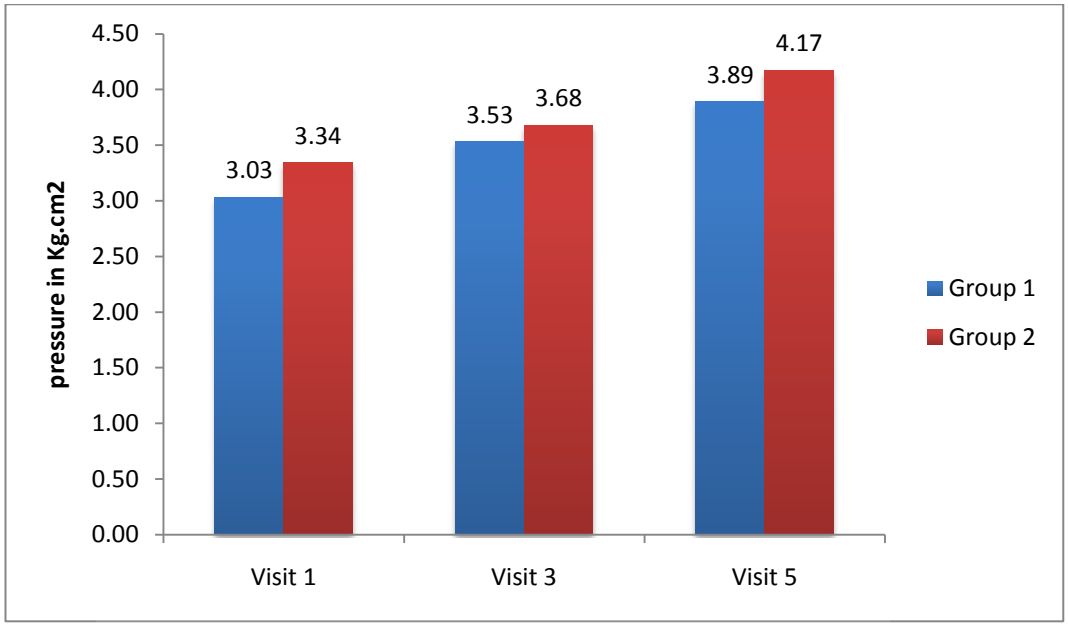

Figure 4.9: Bar graph comparing mean algometer readings for both groups taken at each visit

Figure 4.9 shows a bar graph comparing mean algometer data readings of group 1 and group 2 measured at the first, third and fifth visits. From the bar graph it may be seen that the mean algometer value for group 1 was **3.03 kg.cm2** at the first visit, **3.53 kg.cm2** at the third visit and **3.89 kg.cm2** at the fifth visit. In group 1 an improvement in pain pressure threshold, totalling **28.4%** was noted at the fifth visit compared to the first. The mean algometer value for group 2 was **3.34 kg.cm2** at the first visit, **3.68 kg.cm2** at the third visit and **4.17 kg.cm2** at the fifth visit. In group 2 an improvement in range of motion, totalling **24.9%** was noted at the fifth visit compared to the first.

The Shapiro-Wilks test was used to determine if data was normally distributed across both groups: with regards to the algometer data analysis. Group 1 was not statistically significant ($p > 0.05$) for visit one **(p=0.52)**, visit three **(p=0.42)** and visit five **(p=0.91)**. Group 2 was found not to be statistically significant ($p > 0.05$) for visit one **(p=0.78)**, visit three **(p=0.14)** and visit five **(p=0.16)**.

Intragroup analysis of algometer data readings

Comparative intragroup analysis was performed using the Friedman test and Wilcoxon Signed Ranks test.

The Friedman test revealed a statistically significant difference ($p \leq 0.05$) over time in group 1 **(p=0.00)** and a statistically significant difference ($p \leq 0.05$) over time was also found in group 2 **(p=0.00)**.

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the third visit with those recorded at the third visit. A statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**. A comparison was made of the values recorded at the fifth visit with those recorded at the first visit and a statistically significant difference ($p \leq 0.05$) was found in group 1 **(p=0.00)** and group 2 **(p=0.00)**.

Intergroup analysis of algometer data readings

The Mann–Whitney test was used to compare group 1 and group 2 throughout the sampled data. The Mann-Whitney test revealed that the groups were not statistically significant ($p > 0.05$) at visit one **(p=0.37),** visit three **(p=0.72)**, and at visit five **(p=0.58)**.

CHAPTER FIVE: DISCUSSION

5.1 Introduction

This chapter discusses the demographic data, objective and subjective results of the clinical trial (as presented in chapter four). Possible explanations for these results are outlined by referring to the literature discussed in chapter two and results of previous studies.

5.2. Demographic Data

Each group in the study was comprised of 15 participants each, with group 1 consisting of 7 males and 8 females (1:1.14 ratio) and group 2 consisting of 8 males and 7 females (1:1.14 ratio).

The ages of the participants in group 1 ranged between 21 and 30 years of age, with a mean age of **25.27** years. The ages of participants in group 2 ranged between 23 and 40 years, with a mean age of **26.20** years.

The mean age of all the entire participant selection was **25.76** years of age. The average lifetime prevalence of mechanical low back pain among adults (over 20 years of age) was 62% (Louw, Morris and Grimmer-Somers, 2007). This is confirmed by the mean participant age in this study. Kalichman and Vulfsons (2010) state myofacial pain may affect up to ten percent of the adult population at any given time.

5.3. Subjective Data

5.3.1. Numerical Pain Rating Scale

Clinical Analysis

As can be seen from Figure 4.1, both group 1 and group 2 showed a clinically significant decrease in NPRS values. Mean NPRS values decreased by **61.4%** in group 1, and by **89.4%** in group 2. Group 2 therefore showed the greatest clinical improvement over the five visits.

Intragroup analysis

The Friedman Test was used to determine whether there were statistically significant changes in the NPRS values over time. It was revealed that both groups 1 and 2 demonstrated statistically significant changes over the course of the study.

The Wilcoxon Signed Ranks Test was used to compare the third visit with the first visit and the fifth visit with the first visit within each group. Comparisons between the first and the third visit, and first and the fifth visit revealed a statistically significant difference in group 1 as well as group 2.

Intergroup analysis

The Mann-Whitney test was used to determine and reveal any statistically significant intergroup changes in NPRS values between group 1 and 2 at the first, third and fifth visits. It was revealed that no statistically significant difference between groups 1 and 2 was found at the first and third visits. However, a statistically significant difference was noted at the fifth visit.

5.3.2. Oswestry Disability Index for Lower Back Pain

Clinical analysis

As can be seen from Figure 4.2, both group 1 and 2 demonstrated a clinically significant reduction in Oswestry Disability Index for Lower Back Pain values. Mean Oswestry Disability Index for Lower Back Pain values in group 1 decreased by **68.9%** and by **91.0%** in group 2. Group 2 therefore demonstrated the most clinically significant improvement over the course of the study.

Intragroup analysis

The Friedman test was used to determine and reveal any statistically significant intragroup changes in Oswestry Disability Index for Lower Back Pain values over time. It was revealed that both groups 1 and 2 demonstrated statistically significant changes over the course of the study.

The Wilcoxon Signed Ranks Test was used to compare the third visit with the first visit and the fifth visit with the first visit within each group. Comparisons between the first and the third visit, and first and the fifth visit revealed a statistically significant difference in group 1 as well as group 2.

Intergroup analysis

The Mann-Whitney test was used to determine and reveal any statistically significant intergroup changes in NPRS values between group 1 and 2 at the first visit, third and fifth visits. It was revealed that no statistically significant difference between groups 1 and 2 was found at the first and third visits. However, a statistically significant difference was noted at the fifth visit.

5.3.3 Outcomes of subjective data

Numerical Pain Rating Scale: As previously stated, the Numerical Pain Rating Scale values of group 1 and group 2 indicate a substantial decrease in the participants' perception of pain over the course of the study. However, when comparing the Numerical Pain Rating Scale values of group 1 and group 2, group 2 (dry needling) showed a much larger improvement over the duration of the study than that of group 1 (89.4% as opposed to 61.4%). A statistically significant difference was found in the comparison between the mean NPRS values of group 1 and group 2 at the fifth visit.

Oswestry Disability Index for Lower Back Pain: The Oswestry Disability Index for Lower Back Pain values of group 1 and group 2 indicates a substantial decrease in the participants' perception of disability due to pain over the course of the study. However, when comparing the Oswestry Disability Index for Lower Back Pain values of group 1 and group 2, Group 2 (dry needling) showed a much larger improvement over the duration of the study than that of group 1 (91.0% as opposed to 68.9%). A statistically significant difference was found in the comparison between the mean Oswestry Disability Index for Lower Back Pain of group 1 and group 2 at the fifth visit.

Both group 1 and group 2 revealed positive clinical and statistical changes over the course of the five visits. However, comparative analysis of group 1 and group 2 revealed that the participants' perceived reduction in pain, or disability due to pain, was statistically significant at fifth visit. Group 2 showed a superiority with reference to pain perception and disability due to pain (intergroup analysis), compared to that showed in group 1. The results carry the suggestion that myofascial dry needling is more effective than MET in decreasing participant-rated pain and disability in the case of active quadratus lumborum trigger points (TrPs).

According to Royah and Okhovatian (2012,) Muscle Energy Technique (MET) may influence pain mechanisms and promote hypoalgesia. Lewit and Simons (1984) conducted a study using MET in the treatment of myofascial pain. The study involved 244 patients with musculoskeletal pain. Ninety-four percent of the muscles demonstrated immediate relief of pain and tenderness. Several studies suggest that MET and related

post–isometric techniques reduce pain, discomfort and disability when applied to the spine (Wilson, Payton, Donegan-Shoaf and Dec, 2003). In a local study conducted by Ramsunder, Moodley and Hay (2007), Intergrated Neuromuscular Inhibition Technique which utilizes MET and the manual application of pressure to treat muscle dysfunction, showed positive results with regards to decreasing the patient's pain subjectively.

In a local study conducted by Palm and Pyper (2011), which compared static myofascial dry needling and fanning dry needling, it was shown that static dry needling showed positive clinical improvement and statistically significant changes with regards to pain and disability. This corresponds to the present study that myofascial dry needling is effective in improving participant-rated pain and disability. Baldry (2002) reported that dry needling does cause an improvement in subjective pain as seen in the in the NPRS.

Dry needling has been comprehensively studied and has been shown to be very effective for myofascial pain release (Hong, 2006). Dry needling is an invasive procedure where the needle mechanically disrupts the integrity of the dysfunctional motor end plates (Kline, 2011). The Immediate analgesia produced with dry needling is called the "needle effect (Rachin, 1994), which contributes to pain reduction. Correct placement of the needle in a trigger point can provide a local stretch to the cytoskeletal structures, which unwinds the myosin filaments from the titin gel. This causes the sarcomere to return to its normal resting length by decreasing the amount of overlap between the actin and myosin filaments. The energy consumption crisis is thus resolved and tissue oxygen levels return to normal (Dommerholt and Huijbregts, 2011). Deep dry needling of a TrP causes opiod-mediated pain suppression to be activated (Huguenin, 2004). Large Diameter sensory input occurs via afferent fibers into the dorsal horn, and passage of nociceptive signals into the dorsal horns blocked. The local twitch response during dry needling causes the increase of various chemicals at the TrP to be corrected. Tissue oxygen tension increases as the needle approaches the TrP. After reaching a peak, the tissue oxygen tension returns to almost zero, indicating hypoxia in the central region where the needle was inserted (Osborne and Gatt, 2010). This may decrease the amount of vaso-reactive substances and relieve the energy crisis in the TrP (Travell and Simons, 1999). This may account for the pain and disability reduction seen after myofascial dry needling in this study.

Applications of MET to stretch and increase myofasicial tissue extensibility seem to affect viscoelastic and plastic tissue properties, autonomic mediated change in extracellular fluid dynamics and fibroblast mechanotransduction. Animal and human studies have shown sympathoexcitation and localized activation of the lateral and dorsolateral periaqueductal gray (PAG) from induced or voluntary muscle contraction. Met may increase fluid drainage and augment hypoalgesia within muscles. Rhythmic muscle contraction increases muscle blood and lymph flow rates, and mechanical forces acting on fibroblasts in connective tissues change interstitial pressure and increase transcapillary blood flow. MET may also reduce pro inflammatory cytokines and desensitize peripheral nociceptors. MET may assist lymphatic flow and clearance of excess tissue fluid to augment hypoalgesia changing intramuscular pressure and passive tone of the muscle. The above may explain some of the therapeutic action (pain reduction and disability) of MET (Royah and Okhovatian, 2012). Several clinical trials investigating spinal pain have included MET as a treatment component, and given that treatment significantly reduced the reported pain and disability in these trials, they provide further support for the effectiveness of MET (Licciardone, Stoll and Fulda, 2003, Fryer, Alivizatos and Lamaro, 2005 and Chrown, Whittamore, Rush, Allan, Scott and Archer, 2008). This can account for the pain and disability reduction seen after MET in this study.

Hong (2002) reported that the use of needles has a physiological effect on patients. According to Burger, Yelverton, and Bester (2013), the invasive nature of dry needling compared to a less invasive treatment, in this case MET, may influence the patients' subjective pain measurements. MET could thus be subjectively reported as less effective. This could explain the improved subjective results of dry needling. The invasive nature of dry needling (mechanical direct disruption of TrPs) and consequently the natural response of the human body to foreign objects penetrating the skin and tissue (Hubbard, 2001), could explain why group 2 showed a statistically significant difference to group 1 at the final visit. This natural response includes the migration of satellite cells from other areas in the muscle which aids in muscle regeneration (Dommerhalt, del Moral and Grobli, 2006).

5.4. Objective Data

5.4.1. Lumbar spine range of motion

Lumbar spine flexion

Clinical analysis

As it can be seen from Figure 4.3, both group 1 and 2 demonstrated clinically significant increase mean lumbar spine flexion range of motion. Over the course of the study, mean flexion values increased by **4.52%** in group 1 and increased by **13.07%** in group 2. Group 2 therefore demonstrated the most clinically significant improvement over the course of the study.

Intragroup analysis

The Friedman test was used to determine and reveal any statistically significant intragroup changes in lumbar spine flexion values over time. It was revealed that both groups 1 and 2 demonstrated statistically significant changes over the course of the study.

The Wilcoxon Signed Ranks Test was used to compare the third visit with the first visit and the fifth visit with the first visit within each group. Comparisons between the first and the third visit, and first and the fifth visit revealed a statistically significant difference in group 1 as well as group 2.

Intergroup analysis

The Mann-Whitney test was used to determine and reveal any statistically significant intergroup changes in lumbar spine flexion values between group 1 and 2 at the first visit, third visit and fifth visit. It was revealed that no statistically significant difference between groups 1 and 2 was found at the first visit and third visit. However, a statistically significant difference was noted at the fifth visit.

Lumbar spine extension

Clinical analysis

As it can be seen from Figure 4.4, both group 1 and 2 demonstrated a clinically significant increase in mean lumbar spine extension range of motion. Over the course of the study, mean extension values increased by **10.4%** in group 1 and increased by **30.9%** in group 2. Group 2 therefore demonstrated the most clinically significant improvement over the course of the study.

Intragroup analysis

The Friedman test was used to determine and reveal any statistically significant intragroup changes in lumbar spine extension values over time. It was revealed that both groups 1 and 2 demonstrated statistically significant changes over the course of the study.
The Wilcoxon Signed Ranks Test was used to compare the third visit with the first visit and the fifth visit with the first visit within each group. Comparisons between the first and the third visit, and first and the fifth visit revealed a statistically significant difference in group 1 as well as group 2.

Intergroup analysis

The Mann-Whitney test was used to determine and reveal any statistically significant intergroup changes in lumbar spine flexion values between group 1 and 2 at the first visit, third visit and fifth visit. It was revealed that no statistically significant difference between groups 1 and 2 was found at the first visit. However, a statistically significant difference was noted at the third and fifth visit.

Lumbar spine left lateral flexion

Clinical analysis

As it can be seen from Figure 4.5, both group 1 and 2 demonstrated a clinically significant increase in mean lumbar spine left lateral flexion range of motion. Over the course of the study, mean left lateral flexion values increased by **6.1%** in group 1 and increased by **22.3%** in group 2. Group 2 therefore demonstrated the most clinically significant improvement over the course of the study.

Intragroup analysis

The Friedman test was used to determine and reveal any statistically significant intragroup changes in lumbar spine left lateral flexion values over time. It was revealed that both groups 1 and 2 demonstrated statistically significant changes over the course of the study.

The Wilcoxon Signed Ranks Test was used to compare the third visit with the first visit and the fifth visit with the first visit within each group. Comparisons between the first and third visit for group 1 revealed no statistically significant difference. A statistically significant difference was found in group 2. Comparisons between first and the fifth visit revealed statistically significant differences in both groups.

Intergroup analysis.

The Mann-Whitney test was used to determine and reveal any statistically significant intergroup changes in lumbar spine left lateral flexion values between group 1 and 2 at the first visit, third visit and fifth visit. It was revealed that no statistically significant difference between groups 1 and 2 was found at the first visit. However, a statistically significant difference was noted at the third and fifth visit.

Lumbar spine right lateral flexion

Clinical analysis

As it can be seen from Figure 4.6, both group 1 and 2 demonstrated a clinically significant increase in mean lumbar spine right lateral flexion range of motion. Over the course of the study, mean right lateral flexion values increased by **6.7%** in group 1 and increased by **23.2%** in group 2. Group 2 therefore demonstrated the most clinically significant improvement over the course of the study.

Intragroup analysis

The Friedman test was used to determine and reveal any statistically significant intragroup changes in lumbar spine right lateral flexion values over time. It was revealed that both groups 1 and 2 demonstrated statistically significant changes over the course of the study.

The Wilcoxon Signed Ranks Test was used to compare the third visit with the first visit and the fifth visit with the first visit within each group. When comparing the first visit with the third visit no statistically significant difference was revealed in group 1 but a statistically significant difference was revealed in group 2. When comparing the first visit with the fifth visit, group 1 as well as group 2 revealed a statistically significant difference.

Intergroup analysis

The Mann-Whitney test was used to determine and reveal any statistically significant intergroup changes in lumbar spine right lateral flexion values between group 1 and 2 at the first visit, third visit and fifth visit. It was revealed that no statistically significant difference between groups 1 and 2 was found at the first visit. However, a statistically significant difference was noted at the third and fifth visits.

Lumbar spine left rotation

Clinical analysis

As it can be seen from Figure 4.7, both group 1 and 2 demonstrated a clinically significant increase in mean lumbar spine left rotation range of motion. Over the course of the study, mean left rotation values increased by **18.2%** in group 1 and increased by **31.3%** in group 2. Group 2 therefore demonstrated the most clinically significant improvement over the course of the study.

Intragroup analysis

The Friedman test was used to determine and reveal any statistically significant intragroup changes in lumbar spine left rotation values over time. It was revealed that both groups 1 and 2 demonstrated statistically significant changes over the course of the study.

The Wilcoxon Signed Ranks Test was used to compare the third visit with the first visit and the fifth visit with the first visit within each group. Comparisons between the first and the third visit, and the first and the fifth visit revealed a statistically significant difference in group 1 as well as group 2.

Intergroup analysis.

The Mann-Whitney test was used to determine and reveal any statistically significant intergroup changes in lumbar spine left rotation between group 1 and 2 at the first consultation, third consultation and fifth consultation. It was revealed that no statistically significant difference between groups 1 and 2 was found at the first consultation. However, a statistically significant difference was noted at the third and fifth visits.

Lumbar spine right rotation

Clinical analysis

As it can be seen from Figure 4.8, both group 1 and 2 demonstrated a clinically significant increase in mean lumbar spine right rotation range of motion. Over the course of the study, mean right rotation values increased by **17.2%** in group 1 and increased by **35.8%** in group 2. Group 2 therefore demonstrated the most clinically significant improvement over the course of the study.

Intragroup analysis

The Friedman test was used to determine and reveal any statistically significant intragroup changes in lumbar spine right rotation values over time. It was revealed that both groups 1 and 2 demonstrated statistically significant changes over the course of the study.

The Wilcoxon Signed Ranks Test was used to compare the third visit with the first visit and the fifth visit with the first visit within each group. Comparisons between the first and the third visit, and first and the fifth visit revealed a statistically significant difference in group 1 as well as group 2.

Intergroup analysis

The Mann-Whitney test was used to determine and reveal any statistically significant intergroup changes in lumbar spine right rotation values between group 1 and 2 at the first visit, third visit and fifth visit. It was revealed that no statistically significant difference between groups 1 and 2 was found at the first visit. However, a statistically significant difference was noted at the third and fifth visits.

5.4.2 Pressure algometer

Clinical analysis

As it can be seen from Figure 4.9, both group 1 and 2 demonstrated a clinically significant increase in mean pressure algometer values. Over the course of the study, mean pressure algometer values increased by **28.4%** in group 1 and increased by **24.9%** in group 2. Group 1 therefore demonstrated the most clinically significant improvement over the course of the study.

Intragroup analysis

The Friedman test was used to compare the pressure algometer readings over time within each group and revealed statistically significant changes for both groups over the duration of the study.

The Wilcoxon Signed Ranks Test was used to compare the third visit with the first visit and the fifth visit with the first visit within each group. Comparisons between the first and the third visit, and first and the fifth visit revealed a statistically significant difference in group 1 as well as group 2.

Intergroup analysis

The Mann-Whitney U test was used to compare the values between group 1 and group 2 at the first, third and fifth visits. There were no statistically significant differences found at the first, third and fifth visits between the groups.

5.4.3. Outcomes of objective data

Lumbar spine range of motion: Analysis of the percentage change in lumbar spine range of motion values revealed that both group 1 and group 2 demonstrated clinically significant changes in flexion, extension, lateral flexion (left and right) and rotation (left and right). These results indicate that both techniques are extremely effective in increasing lumbar range of motion however group 2 showed the most clinical significant improvement over the course of the study with regards to lumbar spine range of motion. Intragroup analysis showed statistically significant differences with regards to flexion, extension,

lateral flexion and rotation spine range of motion in group 1 and 2 throughout the course of the study. A statistically significant difference was found in the comparison between the mean flexion, extension, lateral flexion and rotation lumbar spine range of motion values of group 1 and group 2 at the fifth visit. Group 2 showed superiority with reference to lumbar spine range of motion compared to that showed in group 1. The results carry the suggestion that dry needling is more effective than MET in increasing lumbar spine range of motion the case of active quadratus lumborum TrPs.

According to Baldy (2002), range of motion is limited due to pain and the inability to fully stretch the muscle containing the active TrPs. Joint dysfunction and muscle hypertonicty is associated with a restriction in movement (Peterson and Bergman, 2002). Travell and Simons (1999) state when a TrP is inactivated and the taut band is released, range of motion returns to normal. According to Cummings and White (2001), dry needling may mechanically disrupt the dysfunctional motor end plates within the TrPs resulting in mechanical and physiological resolution of the TrP. A needle inserted into a TrP may provide a localised stretch to the contracted cytoskeletal structures, which allows for the sarcomeres to return to their normal resting length. The degree of overlap between the protein filaments, actin and myosin, are reduced (Dommerholt and Huijbregts, 2011). Travell and Simons (1983), states that dry needling provides the energy (ATP) to unlock actin-myosin cross-bridge formations as well as the energy for the reuptake of calcium ions. The energy consumption crisis is thus resolved and tissue oxygen levels return to normal (Dommerholt and Huijbregts, 2011). Thus it can be seen that myofascial dry needling resolves the TrP which in turn reduces the taut band of muscle and improves restricted range of motion (Hong, 2008).

Insertion of a needle into a TrP also results in a local twitch response which may lead to alterations in muscle fiber length and muscle relaxation (Baldry, 2001). The 'needle grasp' is a phenomenon caused by muscle fibres contracting around the needle and holding it tightly in place. This phenomenon causes immediate analgesia (Rachlin, 2002). Dry needling promotes blood circulation into the affected TrP in the affected muscle removing metabolites (serotonin, histamine and protogladins) which are pain sensitizes while blood provides nutrients and oxygen to the area to promote healing. This results in relaxtion of previously contracted muscles causing them to increase in length and enabling the muscle

function properly (Gatterman, 1990). This may account for the increase lumbar spine range of motion seen in this study as deactivation of the active quadratus lumborum TrP, using treatment in the form of dry needling therapy, helped restore the quadratus lumborum muscle length, decreased the muscle dysfuntion (TrP) and increased it's functionality. Dry needling brings about the 'release' of TrPs, the restoration of muscle length, decreases in pain and disability which could account for the overall improvement through all the lumbar ranges of motion.

Muscles which become tight and hypertonic are usually those that span more than one joint namely, the quadratus lumborum and erector spinae. If hypertonic musculature persists, containing TrPs, it can alter or restrict the patients' pattern of movement. A small number of studies have demonstrated that MET can produce increased range of motion in the cervical, thoracic and lumbar spines (Shenk, Adelman and Rouselle, 1994, Shenk, MacDiarmid and Rouselle, 1997, Lenehan, Fryer and McLaughlin, 2003 and Fryer and Ruszkowski 2004). Given that only active spinal range of motion has been reported to increase, it seems likely that a change in stretch intolerance may be responsible for range of motion gains. Stretching and isometric contraction stimulate muscle and joint mechanoreceptors and proprioceptors. Large diameter mechanorepectors produces inhibition of pain at the dorsal horn of the spinal cord. The application of MET may decrease the patient's perception of muscle pain and appear to produce lasting changes in stretch tolerance which may account for the increase in lumbar spine range of motion seen in this study (Chaitow, 2006). According to a study compiled by Ballantyne, Fryer and McLaughlin (2003), a greater passive torque was tolerated post MET, with regards to hamstring extensibility, which allowed for greater range of motion to be achieved which could provide a possible explanation as to why lumbar range of motion increased when MET was applied to the quadratus lumborum as seen in this study.

Another reason why range of motion during treatment in the form of MET may have increased lumbar spine range of motion is due to the post isometric relaxation of the muscle. Ward (2003), states that the goal of post isometric relaxation is to accomplish muscle relaxation. Post-isometric relaxation is the term referring to when a muscle or group of muscles experiences reduced muscle tone following an isometric contraction. Passive stretching can now be accomplished during this relaxed refractory period. Golgi

tendon organ proprioceptors experience an increased tension during muscle contraction and a reflex neurological loop is activated causing inhibition or a post-isometric relaxation effect in that muscle (Chaitow, 2006). Post isometric relaxation is the essence of many effective TrP release techniques. Gentle muscle contraction tends to equalize sarcomere length in fibers affected by TrPs. Sarcomeres within contraction knots can no longer exert any contractile forces because they are already maximally shortened. However the sarcomeres between the TrP and the muscle fiber attachments are in an optimal state for muscle contraction. Therefore gentle voluntary contraction allows the lengthened sarcomeres to exert an effective elongation force on the shortened sarcomeres of the TrP and thus alleviate the TrP (Simons, 2002). Travell and Simons (1999) claim that stretching of a muscle with TrPs might be useful since stretching can reduce the contraction knot as well as increase blood flow to the area. Therefore the increase of blood flow and well as stretching of the TrP might explain the therapeutic mechanisms of post isometric relaxation and thus the increase of lumbar range of motion seen in this study and the quadratus lumborum as a whole was in a state of muscle relaxation.

Viscoelasticity is the term used to describe connective tissues as having mechanical properties relating to their fluid or gel components and their elastic properties. Tissue responds with slow elongation or 'creep' when a constant stretching force is applied to the tissue. The tissue 'creep' results in a loss of energy (hysteresis) and repetition of loading will result in greater deformation. Isometric muscle contractions and stretching have been found to produce similar reductions in tissue tension. Contractions and stretching techniques (as used in MET) may be more affective for producing viscoelastic change than passive stretching alone. The combined forces could produce greater viscoelastic change and passive extensibility. Stretch and isometric contractions may affect water content and produce an alteration to the length and stiffness of the tissue involved. Therefore MET may help realign maturing connective tissues along the lines of force, and break poorly aligned cross linkages (Chaitow, 2006). This could also account for the increase in lumbar spine in range of motion seen in this study as MET of the quadratus lumborum muscle may have reduced tissue tension within the muscle.

A few studies have reported spinal range of motion gains following MET. MET has been demonstrated to produce increases in spinal range of motion when applied to a single motion segment. Shenk, Adelman and Rousselle (1994) examined the effects of MET on range of motion for the cervical region over a four week period involving multiple MET sessions and noted that cervical range of motion significantly increased. Shenk *et al* (1994), applied MET to the thoracic spine in the direction of the restricted rotation significantly produced increased range of active trunk rotation. Lenehan, Fryer and McLaughlin (2003), showed an increased in thoracic rotation following one MET isometric contraction. A study by Prachi, Basavaraj, Santosh and Subhash (2010), concluded that MET on the quadratus lumborum showed significant statistically difference in reduction in disability and increase in spinal range of motion which conforms with the results seen in this study. Research conducted in Stockholm by Brodin (1987), investigated the effects of MET on low back pain sufferers. The group receiving treatment in the form of MET showed significant pain reduction as well as an increase in mobility of the lumbar spine. This evidence may suggest as to why MET was seen to increase lumbar range of motion in this study.

When looking at range of motion as a whole, it appears that group 2 improved the most overall. This is probably due to the fact that the specificity of dry needling had a more direct, aggressive, invasive and accurate effect on the active quadratus lumborum TrP being treated. Chaitow (2006) hypothesises that partial contraction (20 -30% of the patients strength) may fail to achieve activation of the fibers housing TrP since the light contractions used in MET fail to recruit more than a percentage of the muscles potential. It is also suggested than when a muscle is stretched as a whole, the TrP within the muscle may not lengthen specifically. Local stretches would seem more beneficial in achieving lengthening of the taut short myofascial tissues surrounding the TrP. This may account for the recurrence of TrP activity in the same sight following treatment. Travell and Simons (1999), further states that the reason for failure of met is that the tissues being stretched were not the precise structures housing the TrP. Therefore, the more invasive, direct approach of dry needling may prove to be more specific and effective than MET for decreasing active quadratus lumborum TrPs. This may account for the statistical superiority of group 2 when compared with group 1 throughout the course of the study.

Algometer: Analysis of the percentage change in pain pressure threshold values revealed that group 1 and group 2 responded positively to the treatment administered however, group 1 showed a marginal clinically superiority over the course of the study. The results therefore suggest that both treatment methods were effective in increasing pain pressure threshold values. Intragroup analysis showed statistically significant differences with regards to pain pressure threshold values in group 1 and 2 throughout the course of the study. No statistically significant difference was found in the comparison between the mean pain pressure threshold values of group 1 and group 2 throughout the study. The results carry the suggestion that the treatments are both as effective in increasing pain pressure threshold values in the case of active quadratus lumborum TrPs.

In a local study conducted by Martin, Wilcox and Moodley (2002), where the effectiveness of ischaemic compression was compared to myofascial dry needling in active TrPs in the quadratus lumborum muscle in the treatment of lower back pain, pain pressure threshold was shown to increase after dry needling therapy. A decrease in pain due to TrP deactivation will result in an increased pressure pain threshold (Hong, 1994). It has been documented that dry needling of TrPs results in immediate and significant pain relief of pain (Hong, 2002).

In a study conducted by Dearing and Hamilton (2007), comparing the examination of pain pressure threshold of TrPs using MET and Ischeamic compression, it was concluded that both ischaemic compression and MET produce a significant reduction in pain sensitivity at TrPs in the upper trapezius muscle.

At the end of treatment of group 2, more pressure could be exerted on the TrP before the pain threshold was reached than before the onset of treatment. This may be attributed to the mechanical integrity of the TrP being mechanically disrupted by the needle. The insertion of the needle may normalize the length of contracted sarcomeres by providing a local stretch to the cytoskeletel structures and reducing the overlap between the actin and myosin filaments. This triggers changes in the endplate cholinesterase and Ach receptors (Dommerholt and Huijbregts, 2011). This may cause the blockage of intra-dorsal horn passage of nociceptive information in the TrP and cause an improvement of the pain pressure threshold in the TrP as it resolves (Baldry, 2002). The elicitation of a local twitch

response through dry needling is also thought to improve the pain pressure threshold in a TrP (Dommerhalt, del Moral and Groblil, 2006). This may explain improvements in pain pressure threshold values in group 2.

The exact mechanism by which increased pain pressure threshold occurs by MET is still unclear, and may involve both neurophysiological and mechanical factors (such as viscoelastic and plastic changes) in the connective tissue elements in the muscle (Royah and Okhovatian, 2012). In a study conducted by Dearing and Hamilton (2007), comparing the examination of pain pressure threshold of TrPs using MET and Ischeamic ompression, it was concluded that both ischameic compression and MET produce a significant reduction in pain sensitivity at TrPs in the upper trapezius muscle.

Contractions and stretching techniques (as used in MET) may be more affective for producing viscoelastic change than passive stretching alone. The combined forces could produce greater viscoelastic change and passive extensibility in the connective tissue element of the muscle. Stretch and isometric contractions may affect water content and produce an alteration to the length and stiffness of the tissue involved by altering the elastic component in the muscle. MET may help realign maturing connective tissues along the lines of force, break poorly aligned cross linkages and have a direct effect on TrPs (Chaitow, 2006).

The application of MET may decrease the patient's perception of muscle pain and appear to produce lasting changes in stretch tolerance. Large diameter mechanorepectors produces inhibition of pain at the dorsal horn of the spinal cord. (Chaitow, 2006).

Post-isometric relaxation is the term referring to when a muscle or group of muscles experiences reduced muscle tone following an isometric contraction. Passive stretching is administered during this relaxed refractory period. Golgi tendon organ proprioceptors experience an increased tension during muscle contraction and a reflex neurological loop is activated causing inhibition or a post-isometric relaxation effect in that muscle (Chaitow, 2006).

Post isometric relaxation is the essence of many effective TrP release techniques. Gentle muscle contraction tends to equalize sarcomere length in fibers affected by TrPs. Sarcomeres within contraction knots can no longer exert any contractile forces because they are already maximally shortened. However the sarcomeres between the TrP and the muscle fiber attachments are in an optimal state for muscle contraction. Therefore gentle voluntary contraction allows the lengthened sarcomeres to exert an effective elongation force on the shortened sarcomeres of the TrP (Simons, 2002). As stated previously, a decrease in pain due to TrP deactivation will result in an increased pressure pain threshold (Hong, 1994). This may explain the improvements in pain pressure threshold values in group 1. Group 1 was seen to be marginally clinically superior to group 2 with regards to pain pressure threshold values which may be attributed to post needling soreness commonly experienced with myofascial dry needling.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The aim of this comparative study was to compare the effect of Muscle Energy Technique (MET) and myofascial dry needling of the quadratus lumborum in the treatment of myofascial trigger points (TrPs) with regards to pain, disability and lumbar spine range of motion. These effects were based on digital inclinometer measurements of lumbar spine range of motion and algometer measurements of pain pressure threshold and results obtained from the Numerical Pain Rating Scale (NPRS) and The Oswestry Disability Index for Lower Back Pain (ODI).

When mean NPRS and ODI values were statistically analysed independently, group 1 showed a statistically significant difference in all of measurements. Group 2 also showed a statistically difference in all of the measurements.

When lumbar spine range of motion values and pain pressure threshold measurements were statistically analysed independently, group 1 showed a statistically significant difference in all of measurements. Group 2 also showed a statistically difference in all of the measurements.

When mean NPRS and ODI as well as lumbar spine range of motion values of group 1 and 2 were statistically analysed by comparison, group 2 showed a statistically significant difference between the initial and final visits in all of the of the measurements. However, when pain pressure threshold values were compared between the initial and final visits, no statistically significant differences were found.

Therefore it can be concluded, based on the results, that myofascial dry needling was more effective than MET with regards to the subjective pain, disability and lumbar spine range of motion. However with regards to pain pressure threshold values, there was no superiority of either treatment. This study suggests that myofascial dry needling is a preferential treatment option than MET in the case of active quadratus lumborum TrPs as it is possible that dry needling alone is more effective in reducing pain, disability and increasing lumbar spine range of motion. However this does not rule out MET as

treatment for active TrPs as objectively MET reduces objective pain as effectively as dry needling.

Myofascial dry needling is an invasive procedure whereas MET is a safe, non invasive manual intervention therapy for the treatment of active quadratus lumborum TrPs. The results of the study have provided medical professionals additional treatment protocol for active myofasical TrPs as patients who are contraindicated for dry needling, suffer from post needling soreness and needle phobias would be better suited to receiving treatment in the form of MET as it has been proven to effectively reduce pain and increase lumbar range of motion.

6.2. Recommendations

The following are some recommendations of the recommendation that could improve future related research:

- Further research should involve measuring the strength of the muscle contractions used in MET accurately (between twenty-thirty percent).
- Had more visits been included in the treatment protocol, group 1 might be more statistically comparable to group 2 with regards to subjective pain and lumbar range of motion measurements osteopathic manual techniques are more effective when administered over a longer period of time (Simons, 2002).
- In order to determine the long-term benefits of treatment, a follow up visit should be included a month after the final visit.
- Future research should be conducted aiming to achieve the most effective treatment protocol for active acute versus active chronic TrPs.
- A study involving longer rest periods between dry needling sessions which provide better results as post needling soreness could be reduced.
- Future research where a post needling protocol including stretching is incorporated in the treatment of active TrPs.
- A study which incorporates chiropractic adjustments, MET and dry needling in the treatment of active quadratus lumborum TrPs with regards to pain, disability and lumbar range of motion.

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APPENDIX A

Advertisement

Free Chiropractic Treatment!

(IF YOU COMPLY WITH THE INCLUSION CRITERIA)

DO YOU SUFFER FROM LOWER BACK PAIN???

Are you between the age of 18 and 45 years old?

Take part in a research study aimed to treat myofascial trigger points.

Treatment is conducted in the Supervised UJ clinic at Gate 7,

Sherwell road, Doornfontein. If you are interested please contact me.

JOSHUA GREENBERG 082 450 0771

APPENDIX B

DEPARTMENT OF CHIROPRACTIC

INFORMATION AND CONSENT FORM

I, Joshua Greenberg, hereby invite you to participate in my research study. I am currently a Chiropractic student, completing my Masters Degree at the University of Johannesburg.

The aim of the study is to compare the effects of Muscle Energy Technique to myofascial dry needling of quadratus lumborum in the treatment of myofascial trigger points.

You must be between the ages of 18-45. If you fit the inclusion criteria you will be selected and placed in one of two groups. The study will take place over two weeks, and you will receive four treatments, with a fifth consultation where only measurements will be taken. Group one will receive treatment called dry needling where by a solid needle will be inserted into an active quadratus lumborum trigger point. Group two will receive treatment called Muscle Energy Technique applied to the quadratus lumborum muscle with an active myofascial trigger point. Both groups will be palpated for active myofascial trigger points in the quadratus lumborum muscles and the most active trigger points will be used in this study. A case history, physical exam and lumbar spine regional exam will be done at the first visit. Data in the form of a Numerical Pain Rating Scale, Oswestry Disability Index for Lower Back Pain, pain pressure tolerance as well as lumbar spine range of motion readings will be collected on the first, third and fifth consultations. Dry needling can be an uncomfortable procedure and post needling soreness may be experienced. Muscle Energy Technique is an osteopathic technique and it is safe and non invasive.

The research will take place at the University of Johannesburg Day Clinic. Your privacy will be protected by ensuring your anonymity and confidentiality when compiling the research dissertation.

All procedures will be explained to you and all participation is entirely on a voluntary basis; withdrawal at any stage will not cause you any harm. Potential benefits of this study include increase in the lumbar range of motion, reduction in pain and resolution of quadratus lumborum myofascial trigger points. Discomfort experienced may be post needling soreness which is normal and a minor stretching pain or discomfort during or after the muscle energy technique used, which is also a normal response. Any skin irritation after needling or increase of pain must be reported to the practitioner. After this study is complete, I will provide you with feedback regarding the outcome if you so wish.

I have fully explained the procedures and their purpose. I have asked whether or not any questions have arisen regarding the procedures and have answered them to the best of my ability.

Date:_____

Researcher:_____

I have been fully informed as to the procedure to be followed and have been given a description of the discomfort, risks and benefits expected from the treatment. In signing this consent form I agree to this form of treatment and understand my rights and that I am free to withdraw my consent and participation in this study at any time. I understand that if I have questions at any time, they will be answered.

Date:_____

Participant:_____

Should you have any concerns or queries regarding the current study, the following persons may be contacted:

Researcher: Joshua Greenberg (082 450 0771)

Supervisor: Dr. C. Yelverton (011 559 6218)

APPENDIX C

Dry needling contra-indications (Rachlin, 1994)

- Bleeding disorders
- Anticoagulants
- Systemic infections
- Local infections
- Pregnancy
- Patients appearing or feeling ill

APPENDIX D

Case History

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

CASE HISTORY

Date: _____

Patient: _____ **File No:** _____

Age: _____ **Sex:** _____ **Occupation:** _____

Student: _____ **Signature:** _____

FOR CLINICIAN'S USE ONLY

Initial visit clinician: _____ **Signature:**_____

Case History: _____

Examination:

Previous:	UJ	Current:	UJ
	Other		Other

X-ray Studies:

Previous:	UJ	Current:	UJ
	Other		Other

Clinical Path. Lab:

Previous:	UJ	Current:	UJ
	Other		Other

Case status:

PTT: Conditional: Signed off: Final sign out:

Recommendations:

Students case history

1. *Source of history:*

2. *Chief complaint:* *(patient's own words)*

3. *Present illness:*

Location

Onset

Duration

Frequency

Pain (character)

Progression

Aggravating factors

Relieving factors

Associated Sx's and Sg's

Previous occurrences

Past treatment and outcome

4. *Other complaints:*

5. *Past history*

   General health status

   Childhood illnesses

   Adult illnesses

   Psychiatric illnesses

   Accidents/injuries

   Surgery

   Hospitalisation

6. *Current health status and lifestyle*

   Allergies

   Immunizations

   Screening tests

   Environmental hazards

   Safety measures

Exercise and leisure

Sleep patterns

Diet

Current medication

Tobacco

Alcohol

Social drugs

7. *Family history:*
   Immediate family:

Cause of death

DM

Heart disease

TB

HBP

Stroke

Kidney disease

CA

Arthritis

Anaemia

Headaches

Thyroid disease

Epilepsy

Mental illness

Alcoholism

Drug addiction

Other

8. *Psychosocial history:*

Home situation

Daily life

Important experiences

Religious beliefs

9. *Review of systems:*

General

Skin

Head

Eyes

Ears

Nose/sinuses

Mouth/throat

Neck

Breasts

Respiratory

Cardiac

Gastro-intestinal

Urinary

Genital

Vascular

Musculoskeletal

Neurologic

Haematologic

Endocrine

Psychiatric

APPENDIX E

Physical Examination

UNIVERSITY OF JOHANNESBURG

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

Underline abnormal findings in **RED.**

Date: _____

Patient: _____ **File No:** _____

Clinician: _____ **Signature:** _____

Student: _____ **Signature:** _____

Height: _____ **Weight:** _____ **Temp:** _____

Rates: **Heart:** _____ **Pulse:** _____ **Respiration:** _____

Blood pressure:	Arms:	L	R
	Legs:	L	R

General Appearance:

_____

_____

_____

_____

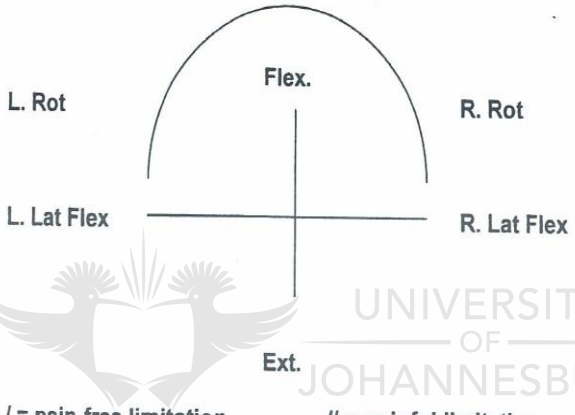
_____

_____

1

STANDING EXAMINATION

1. Minor's sign
2. Skin changes
3. Posture: Erect
   Adam's
4. Ranges of motion (Thoracolumbar Spine)
   T/L spine: Flexion: 90° (fingers to floor)
   Extension: 50°
   R. lat. flex: 30° (fingers down leg)
   L. lat. flex: 30° (fingers down leg)
   Rot. to R: 35°
   Rot. to L: 35°



/ = pain-free limitation // = painful limitation

5. Romberg's sign
6. Pronator drift
7. Trendelenburg's sign
8. Gait: - rhythm
   - balance
   - pendulousness
   - on toes
   - on heels
   - tandem
9. Half squat
10. Scapular winging
11. Muscle tone
12. Spasticity/Rigidity

13. Shoulder: skin
    symmetry
    ROM
    - glenohumeral
    - scapulo-thoracic
    - acromioclavicular
    - elbow
    - wrist

14. Chest measurement:

	L	R
- inspiration	cm	cm
- expiration	cm	cm

15. Visual acuity

16. Breast examination:
Inspection:
- skin
- size
- contour
- nipples
- arms overhead
- hands against hips
- leaning forward

Palpation
- axillary lymph nodes
- breast incl. tail

SEATED EXAMINATION

1. Spinal posture
2. Head
   - hair
   - scalp
   - skull
   - face
   - skin
3. Eyes:
   Observation
   - conjunctiva
   - sclera
   - eyebrows
   - eyelids
   - lacrimal glands
   - nasolacrimal duct
   - position and alignment
   - corneas and lenses

- corneal reflex
- ocular movement

	L			R	
III	IV	VI	III	IV	VI

- visual fields
- accommodation
- Opthalmoscopic
- Examination
  - iris
  - pupils
  - red reflex
  - optic disc
  - vessels
  - general background

- macula
- vitreous
- lens

4. Ears:
- Inspection
  - auricle
  - ear canal
  - drum
- auditory acuity
- Weber test
- Rinne test

5. Nose:
- External
- Internal
  - septum
  - turbinates
  - olfaction

6. Sinuses (frontal & maxillary):
  - tenderness
  - transillumination

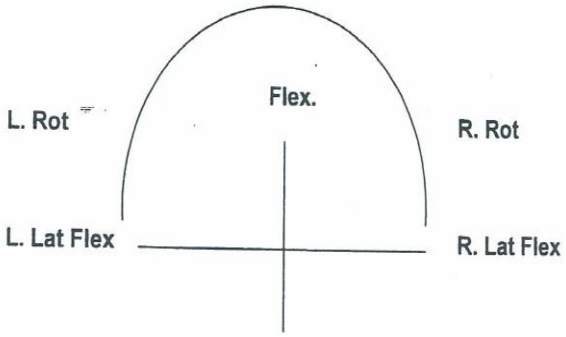
7. Mouth and pharynx:
- lips
- buccal mucosa
- gums and teeth
- roof
- tongue
  - inspection
  - movement
  - taste
  - palpation
- pharynx
  - CN X
  - inspection

9. Neck
- posture
- size
- swelling
- scars
- discolouration
- hair line

Ranges of motion (cervical spine)

The following are normal ranges of motion

Forward flexion	=	45 ° chin to larynx or sternum
Extension	=	55 ° forehead parallel to ground
L/R Rotation	=	70 °
L/R Lat Flexion	=	40 °



- lymph nodes
- trachea
- thyroid
- carotid arteries (thrills, bruit)
- Cranial Nerves
  - CN V
  - CN VII
  - CN VIII (nystagmus)
  - CN IX
  - CN XI
  - CN X11

9. NEUROLOGICAL EXAMINATION (CERVICAL SPINE)

DERMATOMES	Left	Right	MYOTOMES	Left	Right	REFLEXES	Left	Right
C2			Neck Flexion C1/2			Biceps C5		
C3			Lat. Neck Flexion C3			Brachio – radialis C6		
C4			Shoulder Elevation C4			Triceps C7		
C5			Shoulder Abduction C5					
C6			Elbow Flexion C5					
C7			Elbow Extension C7					

C8			Elbow Flexion at 90 ° C6	
T1			Forearm Pronation C6	
			Forearm Supination C6	
			Wrist Extension C6	
			Wrist Flexion C7	
			Finger Flexion C8	
			Finger Abduction T1	
			Finger Adduction T1	

9. Peripheral vasculature:

- Inspection
  - skin
  - nail beds
  - pigmentation
  - hair loss
- Palpation
  - pulses: femoral, popliteal, post. Tibial, dorsalis pedis, radial, brachial
  - lymph nodes: epitrochlear, femoral (horizontal & vertical)
  - temperature (feet and legs)

- Manual compression test
- Retrograde filling (Tredelenburg) test
- Arterial insufficiency test

10. Musculoskeletal:

(i) ROM

- hip

		L	R
flex.	90/120		
ext.	15		
abd.	45		
add.	30		
int rot	40		
ext rot	45		
		L	R
flex.	130		
ext.	0/15		

		L	R
plantar Flex	45		
dorsiflex	20		
inversion	30		
eversion	20		
		L	R
Apparent			
Actual			

- knee
- ankle

(ii) leg length

- Co-ordination
  - point to point
  - dysdiachokinesia

10. TMJ
- Inspection
  - ROM
  - deviation
- Palpation
  - crepitus
  - tenderness

11. Thorax
- Inspection
  - skin
  - shape
  - respiratory distress
  - rhythm (respiratory)
  - depth (respiratory)
  - effort (respiratory)
  - intercostals/supraclavicular retraction
- Palpation
  - tenderness
  - masses
  - respiratory expansion
  - tactile fremitus
- Percussion
  - lungs (posterior)
  - diaphgragmatic excursion
  - kidney punch
- Auscultation

  (i) breath sounds
  - vesicular
  - bronchial

  (ii) adventitious sounds
  - crackles (rales)
  - wheezes (rhonchi)
  - rubs

  (iii) voice sounds
  - broncophony
  - whispered pectoriloquey

- egophony

- Cardiovascular
  - auscultation (aortic murmurs)
  - Allen's test

SUPINE EXAMINATION

1. JVP
2. PMI
3. Auscultation heart (L. lat. Recumbent)
4. respiratory excursion
5. percussion chest (anterior)
6. breast palpation
7. Abdominal Examination

- Inspection
  - skin
  - umbilicus
  - contour
  - peristalsis
  - pulsations
  - hernias (umbilical/incisional)

- Auscultation
  - bowel sound
  - bruit

- Percussion
  - general
  - liver
  - spleen

- Palpation
  - superficial reflexes
  - cough
  - light
  - rebound tenderness
  - deep
  - liver
  - spleen
  - kidneys
  - aorta
  - intra-/retro-abdominal wall mass
  - shifting dullness
  - fluid wave

- Acute abdomen
  - where pain began and now
  - cough
  - tenderness
  - guarding/rigidity
  - rebound tenderness
  - rovsing's sign
  - psoas sign
  - obturator sign
  - cutaneous hyperaesthesia

- rectal exam
- Murphy's sign

MENTAL STATUS

(i) Appearance and behaviour
- level of consciousness
- posture and motor behaviour
- dress, grooming, personal hygiene
- facial expression
- affect

(ii) Speed and language
- quantity
- rate
- volume
- fluency
- aphasia (pm)

(ii) Mood

(v) Memory and attention
- orientation (time, place, person)
- remote memory
- recent memory
- new learning ability

(vi) Higher cognitive functions
- information and vocabulary
- (general and specialised knowledge)
- abstract thinking

NEUROLOGICAL EXAMINATION (LUMBAR SPINE)

DERMATOMES	Left	Right	MYOTOMES	Left	Right	REFLEXES	Left	Right
T12			Hip Flexion (L1/L2)			Patellar (L3, 4)		
L1			Knee Extension (L2, 3, 4)			Medial Hamstring (L5)		
L2			Knee Flexion (L5/S1)			Lateral Hamstring (S1)		
L3			Hip Int. Rot (L4/L5)					
L4			Hip Ext. Rot (L5/S1)					
L5			Hip Adduction (L2, 3, 4)					
S1			Hip Abduction (L4/5)					
S2			Ankle Dorsiflexion					

			(L4/L5)	
S3			Hallux Extension (L5)	
			Ankle Plantar Flexion (S1/S2)	
			Eversion (S1)	
			Inversion (L4)	
			Hip Extension (L5/S1)	

APPENDIX F

Lumbar Spine and Pelvis Regional Examination

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

Date: _____

Patient: _____ **File No:** _____

Clinician: _____ **Signature:** _____

Student: _____ **Signature:** _____

STANDING

BODY TYPE

POSTURE

OBSERVATION:

Muscle Tone

Bony + Soft Tissue Contours

Skin

Scars

Discolouration

Step deformity

SPECIAL TESTS

Schober's Test

Spinous Percussion

Treadmill

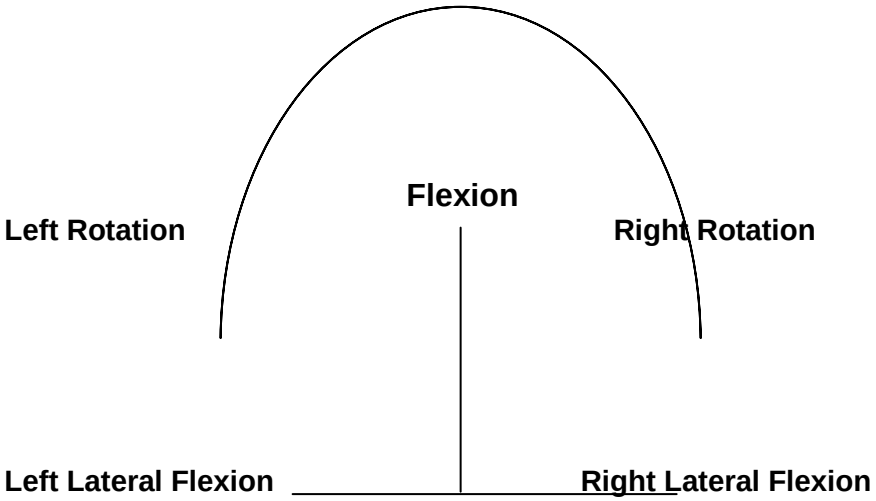
Minor's Sign

Quick Test

Trendelenburg Test

RANGE OF MOTION

Forward flexion	=	40 - 60º (15cm from floor)
Extension	=	20 - 35º
L/R Rotation	=	3 - 18º
L/R Lat Flexion	=	15 - 20º



Extension

/ = Pain free limitation **// = Painful limitation**

6. GAIT

- Rhythm, pendulousness
- On Toes (S1)
- On Heels (L4, 5)
- Halt Squat on one leg (L2, 3, 4)
- Tandem Walking

7. MOTION PALPATION – sacroiliac joints

B. SITTING

01. SPECIAL TESTS

- Tripod Test
- Kemp's Test
- Valsalva Manoeuvre

MOTION PALPATION

Jt. Play			Left					Right				Jt. Play		
P/A	**Lat**	**Fle**	**Ext**	**LF**	**AR**	**PR**		**Fle**	**Ext**	**LF**	**AR**	**PR**	**P/A**	**Lat**
							T10							
							T11							
							T12							
							L1							
							L2							
							L3							
							L4							
							L5							
					U	**L**	S1	**U**	**L**					

C. SUPINE

01. OBSERVATION

- Hair, Skin, Nails
- Fasciculations

2. PULSES

- Femoral
- Popliteal
- Dorsalis Pedis
- Posterior Tibial

3. MUSCLE CIRCUMFERENCE

	LEFT	RIGHT
THIGH	cm	cm
CALF	cm	cm

4. LEG LENGTH

	LEFT	RIGHT
ACTUAL	cm	cm
APPARENT	cm	cm

5. ABDOMINAL EXAMINATION

- Observation
- Abdominal Reflexes
- Auscultation Abdomen and Groin
- Palpation Abdomen and Groin

Comments: _____

NEUROLOGICAL EXAMINATION

DERMATOMES	L	R	MYOTOMES	L	R	REFLEXES	L	R
T12			**Hip Flexion (L1/L2)**			Patellar (L3, 4)		
L1			**Knee Extension (L2, 3, 4)**			Medial Hamstring (L5)		
L2			**Knee Flexion (L5/S1)**			Lateral Hamstring (S1)		
L3			**Hip Int. Rot (L4/L5)**			Tibialis Posterior (L4, 5)		
L4			**Hip Ext. Rot (L5/S1)**			Archilles (S1/S2)		
L5			**Hip Adduction (L2, 3, 4)**			Plantar Reflex		
S1			**Hip Abduction (L4/5)**					
S2			**Ankle Dorsiflexion (L4/L5)**					
S3			**Hallux Extension (L5)**					
			Ankle Plantar Flexion (S1/S2)					
			Eversion (S1)					
			Inversion (L4)					
			Hip Extension (L5/S1)					

SPECIAL TESTS

- SLR
- WLR
- Braggard's
- Bowstring
- Sciatic Notch Pressure
- Sign of the Buttock
- Bilateral SLR
- Patrick Faber
- Gaenslen's Test
- Gapping Test
- "Squish" Test
- Gluteus Maximus Stretch
- Thomas' Test
- Rectus Femoris Contracture Test
- Hip Medial Rotation
- Psoas Test

LATERAL RECUMBENT

- Sacroiliac Compression
- Ober's Test
- Femoral Nerve Stretch Test
- Myotomes:
  - Quadratus Lumborum Strength
  - Gluteus Medius Strength

PRONE

- Facet joint challenge
- Myofascial Trigger points:
    - Quadratus Lumborum
    - Gluteus Medius
    - Gluteus Maximus
    - Piriformis
    - Tensor Fascia Lata
    - Hamstrings
- Skin Rolling
- Erichsen's Test
- Sacroiliac Tenderness
- Pheasant's Test
- Gluteal Skyline
- Myotomes:
    - Gluteus Maximus strength

NON-ORGANIC SIGNS

- Pin-point pain
- Axial Compression
- Trunk Rotation
- Burn's Bench Test
- Flip Test
- Hoover's Test
- Ankle Dorsiflexion Test
- Pin-point pain

APPENDIX G

SOAP Note

CHIROPRACTIC DAY CLINIC

SOAP NOTE:

Patient:	Visit No:
File No:	Student:
Date:	Clinician:

S: O:

A: P:

Comments:	
Patient:	Visit No:
File No:	Student:
Date:	Clinician:

S: O:

A: P:

Comments:

APPENDIX H

Numerical Pain Rating Scale (Marquie et al, 2008)

Name:_____

Please mark in one of the boxes to indicate how severe your pain is:

Visit 1 - Date:

No pain Worst Pain Imaginable

0	1	2	3	4	5	6	7	8	9	10

Visit 3 - Date:

No pain Worst Pain Imaginable

0	1	2	3	4	5	6	7	8	9	10

Visit 5 - Date:

No pain Worst Pain Imaginable

0	1	2	3	4	5	6	7	8	9	10

APPENDIX I

Oswestory Disability Index (Fairbank & Pynsent, 2000)

Name: _____Date:_____

This questionnaire has been designed to give us information as to how your back pain is affecting your ability to manage in everyday life. Please answer by checking one box in each section for the statement which best applies to you. We realize you may consider that two or more statements in any one section apply, but please just shade out the spot that indicates the statement which most clearly describes your problem.

Section 1: Pain Intensity o I have no pain at the moment o The pain is very mild at the moment o The pain is moderate at the moment o The pain is fairly severe at the moment o The pain is very severe at the moment o The pain is the worst imaginable at the moment	**Section 6: Standing** o I can stand as long as I want without extra pain o I can stand as long as I want but it gives me extra pain o Pain prevents me from standing for more than 1 hour o Pain prevents me from standing for more than 30 minutes o Pain prevents me from standing for more than 10 minutes Pain prevents me from standing at all
Section 2: Personal Care (e.g. washing, dressing) o I can look after myself normally without causing extra pain o I can look after myself normally but it causes extra pain o It is painful to look after myself and I am slow and careful o I need some help but can manage most of my personal care o I need help every day in most aspects of self-care o I do not get dressed, wash with difficulty and stay in bed	**Section 7: Sleeping** o My sleep is never disturbed by pain o My sleep is occasionally disturbed by pain o Because of pain I have less than 6 hours sleep o Because of pain I have less than 4 hours sleep o Because of pain I have less than 2 hours sleep o Pain prevents me from sleeping at all
Section 3: Lifting o I can lift heavy weights without extra pain o I can lift heavy weights but it gives me extra pain o Pain prevents me lifting heavy weights off the floor but I can manage if they are conveniently placed (eg. on a table) o Pain prevents me lifting heavy weights but I can manage light to medium weights if they are conveniently positioned o I can only lift very light weights o I cannot lift or carry anything	**Section 8: Sex Life (if applicable)** o My sex life is normal and causes no extra pain o My sex life is normal but causes some extra pain o My sex life is nearly normal but is very painful o My sex life is severely restricted by pain o My sex life is nearly absent because of pain o Pain prevents any sex life at all
Section 4: Walking o Pain does not prevent me walking any distance o Pain prevents me from walking more than 1 mile o Pain prevents me from walking more than ½ mile o Pain prevents me from walking more than 100 yards o I can only walk using a stick or crutches o I am in bed most of the time	**Section 9: Social Life** o My social life is normal and gives me no extra pain o My social life is normal but increases the degree of pain o Pain has no significant effect on my social life apart from limiting my more energetic interests e.g. sport o Pain has restricted my social life and I do not go out as often o Pain has restricted my social life to my home o I have no social life because of pain
Section 5: Sitting o I can sit in any chair as long as I like o I can only sit in my favourite chair as long as I like o Pain prevents me sitting more than one hour o Pain prevents me from sitting more than 30 minutes o Pain prevents me from sitting more than 10 minutes o Pain prevents me from sitting at all	**Section 10: Travelling** o I can travel anywhere without pain o I can travel anywhere but it gives me extra pain o Pain is bad but I manage journeys over two hours o Pain restricts me to journeys of less than one hour o Pain restricts me to short necessary journeys under 30minutes o Pain prevents me from travelling except to receive treatment

APPENDIX J

LROM Digital Inclinometer

Name:_____

Visit 1: Date_____

Flexion	Extension	R Rotation	L Rotation	R Lat Flex	L Lat Flex

Visit 3: Date_____

Flexion	Extension	R Rotation	L Rotation	R Lat Flex	L Lat Flex

Visit 5: Date_____

Flexion	Extension	R Rotation	L Rotation	R Lat Flex	L Lat Flex

APPENDIX K

Algometer Measurement Table

Pain Pressure Threshold (Kg/cm sq per second)	Visit 1	Visit 3	Visit 5
Reading 1			
Reading 2			
Reading 3			
Average			

Name:_____

APPENDIX L

Muscle Energy Technique (Chaitow, 2006)

The patient lies supine with the feet crossed (the side to be treated crossed under the non treated-side leg) at the ankle.

The patient is arranged in a light side-bend, away from the side to be treated, so that the pelvis is towards that side, and the feet and head away from that side ('banana shaped').

As this side-bend is being achieved the affected quadratus lumborum can be palpated for bind so that the barrier is correctly identified.

The patient's heels are placed just off the side of the table, anchoring the lower extremities and pelvis.

The patient's places the arm of the side to be treated behind his/her neck as the practitioner, standing on the side opposite that to be treated, slides his cephalad hand under the patient's shoulders to grasp the treated-side axilla.

The patient grasps the practitioner's cephalad arm at the elbow, with the treated side hand making the contact more secure.

The patient's non-treated side hand should be interlocked with the practitioner's cephalad hand.

The patient's treated side elbow at this stage should be pointing superiorly.

The practitioner's cauded hand is placed firmly but carefully on the anterior superior iliac spine, on the side to be treated.

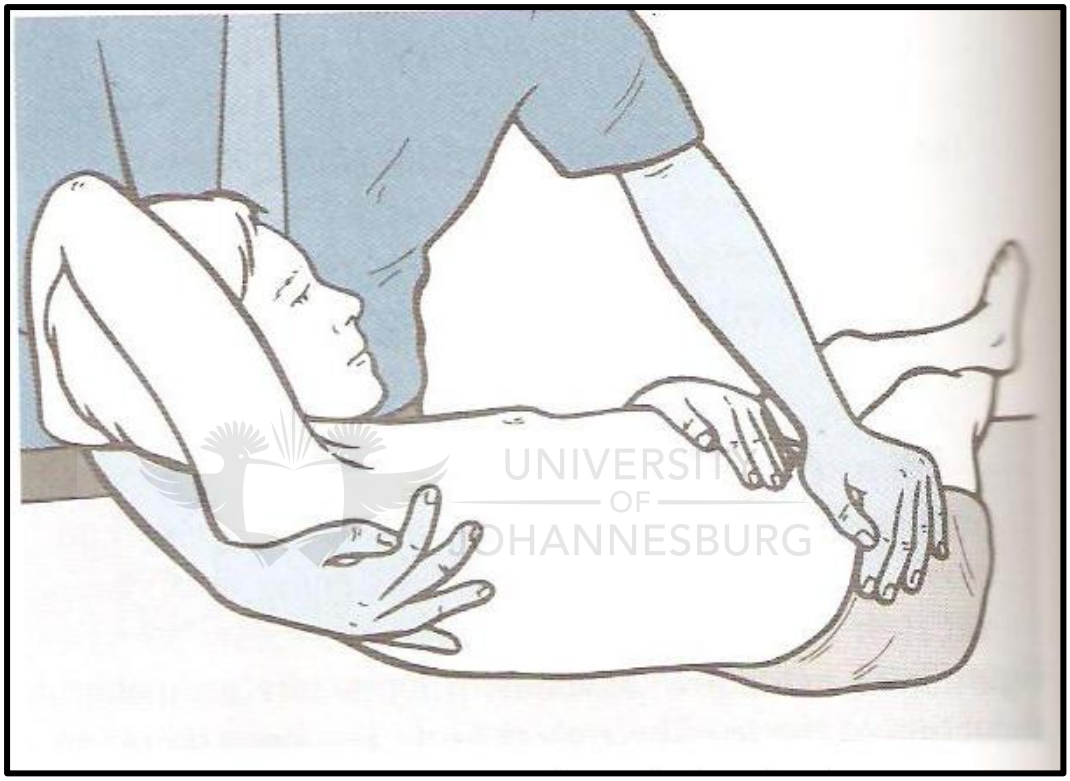
This should produce an isometric contraction in quadratus lumborum on the side to be treated.

After 7 seconds the patient is asked to relax completely and then to side bend towards the non-treated side, as the practitioner simultaneously transfers his body weight from the

cephalad leg to the caudad leg and leans backwards slightly, in order to side-bend the patient.

This effectively stretches quadratus lumborum. The stretch is held for 30 seconds, allowing the lengthening of shortened musculature in the region.

Repeat as necessary.



MET for shortness in quadratus lumborum ('banana') (Chaitow, 2006)