

AN INVESTIGATION INTO THE EFFECT OF EXAMINER-TRAINING ON THE INTER-EXAMINER RELIABILITY OF THE PALPATION OF MYOFASCIAL TRIGGER POINTS.

By

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

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DEDICATION

I sincerely dedicate this dissertation to:

My sister, **Kusturie Moodley**, I am truly grateful for all the sacrifices that you have endured throughout your life for me. Your strength has given me the determination to pursue my dreams and overcome every hurdle in life. I thank you for providing me with the platform to reach for the stars, without you none of this would be possible. Your constant love, support and interminable determination to see me successful has been the foundation for this journey and has finally concluded in this achievement. I love you!

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~Author Unknown

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ABSTRACT

Background: Myofascial pain is a disorder, characterized by the presence of trigger points (MTrP). It is recognised by unique features which include a tender point in a taut band of muscle, a local twitch response (LTR), a characteristic referred pain pattern, and the reproduction of the patient's usual pain upon examination. A debate exists as to the precise diagnostic criteria used in identifying trigger points. This has hampered the standardized assessment and treatment of Myofascial Pain Syndrome and has led to contradictory findings being reported by various authors due to the lack of a reliable diagnostic tool.

Objectives: The first objective was to determine the inter-examiner reliability of palpation of MTrPs in the trapezius and gluteus medius muscles. The second objective was to determine whether training and standardization in palpation techniques would improve inter-examiner reliability of palpation of MTrPs.

Methods: This study was designed as a quantitative pre and post intervention inter-examiner reliability study. Three examiners (one qualified Chiropractor, one senior chiropractic intern from the CDC and the researcher) were used to examine sixty patients (thirty symptomatic and thirty asymptomatic) for MTrPs. This study was conducted in two phases. During the myofascial examination of patients examiners were required to determine whether a MTrP was present or absent, differentiate whether the MTrP was active or latent and determine the presence or absence of the five characteristics of MTrP (tender point in a taut band of muscle, a local twitch response (LTR), a pain characteristic referred pain pattern, the reproduction of the patient's usual pain and a jump sign) however, in phase one the researchers were blinded to the characteristics being investigated. Subsequent to phase one, examiners had to attend two, one hour discussion sessions to reduce individual variation in the application of palpation techniques.

Results: Inter-examiner reliability was assessed using Fleiss Kappa statistic, percentage agreement and confidence intervals. The results show that three examiners are able to attain acceptable agreement in the palpation of MTrPs, since the features (described above) were shown to improve considerably in phase two after the training session in which standardization of techniques was emphasized.

Conclusion: This study provides preliminary evidence that MTrP palpation is reliable and therefore, useful diagnostic tool in the identification of MTrPs and the diagnosis of Myofascial Pain Syndrome.

Key Words: Myofascial pain syndrome; Myofascial trigger point; Palpation; Inter- examiner reliability

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LIST OF ABBREVIATIONS

%	Percentage
AChE	Acetylcholine Esterase
ASICs	Acid Sensing Ion Channels
ATP	Adenosine Triphosphate
Ca	Calcium
CBT	Cognitive Behavioural Therapy
CDC	Chiropractic Day Clinic
CGRP	Calcitonin Gene Related Peptide
CI	Confidence Interval
EMG	Electromyography
Gmed	Gluteus Medius Muscle
IFC	Interferential Current Therapy
IL-1β	Interleukin-1 Beta
kg	Kilograms
L	Left
LASER	Light Amplification by Stimulated Emission of Radiation
LTR	Local Twitch Response
m	Meters
MPS	Myofascial Pain Syndrome
MRE	Magnetic Resonance Elastography
MTrP	Myofascial Trigger Point
MTrPs	Myofascial Trigger Points
n	Sample size
Na	Sodium
NSAIDs	Nonsteroidal Anti-Inflammatory Drugs
p	Kappa
painrecog	Pain Recognition

R	Right
refpain	Referred pain
SCM	Sternocleidomastoid Muscle
SEA	Spontaneous Electrical Activity
SR	Sarcoplasmic Reticulum
Std Deviation	Standard Deviation
tenderpt:	Tender point within a taut band
TENS	Transcutaneous Electrical Nerve Stimulation
TNF α	Tumour Necrosis Factor Alpha
TP	Trigger point
Trap	Trapezius Muscle
VSE	Vibration Sonoelastograph

CHAPTER ONE

INTRODUCTION

1.1. INTRODUCTION TO THE STUDY

Myofascial pain is a disorder characterized by localized muscle tenderness and pain (Bennet, 2007). The characteristic physical finding of myofascial pain is the presence of a myofascial trigger point (MTrP) (Gerwin, Shannon, Hong, Hubbard and Gervitz, 1997).

A MTrP is defined as a highly localized, hyperirritable spot in a palpable taut band (Travell, Simons and Simons, 1999). Myofascial trigger points (MTrPs) may be described as active or latent depending on the clinical and pain referral patterns. Active MTrPs can cause spontaneous pain at rest, with pain increasing on contraction or stretching of the involved muscle (Bennet, 2007). Palpation of an active MTrP may cause local or referred pain pattern, although sometimes both may occur (Rachlin, 2002). In comparison, a latent MTrP is painful only when direct pressure is applied onto the MTrP (Bennet, 2007).

The development of MTrPs in muscle fibers occurs as a result of acute muscle injury, overuse, repetitive strain or microtrauma (Cummings and Baldry, 2007). Factors that perpetuate the development of MTrPs include mechanical stress, biomechanical malalignment, nutritional or metabolic deficiencies or psychological factors (Travell *et al.*, 1999).

Myofascial pain is the most common causes of pain and dysfunction in the musculoskeletal system (Cummings and Baldry, 2007) and is often an overlooked source of musculoskeletal pain (Simons, 2004). A study conducted by Friction, Kroening, Haley and Siegert (1985) in a clinic specializing in head and neck pain reported that 55% of cases had a myofascial etiology.

People of any age can develop MTrPs although it commonly occurs between the ages of 30 and 60 years (Travell *et al.*, 1999). MTrPs can occur in both genders however, the incidence appears to be slightly higher in females (Han and Harrison, 1997).

A wide range of treatment methods are applied in the treatment of MTrPs. These include dry-needling and trigger point injection, stretch, massage, ischemic compression, application of heat or ice, electrotherapy and the elimination of perpetuating factors (Travell *et al.*, 1999).

A debate as to the precise diagnostic criteria used in identifying trigger points exists in the literature despite the presence of a unique set of criteria being made popular by Travell, Simons and Simons (Myburgh, Larsen and Hartvigen, 2008). This has hampered the standardized assessment and treatment of Myofascial Pain Syndrome (MPS) (Travell *et al.*, 1999) and has led to contradictory findings being reported by various authors due to the lack of a reliable diagnostic tool. Bohr (1995) criticized the reliability and validity of MTrP identification claiming that many of the studies aimed at identifying palpation as a valid tool for the detection of MTrPs were methodologically flawed.

Identification of the physical signs of MTrPs is imperative in obtaining meaningful clinical information in the diagnosis of MPS. The simplest and most common method to identify the physical signs of MTrPs in a clinical setting is by palpation of the muscle (Gerwin *et al.*, 1997). However, reliability studies which have focused proving palpation as a valid diagnostic tool has produced conflicting results. It is therefore, essential that further well designed studies need to be conducted in order to establish and standardize palpation as a reliable and valid diagnostic tool.

1.2. RATIONALE FOR THIS STUDY

1.2.1. Rationale One

In the clinical setting, palpation is an important method employed in the diagnosis of myofascial pain (Gerwin *et al.*, 1997). According to Sciotti, Mittak, DiMarco, Ford, Plezbert, Santipadri, Wigglesworth and Ball (2001) there is a lack of adequately controlled studies which have examined the ability of clinicians to reliably and consistently identify MTrPs. Tough, White, Richards and Campbell (2007) and Myburgh *et al.*, (2008) recommended that further research is required to investigate the reliability and validity of palpation and other diagnostic criteria used to determine the presence of MTrPs.

1.2.2. Rationale Two

Travell *et al.*, (1999) popularized a set of distinctive criteria for determining the diagnosing the presence of MTrPs. After a while these criteria have varied and as a result fewer criteria are now considered adequate for the identification and diagnosis of MTrPs (Tough, White, Richards and Campbell, 2007). Bohr (1995) and Baldry (1993) suggested that the lack of agreement regarding appropriate diagnostic criteria for examining trigger points is responsible for the poor recognition of MTrPs clinically. According to Myburgh *et al.*, (2008), there has not been a study that has determined the reliability and validity of the diagnosis of MPS which has included all the trigger point criteria as described by Travell *et al.*, (1999).

1.2.3. Rationale Three

Myburgh *et al.*, (2008) noted that although the standardization of MTrP characteristics was essential in reliability studies, the standardization of palpation and other areas of the myofascial examination were less defined. According to Lucas (2007) clinicians have different findings when palpating MTrPs which arise from different sources. These differences may account for the poor results from inter-examiner reliability studies. Standardization of all aspects of the MTrP examination is imperative in obtaining acceptable results in inter-examiner reliability (Gerwin *et al.*, 1997).

1.2.4. Rationale Four

Gerwin *et al.*, (1997) suggested the importance of a training programme. According to Gerwin *et al.*, (1997) a training programme is imperative in achieving uniformity in the myofascial examination. Studies that have compared the effect of training on the results of reliability have produced contrasting results prompting the need for further studies to determine the effect of training on reliability of palpation of MTrPs.

1.3. AIMS OF THE STUDY

1.3.1. The **first aim of this study** is to assess the inter-examiner reliability in the palpation of myofascial trigger points in the trapezius and gluteus medius muscles using the criteria as described by Travell *et al.*, (1999).

1.3.2. The **second aim of this study** is to determine if the inter-examiner reliability in the palpation of myofascial trigger points in the trapezius and gluteus medius muscles will improve after a training session and standardization of the palpation technique and other areas of the myofascial examination.

1.4. OBJECTIVES OF THE STUDY

1.4.1. Objective 1

To investigate the inter-examiner reliability of palpation of MTrPs in the trapezius muscle between three examiners.¹

1.4.2. Objective 2

To investigate the inter-examiner reliability of palpation of MTrPs in the gluteus medius muscle, between three examiners.¹

1.4.3. Objective 3

To re-evaluate the inter-examiner reliability of palpation of MTrPs in the trapezius muscle, between three examiners as discussed in the training session.

1.4.4. Objective 4

To re-evaluate the inter-examiner reliability of palpation of MTrPs in the gluteus medius muscle, between three examiners as discussed in the training session.¹

1.4.5. Objective 5

To descriptively compare the inter-examiner reliability between objectives 1 and 3; 2 and 4

¹ the presence a tender point within a taut band, patient recognition of pain, presence of a characteristic referred pain pattern, jump sign and local twitch response.

1.5. SCOPE OF THE STUDY

This study took the form of an inter-examiner reliability study using three examiners to examine sixty patients ranging in age from 18 to 45. Both asymptomatic and symptomatic patients with regards to a neck and/or a low back complaint were incorporated into this study. MTrPs in the trapezius and gluteus medius muscles were examined. The researcher, a qualified chiropractor and a senior chiropractic intern from the Chiropractic Day Clinic (CDC) were used as examiners. The examiners were blinded to all the findings obtained by the researcher throughout the clinical procedure. This study was conducted in two phases with an examiner training session conducted between phase one and two.

SPSS version 15.0 was used to analyze the data. Fleiss kappa statistics and percentage agreement was calculated for inter-examiner reliability measurements. The 95% confidence interval of the pre and post samples was used to examine for overlap (Esterhuizen, 2010).

Note:

Throughout the write-up of this study the terms myofascial trigger point (MTrP) and Trigger point (TP) are used interchangeably.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION

Myofascial Pain Syndrome (MPS) is a common musculoskeletal disorder caused by myofascial trigger points (MTrPs) (Bennet, 2007) and may be associated with sensory, motor and autonomic phenomena (Cumming and Baldry, 2007).

MTrPs may occur in any muscle group however muscles involved in posture are the most commonly affected (Rickards, 2006). The parts of the muscle most frequently affected include the muscle's insertion, any free border of the muscle and the belly of the muscle (Baldry, 1998). Ligaments, tendons, joint capsule, skin and the periosteum may also develop MTrPs (Travell *et al.*, 1999).

MTrPs may develop as a result of acute trauma or repetitive microtrauma (Alvarez and Rockwell, 2002). Perpetuating factors of MTrPs include: mechanical and structural stresses, metabolic and endocrine inadequacies, psychological factors and occupational and recreational activities (Travell *et al.*, 1999).

2.2. INCIDENCE AND PREVALENCE OF MYOFASCIAL PAIN SYNDROME

Although MPS is a subject of intense study in the literature, it is still not well understood and often goes unrecognized, misdiagnosed and mistreated (Auleciems, 1995). It is a commonly encountered problem in the outpatient setting and an increasing interest in the Chiropractic profession towards the management of disorders such as MPS is developing (Schneider, 1995).

Precise figures concerning the incidence and prevalence of MPS in South Africa is unknown (Ferreira, 2006). Skootsky, Jaeger and Oye (1989) reported that thirty percent of patients attending a primary care general internal medicine practice were diagnosed with myofascial pain. According to Wheeler (2004), an estimate of 44 million Americans suffer from myofascial pain. Epidemiological studies conducted in the United States concluded that 30-85% of patients claimed that MTrPs were there primary source of pain (Friction, 1994). Gerwin (1995) found that of the 96 patients presenting to a pain medical center, 93% had at

least part of their pain caused by MTrPs and in 74% of these cases MTrPs were thought to be the primary cause of their pain. Similar to the study by Friction (1994), Han and Harrison (1997) also found that the incidence of MPS varied between 30 and 85% in patients presenting to pain clinics. Chaiamnuay, Darmawan, Muirden and Assawatanabodee (1998) found MPS was the second most common diagnosis encountered in rural villages of Thailand, of the 2 436 subjects examined, 36.2% had musculoskeletal pain of myofascial origin.

Although the incidence of trigger points is found in both genders, the incidence appears higher in women (Han and Harrison, 1997). Hou, Tsai, Cheng, Chung and Hong (2002) found that of the 119 patients treated for MPS, 107 were female. Walker (2002) found that 72% of the 60 patients treated for MPS were female while Wilks (2003) established that 60% of the 60 patients treated for MTrPs were female. Sola, Rodenburger, and Getty (1955) also found that women had a higher incidence of trigger points while examining the shoulder muscles of 200 asymptomatic young adults. The researchers found that 54% of females and only 45% of males had trigger points in their shoulder muscle. Tunks and Crook (1999) suggested that women have a lower tenderness threshold over tender points than men which may account for the higher incidence in females. According to Katz (2002), women are twice as likely to complain of chronic pain.

MTrPs may develop in all age groups however, middle aged individuals are more likely to present with MTrPs. Young people are more resistant to injury and the muscles of young individuals heal faster as a result are unlikely to develop active MTrPs however, with age muscles become more degenerate, less resilient and slower to heal (Cummings and Baldry, 2007). Active MTrPs commonly occur in middle aged individuals while elderly individuals frequently develop latent MTrPs (Cummings and Baldry, 2007).

Van Aardenne (2002) treated 60 patients between the ages of 20-60 for myofascial pain and found that 48.2% of the patients were between the ages of 31-50 while 36.6% were between the ages of 20-31. A study conducted by Tunks and Crook (1999) found that of 60 patients treated for myofascial pain, 52% were between the ages of 32-55 and 43% were between the ages of 20-31. Friction *et al.*, 1985 also found that patients between the ages of 30-49 years old had the highest prevalence of trigger points. These studies confirm that the prevalence of MPS decreases with advancing age and occurs commonly between the ages of 20-50 years (Fomby and Mellion, 1997).

2.3. ETIOLOGY OF MYOFASCIAL TRIGGER POINTS

The etiology of MTrPs is diverse and little consensus exists with respect to the exact causes (Huguenin, 2004). MTrPs can become active as a result of a primary or secondary factor (Baldry, 1998).

Primary Factors

- Mechanical abuse: Either an acute sustained or repetitive muscle overload i.e.: a prolonged muscular contraction may lead to the development of MTrPs (Travell *et al.*, 1999).
- Trauma: This trauma maybe as a result of direct injury or a sudden strain to the muscle. Excessive or unusual exercise of the muscle and repeated minor trauma to the muscle may also cause MTrP. Trauma to the muscle results in an inflammatory response with subsequent cellular damage. This cellular damage results in the release if bradykinin, prostaglandins, histamine, serotonin and potassium ions which result in the sensitization of A-delta (Group III) and C (Group IV) sensory fibers causing pain (Baldry, 1998).
- Leaving a muscle in shortened position for a prolonged period of time especially if the muscle is contracted in the shortened position can produce MTrPs (Travell *et al.*, 1999).
- Nerve compression can cause neuropathic electromyography changes resulting in disturbed microtubule communication between the neuron and the endplate (Travell *et al.*, 1999). Radiculopathy caused by a ruptured intervertebral disc, results in the development of MTrPs in the muscles supplied by the compressed nerve root (Travell *et al.*, 1999).
- Adverse environmental conditions: Exposure to excessive heat, cold or dampness may result in the development of MTrPs (Travell *et al.*, 1999).

Secondary Factors (Baldry, 1998)

- **Compensating synergistic or antagonistic muscles**-May develop MTrPs secondary to the development MTrPs in the primary muscle. Synergistic muscles may develop MTrPs if these muscles are overloaded because the muscles are compensating for the primary muscle which contains the MTrPs. Antagonistic muscles can develop MTrPs when these muscles counteract the tension in the primary muscle which contains the MTrPs

- **Satellite MTrPs** can evolve in referral zone of primary trigger points.
- **Low oxygenation of tissues** makes muscle susceptible to the development of MTrPs.

2.4. PERPETUATING FACTORS OF MYOFASCIAL TRIGGER POINTS

Numerous perpetuating factors are associated MTrPs although they are often ignored and neglected but are a fundamental feature of treatment and will improve the long term prognosis. Perpetuating factors can be viewed as predisposing factors, because their presence can make muscles more susceptible to the activation of MTrPs (Auleciems, 1995).

Perpetuating factors may include any of the following:

- 1) Mechanical stresses - skeletal asymmetry (short leg or small hemipelvis), skeletal disproportion (short upper arms or mortons foot), muscular stress (poor posture, misfitting furniture, prolonged immobility, constricting pressure on muscle and abuse of muscles) (Travell *et al.*, 1999).
- 2) Nutritional inadequacies- Nutritional inadequacies are often ignored clinically .Vitamin B₁, B₆, B₁₂ and C , folic acid, calcium, potassium and iron all play a role in the normal functioning of muscles (Travell *et al.*, 1999). Low levels of these vitamins and minerals often disrupt energy supply to muscle thereby aggravating of MTrPs (Gerwin, 2001). Iron deficiency occurs when ferritin is decreased (Gerwin, 2001). Iron is important for the generation of energy therefore a decrease in iron may contribute to the development and maintenance of MTrPs (Gerwin, 2001).
- 3) Psychological factors such as depression, tension and anxiety may inhibit fast recovery from MTrPs (Travell *et al.*, 1999). Electromyography (EMG) studies conducted by McNulty, Gervitz, Hubbard, Berkoff (1994) showed an increased MTrP electromyographic activity during stress, while the adjacent muscle remained electrically silent. The results from the study conducted by McNulty *et al.*, (1994) imply a mechanism by which emotional factors affect muscle pain.
- 4) Chronic infection due to either bacterial, viral disease or parasitic disease may prevent recovery (Travell *et al.*, 1999).

- 5) Metabolic and endocrine inadequacies including hypothyroidism, hypocalcaemia, hyperuricemia, hypoxia and anemia may impair muscle metabolism (Travell *et al.*, 1999).
- 6) Other factors such as impaired sleep, allergy, radiculopathy and chronic visceral disease may also perpetuate the development of MTrPs (Travell *et al.*, 1999).

2.5. PATHOPHYSIOLOGY OF MYOFASCIAL TRIGGER POINTS

2.5.1. Structure of Skeletal Muscle

It is important to recognize the basic structure and function of the skeletal muscle to understand the nature of MTrPs. Skeletal muscle is a voluntary muscle. It consists of bundles of muscle fibers. Each muscle fiber contains numerous myofibrils (Guyton, 1992). The sarcolemma is the cell membrane of the muscle fiber. Every myofibril contains a chain of sarcomeres. The basic contractile unit of skeletal muscle is the sarcomere. Each sarcomere is made up of thin actin filaments and thick myosin filaments. Interaction of the actin and myosin filaments cause muscle contraction. The myofibrils subsist within a matrix called the sarcoplasm. Within the sarcoplasm are adenosine triphosphate (ATP) producing mitochondria, potassium, magnesium, phosphate, protein enzymes and the sarcoplasmic reticulum (SR). The function of the SR is to store large concentrations of calcium ions, which are necessary for muscle contraction (Guyton, 1992). (Refer to Figure 1).

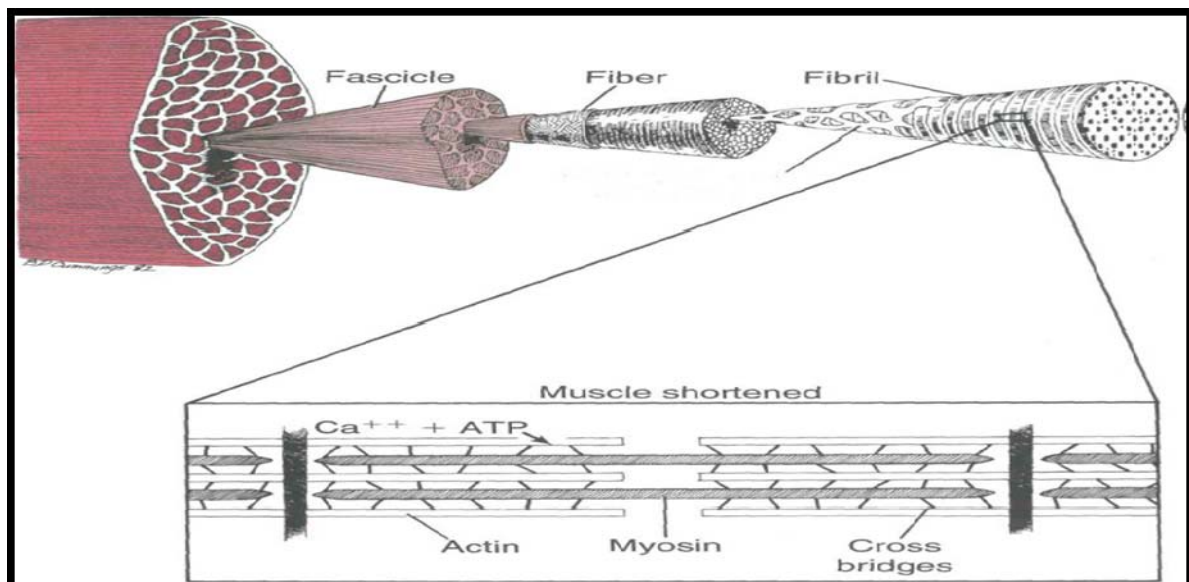


Figure 1: The structure and contractile mechanism of a normal skeletal muscle (Travell *et al.*, 1999).

➤ Mechanism of Muscle Contraction

The initiation of muscle contraction occurs in the following steps (Guyton, 1992)

An action potential is propagated along a motor nerve to its nerve ending on each muscle.

↓

A small amount of acetylcholine (ACh) is secreted at each nerve ending.

↓

Acetylcholine - gated channels open

↓

This allows large amounts of sodium (Na) ions to flow to the interior of the muscle fiber at the point of the nerve terminal.

↓

This initiates an action potential in the muscle fiber. The action potential travels along the entire muscle fiber membrane.

↓

The action potential depolarizes the muscle fiber, causing the release of large quantities of calcium (Ca) ions from the SR.

↓

Ca ions causes the actin and myosin filaments to slide together causing a muscle contraction.

↓

The Ca ions are pumped back into the SR and are stored there until a new action potential is generated.

↓

Removal of the Ca ions causes the muscle contraction to cease.

Figure 2: The initiation of muscle contraction

The development of MTrPs is very diverse and little consensus exists with respect to the exact causes. Several theories have been proposed by different researchers in the field (Travell *et al.*, 1999; Hubbard, 1998; Han and Harrison, 1997; Gatterman and Goe, 1990 and Awad, 1973).

These proposed hypotheses included the Energy Crisis Theory, the Muscle Spindle Concept, the Motor Endplate Hypothesis and the Integrated Hypothesis:

2.5.2. The Energy Crises Theory

The energy crisis theory was designed to explain the presence of the taut band and the pain and tenderness of MTrPs (Hong and Simons, 1998 and Hong, 1996). This theory proposes that an increased demand on a muscle leads to increased calcium release from the injured sarcolemma thus, causing prolonged shortening of the sarcomere (Simons, 1996). Sustained muscle contraction compromises the local circulation and increases metabolism. This impaired circulation, together with the increased metabolic demands generated by the prolonged shortening sarcomere results in cells being unable to produce sufficient local ATP to initiate relaxation, thus the energy crisis (Simons, 1996).

Bengtsson, Henriksson, and Larsson (1986) investigated the concept of altered muscle metabolism that underlies the changes at trigger point sites. Muscle energy stores can be measured by using the level of various phosphate containing compounds such as ATP, phosphocreatine, and adenosine diphosphate. These phosphate containing compounds are capable of donating their phosphate group and releasing energy for muscle activity. Results from this biopsy study of patients with fibromyalgia found that the levels of high-energy phosphates were decreased and low energy phosphates were increased at trigger point sites in these patients therefore supporting the idea of a metabolic derangement at trigger point sites (Bengtsson *et al*, 1986).

2.5.3. Muscle Spindle Concept

MTrPs have highly localized electrical activity (Travell *et al.*, 1999). Hubbard and Berkoff (1993) proposed that this activity originated in the dysfunctional intrafusal muscle spindle which is innervated by the sympathetic nervous system. This theory was however, was later dismissed because the activity of MTrPs was not sufficiently localized to be generated in the endplate and the activity did not have the anticipated location or waveform morphology (Simons, 1996). Researchers since then have claimed that the electrical activity may be motor endplate noise (Simons, 2001 and Simons, Hong and Simons, 2002).

2.5.4. Motor Endplate Hypothesis

According to the motor endplate hypothesis dysfunction in the region of extrafusal motor endplates is responsible for MTrPs. Results from needle EMG studies suggest that the dysfunctional endplates released large amounts of acetylcholine. Simons (1996) suggested that this little amount of activity at the motor endplate is might not be able to cause muscle contraction, however it can result in action potentials being propagated a short distance along the muscle cell membrane. This action potential may result in activation of a small number of contractile elements resulting in some degree of muscle shortening.

2.5.5. Integrated Trigger Point Hypothesis

Integrated trigger point hypothesis combines both electrodiagnostic and histopathological evidence to describe a possible cycle of MTrP development (Simons, 2004).

This theory suggests that an increase in the release of acetylcholine by the nerve terminal of an abnormal motor endplate is caused by an initial insult of the muscle. This results in an abnormal and sustained depolarization of the post-junctional membrane of the muscle fiber (Simons, 2004). Calcium released from the sarcolemma produces a prolonged shortening of the sarcomere (Simons, 2004). As a consequence of the prolonged shortening of the sarcomere, an increase in local energy consumption and reduction in local circulation occurs resulting in localized muscle ischemia, this in turn stimulates the release of neurovascular reactive substances such as serotonin, histamine, bradykinin, capsaicin and prostaglandins sensitize nociceptors. Sensitization of the nociceptors results in local MTrP pain and tenderness. In addition these neurovascular reactive substances stimulate the local autonomic system to release more acetylcholine (Simons, 2004).

Under normal conditions calcium is returned to the sarcoplasmic reticulum (SR) via the calcium pump (Guyton, 1992) however, this process is dependent on ATP to function normally. Due to the energy crisis adequate amounts of ATP are unavailable, leaving the contractile elements exposed to free calcium (Simons, 2004). The absence of ATP also leaves the myosin heads firmly attached (the myosin heads fail to recock) and consequently the muscle stiffens (Simons, 2004).

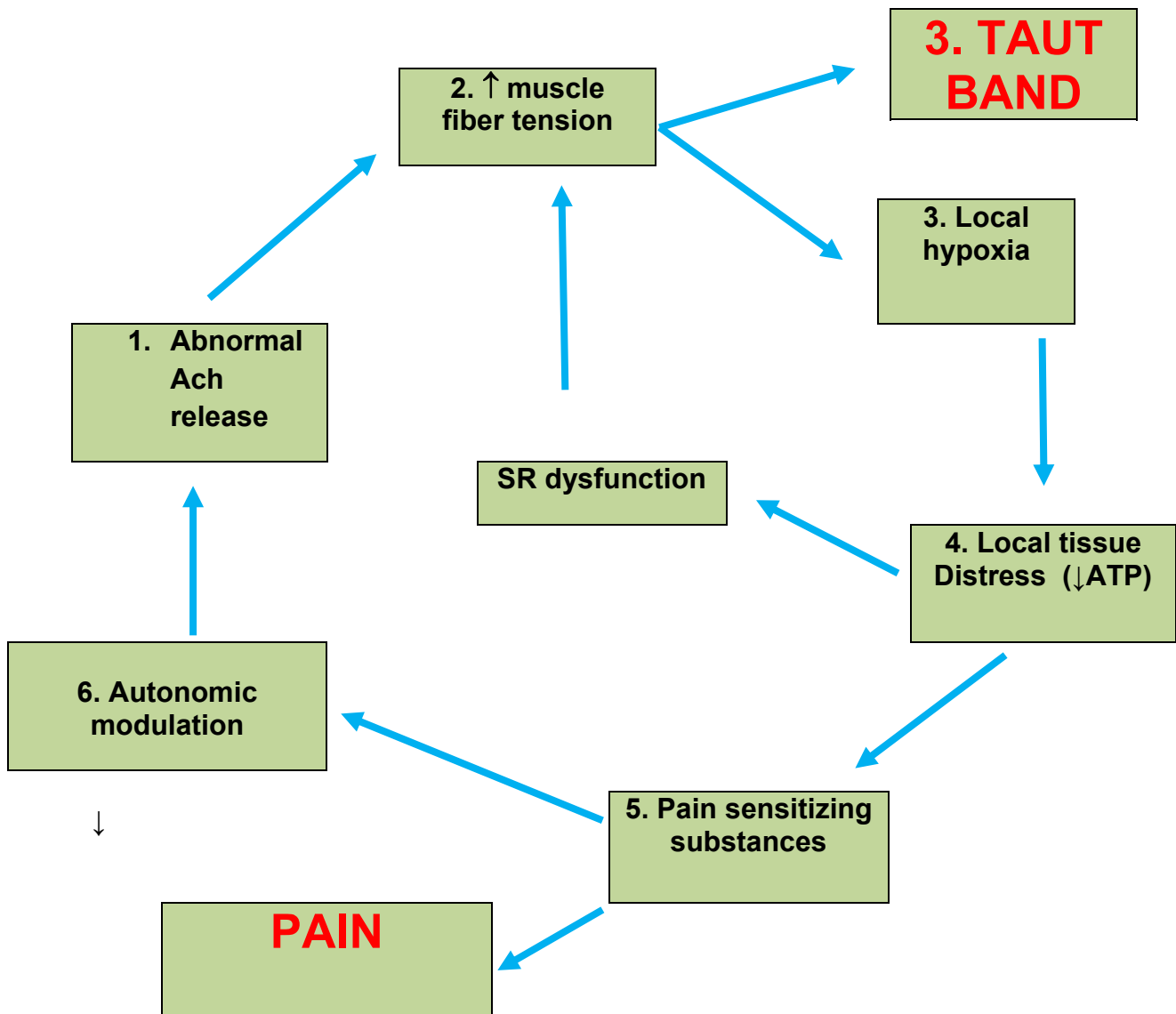


Figure 3: Flow diagram showing Simons' (2004) integrated hypothesis.

Reproduced from Simons (2004, *Journal of Electromyography and Kinesiology* 14(1): 95-107) with permission (Appendix L).

2.6. CLASSIFICATION OF MYOFASCIAL TRIGGER POINTS

A MTrP is a localized hyperirritable spot within a muscle or its fascia and causes local tenderness, referred pain and motor dysfunction when compressed (Travell *et al.*, 1999). According to Travell *et al.*, (1999) two types of MTrPs exist and are classified based on their clinical characteristics (Alvarez and Rockwell, 2002).

2.6.1. Active MTrPs

Active MTrPs can refer pain at rest and on activity (Travell *et al.*, 1999). It prevents full lengthening of and weakens the muscle, mediates a local twitch response when stimulated mechanically, on direct compression produces pain that the patient recognizes and refers pain within a specific pattern characteristic of a particular muscle. An active MTrP may also produce autonomic phenomena in their pain reference zone (Travell *et al.*, 1999).

2.6.2. Latent trigger points

A latent MTrP is painful on palpation or application of direct pressure (Travell *et al.*, 1999). Mechanical overloading, prolonged muscle shortening, or other aggravating (perpetuating) factors may cause latent trigger points to become active (Hong and Simons, 1998; Wreje and Brorsson, 1995).

2.6.3. Primary MTrPs

Primary MTrPs Develop from either acute or chronic overloading of the muscle and when its activation is not due to the action of another muscle (Travell *et al.*, 1999)..

2.6.4. Secondary MTrPs

Secondary occur as a result of mechanical stress and/or neurogenic inflammation due to the activity of a primary MTrP in a muscle. A secondary MTrP becomes active when the muscle that it is located in, is overloaded as a result of acting as a synergist substituting for, or as an antagonist countering the tautness of, the muscle that contains a primary MTrP (Travell *et al.*, 1999).

2.6.5. Satellite MTrPs

A satellite MTrP becomes active because it is located in the zone of reference of another MTrP. It can also become active when the muscle it is located in becomes overloaded when it acts as a synergist or antagonist to the muscle harboring the primary MTrP (Travell *et al.*, 1999).

2.7. CLINICAL CHARACTERISTICS OF MYOFASCIAL TRIGGER POINTS

Table1. Features of MTrPs (Travell *et al.*, 1999)

Clinical features of MTrPs
1. Point tenderness on a taut muscle band
2. Local twitch response
3. Referred pain
4. Reproduction of usual pain
5. Restricted range of motion
6. Weakness without atrophy
7. Autonomic symptoms

2.7.1. A Tender Point within a Taut Band of Skeletal Muscle

According to Myburgh *et al.*, (2008), a taut band is a ropelike structure palpated in a muscle fiber. Baldry (1998) suggests that these nodules represent a MTrP. These nodules are extremely painful when compressed. In a patient who is without pain before compression, the MTrP is termed “latent”, however if pain is present and compression elicits local or referred pain, the MTrP is termed “active” (Travell *et al.*, 1999).

Simons (1996) proposed a mechanism of taut band formation. Simons (1996), suggested that as a result of trauma or abnormal stress, intracellular calcium is released from the muscle fibers. The abnormal release of calcium results in the shortening of muscle fibers. This consequently impairs the local circulation resulting in a decrease in the oxygen and nutrient supply to the area causing an energy crisis and the formation of a taut band (Simons, 1996).

2.7.2. A Local Twitch response (LTR)

A LTR is a brief and rapid fasciculation that occurs either in the fibers of the taut band containing a MTrP, a different taut band in the same muscle, or in a taut band in another muscle (Simons, 2004). A LTR is a spinal reflex (Hong and Yu, 1998; Hong and Torigoe,

1994 and Hong, 1994) and may be stimulated by compression of or by needle insertion into the MTrP (Travell *et al.*, 1999). LTRs appear as high amplitude poly- phasic EMG discharges when recorded (Hong, 1994). Transection of the spinal nerve that innervates that MTrP or infusion of lidocaine into that MTrP eliminates a LTR. Cord transaction and spinal shock can decrease the activity of a LTR (Hong and Simons, 1998).

2.7.3. Patient Recognition of Pain

Compression of a MTrP may produce a local and/or referred pain pattern that is familiar to the patient (Travell *et al.*, 1999). Muscle pain is transmitted by Group III (A delta, thin myelinated) and Group IV (c, non myelinated) afferent nerve fibers (Franz and Mense, 1975). Neurotransmitters involved in the pain response include bradykinin, serotonin and prostaglandins (Franz and Mense, 1975). According to Baldry (1998) sensitization of Group III (A delta) fibers result in the development of a sharp short lasting pain, while sensitization of the Group IV (c) fibers produces an ill- defined, dull achy pain.

2.7.4. A Characteristic Referred Pain Pattern on Compression

Referred pain is felt at a distance from the site of origin (Bron, Franssen, Wensing and Oostendorp, 2007). Referred pain may be spontaneously present or produced during palpation of a MTrP (Myburgh *et al.*, 2008). Referred pain follows a myotomal distribution (Travell *et al.*, 1999). A specific pattern of referred pain for muscles has been established, these were described by Kellergren (1938) described the characteristic patterns of local and referred muscle pain in asymptomatic patients. By injecting an algescic substance (hypertonic saline) into the muscle and asking the patients to describe the region in which they perceived pain Kellergren (1938) was able to map out the referred patterns of muscles.

Referred pain arises from central convergence and facilitation (Borg-Stein and Simons, 2002). Under pathologic conditions, such as myofascial pain convergent connections are facilitated and amplified. These convergent connections arise from the deep afferent nociceptors to the dorsal horn neurons (Mense, Simons and Russell, 2001). Referred pain being projected to nearby myotomes may occur as a result of the spreading of central sensitization to the adjacent spinal segments (Borg-Stein and Simons, 2002). According to Mense (2003) central sensitization refers to the process in which there is an increase in the number of the neurons in the spinal cord reacting to the continuous nociceptive input from the muscle. Central sensitization is characterized by increased excitability of sensory neurons and increase in the receptive field (Mense, 2003).

A study conducted by Mense (1996) on rats showed that when neurons perceive noxious input as coming from more than one source it results in pain referral being experienced. This referral can cross to different spinal cord levels because of the increased spinal cord levels of substance P and calcitonin gene related peptide (CGRP) (Hong, 1996). According to Huguenin (2004) an increased release of Substance P and CGRP in the dorsal horn, results in the increased sensitivity of these areas to the noxious input. Substance P and CGRP levels have been found to be independent, however their source their source is unknown (Huguenin, 2004). It is hypothesized that it may arise from the local neurons or released from higher centers (Huguenin, 2004).

Selzer and Spencer (1969) also hypothesized five mechanisms of referred pain namely: convergence projection, peripheral branching of primary afferent nociceptors, convergence facilitation, sympathetic nervous system and convergence at the supraspinal level.

1. Convergence Projection

Occurs when cutaneous afferents and visceral (or skeletal muscle) afferents join on the same spinal neuron. The brain cannot differentiate whether the information is coming from the skin, muscle or visceral organs (Selzer and Spencer, 1969).

2. Peripheral Branching of Primary Afferent Nociceptors

A single neuron reaches several areas of the body by branching out. The brain may therefore, misinterpret the exact location of the signal from the spinal neuron. Referred pain from MTrPs may extend to the trigger point zone of a muscle via one branch, while another branch may extend to the referred pain zone for that muscle (Selzer and Spencer, 1969).

3. Convergence Facilitation

This theory suggests that the normal activity of the sensory afferents in the reference zone of a MTrP may be sufficiently influenced by abnormal visceral afferent activity resulting in it being perceived as pain (Selzer and Spencer, 1969).

4. Sympathetic Nervous System (SNS)

Stimulation of the SNS may result in referred pain in two ways:

1. By decreasing the blood flow to the vessels that supply the sensory nerve fiber (Selzer and Spencer, 1969).
2. By the release of nociceptive substances in the referred pain zone (Selzer and Spencer, 1969).

5. Convergence at the Supraspinal Level

Pathways may converge at the thalamic or cortical level which can result in image projection of a referred pain pattern (Selzer and Spencer, 1969).

2.7.5. Muscle Weakness

A muscle containing a MTrP may be weak, without apparent atrophy. The magnitude of weakness varies from muscle to muscle and from subject to subject. The weakness occurs because a central inhibition develops which protects the muscle from a painful degree of stretch (Travell *et al.*, 1999).

2.7.6. Restriction of Full Stretch Range of Motion

Restriction of full stretch range of motion occurs as a result shortening of the muscle fibers in a taut band. According to Travell *et al.*, (1999), a muscle with an active MTrP will have a restricted stretch range of motion because of pain. Inactivating the MTrPs and releasing the taut band allows range of motion to return to normal. The degree of limitation is relatively muscle-specific. It is therefore, more useful as a diagnostic criterion in some muscles than in others (Travell *et al.*, 1999).

2.7.7. Non- Pain Related Phenomena

MTrPs can refer vascular, secretory and pilomotor autonomic changes (Travell *et al.*, 1999).

1. Vasomotor Autonomic Effects

Vasomotor autonomic effects commonly occur (Travell *et al.*, 1999). Stimulation of a MTrP in the upper trapezius results in a temporary reduction in the blood flow of the temporal artery on the same and contralateral side of the MTrP. Active MTrPs in the sternal division of the sternocleidomastoid muscle (SCM) can result in discharge and reddening of conjunctiva (Travell *et al.*, 1999).

2. Secretory Autonomic Effects

These include coryza, lacrimation and localized sweating (Travell *et al.*, 1999).

3. Pilomotor Autonomic Effects (gooseflesh/ goosebumps)

Pilomotor autonomic effects may occur spontaneously and is produced by applying pressure to an active MTrP in a specific location. Stimulation of trigger point number seven (Tp7) in the trapezius muscle produces this response (Travell *et al.*, 1999).

4. Disturbance of vestibular function and space perception

Active MTrPs in clavicular division of the SCM can cause imbalance, disorientation of the body and postural dizziness (Travell *et al.*, 1999).

5. Visual Disturbances

Active MTrPs in the SCM regularly cause blurring of vision and intermittent double vision without papillary changes (Travell *et al.*, 1999). Hubbard and Berkoff (1993) found that the electrical amplitudes and the number of spikes recorded from a MTrP region were reduced considerably after injection of phentolamine.

2.8. DIAGNOSIS OF MYOFASCIAL PAIN SYNDROME

The diagnosis of myofascial pain is characterized by the identification of MTrPs. According to Simons (2004), there is no diagnostic gold standard, therefore, diagnosis depends on the detection of distinguishing features in the patient history, physical examination and on the identification of specific and unique clinical signs.

2.8.1. Patient History

Pain, of insidious onset is the most common presenting complaint of MPS and is often described as a constant, deep, and aching. The pain is often poorly localized. Pain intensity may vary from mild to severe (Borg-Stein and Simons, 2002). Patients initially complain of decreased work tolerance, impaired muscle coordination, stiff joints, fatigue, and weakness. At a later stage patients may complain that the pain may be intensified by sleep disturbance, mood changes, and stress (Travell *et al.*, 1999).

Patients may often describe one of the following activities before the onset of myofascial pain (Simons, 2004):

1. Sudden muscle overload
2. Sustained muscular contraction with the muscles in a shortened position
3. Repetitive activity

According to Simons (2004) patients may observe a restriction in specific movements, a restricted range of stretch and an increased sensitivity to stretch. This is due to the activation of MTrPs in the affected muscle. Patients may also report a decrease in the strength of the affected muscle without any observed muscle atrophy (Simons, 2004).

2.8.2. Physical Examination

Locating MTrPs through palpation is the most important part of the clinical examination (Baldry, 1998). Identification of a taut band is a guide to the accurate location of a MTrP during the examination of a taut band the patient is positioned to lengthen the muscle being examined. This stretch should not cause any pain or discomfort. Snapping palpation is then used to locate a taut band (Travell *et al.*, 1999).

After a palpable taut band has been identified, a tender nodule/ point must be located within the taut band. Compression of the MTrP produces local pain or a referred pain pattern characteristic of the muscle in which the trigger point is located (Travell *et al.*, 1999). The presence of a referred pain pattern is indicative of an active MTrP. According to Cummings and Baldry (1998) if an active MTrP is palpated the patient will give a verbal indication that they recognize the pain. The pain is often sufficient to cause the patient to give an involuntary jerk or withdrawal from palpation referred to as the “*jump sign*”. Another diagnostic indicator of a trigger point is the presence of a local twitch response elicited by the compression of, or needle insertion into the trigger point (Travell *et al.*, 1999). Also on examination, the patient may be unable to develop normal strength on static testing of the involved muscle as compared to testing of a contralateral uninvolved muscle (Travell *et al.*, 1999).

Additional symptoms as described by Travell *et al.*, (1999) include proprioceptive disturbances and motor disturbances including spasm of other muscles (synergistic and/or antagonistic muscles) and decreased muscle power or work tolerance. Sympathetically-mediated symptoms including pilomotor responses (“goosebumps”/“gooseflesh”), hyperscretion (sweating), persistent lacrimation, ptosis, vasoconstriction or sensations of intense coldness in the distal part of a limb may all occur spontaneously or when pressure is applied to the MTrP, due to the presence of sympathetic nerve fibers at MTrP sites (Baldry, 1998).

2.9. THE IDENTIFICATION OF MYOFASCIAL TRIGGER POINTS

Reliability according to Hobart, Lamping and Thompson (1996) refers to the accuracy, consistency, stability and reproducibility of the examination technique. Inter-examiner reliability refers measures the agreement between two or more examiners (Gerwin *et al.*, 1997).

There are several concerns associated with the subjective nature in which MTrPs are diagnosed clinically (Borg-Stein and Simons, 2002 and Sciotti *et al.*, 2001). No biochemical, electromyographic, or diagnostic imaging criteria exists for the unequivocal diagnosis of myofascial MTrPs. Palpation skills, in combination with patient feedback, have mainly been used for the diagnosis and treatment of MTrP. A frequent criticism of the reliance on palpation for the diagnosis of MTrPs lies in the lack of adequately controlled studies that have examined the ability of clinicians to reliably identify MTrPs (Sciotti *et al.*, 2001).

Previous reliability studies (Njoo and Van der Does, 1994; Nice, Riddle, Lamb, Mayhew and Rucker, 1992 and Wolfe, Simons, Friction, Bennett, Goldenberg, Gerwin, Hathaway, McCain, Russell and Sanders, 1992) have found poor and inconsistent results.

Wolfe *et al.*, (1992) examined patients with chronic myofascial pain using four rheumatologists. The study design allowed fifteen minutes to evaluate muscles bilaterally in the upper and lower body however, this was a very short time period for the myofascial examination of numerous muscles and midway through the study the number of muscles examined per subject was reduced by half. Local tenderness was a common finding but reliability for taut bands, muscle twitch, and active trigger points was poor. According to Myburgh *et al.*, (2008) multiple sites of examination is not optimal because it relies on patient recall and may suffer from patient recall bias. By reducing the number of muscles examined patient recall bias can be avoided (Myburgh *et al.*, 2008)

Nice *et al.*, (1992) also reported poor agreement among examiners when assessing the inter-tester reliability for the presence of MTrPs in 50 patients with lower back pain. The researchers reported that lack of standardization with respect to patient's position, palpation techniques, force of palpation used in the examination amongst the examiners, varying degrees of clinical experience and training in trigger point examination of examiners may have accounted for the poor inter-tester reliability.

According to Lucas (2007), clinicians have different findings when palpating MTrPs which may arise from different sources. For example clinicians may not palpate the same sites for MTrPs within a specific muscle, and they may not interpret the findings in the same way or

they have different techniques for eliciting various clinical signs e.g. eliciting a local twitch response. These differences may account for the poor results from inter-examiner reliability studies. Standardization of all aspects of the MTrP examination including the type of palpation, the amount of pressure, interpretation of physical signs and the patient position is imperative in obtaining acceptable results in inter-examiner reliability.

A study conducted by Njoo and Van der Does (1994) aimed at identifying clearer criteria for the diagnosis of trigger points, found that subjective signs like local tenderness, pain recognition and jump sign were reliable signs among different examiners. However, objective signs like local twitch response, palpable band and referred pain were not found to be reliable. Five observers working in pairs examined 61 patients with non-specific low back pain and 63 control subjects. The diagnostic criteria evaluated included: localized tenderness, referred pain, palpable band, twitch response, limited stretch range, jump sign, and pain recognition, these characteristics were recorded as either absent or present. The examiners in this study were medical students however, no remark was made as to the extent of their training and experience in myofascial trigger point examination. According to Hsieh, Hong, Adams, Platt, Danielson, Hoehler and Tobis (2000) experience in the MTrP examination is necessary to obtain acceptable inter-examiner reliability for the palpation of MTrPs. The researches' concluded that localised tenderness and the presence of either the jump sign or pain recognition maybe useful as diagnostic criteria for the presence of trigger points clinically.

Lew, Lewis and Story (1997) used two experienced clinicians to identify the location of latent MTrPs in the upper trapezius muscles. 58 subjects were used and examiners marked the locations of MTrPs on an enlarged body diagram. Results concluded that inter-examiner agreement for locating latent MTrPs in this muscle was poor.

Gerwin *et al.*, (1997) stated that identification of MTrPs relies on effective palpation skills and the specific knowledge of musculoskeletal structure and function. It was therefore suggested that identification of MTrPs is a skill that might be trainable.

A two phased study conducted by Gerwin *et al.*, (1997) showed that a training period dramatically increased the inter-rater reliability of the trigger point examination. A lack of intra group training resulted in the failure of initial attempts to examine inter-rater reliability of palpation of MTrPs. A second attempt was made this however was preceded by a three hour team training session. In both phases four physicians examined 25 subjects using the following criteria: a tender point in a taut band of muscle, a local twitch response, a pain

referral pattern characteristic of trigger points of specific areas in each muscle and the reproduction of the patient's usual pain. Results showed that agreement was near perfect for the assessment of the taut band and was substantial for all other diagnostic features apart from local twitch response. The study also showed that the interrater reliability of different features varies with the local twitch response being the most difficult and that the interrater reliability of the identification of MTrP features among different muscles also differs.

In contrast to the results found by Gerwin *et al.*, (1997), Hsieh *et al.*, (2000) found no difference between trained and untrained individuals in the palpation of MTrPs. This study was designed to assess inter-examiner reliability of palpation of three characteristics in low back muscles specifically the presence of a taut band, local twitch response and referred pain in the muscles. The researchers concluded that MTrP palpation is not reliable for identifying the taut band and local twitch response, and MTrP palpation is only slightly reliable for identifying referred pain after training.

Sciotti *et al.*, (2001) suggested that this inconsistency of results achieved by Gerwin *et al.*, (1997) and Hsieh *et al.*, (2000) may be due to the different anatomical regions and patient populations used in the studies. Sciotti *et al.*, (2001) therefore suggested further adequately controlled studies that examined the ability of clinicians to reliably and consistently identify MTrPs after training are needed.

Al-Shenqiti & Oldham (2005) attempted to identify the clinical signs of MTrPs in the rotator cuff muscles. Clinical diagnostic characteristics of myofascial trigger points used in this study incorporated: taut band, spot tenderness, jump sign, pain recognition, referred pain and local twitch responses. 51 patients diagnosed with rotator cuff tendinitis were examined using a test-retest protocol over three days. Results from the study showed that the palpable taut band, spot tenderness, jump sign and pain recognition were the most reliable of the trigger point's diagnostic characteristics. Referred pain and local twitch response reliability differed depending on the muscle being studied. This study reiterates results demonstrated by Gerwin *et al.*, (1997) who concluded that the occurrence of trigger point recognition depends on the precise characteristic and the specific muscle being examined.

Chettiar (2001) developed the Myofascial Diagnostic Scale. The scale represents the myofascial signs using numerical grading. Vaghmaria (2005) evaluated the Myofascial Diagnostic Scale for its inter-examiner reliability however found that the subjective findings

were more reliable than the objective findings. Although this scale is not peer reviewed and unpublished it provides a tool for the diagnosis of Myofascial Pain Syndrome.

Palpation according to Paulet and Fryer (2008) is used by various disciplines of manual therapists in the assessment, diagnosis and manipulative treatment of patients with musculoskeletal pain and remains in conjunction with patient feedback the only available method for the clinical diagnosis of myofascial pain. Hsieh *et al.*, (2000) suggested that clinical experience coupled with training and standardization procedures are necessary to achieve acceptable inter-examiner reliability for the palpation of MTrPs consequently, further well designed studies need to be conducted for palpation to be considered as a reliable diagnostic tool.

2.10. DIAGNOSTIC TESTING

Numerous studies have attempted to find a suitable confirmatory test for MTrPs. These include laboratory blood tests, histological, electromyography, thermography, ultrasound, pressure algometry and magnetic resonance elastography studies.

2.10.1. Laboratory Tests

Laboratory tests are essential in identifying any underlying metabolic, hormonal or nutritional disorders as a cause of myofascial pain (Borg- Stein, 2006). Traditional laboratory studies including erythrocyte sedimentation rate (ESR), antinuclear antibody, and full blood count (FBC) are normal in myofascial pain (Graff-Radford, 2004). Thyroid tests may be normal however, are essential in order to exclude hypothyroidism and hyperthyroidism as a source of myalgia (Borg- Stein, 2006). Hypothyroidism produces a hypometabolic state which is thought to promote trigger point development (Gerwin, 2005).

2.10.2. Histology

Travel *et al.*, (1999) suggested that the contracted portion of muscle fibers called the “contraction knot” is the histological marker for MTrPs. Simons and Stolov (1976) examined canine muscles histologically using MTrP criteria. Results from muscle cross sections showed darkly staining, large round fibers while longitudinal muscle sections showed central bulges with highly contracted muscle. Windisch, Reitinge, Traxler, Radner, Neumayer and Feigl (1999) biopsied palpable muscle nodules from fresh cadavers and compared the histology to control areas from the same muscle. An increase in the average diameter of muscle fibers of the nodules was found. On electron microscopy of the nodules an excess of

A bands and a lack of the I band configuration was found, this is a sign of contracted sarcomeres. (Refer to Figure 4).

De Stefano, Selvi, Villanova, Frati, Manganelli, Franceschini, Biasi and Marcolongo (2000) used an immunochemistry biopsy to study the investigate the level of Substance P in 27 volunteers (nine healthy women, nine women suffering from fibromyalgia and nine women suffering from myofascial pain was used). Results showed that although the number of Substance P immunoreactive nerve fibers areas showed no difference, the quantity of Substance P in the nerve fibers showed significant differences between the three groups with the level of Substance P concentration highest in the group with myofascial pain.

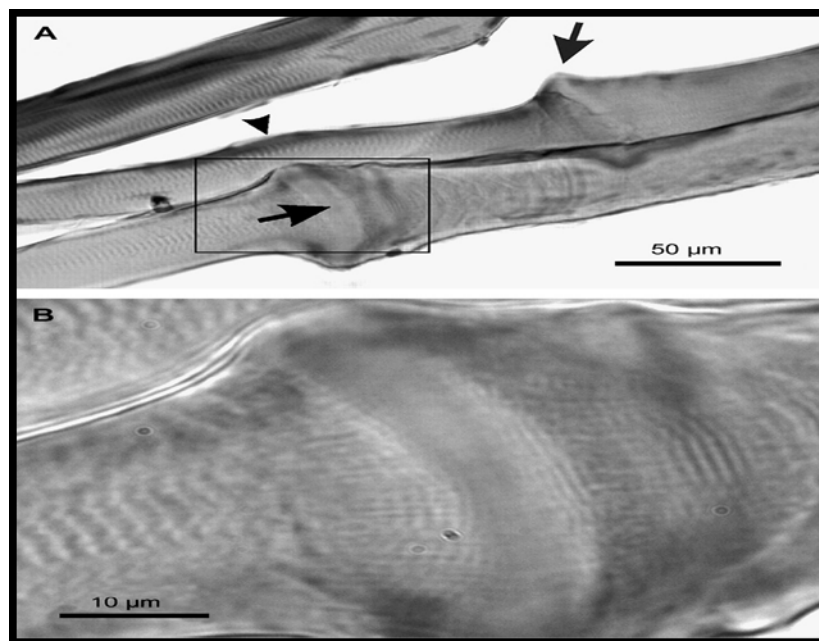


Figure 4: Contraction disks (arrows) cause marked bulging of the sarcolemma that can impinge on adjacent muscle fibers and distort their sarcomere pattern (arrowhead). (B) Enlarged view of the boxed area in (A). Note the abnormally contracted regions flanking the hyaline center of the disk compared with the normal A.

Reproduced from Bennet (2007, *Best Practice & Research Clinical Rheumatology* 21: 427-445) with permission (Appendix M).

2.10.3. Thermography

Infrared, electrical and liquid crystal thermography have been used to identify MTrPs (Baldry, 1998). Krause and Christiansen (1992) used infrared thermography to evaluate 11 volunteers with MTrPs and 11 asymptomatic controls. Results showed a decrease in temperature from precompression levels during compression however, when similar but asymptomatic areas were compressed, no considerable changes in temperature were seen at distal sites. In contrast, Swerdlow and Dieter (1992) showed that the thermographic “hot spots” observed were not active MTrPs. The researchers evaluated 365 patients with trigger points in the upper back. Although the researchers found thermographic “hot spots”, the sites at which “hot spots” were located did not correspond to the areas in which the MTrPs were discovered on clinical examination. Simons (1993) also suggested that some MTrPs can occur in “normal temperature region” and hot spots may occur for other reasons.

2.10.4. Electromyography (EMG)

According to Echternach (2008) EMG is the study of intrinsic activity of muscle (Refer to Figure 5, picture d). Surface EMG uses electronic devices to measure the energy of muscle (Cram and Criswell, 2010). Highly localized electrical activity is characteristic of MTrP and was first described in human subjects by Hubbard and Berkoff (1993) and later investigated by other researchers (Hong and Simons, 2002; Chen, Chen, Kuan, Chung and Hong, 1998 and Simons, Hong and Simons, 1995). This pattern of electrical activity is termed spontaneous electrical activity (SEA). In a resting muscle SEA is seen as low amplitude background noise, with superimposed high amplitude spike activity (Simons *et al.*, 1995). Results from needle EMG studies suggest that each trigger point contains minute loci, which are mostly located at the motor endplate. These minute loci produce endplate noise (EPN) (Simons, 2001; Hong and Simons, 1998; and Hubbard and Berkoff, 1993). EPN represents an increase in ACh released from the nerve terminals (Refer to Figure 5 picture e).

A study conducted by Audette, Wang and Smith (2004) reported on the generation of an electromyographic activity from the stimulation of active trigger points or latent trigger points. During this study the recording electrodes were inserted ipsilaterally into both the muscle with the trigger point and into the same muscle on the contralateral side. In subjects with active trigger points, bilateral motor unit activation was observed. Stimulation of latent trigger points only produced ipsilateral motor unit activation. This may provide a possible diagnostic test to distinguish between latent and active MTrPs.

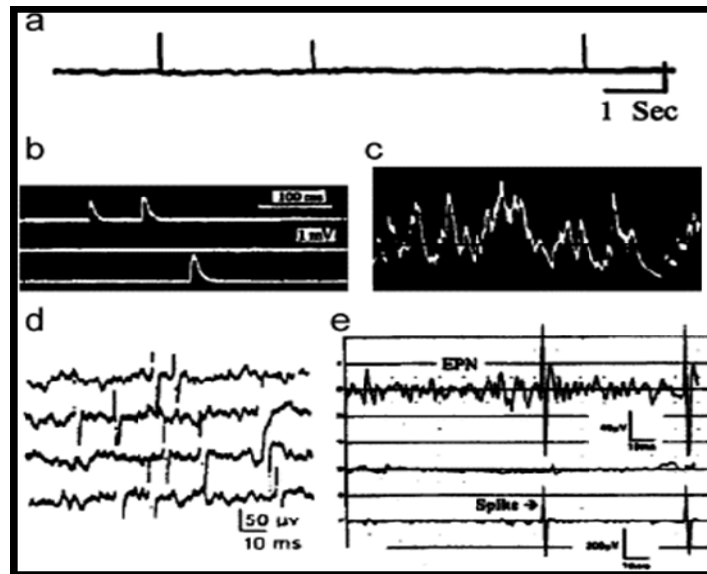


Figure 5: Comparisons of normal miniature endplate potentials (MEPPs) and endplate noise.

(A) Normal human MEPPs. (B) Normal rat MEPPs. (C) Experimentally induced endplate noise. (D) Textbook “normal” endplate potentials. (E) Endplate noise and spikes from a human trigger point.

Reproduced from Simons (2004, *Journal of Electromyography and Kinesiology* 14(1): 95-107) with permission (Appendix L).

2.10.5. Pressure Algometry

An algometer is a hand held pressure gauge calibrated in kg/cm^2 which is attached to a rod with a 1cm round rubber tip at the end and is used to assess the minimal pressure needed to provoke pain (Vandereeken, Oostendorp, Vaes and Duquet, 1996). Fischer (1988) used a pressure algometer to measure the minimum force which provokes pain. According to Fischer (1988) pressure algometry can be used to document local pain and referred pain quantitatively. Pressure algometry is used mainly to quantify changes in the MTrP in response to treatment (Gerwin *et al.*, 1997). Reeves, Jaeger and Graff- Radford (1986) demonstrated that the pressure algometer may be used reliably to qualify and measure trigger point sensitivity.

Delaney and McKee (1993) conducted a study aimed at determining the intra-rater and inter-rater reliability of using a pressure threshold meter to measure trigger point sensitivity using fifty healthy adult volunteers. Two examiners examined MTrPs in the trapezius muscle.

Results showed that pressure threshold meter is very reliable in measuring trigger point sensitivity and can be valuable in the diagnosis and monitoring the treatment of MPS.

Tunks, McCain, Hart, Teasell, Goldsmith, Rollman, McDermid and DeShane (1995) used three examiners to determine the reliability with which tenderness can be assessed in patients with chronic myalgias, using dolorimetry and palpation. Results indicated that these methods showed good inter-rater reliability and consistency. Dolorimetry and palpation are reliable to distinguishing control patients from patients with myofascial pain and fibromyalgia however, the use of dolorimetry and palpation cannot distinguish patients with myofascial pain from those with fibromyalgia.

Bendtsen, Jensen, Jensen and Olesen (1994) used the palpometer to examine whether the reliability of tenderness assessment can be improved by using a technique called "pressure-controlled palpation". The palpometer is a pressure-sensitive plastic film attached to the index finger and records the pressure exerted. The palpometer can be used to quantify the amount of finger pressure an examiner uses to elicit tenderness in a muscle (Bendtsen *et al.*, 1994) however it cannot be used in identifying other characteristic features of the MTrP that distinguish it from other causes of muscle pain (Gerwin *et al.*, 1997).

2.10.6. Magnetic Resonance Elastography (MRE)

MRE is a magnetic resonance based phase contrast imaging technique. MRE is non-invasive and uses an oscillating motion sensitizing gradient to detect vibratory displacements. These vibratory displacements are caused by an outside source of shear vibration. The displacement data is collected and then used to calculate the stiffness in the tissue. Shear waves travel faster and produce longer wavelengths in stiffer tissue (Muthupillai, Lomas, Rossman, Greenleaf, Manduca and Ehman, 1995).

Chen, Basford and An (2008) conducted a study using four symptomatic and four asymptomatic women to determine whether MRE techniques could localize and investigate the properties of MTrPs. They postulated that since taut bands are stiffer than surrounding muscle fibers it would result in longer wavelengths and chevron wave fronts. Results showed that taut bands are stiffer than the surrounding areas and therefore MRE can be used objectively to determine the presence of taut bands (Refer to Figure 6).

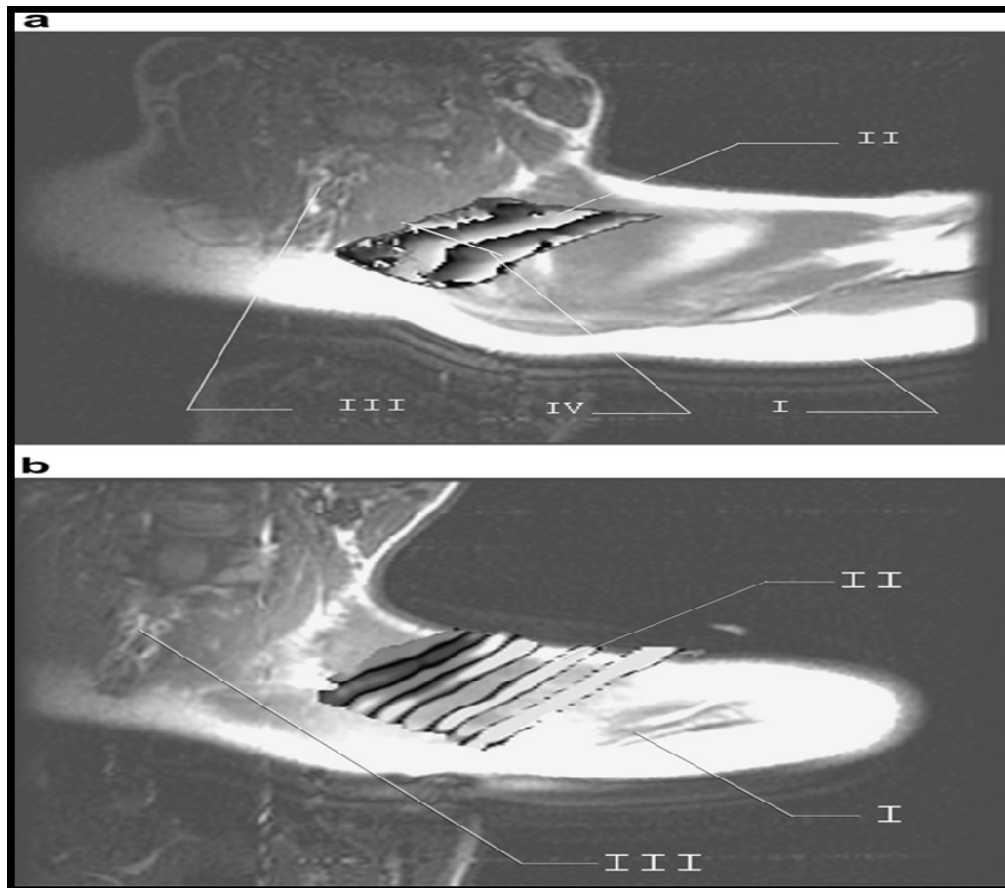


Figure 6: MRE phase image of upper trapezius

(a) Typical MRE phase image of upper trapezius of a patient with myofascial pain, showing chevron-shaped wave fronts under the band-like vibration. **I.** Spine of Scapula. **II.** MRE phase image with chevron-shaped wave fronts observed in the region of taut band palpated. **III.** Myofascial taut band identified by the palpation examination. **IV.** Cervical Spine. **(b)** Typical MRE phase image of upper trapezius of a healthy human subject showing planar wave propagation under the band-like vibration. **I.** Spine of Scapula. **II.** MRE phase image with planar wave fronts observed in the upper trapezius. **III.** Cervical Spine.

Reproduced from Chen, Basford and An (2008, *Clinical Biomechanics* 23 623–629) with permission (Appendix N).

2.10.7. Diagnostic Ultrasound

Diagnostic Ultrasound is capable of detecting soft tissue pathology in muscles, tendons and surrounding fascia (Van Holsbeeck and Introcaso, 1991). Diagnostic Ultrasound can be useful in the characterization of the viscoelastic properties of myofascial tissue (Sikdar, Shah, Gilliams, Gebreab and Gerber, 2008). It can also be used to measure hemodynamic changes ensuing from compression of blood vessels and to provide measures of tissue

performance (e.g. muscle contraction) (Chi-Fishman, Hicks, Cintas, Sonies and Gerber, 2004).

Lewis and Tehan (1999) conducted a pilot study to assess the use of diagnostic ultrasound to clinically identify active MTrPs in 11 subjects. However, results showed no correlation between clinical identification of active MTrPs and diagnostic ultrasound.

Sikdar, Shah, Gebread, Yen, Gilliams and Gerber (2009) conducted a study aimed at describing the characteristics of MTrPs using ultrasound imaging techniques. In this study a 12~5Hz ultrasound transducer vibration sonoelastograph (VSE) and Doppler imaging was used. Results showed that MTrPs are seen as focal hypoechoic regions in 2D ultrasound and as decreased vibration amplitude on VSD (Refer to Figure 7). The hypoechoic and stiffer nodules are contraction knots that occur as a result of increased muscle contraction, local injury and decrease in the oxygen supply (Sikdar *et al.*, 2009).

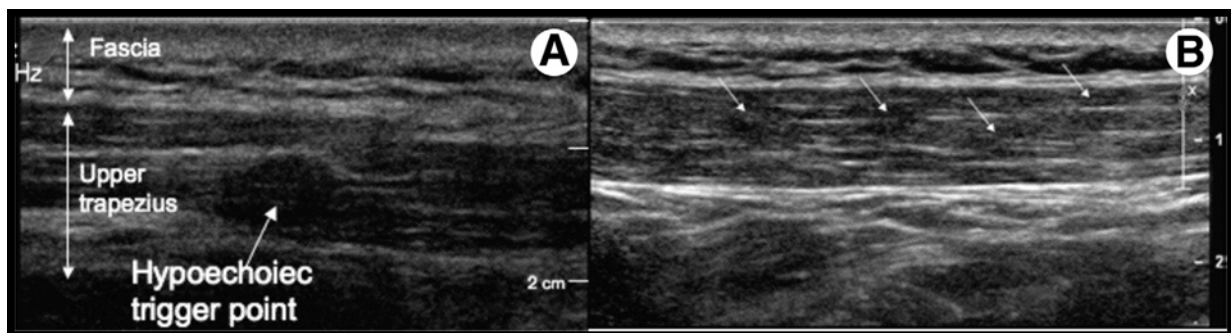


Figure 7: Gray-scale imaging of a trigger point in the upper trapezius.

(A) An isolated MTrP appears as a well-defined focal hypoechoic nodule. **(B)** A series of 4 hypoechoic MTrPs in the upper trapezius.

Reproduced from Sikdar, Shah, Gebread, Yen, Gilliams and Gerber (2009, *Archives of Physical and Medical Rehabilitation* 90:1829-1838) with permission (Appendix O).

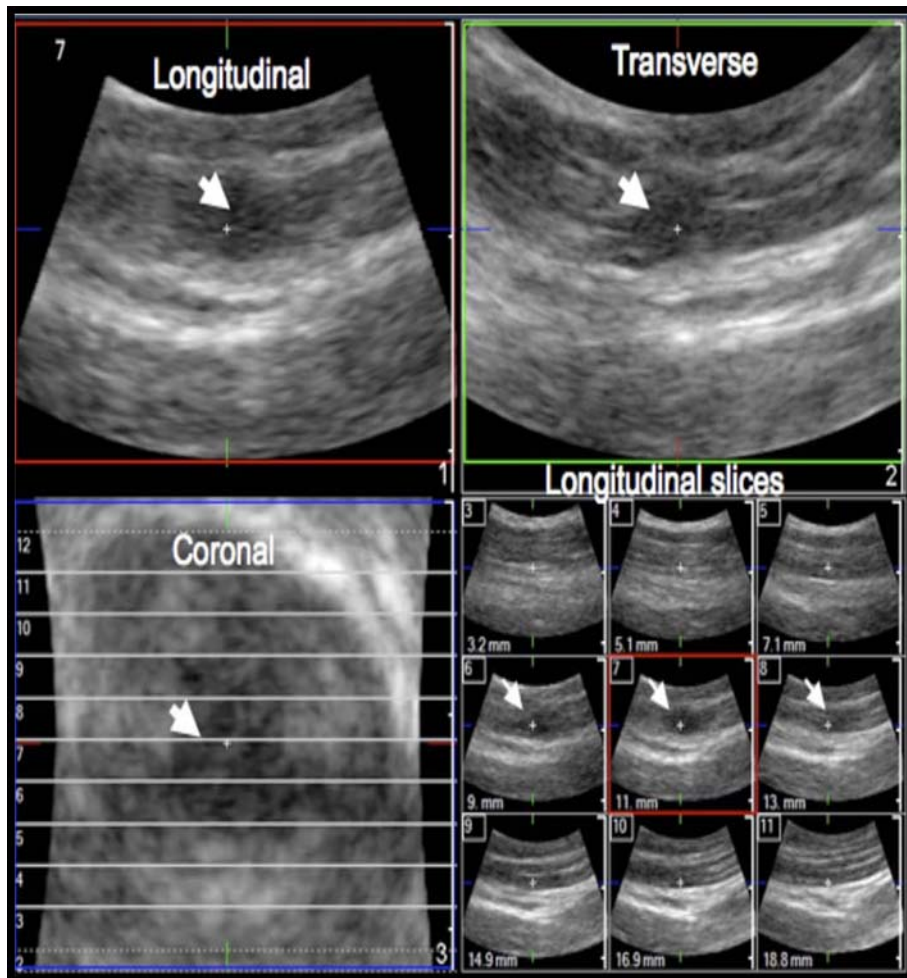


Figure 8: 3D imaging of trigger points.

A mechanically scanned 3D probe (3D9-3v) was used for 3D imaging in a subject with a latent trigger point. The MTrP is clearly identified (arrows) in all 3 planes as well as in a multi slice view.

Reproduced from Sikdar, Shah, Gebread, Yen, Gilliams and Gerber (2009, *Archives of Physical and Medical Rehabilitation* 90:1829-1838) with permission (Appendix O) .

An advantage of diagnostic ultrasound images is the ability to examine vasculature and blood flow around MTrPs. Doppler flow waveforms of arteries in the area of active MTrPs showed high resistance blood flow with a retrograde diastolic flow. This pattern of blood flow differs from the blood flow of latent MTrPs and normal muscle. The increased vascular resistance is consistent with blood vessel compression caused by continued contraction at the MTrP (Sikdar *et al.*, 2009) (Refer to Figure 9).

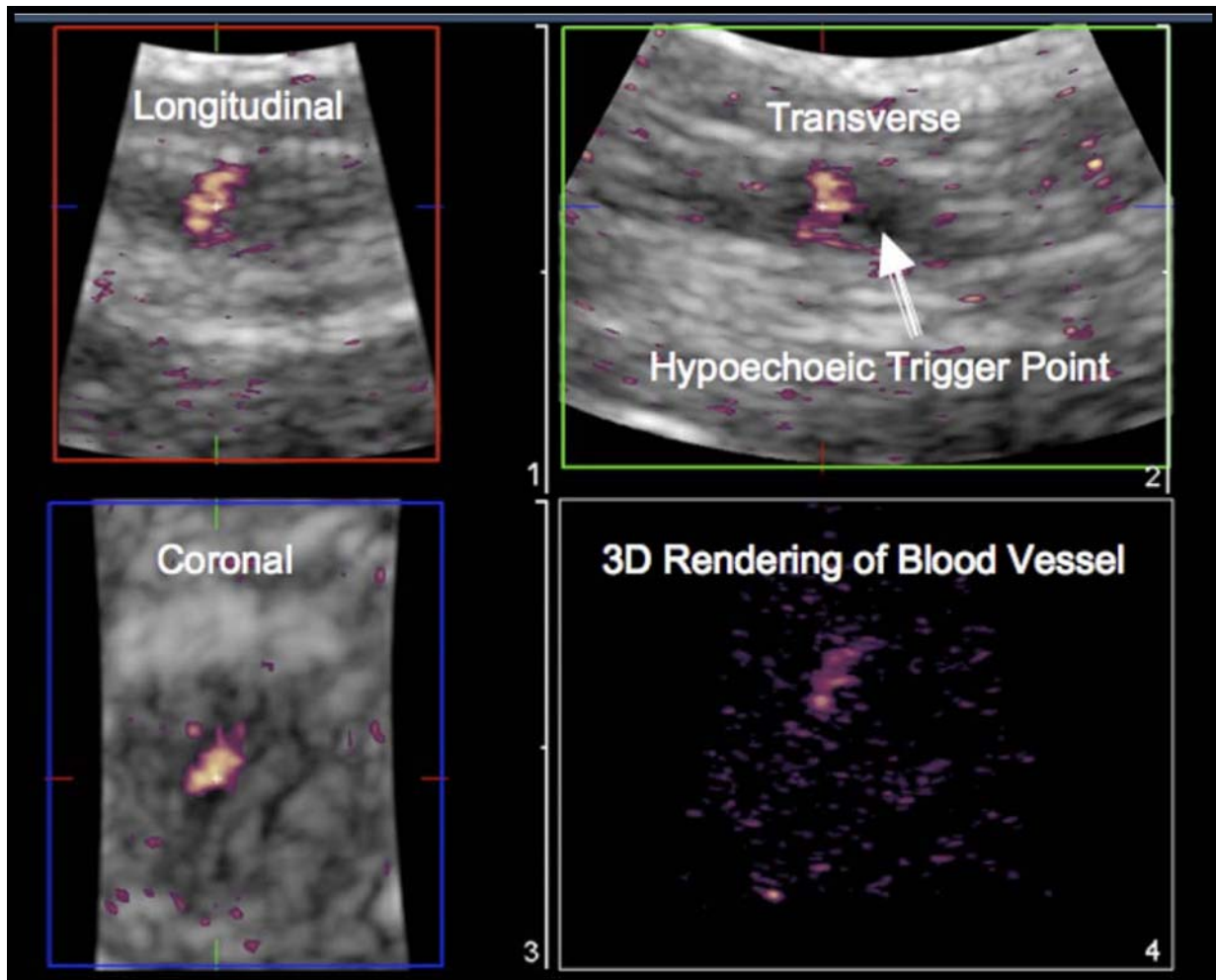


Figure 9: 3D color Doppler imaging of blood vessels passing through trigger points.

A mechanically scanned 3D probe (3D9-3v) was used for 3D imaging in a subject with a latent trigger point. The blood vessel is clearly visualized in all 3 planes.

Reproduced from Sikdar, Shah, Gebread, Yen, Gilliams and Gerber (2009, *Archives of Physical and Medical Rehabilitation* 90:1829-1838) with permission.

2.10.8. Biochemical Sampling

MTrPs, when painful can stimulate muscle nociceptors which create motor and sensory changes in the peripheral and central nervous systems. This process is called sensitization (Shah and Gilliams, 2008).

Shah and Gilliams (2008) developed a microdialysis technique to measure the biochemical environment of skeletal muscle. This was done to observe the peripheral factors that affect

the sensitization process. This technique uses a microdialysis needle, perfused with sterile normal saline to achieve equilibrium with muscle tissue (Refer to Figure 10).

Nine volunteers: three healthy, three with latent MTrPs in upper their trapezius and three with active MTrPs in upper their trapezius were used in this study. Active trigger points have significantly higher concentration of, bradykinin, CGRP, protons, SP, interleukin-1beta (IL-1 β), serotonin, tumour necrosis factor alpha (TNF α) and noradrenaline when compared to normal muscle and latent trigger points. Also the pH was lower in the active MTrP group than the other two MTrP groups (Shah and Gilliams, 2008).

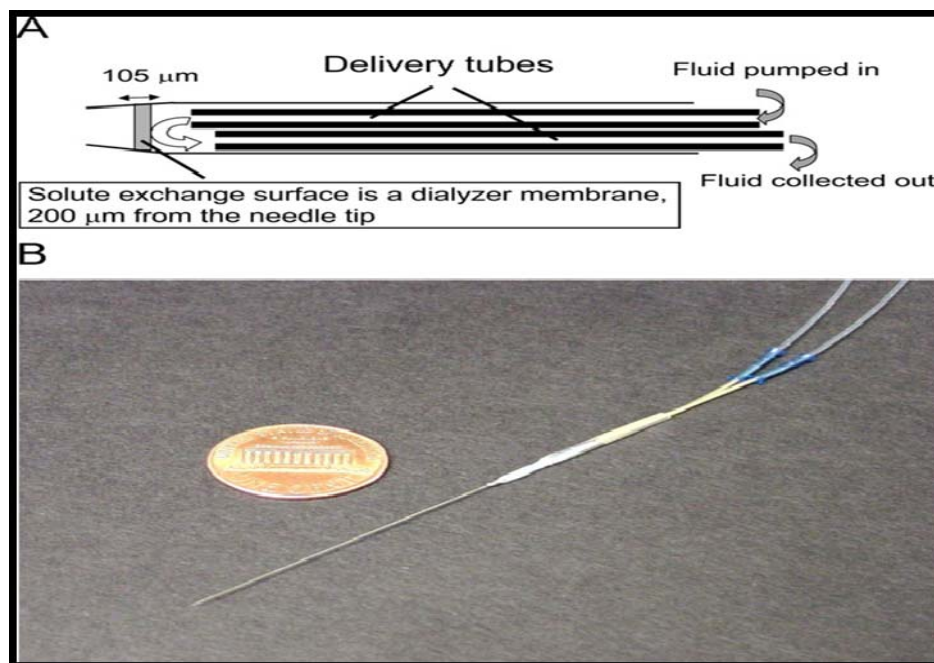


Figure 10: (A) A schematic picture of microdialysis (B) photo of needle.

Reproduced from Shah and Gilliams (2008, *Journal of Bodywork and Movement Therapies* 12, 371–384) with permission.

➤ Roles of biochemical substances associated with pain and inflammation

1. pH

According to Issberner, Reeh and Steen (1996) acidic pH levels within muscle are associated with pain and lowered nociceptor threshold sensitivity. An acidic environment is seen during ischemia and hypoxia or after exercise. Stressed or injured muscle tissue can release protons, activating acid sensing ion channels (ASICs) and vanilloid nociceptors that indicate hyperalgesia. As a result of the capillary constriction and increased metabolic demands of the contracted muscle, ischemia and hypoxia can occur at the site of the MTrP, thus sensitizing peripheral and central nociceptors (Gerwin, Dommerholt, and Shah, 2004).

The Integrated Hypothesis suggests that acetylcholine esterase (AChE) is inhibited by an acidic pH therefore an excess of ACh is left in the synaptic cleft (Gerwin *et al.*, 2004).

2. Neuropeptides

When nociceptive neurons are stimulated this can mediate the release of neuropeptides, such as Substance P and CGRP (Gerwin *et al.*, 2004 and Shah; Gilliams, 2008).

- Substance P

The release of SP results in the sensitization of nociceptors, vasodilation, increased vascular permeability, and mast cell degranulation which results in the release of other inflammatory mediators (Gerwin *et al.*, 2004; Shah and Gilliams, 2008). Trauma and a local inflammatory reaction can result in increased production of substance P in the neurons of dorsal root ganglia. This increased release of substance P in both the spinal cord and peripheral soft tissue can result in allodynia (decreased pain threshold) and hyperalgesia (increased pain sensitivity) (De Stefano *et al.*, 2000)

- CGRP

CGRP and ACh are found at the synaptic endings of the motor nerve. CGRP acts as a catalyst for the release of ACh from the motor nerve fiber terminal. It is released when the nerve ending is stimulated or by the accumulation of ACh that is caused by the inhibition of AChE (Gerwin *et al.*, 2004; Shah and Gilliams, 2008).

The release of CGRP results in an increase number of surface acetylcholine receptors on the muscle cell membrane and the inhibition of AChE activity at the neuromuscular junction. It has been suggested that CGRP increases the concentration of ACh at the motor endplate resulting in an increased occurrence of small endplate potentials, resulting in sarcomere contraction and the formation of taut bands in skeletal muscle (Gerwin *et al.*, 2004; Shah and Gilliams, 2008).

3. Catecholamines

- Serotonin

Serotonin is released in areas of tissue damage from platelets, mast cells, and basophils that infiltrate the damaged area. Serotonin is a vasoconstrictor (Gerwin *et al.*, 2004; Shah and Gilliams, 2008).

- Noradrenaline

Noradrenalin is a sympathetic neurotransmitter. An increase level of noradrenalin may be linked to an increase in the sympathetic activity in the motor endplate region of MTrPs (Gerwin *et al.*, 2004; Shah and Gilliams, 2008).

4. Cytokines

- Interleukin-1beta and tumour necrosis factor alpha

TNF α and IL-1 β produces muscle hyperalgesia. TNF α causes a continuing nociceptive activity onto dorsal horn cells resulting in central sensitization thus causing referred pain, spontaneous activity of dorsal horn transmission cells and an increase in the response from these cells to nociceptive input (Gerwin *et al.*, 2004; Shah and Gilliams, 2008).

Although some of the techniques described above are useful in the identification of MTrPs, these techniques are difficult to use in clinics for patient examination as they are time consuming, costly and require professionally trained individuals to yield accurate results (Gerwin *et al.*, 1997).

2.11. MANAGEMENT OF MYOFASCIAL PAIN

The goal of treatment is to inactivate the MTrP and prevent its reoccurrence (Gerwin, 1993). In order to successfully treat MPS the physiologic and psychosocial stresses that are often implicated in the development of myofascial pain must be taken into account (Han and Harrison, 1997). According to Auleciems (1995), perpetuating factors must be corrected in order to maximize the long term response to any treatment. When efficiently managed MPS has an excellent prognosis however long-term management and lifestyle modification is necessary to prevent recurrences (Auleciems, 1995).

The therapies used in the treatment of myofascial pain summarized in the table below:

Table 2: Treatment of Myofascial Pain

Therapy	Mechanism of Action
➤ Manual Therapy	
1. Cryotherapy	Physiological effects of cryotherapy include vasoconstriction of blood vessels, decreasing local metabolism, decreasing blood histamine, the release and reduction of nerve excitability (Schafer and Faye, 1990), spinal inhibitory mechanisms, pain inhibition transmission, muscle spasm and inflammation (Travell <i>et al.</i> , 1999).
2. Heat	It increases blood flow and tissue distensibility and decreases muscle spasm and pain (Travell <i>et al.</i> , 1999).
3. Passive and Active Stretching	Stretching of the effective muscle restores the normal length and flexibility to the muscles (Yap, 2007). According to Bennet (2007), focal muscle contractions result in prolonged use of ATP. Therefore the restoration of a muscle to its full stretch length breaks the relationship between the energy crisis and contraction of sarcomeric unit (Bennet, 2007).

Therapy	Mechanism of Action
➤ Manual Therapy	
4. Spray and Stretch	Blocks reflex spasm and pain, allowing for gradual and passive stretching of the muscle and inactivation of the trigger point (Auleciems, 1995).
5. Massage	Massage breaks up fibrous bands in muscle and improves circulation. This reduces the concentration of pain mediators (Travell <i>et al.</i> , 1999). Massage is also hypothesized to deactivate MTrPs by relaxing the musculature and increasing the release of endorphin (Yap, 2007).
6. Ischemic compression	Produces local ischemia which results in improved circulation to the affected area (Auleciems, 1995).
7. Trigger Point Release	Relaxes contracted muscles, increases circulation, venous and lymphatic drainage, and stimulates the stretch reflex of muscles and overlying fascia (Travell <i>et al.</i> , 1999).
8. Post Isometric Relaxation	Alternate contraction of the agonist and antagonist muscle against resistance slowly lengthens the muscle and increases range of motion (Gerwin, 1993).
➤ Electrotherapy	
9. Transcutaneous Electrical Nerve Stimulation (TENS)	Activates the large diameter fibers to close the pain gate in the dorsal horn of the spinal cord or at a higher level and thus eliminating pain (Melsack and Wall, 1988).
10. Ultrasound	Ultrasound results in a decrease in joint stiffness, muscle pain and spasm, an increase in blood flow and can stimulate soft tissue repair and regeneration. Pain is decreased by dilution of pain mediators (Rickards, 2006).

Therapy	Mechanism of Action
➤ Electrotherapy	
11. Interferential Current Therapy (IFC)	IFC results in a suppressing effect on the sympathetic segment of the automatic nervous system. This results in a decrease in pain and increases circulation, which improves tissue oxygen supply and rapid elimination of toxic metabolic products (Hou, <i>et al.</i> , 2002).
12. Light amplification by stimulated emission of radiation (LASER)	According to Baldry (1998) the use of laser promotes tissue healing and decrease in pain.
➤ Psychological therapy	
13. Stress management	Decreases environmental stressors that precipitate and increase pain (Hans and Harrison, 1997).
14. Cognitive behavioral therapy (CBT)	CBT decreases the neural circuitry involved in inapt emotional responses to pain and other symptoms. The goal of CBT is to increase a patient's sense of control over their pain (Bennet and Nelson, 2006).
15. Electromyographic Biofeedback	Uses feedback about their muscle tension with the help of surface electrodes that record muscle activity. Patients are then taught to relax muscles to decrease pain (Harris and Claux, 2002).
➤ Pharmacologic Intervention	
16. Nonsteroidal Anti-Inflammatory Drugs (NSAIDs)	NSAIDs have been advocated for pain relief and to decrease inflammation (Wheeler, 2004).
17. Opioid Analgesics	Opioid analgesics produce a rapid reduction in pain (Wheeler, 2004).
18. Muscle Spasmolytics	Provides muscle relaxation (Wheeler, 2004).

Therapy	Mechanism of Action
➤ Pharmacologic Intervention	
19. Antidepressants	Used to treat chronic pain, ease insomnia and diminish painful dysesthesia (Wheeler, 2004).
➤ Needling Therapy	
20. Dry Needling	<p>Many mechanisms have been suggested by which dry-needling maybe effective in the deactivation of MTrPs (Hong, 1994, Travell et al., 1999). The proposed mechanisms are as follows:</p> <ol style="list-style-type: none"> 1. Mechanical disruption of the taut palpable band in the muscle, which subsequently desensitizes the local nerve endings. 2. Release of increased levels of extracellular potassium, which leads to the depolarization of nerve fibers (Han and Harrison, 1997). 3. Dry needling uses hyperstimulation analgesia to disrupt the positive feedback mechanism that perpetuates pain (Gatterman and Goe, 1990). 4. Dry needling damages motor endplates causing the denervation of distal axons when the needle hits a trigger point (Travell et al., 1999).

Therapy	Mechanism of Action
➤ Needling Therapy	
21. Myofascial Trigger Point Injection	<p>The proposed mechanisms through which injections inactivate trigger points are as follows (Han and Harrison, 1997 and Travell et al., 1999):</p> <ol style="list-style-type: none"> 1. Mechanical disruption of the muscle fibres and nerve endings due to the needle. 2. Interruption of the central feedback mechanism. 3. Depolarization block of the nerve fibers by the released intracellular potassium. 4. Injection of local anaesthetics or saline solutions results in the dilution of nociceptive substances. 5. Removal of metabolites and nerve-sensitizing occurs as a result of the local vasodilation or local hemorrhage when local anaesthetics are injected.

2.12. ANATOMY OF THE MUSCLES

2.12.1. The Trapezius Muscle

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

Anatomical Attachments- The trapezius muscle is attached proximally to the medial third of the superior nuchal line; external occipital protuberance, ligamentum nuchae and spinous processes of C7-T12 vertebrae. It is distally attached to the lateral third of the clavicle, acromion, and spine of the scapula (Moore and Dalley, 1999). The trapezius muscle is divided into upper, middle and lower fibers.

Six MTrPs can be located in the trapezius Muscle. Two MTrPs are found in the upper fibers of the muscle, namely Tp1 and Tp2. The middle fibers contain Tp's 5, 6 and 7 and the lower fibers Tp's 3 and 4 (Travell *et al.*, 1999).

- **Myofascial Trigger Points**

- **Location Trigger Points**

1. **TP1** is located in the free margin of the upper trapezius midway between the spinous processes and the acromion. (Refer to Figure 11). (Travell *et al.*, 1999).
2. **TP2** is located caudal and posterior to the free border of the upper trapezius. It is located at the level of C₅ to C₆, halfway between the acromion and the spinous processes (Refer to Figure 12) (Travell *et al.*, 1999).

- **Referred pain pattern of Trigger Points**

1. **TP1** refers pain unilaterally upward along the posterolateral aspect of the neck to the mastoid process. The referred pain may extend to the side of the neck, in the temple and the back of the orbit and may also include the angle of the jaw (Refer to Figure 11) (Travell *et al.* 1999).
2. **TP2** refers pain posterior to the reference of TP1 in the cervical region blending with TP1's distribution behind the ear (Refer to Figure 12) (Travell *et at.*, 1999).

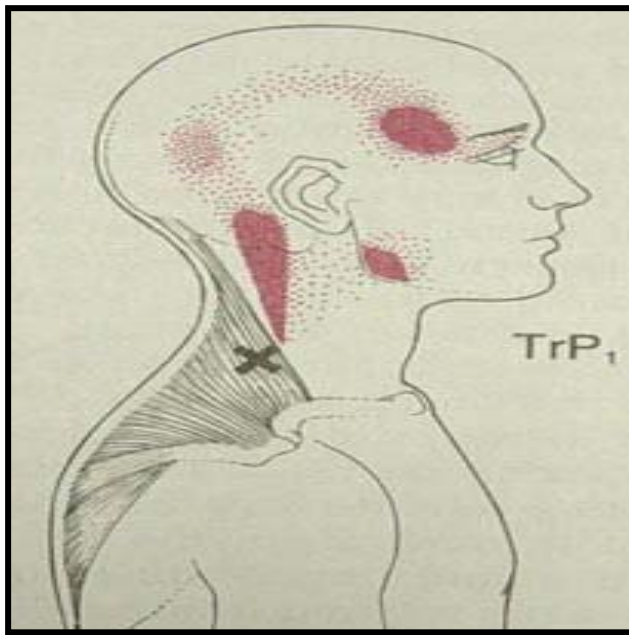


Figure 11: Referred pain patterns and location of TP1 in the upper trapezius (Travell *et al.*, 1999).

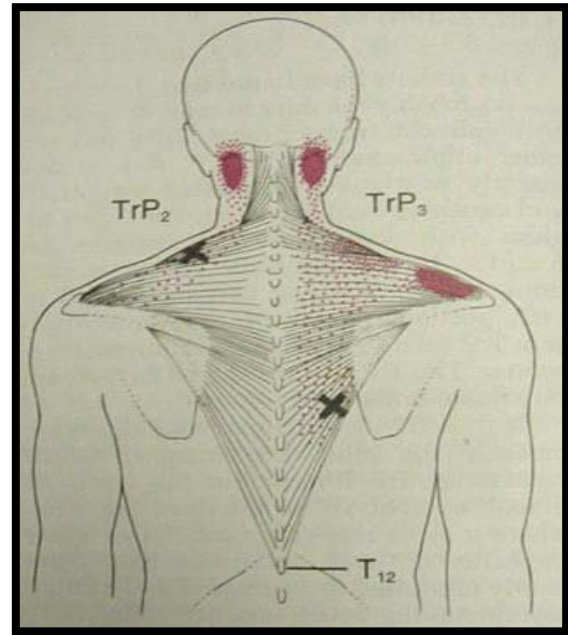


Figure 12: Referred pain patterns and location of TP1 in the upper trapezius (Travell *et al.*, 1999).

2.12.2. The Gluteus Medius Muscle

Anatomical Attachments- The gluteus medius muscle originates at the outer surface of ilium from iliac crest and posterior gluteal line above to the anterior gluteal line and gluteal aponeurosis below. It inserts at the lateral surface of greater trochanter (Moore and Dalley, 1999).

Three MTrPs are located in the gluteus Medius muscle namely TP1, TP2, TP3.

- **Trigger Points**

- **Location of Trigger Points** (Refer to Figure 13)

1. **TP1** is located near the iliac crest in the posterior part of the muscle close to the sacroiliac joint (Travell *et al.*, 1999).
2. **TP2** is located just inferior to the iliac crest, centered along the length of the iliac crest (Travell *et al.*, 1999).

3. **TP3** is located just inferior to the iliac crest close to the anterior superior iliac spine (Travell *et al.*, 1999).

➤ **Referred Pain Patterns of Trigger Points** (Refer to Figure 13)

1. **TP1** refers pain and tenderness along the posterior crest of the ilium, to the region of the sacroiliac joint and over the sacrum on the same side, the pain may also extent over majority of the buttock (Travell *et al.*, 1999).
2. **TP2** refers pain laterally and to the mid gluteal region. The pain and tenderness may extend posteriorly and laterally into the upper thigh (Travell *et al.*, 1999).
3. **TP3** refers pain over the iliac crest, over the lowest lumbar region and bilaterally over the sacrum (Travell *et al.*, 1999).

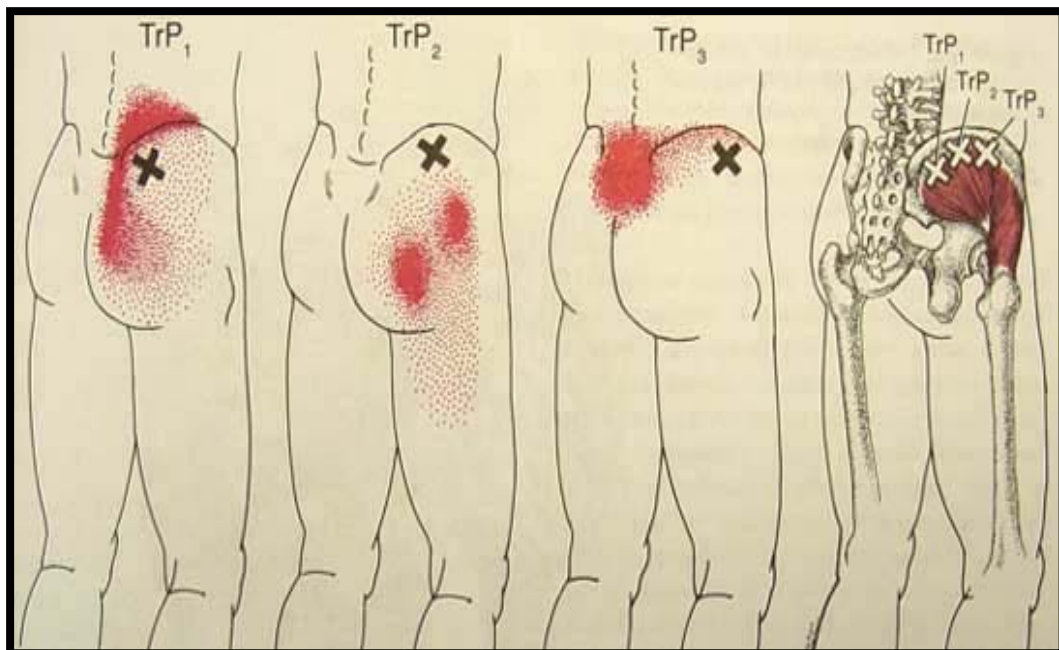


Figure 13: Referred pain patterns and location of MTrPs in the gluteus medius muscle (Travell *et al.*, 1999)

CHAPTER THREE

METHODOLOGY

3.1. STUDY DESIGN

This study was designed in the form of a pre and post intervention inter-examiner reliability study that used both symptomatic and asymptomatic patients.

3.2. SAMPLING

3.2.1. Subject recruitment and Advertising

Subjects were recruited with the use of advertisements (**Appendices A and B**) that were placed on notice boards of the Chiropractic Day Clinic (CDC), and around the Durban University of Technology campuses. Recruitment also involved direct personal approach from the researcher to potential subjects. Prospective subjects were requested to contact the researcher telephonically for more information regarding the study.

3.2.2. Sample Size

This study was conducted in two phases. A sample size of 30 subjects was used in each phase therefore a total number of 60 subjects were used. Prospective subjects who responded telephonically or personally to the advertisement were provided with more information by the researcher and were asked the following questions.

1. "How old are you?"
2. "Do you have low back or neck pain?"
3. "If the patient answers 'yes' to question 2 the researcher then inquired about the duration and nature of the pain?"

If the subject is outside the age range of 18-45 years he/she were immediately excluded. The subjects were told to refrain from taking anti-inflammatory or muscle relaxant medication 48 hours prior to their appointment or from receiving any other treatment for two weeks prior to their appointment.

3.3. INCLUSION AND EXCLUSION CRITERIA

3.3.1. Inclusion Criteria

- Subjects between the ages of 18-45 years old. Esenyel, Caglar and Aldemir (2000) recommended that a young population should be used to minimize pain that could be caused from degenerative disc or joint disease.
- The study incorporated asymptomatic and symptomatic subjects with regard to neck and low back pain. Symptomatic subjects were defined as those who have been diagnosed with chronic (6 weeks or longer) mechanical neck and or low back pain. For the purpose of this study mechanical neck pain was defined as a dull achy discomfort located between the occiput and the third thoracic vertebra (Windsor, 2004) and mechanical low back pain was defined as pain that extends from the twelfth ribs bilaterally to the gluteal folds bilaterally (Nyland and Grimmer, 2003). Asymptomatic subjects were defined as those who had no history of neck or low back pain during the last 6 months.
- Willingness to be examined in the upper half of the body (excluding the breasts) and the upper gluteal region.

3.3.2. Exclusion Criteria

- Subjects who did not fall within the recommended age limit of between 18-45 years were excluded.
- Subjects who were unwilling to sign the Informed Consent Form.
- Subjects with cervical or lumbar radiculopathy (Hsieh *et al.*, 2000).
- Subjects who were pregnant (Hsieh *et al.*, 2000)
- Subjects with spinal disorders e.g. osteoporosis, fractures and unstable spondylolisthesis (Hsieh *et al.*, 2000)
- Subjects with serious medical condition e.g. advanced cancer and heart failure (Hsieh *et al.*, 2000)
- Subjects taking, or those who have taken anti-inflammatory or muscle relaxant medication during the three days prior to the consultation were excluded from the study. However, if the patient wished to re enter the study they could after a 48 hour wash out period (Hsieh *et al.*, 2000; Seth, 1999).
- Subjects receiving or those who had received other manual therapy treatments for their neck or low back pain were not be included unless they discontinued the treatment and entered the study a minimum of two weeks later.

3.4. CLINICAL ASSESSMENT AND PROCEDURE

3.4.1. Examiners:

One qualified Chiropractor, one senior chiropractic intern from the CDC and the researcher were used as the examiners.

This study was conducted in two phases.

3.4.2. Phase One

Subjects presenting to the CDC to participate in this study had the details of the study explained to them by the researcher. Each participant received a copy of the Letter of Information (**Appendix C**) which they were asked to read and sign. The Letter of Information gave a brief description of the study.

At the initial consultation, at the CDC, the prospective subjects underwent a full case history (**Appendix D**), a revised physical exam (**Appendix E**) and a cervical (**Appendix F**) and a lumbar spine (**Appendix G**) orthopedic examination.

➤ Examination procedure

In phase one the researcher and the other two examiners used different data sheets (**Appendices H and I**). The researcher examined the subject first followed by the two examiners in a random order. All findings made by the researcher in phase one was recorded onto a data sheet (**Appendix I**). All data collected the examiners (the qualified chiropractor and the chiropractic intern) were recorded onto data sheets (**Appendix H**).

The data collected by the researcher was kept confidential and the examiners were unaware of all the researcher's findings such as: the history, physical examination, cervical regional, lumbar orthopedic examination and the myofascial examination. As a result, blinding was achieved amongst the examiners.

The following clinical diagnostic criteria for MTrPs were assessed only by the researcher in the first phase:

- (1) The presence or absence of MTrPs
- (2) If the MTrP is active or latent

(3) And the presence or absence of the following diagnostic criteria was assessed:

- The presence a tender point within a taut band.
- Patient recognition of pain.
- The presence of a characteristic referred pain pattern.
- The presence of a jump sign.
- The presence of a local twitch response

The other two examiners (i.e. the qualified Chiropractor, one senior chiropractic intern) also had to determine the presence or absence of MTrPs and distinguish the MTrP is active or latent however, they were unaware of the criteria investigated. The examiners had to conclude which the criteria that they felt were essential in the diagnosis of MTrPs and state whether the criteria was present or absent in the subject.

Each examiner palpated two muscles, the upper trapezius (TP1 and TP2) and the gluteus medius muscle (TP1, TP2, and TP3) bilaterally. These muscles were chosen as they are common source of neck and low back pain respectively (Sciotti *et al.*, 2001 and Travell *et al.*, 1999). In this phase the examiners must state whether a MTrP is (1) present or absent, (2) if the MTrP is active or latent, (3) and the physical findings of MTrP found during examination of the subject.

The subjects were encouraged to interact with the examiners, however the subjects were instructed not to reveal whether he/she was symptomatic or asymptomatic or the findings of the previous examiners. According to Myburgh *et al.*, (2008) touch, observation and patient feedback during trigger point examination must be combined in order to produce consistent findings.

Examiners attended two, one hour discussion /training sessions (as discussed in 3.5.3) prior to the commencement of phase two.

3.4.3. Examiner Discussion Session

In order to reduce individual variation in the application of palpation techniques all examiners were required to attend two, one hour discussion/training session (Gerwin *et al.*, 1997). Training manuals (**Appendix J**) containing information detailing the criteria used to identify and diagnose MTrPs were given to the examiners. The discussion session was conducted by the researcher. During the discussion session, definitions of the features of MTrPs were reviewed, to be certain that examiners interpret the physical findings similarly. Each clinical feature was reviewed by the researcher to eliminate any variation in the interpretation of the physical findings. A consensus regarding the type of palpation, the amount of pressure, and the patient position used during the palpation of each trigger point was reached. Any discrepancies among the findings was discussed then re-evaluated and reassessed until all the examiners can elicit all the same signs and were in agreement about the physical findings.

3.4.4. Phase Two

Subjects presenting to the CDC to participate in this study had the details of the study explained to them by the researcher. Each participant received a copy of the Letter of Information (**Appendix C**) which they were asked to read and sign. The Letter of Information gave a brief description of the study.

At the initial consultation, at the CDC, the prospective subjects underwent a full case history (**Appendix D**), a revised physical exam (**Appendix E**) and a cervical (**Appendix F**) and a lumbar spine (**Appendix G**) orthopedic examination.

➤ Examination procedure

The researcher examined the subject first followed by the other examiners in a random order. Each examiner again palpated two muscles, the upper trapezius (TP1 and TP2) and the gluteus medius muscle (TP1, TP2, and TP3) bilaterally.

- Examiners were required to determine the following:

(1) The presence or absence of MTrPs

(2) If the MTrP is active or latent

(3) And the presence or absence of the following diagnostic criteria was assessed:

- The presence a tender point within a taut band.
- Patient recognition of pain.
- The presence of a characteristic referred pain pattern.
- The presence of a jump sign.
- The presence of a local twitch response.

All data collected by the examiners were recorded on separate data sheets (**Appendix I**).

3.5. THE EXAMINATION TECHNIQUE

3.5.1 Patient Position

➤ The Trapezius Muscle

The trigger points in the trapezius muscle were examined while the patient was in the seated position. For the examination of **TP1** and **TP2** the patient was seated with the ear slightly toward the same shoulder decreasing the slack on the muscle. The examiners used a pincer grasp to lift the entire mass of the free margin of the upper trapezius of the underlying supraspinatus muscle (Travell *et al.*, 1999).

➤ The Gluteus Medius Muscle

All trigger points in the gluteus medius muscle is examined while the patient lies on the side opposite to the affected muscle. Flat palpation is used to identify **TP1** which has the most posterior location. **TP2** and **TP3** are the most anteriorly located MTrPs (Travell *et al.*, 1999).

3.5.2. Types of Palpation

• Flat Palpation

Flat palpation was used when the muscle being examined can be pressed against the underlying bone (Travell *et al.*, 1999). During flat palpation the moving fingertip slides the patient's skin across the muscle fibers allowing for the discovery of underlying structures (Travell *et al.*, 1999).

- Step 1- The patient's skin was pushed to one side
- Step 2- The examiner's finger tip slid across the muscle fiber to find the presence of a taut band.
- Step 3- The patient's skin was then pushed to the other side on the completion of palpation.

- **Pincer Palpation**

Pincer palpation was used when the opposite sides of the muscle being examined are accessible (Travell *et al.*, 1999). During pincer palpation the muscle belly was clasped between the thumb and the finger and compressed, rolling the muscle back and forth to locate taut bands (Travell *et al.*, 1999).

3.5.3. Myofascial Trigger Point Examination

1. The Taut Band and the Tender Spot

In order to palpate the taut band the affected muscle was placed in a stretched position. The examiner palpated the muscle perpendicular to orientation of the muscle fibers using either pincer palpation (trapezius muscle) or flat palpation (gluteus medius muscle). The palpable band feels like a taut cord of tense muscle fibers (Travell *et al.*, 1999). Once the taut band was found, the examiner palpated along the taut band to find the spot of maximum tenderness (this is known as the tender spot).

2. LTR

Snapping palpation was used to elicit a local twitch response. Once a tender spot is found within the palpable band, the point was rolled under the examiner's fingertip and a rapid and strong palpation is applied while observing the skin above the muscle fibers for a distinguishing short and rapid movement.

3. Jump Sign

While applying adequate pressure on a MTrP the examiner carefully examined the patient's reaction. According to Friction (1994) the patient's reaction to firm palpation is termed a "jump sign". A positive jump sign may include withdrawal of the head, wrinkling of the face or forehead. According to Travell *et al.*, (1999), the amount of pressure required to cause a reaction from the patient gives a sign of the irritability of the MTrP.

4. Referred Pain

Compression of a localized spot of tenderness in a taut band, may result in referred pain. Referred pain in this study was defined as any pain that arises in a trigger point, but is felt at a distance from the trigger point (Travell *et al.*, 1999). When the patient reported a referred pain sensation, they were asked by the examiner to describe the area of referral. The examiner then decided whether this area was similar to the conventional referred pain patterns described by Travell *et al.*, (1999).

5. Patient Recognition of Pain

While applying pressure to the tender point within the taut band, the patient was asked if he or she felt any pain or any other sensation (e.g. tingling) in the area around where pressure was being applied. According to Cummings and Baldry (2007) if an active MTrP is palpated the patient will give a verbal indication that they recognize the pain which may include responses such as "That's it" or "Oh yes".

A standardized amount of pressure during palpation was used. A 3kg/cm² of pressure was applied over the trapezius muscle and a 5kg/cm² of pressure was applied over the gluteus medius muscles. This was done by applying the appropriate pressure to an algometer placed against a hard surface and approximating that pressure when palpating muscles (Hsieh *et al.*, 2000). This method of standardization of pressure was used in the study conducted by Hsieh *et al.*, (2000). According to Gerwin *et al.*, (1997) no uniform force or pressure that can be applied to all muscles exists. Differences in tissue compliance, size of the taut band, and depth of the muscle necessitate different degrees of force applied to the tissue in order to determine the presence or absence of the taut band and tender point (Travell *et al.*, 1999). This method was practiced by the examiners during the discussion session.

3.6. BACKGROUND TO STATISTICAL ANALYSIS

Inter-examiner reliability was assessed using Fleiss Kappa statistics calculated with Stat Tools freeware (http://amchang.net/StatTools/CohenKappa_Pgm.php#Fleiss's Kappa from rating scores). Pearson's chi square test was used to compare the genders of participants in phases 1 and 2, and Student's t tests were used to compare their ages, height and weights in order to assess whether the groups were comparable. A p value < 0.05 was considered as statistically significant.

3.6.1. Fleiss Kappa Statistic

Fleiss Kappa is statistical measure designed for assessing inter- examiner reliability. It is related to Cohen's Kappa however, Cohen's Kappa can only be used when the inter-examiner reliability of two examiners are being investigated. Fleiss Kappa can be used to study the inter examiner reliability of any number of examiners (Fleiss, 1971).

According to Uebersax (1987) and Randolph (2005), Fleiss Kappa can be influenced by prevalence (positive and negative findings) and bias, which can lead to the contradiction of high agreement but low kappa.

To facilitate consistent classification when describing the strength of agreement associated with kappa statistics, the following labels were assigned to the consequent ranges of kappa (Landis and Koch, 1977). However, this table was termed “arbitrary” by Landis and Koch (1977) and according to Gwet (2010), these guidelines may be a disadvantage as the number of categories and subjects will affect the magnitude of the value.

Table 3: Interpretation of Kappa

Kappa	Agreement
< 0	No Agreement
<0.20	Poor Agreement
0.21– 0.40	Fair Agreement
0.41–0.60	Moderate Agreement
0.61–0.80	Strong Agreement
0.81–0.99	Almost perfect agreement

Nevertheless Fleiss kappa and its classification continue to be used as no other measurement or classification exists (Esterhuizen, 2010 and Randolph, 2005).

3.6.2. 95% Confidence Intervals

According to Easton and McColl (1997), a confidence interval is a particular kind of interval estimate of a population parameter. A confidence interval is used to indicate the reliability of an estimate and provides a method of measuring how confident researchers are in the

accuracy of results. A confidence interval is always expressed as a percentage e.g. 95% (Easton and McColl, 1997).

In this study the 95% confidence intervals of the pre and post samples were examined for overlap. If overlap was found, then it was inferred that the two estimates are not significantly different at the 95% level. However, if an overlap was not found then it was deduced that the pre and post samples were significantly different (Esterhuizen, 2010).

3.6.3. Percentage Agreement

Percentage agreement is used to measure the inter-examiner agreement or reliability. Percent agreement is calculated by adding up the number of cases that received the same rating by examiners and dividing that number by the total number of cases rated by examiners (Brikimer and Brown, 1979). Point-by-point reliability (also known as interval-by-interval or as moment-by-moment reliability), is a percentage agreement measure that is used to calculate the percentage of all observation occasions for which the examiners agree concerning whether or not target behaviour occurred. When this proportion is converted to a percentage it is used as the reliability measure (Brikimer and Brown, 1979). According to Stemler (2004) the percent agreement statistic is easy to calculate and explain.

3.6.4. Student's t-tests

Student's t-tests are used to compare two small sets of quantitative data when samples are collected independently of one another. Student's t-test is used when one nominal variable and one measurement variable is available and a comparison of the mean values of the measurement variable is needed. The nominal variable must have only two values, such as "male" and "female" (McDonald, 2009)

3.6.5. Pearson's chi-square

Pearson's Chi-square is the most common type of chi-square test. Pearson chi-square is used when one nominal variable, with two or more values is available (McDonald, 2009).

CHAPTER FOUR

RESULTS

This chapter includes discussion of demographic data and the results after statistical analysis of the data obtained.

4.1. DEMOGRAPHIC DATA

There were 60 subjects in the study: 30 participants in phase one (15 symptomatic and 15 asymptomatic) and 30 participants in phase two (15 symptomatic and 15 asymptomatic).

4.1.1 Age, Height and Weight Distribution

Student's t- tests were used to compare the ages, height and weights of participants in order to assess whether the groups were comparable.

The summary statistics for age, height and weight are shown in the Table 4:

Table 4: Comparison of demographic characteristics between the two phases (n=60)

Phase	N		Age	Height (m)	Weight (kg)
1	30	Mean	22.53	1.574	59.53
		Std. Deviation	5.406	.1252	7.454
		Minimum	18	1.3	47
		Maximum	44	1.9	75
2	30	Mean	21.30	1.567	64.03
		Std. Deviation	3.816	.0802	13.561
		Minimum	18	1.4	45
		Maximum	34	1.7	110

N=sample size; m =meters; kg= Kilograms; Std. Deviation= Standard Deviation

The values were similar for phase 1 and 2 participants. There were no significant differences between the two groups for any of these variables ($p=0.312$, 0.797 and 0.117 respectively). The lack of significant differences between the two groups is an advantage to the study as it allows for greater homogeneity because the sample groups are more comparable (Mouton, 1996).

Table 4 shows that the mean age in phase one 22.53. The youngest participant was 18 years old while the oldest was 44 years old. In phase two the mean age was 21.30 with the youngest participant being 18 years and the oldest participant being 34 years old. This conforms to the literature which suggests that myofascial pain occurs commonly between the ages of 20-50 years (Fomby and Mellion, 1997; Tunks and Crook, 1999 and Van Aardenne, 2002).

4.1.2. Gender Distribution

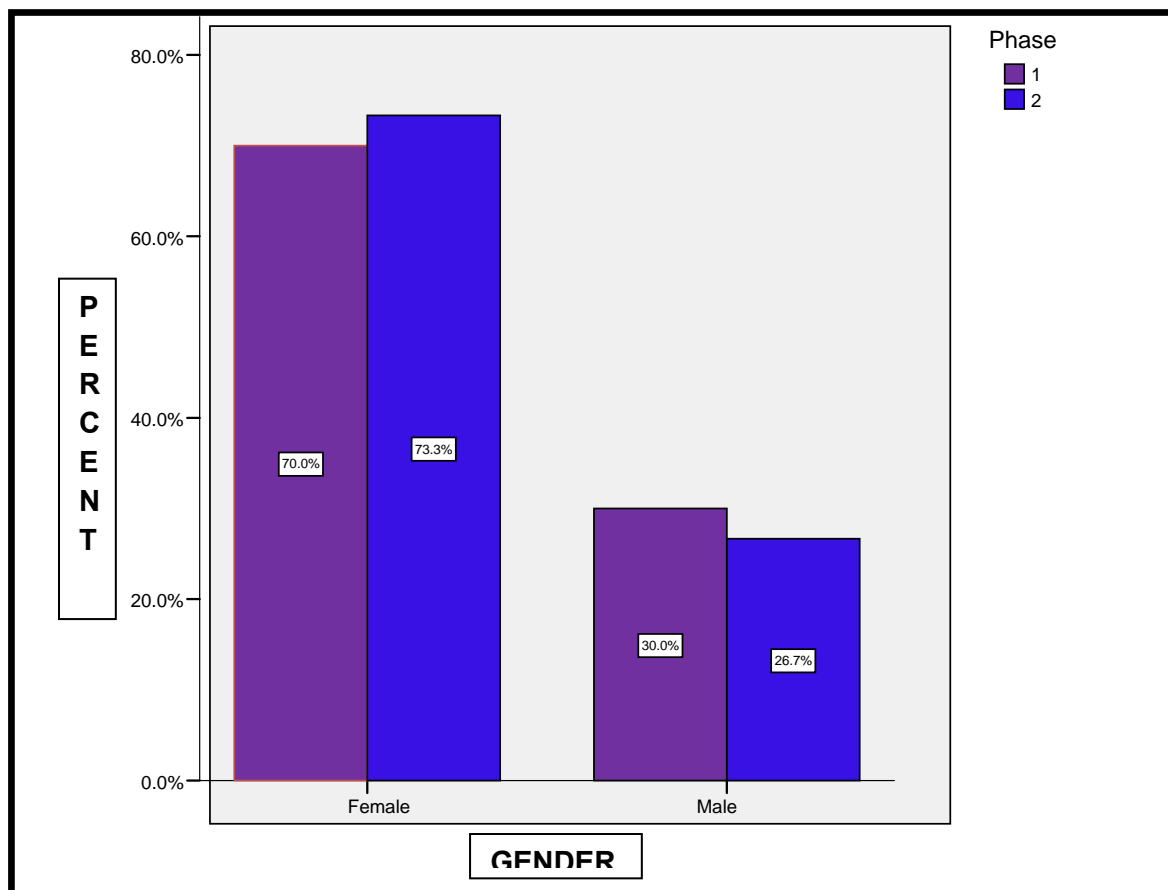


Figure 14: Gender Distribution between Phase 1 and 2.

Pearson's chi square test was used to compare the genders of participants in phases 1 and 2. Figure 14 shows that there was a similar distribution of male and female participants in phases 1 and 2. In phase 1 there were 70% females and in phase 2 there were 73%

females. In the literature females, have a increased incidence of MTrPs than males (Wilks, 2003; Sola, 1995; Katz, 2002; Hou *et al.*, 2002 and Han and Harrison, 1997) this is supported by the statistical findings of this study.

4.2. PHASE ONE – PRE- INTERVENTION RESULTS

4.2.1. Determining the Presence or Absence of MTrPs

Table 5: Inter- Examiner Agreement for Determining Presence or Absence of MTrPs

MTrP and location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1R	58.89 %	-0.2352 to 0.1780	-0.0286	No Agreement
TrapTP1L	78.89 %	-0.2119 to 0.2013	-0.0053	No Agreement
TrapTP2R	88.89 %	-0.0066 to 0.4066	0.2000	Poor Agreement
TrapTP2L	81.81 %	-0.1481 to 0.2651	0.0585	Poor Agreement
GMedTP1	80.00 %	-0.1802 to 0.2330	0.0264	No Agreement
GMedTP1L	78.89 %	-0.1047 to 0.3085	0.1019	Poor Agreement
GMedTP2R	83.83 %	-0.1090 to 0.3042	0.0976	Poor Agreement
GMedTP2L	57.56 %	-0.2465 to 0.1667	-0.0399	No Agreement
GMedTP3R	71.11 %	-0.3627 to 0.0505	-0.1561	No Agreement
GMedTP3L	67.78 %	-0.4283 to -0.0151	-0.2217	No Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left. (E.g. TrapTP1R means trapezius trigger point 1 on the right; GMedTP3L means gluteus medius trigger point 3 on the left).

As shown in Table 5 a poor level of agreement existed between examiners in phase one. The kappa ranged from no agreement to poor agreement while the percentage agreement ranged from 57.56% to 88.89%. Gluteus medius trigger point 2 on the left had the lowest percentage agreement (57.56%) between examiners, while trapezius trigger point 2 on the right had the highest percentage agreement (88.89%) between examiners.

4.2.2. Determining the Type of MTrP

Table 6: Inter- Examiner Agreement for Determining the Type of MTrP

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1R	58.89 %	-0.1102 to 0.1936	0.0417	Poor Agreement
TrapTP1L	50.00 %	-0.1691 to 0.1551	-0.0070	No Agreement
TrapTP2R	63.33 %	-0.6673 to -0.3055	-0.4864	No Agreement
TrapTP2L	50.00 %	-0.2678 to 0.0272	-0.1203	No Agreement
GMedTP1R	54.44 %	-0.0820 to 0.2332	0.0756	No Agreement
GMedTP1L	41.11 %	0.0896 to 0.8558	0.4727	Moderate Agreement
GMedTP2R	60.00 %	-0.1138 to 0.2063	0.0462	Poor Agreement
GMedTP2L	42.53 %	-0.2272 to 0.1391	-0.0440	No Agreement
GMedTP3R	26.67 %	-0.3344 to 0.0164	-0.1590	No Agreement
GMedTP3L	20.00 %	-0.4461 to -0.069	-0.2557	No Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscles; TP =Trigger Point; R=Right; L=Left (E.g. TrapTP1R means trapezius trigger point 1 on the right; GMedTP3L means gluteus medius trigger point 3 on the left).

As shown in Table 6 a poor level of agreement existed between examiners in phase one. The kappa ranged from no agreement /poor agreement to moderate agreement while the

percentage agreement ranged from 20.00% to 63.33%. Gluteus medius trigger point 3 on the left had the lowest percentage agreement (20.00%) between examiners, while trapezius trigger point 2 on the right had the highest percentage agreement (63.33%) between examiners.

4.2.3. A Tender Point within a Taut Band of Skeletal Muscle

Table 7: Inter- Examiner Agreement for Tender Point within a Taut Band of Skeletal

MTrP and location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1Rtenderpt	71.11 %	-0.1102 to 0.1936	0.0061	Poor Agreement
TrapTP1Ltenderpt	66.67%	-0.2355 to 0.1160	-0.0597	No Agreement
TrapTP2Rtenderpt	77.78%	-0.2127 to 0.1210	-0.0459	No Agreement
TrapTP2Ltenderpt	71.11%	-0.1762 to 0.1547	-0.0107	No Agreement
GMedTP1Rtenderpt	73.33%	-0.2618 to 0.0920	-0.0849	No Agreement
GMedTP1Ltenderpt	71.11%	-0.1187 to 0.2186	0.0500	Poor Agreement
GMedTP2Rtenderpt	70.00%	-0.1642 to 0.1573	-0.0034	No Agreement
GMedTP2Ltenderpt	45.56 %	-0.2328 to 0.1100	-0.0614	No Agreement
GMedTP3Rtenderpt	63.33%	-0.3353 to 0.0235	-0.1559	No Agreement
GMedTP3Ltenderpt	57.78 %	-0.4270 to - 0.0894	-0.2582	No Agreement
Muscle				

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left; tenderpt= Tender Point within taut palpable band; (E.g. TrapTP1Rtenderpt means trapezius muscle trigger point 1 on the right

tender point within a taut band, GMedTP1Rtenderpt means gluteus medius trigger point 1 on the right tender point within a taut band)

Table 7 shows a poor level of agreement between examiners in phase one. The kappa ranged from no agreement to poor agreement while the percentage agreement ranged from 45.56 % to 77.78%. Gluteus medius trigger point 2 on the left had the lowest percentage agreement (45.56%) between examiners, while trapezius trigger point 2 on the right had the highest percentage agreement (77.78%) between examiners.

4.2.4. Local Twitch Response

Table 8: Inter Examiner Agreement for Local Twitch Response

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1R LTR	60.00%	-0.2569 to 0.0627	-0.0971	No Agreement
TrapTP1L LTR	66.67%	-0.2977 to 0.0575	-0.1201	No Agreement
TrapTP2R LTR	72.22%	-0.0644 to 0.2559	0.0958	Poor Agreement
TrapTP2L LTR	66.67%	-0.2545 to 0.0935	-0.0805	No Agreement
GMedTP1 LTR	70.00%	-0.2083 to 0.1378	-0.0352	No Agreement
GMedTP1L LTR	75.56%	-0.0862 to 0.2554	0.0846	Poor Agreement
GMedTP2R LTR	60.00%	-0.3199 to 0.0217	-0.1491	No Agreement
GMedTP2L LTR	65.56%	-0.2428 to 0.1400	-0.0514	No Agreement
GMedTP3R LTR	76.67%	-0.1459 to 0.1934	0.0237	Poor Agreement
GMedTP3L LTR	85.56%	-0.0748	-0.2468 to 0.0973	No Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left; LTR= Local Twitch Response; (E.g. TrapTP1RLTR means trapezius muscle trigger point 1 on the right local twitch response, GMedTP1RLTR means gluteus medius trigger point 1 on the right local twitch response)

Table 8 demonstrates a poor level of agreement between examiners in phase one. The kappa ranged from no agreement to poor agreement while the percentage agreement ranged from 60.00% - 85.56%. Trapezius trigger point 1 on the right and Gluteus Medius trigger point 2 on the right had the lowest percentage agreement (60.00%) between examiners while Gluteus Medius trigger point 3 on the left had the highest percentage agreement (85.56%) between examiners.

4.2.5. Pain Recognition

Table 9: Inter- Examiner Agreement for Pain Recognition

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1Rpainrecog	62.22%	-0.2206 to 0.0887	-0.0660	No Agreement
TrapTP1Lpainrecog	63.33%	-0.2480 to 0.0779	-0.0850	No Agreement
TrapTP2R painrecog	70.00%	-0.2119 to 0.1035	-0.0542	No Agreement
TrapTP2Lpainrecog	67.78%	-0.2545 to 0.0734	-0.0905	No Agreement
GMedTP1painrecog	71.11%	-0.1344 to 0.2061	0.0359	Poor Agreement
GMedTP1Lpainrecog	74.44%	-0.0807 to 0.2865	0.1029	Poor Agreement
GMedTP2Rpainrecog	65.56%	-0.1607 to 0.1580	-0.0013	No Agreement
GMedTP2Lpainrecog	75.56%	-0.2186 to 0.1588	-0.0299	No Agreement
GMedTP3Rpainrecog	65.56%	-0.3682 to 0.0200	-0.1741	No Agreement

GMedTP3Lpainrecog	66.67%	-0.4684 to -0.0813	-0.2749	No Agreement
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%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left; painrecog= Pain recognition; (E.g. TrapTP1Rpainrecog means trapezius muscle trigger point 1 on the right pain recognition, GMedTP1Rpainrecog means gluteus medius trigger point 1 on the right pain recognition)

As shown in Table 9 a poor level of agreement between examiners for this characteristic in phase one. The kappa ranged from no agreement to poor agreement while the percentage agreement ranged from 62.22% to 75.56%. Trapezius trigger point 1 on the right recorded the lowest percentage agreement (62.22%) between examiners while gluteus medius trigger point 2 on the left recorded the highest percentage agreement (75.56%) between examiners.

4.2.6. Referred Pain

Table 10: Inter-Examiner Agreement for Referred Pain

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1Rrefpain	64.44%	-0.1114 to 0.1917	0.0402	Poor Agreement
TrapTP1Lrefpain	73.33%	-0.0795 to 0.2331	0.0768	Poor Agreement
TrapTP2Rrefpain	66.67%	0.0048 to 0.3024	0.1536	Poor Agreement
TrapTP2Lrefpain	71.11%	0.0055 to 0.3111	0.1583	Poor Agreement
GMedTP1 Rrefpain	66.67%	-0.1066 to 0.1984	0.0459	Poor Agreement
GMedTP1Lrefpain	74.44%	0.0475 to 0.3613	0.2044	Fair Agreement
GMedTP2Rrefpain	68.89%	-0.0795 to 0.2223	0.0714	Poor Agreement
GMedTP2Lrefpain	72.22%	-0.0340 to 0.2878	0.1269	No Agreement
GMedTP3Rrefpain	74.44%	-0.1407 to	0.0173	Poor Agreement

		0.1754		
GMedTP3Lrefpain	83.33%	-0.2529 to 0.0676	-0.0926	No Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left; refpain=Referred Pain; (E.g. TrapTP1R refpain means trapezius muscle trigger point 1 on the right referred pain, GMedTP1R refpain means gluteus medius trigger point 1 on the right referred pain)

Table 10 shows a poor level of agreement between examiners in phase one. The kappa ranged from poor agreement to fair agreement while the percentage agreement ranged from 64.44% - 83.33%. Trapezius trigger point 1 on the right recorded the lowest percentage agreement (64.44%) between examiners while gluteus medius trigger point 3 on the left recorded the highest percentage agreement (83.33%) between examiners.

4.2.7. Jump Sign

Table 11: Inter- Examiner Agreement for Jump Sign

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1Rjumpsign	47.78%	-0.2612 to 0.0315	-0.1148	No Agreement
TrapTP1Ljumpsign	51.11%	-0.2209 to 0.0822	-0.0693	No Agreement
TrapTP2Rjump sign	55.56%	-0.2073 to 0.0880	-0.0596	No Agreement
TrapTP2Ljumpsign	50.00%	-0.1944 to 0.0998	-0.0473	No Agreement
GMedTP1jump sign	51.11%	-0.2196 to 0.0735	-0.0730	No Agreement
GMedTP1Ljump sign	58.89%	-0.1208 to 0.1756	0.0274	Poor Agreement
GMedTP2Rjumpsign	43.33%	-0.2816 to 0.0098	-0.1359	No Agreement
GMedTP2Ljumpsign	44.44%	-0.2981 to - 0.0025	-0.1503	No Agreement

GMedTP3Rjumpsign	53.33%	-0.2584 to 0.0482	-0.1051	No Agreement
GMedTP3L jumpsign	60.00%	-0.2901 to 0.0201	-0.1350	No Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left; ; (E.g. TrapTP1R jumpsign means trapezius muscle trigger point 1 on the right jumpsign , GMedTP1R jumpsign means gluteus medius trigger point 1 on the right jumpsign)

As depicted in Table 11 a poor level of agreement between examiners in phase one. The kappa ranged from no agreement to poor agreement while the percentage agreement ranged from 43.33% - 60.00%. Gluteus Medius trigger point 2 on the right recorded the lowest percentage agreement (43.33%) between examiners while gluteus medius trigger point 3 on the left recorded the highest percentage agreement (60.00%) between examiners.

4.3. PHASE TWO- POST- INTERVENTION RESULTS

4.3.1. Determining the Presence or Absence of MTrPs

Table 12: Inter- Examiner Agreement for Determining Presence or Absence of MTrPs

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1R	93.33%	-0.2780 to 0.1352	-0.0714	No Agreement
TrapTP1L	83.67%	-0.2191 to 0.1941	-0.0125	No Agreement
TrapTP2R	97.78%	0.3484 to 0.7530	0.5507	No Agreement
TrapTP2L	92.22%	-0.2909 to 0.1223	-0.0843	No Agreement
GMedTP1R	91.11%	-0.1943 to 0.2189	0.0123	Poor Agreement
GMedTP1L	86.67%	-0.2216 to 0.1916	-0.0150	Poor Agreement
GMedTP2R	90.00%	-0.0720 to 0.3412	0.1346	Poor Agreement
GMedTP2L	91.11%	0.0242 to 0.4374	0.2308	Fair Agreement
GMedTP3R	85.56%	0.1915 to 0.6048	0.3981	Fair Agreement
GMedTP3L	86.67%	0.2534 to 0.6666	0.4600	Moderate Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Mucles; TP =Trigger Point; R=Right; L=Left (E.g. TrapTP1R means trapezius trigger point 1 on the right; GMedTP3L means gluteus medius trigger point 3 on the left).

As demonstrated on Table 12 the kappa ranged from poor agreement to moderate agreement while the examiner achieved a high level of percentage agreement which ranged from 83.67% - 97.78% in phase two. Trapezius trigger point 1 on the left recorded the lowest percentage agreement (83.67%) between examiners while trapezius trigger point 2 on the right recorded the highest percentage agreement (97.78%) between examiners.

4.3.2. Determining the Type of MTrP

Table 13: Inter- Examiner Agreement for Determining Type of MTrP

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1R	86.67%	0.1727 to 0.5590	0.3659	Fair Agreement
TrapTP1L	84.44%	0.0780 to 0.4474	0.2627	Fair Agreement
TrapTP2R	90.00%	0.3484 to 0.7530	0.5507	Moderate Agreement
TrapTP2L	85.56%	0.0583 to 0.4438	0.2511	Fair Agreement
GMedTP1R	78.89%	-0.6546 to -0.1445	-0.3996	No Agreement
GMedTP1L	90.00%	-1.2584 to -0.5409	-0.8997	No Agreement
GMedTP2R	90.00%	-0.5389 to 0.0389	-0.2500	No Agreement
GMedTP2L	88.89%	-1.1137 to -0.4172	-0.7654	No Agreement
GMedTP3R	85.56%	0.1915 to 0.6048	0.3981	Fair Agreement
GMedTP3L	71.42%	0.2263 to 0.6144	0.4203	Moderate Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left; %= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscles; TP =Trigger Point; R=Right; L=Left (E.g. TrapTP1R means trapezius trigger point 1 on the right; GMedTP3L means gluteus medius trigger point 3 on the left).

Table 13 shows a fair level of agreement between the examiners in phase two. The kappa ranges from no agreement/poor agreement to moderate agreement. The percentage agreement achieved by examiners was high and ranged from 71.42 – 90.00%. Gluteus Medius trigger point 3 on the left recorded the lowest percentage (71.42%) while trapezius trigger point 2 on the right , gluteus medius trigger point 1 on the left and gluteus medius trigger point 2 on the right recorded the highest percentage agreement (90.00%).

4.3.3. A Tender Point within a Taut Band of Skeletal Muscle

Table 14: Inter- Examiner Agreement for a Tender Point within a Taut Band of Skeletal Muscle

MTrP and location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1Rtenderpt	93.33%	-0.2780 to 0.1352	-0.0714	No Agreement
TrapTP1Ltenderpt	90.00%	-0.2191 to 0.1941	-0.0125	No Agreement
TrapTP2Rtenderpt	97.78%	-0.2293 to 0.1839	-0.0227	No Agreement
TrapTP2Ltenderpt	91.11%	-0.3042 to 0.1090	-0.0976	No Agreement
GMedTP1Rtenderpt	92.22%	-0.1670 to 0.2462	0.0396	Poor Agreement
GMedTP1Ltenderpt	87.78%	-0.1956 to 0.2176	0.0110	Poor Agreement
GMedTP2Rtenderpt	90.00%	-0.0720 to 0.3412	0.1346	Poor Agreement
GMedTP2Ltenderpt	91.11%	0.0242 to 0.4374	0.2308	Fair Agreement
GMedTP3Rtenderpt	81.16%	0.1915 to 0.6048	0.3981	Fair Agreement
GMedTP3Ltenderpt	86.67%	0.2263 to 0.6144	0.4203	Moderate Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Mucles; TP =Trigger Point; R=Right; L=Left; tenderpt=Tender Point within taut palpable band; TrapTP1Rtenderpt= Trapezius trigger point 1 on the right tender point within a taut band. (E.g. TrapTP1Rtenderpt means trapezius muscle trigger point 1 on the right tender point within a taut band, GMedTP1Rtenderpt means gluteus medius trigger point 1 on the right tender point within a taut band)

Table 14 shows that the Kappa agreement between examiners ranged from no agreement to moderate agreement in phase two. The percentage agreement for a tender point within a taut band of skeletal muscle varied from 81.16% - 97.78%. The lowest percentage

agreement was recorded in the Gluteus Medius trigger point 3 on the right (81.16%) while the highest percentage agreement was recorded in the Trapezius trigger point 2 on the right (97.78%).

4.3.4. Local Twitch Response

Table 15: Inter- Examiner Agreement for Local Twitch Response

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1RLTR	87.78%	0.1842 to 0.5974	0.3908	Fair Agreement
TrapTP1LLTR	90.00%	0.0734 to 0.4866	0.2800	Fair Agreement
TrapTP2RLTR	87.78%	0.2338 to 0.6470	0.4404	Moderate Agreement
TrapTP2LLTR	87.78%	-0.1387 to 0.2745	0.0679	Poor Agreement
GMedTP1LTR	96.67%	0.0085 to 0.4217	0.2151	Fair Agreement
GMedTP1LLTR	97.78%	-0.2293 to 0.1839	-0.0227	No Agreement
GMedTP2RLTR	98.89%	-0.2178 to 0.1954	-0.0112	No Agreement
GMedTP2LLTR	93.33%	-0.1670 to 0.2462	0.0396	Poor Agreement
GMedTP3RLTR	97.78%	-0.2293 to 0.1839	-0.0227	No Agreement
GMedTP3LLTR	98.89%	-0.2178 to 0.1954	-0.0112	No Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscles; TP =Trigger Point; R=Right; L=Left; LTR= Local Twitch Response; (E.g. TrapTP1RLTR means trapezius muscle trigger point 1 on the right local twitch response, GMedTP1RLTR means gluteus medius trigger point 1 on the right local twitch response)

Table 15 shows that the kappa agreement ranged from no agreement to moderate agreement in phase two. Percentage agreement between the examiners overall was high

and ranged from 87.87%- 98.89%. The trapezius trigger point 1 on the right, trapezius trigger point 2 on the right and the left achieved the lowest percentage agreement (87.87%) while gluteus medius trigger point 2 on the right, gluteus medius trigger point 3 on the left achieved the highest percentage agreement (98.89%).

4.3.5. Pain Recognition

Table 16: Inter -Examiner Agreement for Pain Recognition

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	p value	Classification of agreement
TrapTP1R painrecog	95.56%	-0.2909 to 0.1223	-0.0843	No Agreement
TrapTP1L painrecog	90.00%	-0.2191 to 0.1941	-0.0125	No Agreement
TrapTP2Rpainrecog	97.78%	-0.2293 to 0.1839	-0.0227	No Agreement
TrapTP2L painrecog	92.22%	-0.2909 to 0.1223	-0.0843	No Agreement
GMedTP1Rpainrecog	91.11%	-0.1943 to 0.2189	0.0123	Poor Agreement
GMedTP1Lpainrecog	87.78%	-0.1956 to 0.2176	0.0110	Poor Agreement
GMedTP2Rpainrecog	91.11%	-0.0351 to 0.3781	0.1715	Poor Agreement
GMedTP2Lpainrecog	91.11%	0.0741 to 0.4873	0.2807	Fair Agreement
GMedTP3Rpainrecog	85.56%	0.1915 to 0.6048	0.3981	Fair Agreement
GMedTP3Lpainrecog	88.89%	0.2991 to 0.6992	0.4991	Moderate Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left; painrecog= Pain Recognition; (E.g. TrapTP1Rpainrecog means trapezius muscle trigger point 1 on the right pain recognition, GMedTP1Rpainrecog means gluteus medius trigger point 1 on the right pain recognition)

As shown in Table 16 the kappa agreement ranged from no agreement to moderate agreement in phase two. Percentage agreement for pain recognition between the examiners overall was high and ranged from 85.56%- 97.78%. The percentage agreement for pain recognition was lowest in the gluteus medius trigger point 3 on the right (85.56%) while the highest score was recorded in the trapezius trigger point 2 on the right (97.78%).

4.3.6. Referred Pain

Table 17: Inter- Examiner Agreement for Referred Pain

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1Rrefpain	92.22%	0.1918 to 0.6050	0.3984	Fair Agreement
TrapTP1Lrefpain	94.44%	0.1761 to 0.5893	0.3827	Fair Agreement
TrapTP2Rrefpain	92.22%	0.3434 to 0.7566	0.5500	Moderate Agreement
TrapTP2Lrefpain	92.22%	0.2013 to 0.6145	0.4079	Moderate Agreement
GMedTP1refpain	95.56%	-0.2531 to 0.1601	-0.0465	No Agreement
GMedTP1Lrefpain	97.78%	-0.2293 to 0.1839	-0.0227	No Agreement
GMedTP2Rrefpain	96.67%	0.1581 to 0.5713	0.3647	Fair Agreement
GMedTP2Lrefpain	98.89%	0.1037 to 0.5169	0.3103	Fair Agreement
GMedTP3Rrefpain	97.78%	-0.2293 to 0.1839	-0.0227	No Agreement
GMedTP3Lrefpain	94.44%	-0.2654 to 0.1478	-0.0588	No Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left; repain= Referred Pain; (E.g. TrapTP1R repain means trapezius muscle trigger point 1 on the right referred pain, GMedTP1R repain means gluteus medius trigger point 1 on the right referred pain)

Table 17 shows that the overall kappa agreement was fair in phase two. The kappa scores ranged from no agreement to moderate agreement. The overall percentage agreement was high with the percentage agreement ranging from 92.22% to 98.89%. Trapezius trigger point 1 on the right, trapezius trigger point 2 on the right and left recorded the lowest percentage agreement (92.22%) while gluteus medius trigger point 2 on the left recorded the highest percentage agreement (98.89%).

4.3.7. Jump Sign

Table 18: Inter- Examiner Agreement for Jump Sign

MTrP and Location	(%) agreement between examiners	Kappa (95% CI)	Kappa (p) value	Classification of agreement
TrapTP1Rjumpsign	82.22%	-0.0720 to 0.3412	0.1346	Poor Agreement
TrapTP1Ljumpsign	80.00%	-0.0678 to 0.3454	0.1388	Poor Agreement
TrapTP2R jump sign	80.00%	-0.3246 to 0.0886	-0.1180	No Agreement
TrapTP2Ljumpsign	80.00%	-0.1802 to 0.2330	0.0264	Poor Agreement
GMedTP1jump sign	82.22%	-0.0786 to 0.3346	0.1280	Poor Agreement
GMedTP1Ljump sign	80.00%	-0.0264 to 0.3868	0.1802	Poor Agreement
GMedTP2Rjumpsign	81.11%	0.0191 to 0.4323	0.2257	Fair Agreement
GMedTP2L jumpsign	88.89%	0.3259 to 0.7391	0.5325	Moderate Agreement
GMedTP3Rjumpsign	83.33%	0.1050 to 0.5182	0.3116	Fair Agreement
GMedTP3L jumpsign	81.11%	0.2257	0.0191 to 0.4323	Fair Agreement

%= Percentage; MTrP=Myofascial trigger point; CI= Confidence Interval; p= Kappa; Trap= Trapezius Muscle; GMed= Gluteus Medius Muscle; TP =Trigger Point; R=Right; L=Left; (E.g. TrapTP1R jumpsign

means trapezius muscle trigger point 1 on the right jumpsign , GMedTP1R jumpsign means gluteus medius trigger point 1 on the right jumpsign)

Table 18 shows that the kappa agreement ranged from no agreement to moderate agreement in phase two. The overall percentage agreement was high. The percentage agreement varied between 80.00% and 88.89%. The examiners achieved the lowest percentage agreement for the jump sign in the trapezius trigger point 1 on the left, trapezius trigger point 2 on the right and left and gluteus medius trigger point 1 on the left (80.00%). The highest percentage agreement for jump sign occurred in the gluteus medius trigger point 1 on the left (88.89%).

4.4. COMPARISON BETWEEN PHASE ONE AND PHASE TWO

In this section the highlighted figures show the improvement of results from phase one

4.4.1. Trapezius Muscle TP1- Right

Table 19: Characteristics for Trapezius Muscle TP1- Right

Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
TrapTP1 R pres/abs	-0.0286	-0.0714	-0.2352 to 0.1780	-0.2780 to 0.1352	58.89%	93.33%*
Type of MFTP Trap TP1 R	0.0417	0.3659*	-0.1102 to 0.1936	0.1727 to 0.5590	58.89%	86.67%*
TrapTP1 R tenderpt	0.0061	-0.0714	-0.1686 to 0.1807	-0.2780 to 0.1352	71.11%	93.33%*
TrapTP1R LTR	-0.0971	0.3908 *	-0.2569 to 0.0627	0.1842 to 0.5974	60.00%	87.78%*
TrapTP1R painrecog	-0.0660	-0.0843	-0.2206 to 0.0887	-0.2909 to 0.1223	62.22%	95.56%*
TrapTP1R refpain	0.0402	0.3984 *	-0.1114 to 0.1917	0.1918 to 0.6050	64.44%	92.22%*
TrapTP1R jumpsign	-0.1148	0.1346 *	-0.2612 to 0.0315	-0.0720 to 0.3412	42.78%	82.22%*

CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; Trap=Trapezius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; refpain= Referred Pain; R=Right.

*-The highlight figures demonstrate the improvement of the percentage agreement in phase two

Table 19 demonstrates the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements. Table 18 shows that the kappa agreement improved significantly for local twitch response, improving from -0.0971 in phase one to 0.3908 in phase two. The percentage agreement for LTR improved from 60.00% in

phase one to 87.78% in phase two. The kappa statistic for the characteristic referred pain improved from 0.0402 in phase one to 0.3984 in phase two, while the percentage agreement for this characteristic improved from 62.22% to 92.22% in phase two. The kappa statistic for the characteristic jump sign agreement improved from -0.1148 IN phase one to 0.1346 in phase two, while the percentage agreement for this characteristic improved from 42.78% to 92.22% in phase two. Significant improvement in the kappa agreement of the type of trigger point between examiners was also noted in phase two, the kappa increased from 0.0417 in phase one to 0.3659 in phase two. The percentage agreement also improved significantly in phase two for the ability to determine the type of MTrP. It improved from 58.89% in the first phase to 93.33% in phase two. The percentage agreement for the characteristics tender point within a taut band and pain recognition also improved in phase two. The percentage agreement for a tender point within a taut band improved from 71.11% in the first phase to 93.33% in the phase two, while the percentage agreement for pain recognition improved from 62.22%in phase one to 95.56% in phase two.

4.4.2. Trapezius Muscle TP1-Left

4.4.3. Table 20: Characteristics for Trapezius muscle - TP1-Left

Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
TrapTP1L Pres/abs	-0.0053	-0.0125	-0.2119 to 0.2013	-0.2191 to 0.1941	78.89%	86.67%*
Type of MFTP Trap TP1 L	-0.0070	0.2627*	-0.1691 to 0.1551	0.0780 to 0.4474	50.00%	84.44%*
TrapTP1L tenderpt	-0.0597	-0.0125	-0.2355 to 0.1160	-0.2191 to 0.1941	66.67%	90.00%*
TrapTP1L LTR	-0.1201	0.2800*	-0.2977 to 0.0575	0.0734 to 0.4866	66.67%	90.00%*
TrapTP1L painrecog	-0.0850	-0.0125	-0.2480 to 0.0779	-0.2191 to 0.1941	63.33%	90.00%*
TrapTP1L refpain	0.0768	0.3827*	-0.0795 to 0.2331	0.1761 to 0.5893	73.33%	94.44%*
TrapTP1L jumpsign	-0.0693	0.1388*	-0.2209 to 0.0822	-0.0678 to 0.3454	51.11%	80.00%*

CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; Trap=Trapezius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; refpain= Referred Pain; L=Left

*-The highlight figures demonstrate the improvement in phase two

Table 20 shows the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements. Table 19 demonstrates that the intervention significantly improved the kappa agreement between the examiners for determining the type of trigger point. The kappa improved from -0.0070 in phase one to 0.2627 in phase two,

while the percentage agreement for determining the type of trigger point improved from 50.00% to 84.44%. The Kappa agreement for referred pain improved from 0.0768 in phase one to 0.3827 in phase two, while the percentage agreement for referred pain improved from 73.33% in phase one to 94.44% in phase two. The kappa agreement for the characteristic jump sign improved from -0.0693 in the first phase to 0.1388 in phase two, while the percentage agreement for this characteristic improved from 51.11% in phase one to 80.00% in phase two. The percentage agreement also improved significantly in phase two for determining the type of MTrP (it improved from 78.89% in phase one to 86.67% in phase two), tender point (it improved from 66.67% in phase one to 90.00% in phase two) and pain recognition (it improved from 63.33% in phase one to 90.00% in phase two).

4.4.4. Trapezius Muscle TP2- Right

Table 21: Characteristics of Trapezius Muscle TP 2- Right

Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
TrapTP2R Pres/ab	0.2000	-0.0227	-0.0066 to 0.4066	-0.2293 to 0.1839	88.89%	97.78%*
Type of MFTP Trap TP2 R	-0.4864	0.5507 *	-0.6673 to - 0.3055	0.3484 to 0.7530	63.33%	90.00%*
Trap TP2 R tenderpt	-0.0459	-0.0227	-0.2127 to 0.1210	-0.2293 to 0.1839	77.78%	97.78%*
Trap TP2 R LTR	0.0958	0.4404 *	-0.0644 to 0.2559	0.2338 to 0.6470	72.22%	87.78%*
Trap TP2 R painrecog	-0.0542	-0.0227	-0.2119 to 0.1035	-0.2293 to 0.1839	70.00%	97.78%*
Trap TP2 R refpain	0.1536	0.5500*	0.0048 to 0.3024	0.3434 to 0.7566	66.67%	92.22%*
Trap TP2 R jumpsign	-0.0596	-0.1180	-0.2073 to 0.0880	-0.3246 to 0.0886	55.56%	80.00%*

CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; Trap=Trapezius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; refpain= Referred Pain; R=Right

***-The highlight figures demonstrate the improvement in phase two**

Table 21 shows the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements. Table 20 reveals that a significant improvement was noted in the kappa agreement in this MTrP for determining the type of trigger point. The kappa improved from -0.4864 in phase one to 0.5507 in phase two, while the percentage agreement improved from 63.33% to 90.00%. The kappa and the percentage agreement for local twitch response (0.0958 in phase one to 0.4404 in phase two and 72.22% in phase one to 87.78% phase two) and referred pain (0.1536 in phase one to 0.5500 and 66.67% phase two in phase one 92.22% phase two) also improved following the intervention. The percentage agreement improved significantly in phase two for determining the type of MTrP (88.89% in phase one to 97.78% phase two). The percentage agreement improved significantly in phase two for the following characteristics tender point (77.78% in phase one to 97.78% phase two), pain recognition (70.00% in phase one to 97.78% phase two) and jump sign (55.56% in phase one to 80.00% phase two) .

4.4.5. Trapezius Muscle TP2-Left

Table 22: Characteristics for Trapezius Muscle TP2- Left

Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
Trap TP2 L Pres/abs	0.0585	-0.0843	-0.1481 to 0.2651	-0.2909 to 0.1223	81.11%	92.22%*
Type of MFTP Trap TP2 L	-0.1203	0.2511 *	-0.2678 to 0.0272	0.0583 to 0.4438	50.00%	85.56%*
Trap TP2 L tenderpt	-0.0107	-0.0976	-0.1762 to 0.1547	-0.3042 to 0.1090	71.11%	91.11%*
Trap TP2 L LTR	-0.0805	0.0679 *	-0.2545 to 0.0935	-0.1387 to 0.2745	66.67%	87.78%*
Trap TP2 L painrecog	-0.0905	-0.0843	-0.2545 to 0.0734	-0.2909 to 0.1223	67.78%	92.22%*
Trap TP2 L refpain	0.1583	0.4079*	0.0055 to 0.3111	0.2013 to 0.6145	71.11%	92.22%*
Trap TP2 L jumpsign	-0.0473	0.0264	-0.1944 to 0.0998	-0.1802 to 0.2330	50.00%	80.00%*

CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; Trap=Trapezius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; refpain= Referred Pain; L=Left

*-The highlight figures demonstrate the improvement in phase two

Table 22 demonstrates the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements. Table 21 shows that a significant improvement was noted in the kappa agreement in this MTrP for determining the type of trigger point. The kappa for this feature improved from -0.1203 in phase one to 0.2511 in phase two, while the percentage agreement for determining the type of trigger point

improved from 50.00% to 85.56%. Referred pain also showed significant improvement in the kappa agreement, improving from 0.1583 to 0.4079, while the percentage agreement for referred pain improved from 71.11% to 92.22%. The percentage agreement improved from 81.11% in phase one to 92.22% in phase two for the ability to determine the type of MTrP. The percentage agreement for tender point within a taut band detection (71.11% to 91.11%), local twitch response (66.67% to 87.78%), pain recognition (67.78% to 92.22%) and jump sign (50.00% to 80.00%) also improve significantly in phase two.

4.4.6. Gluteus Medius Muscle TP1-Right

Table 23: Characteristics of Gluteus Medius Muscle TP1-Right

-Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
GMed TP1R pres/abs	0.0264	0.0123	-0.1802 to 0.2330	-0.1943 to 0.2189	80.00%	91.11%*
Type of MFTP GMed TP1 R	0.0756	-0.3996	-0.0820 to 0.2332	-0.6546 to - 0.1445	54.44%	78.89%*
GMed TP1 R tenderpt	-0.0849	0.0396	-0.2618 to 0.0920	-0.1670 to 0.2462	73.33%	92.22%*
GMed TP1 R LTR	-0.0352	0.2151 *	-0.2083 to 0.1378	0.0085 to 0.4217	70.00%	96.67%*
GMed TP1 R painrecog	0.0359	0.0123	-0.1344 to 0.2061	-0.1943 to 0.2189	71.11%	91.11%*
GMed TP1 R refpain	0.0459	-0.0465	-0.1066 to 0.1984	-0.2531 to 0.1601	66.67%	95.56%*
GMed TP1 R jumpsign	-0.0730	0.1280*	-0.2196 to 0.0735	-0.0786 to 0.3346	51.11%	82.22%*

CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; Trap=Trapezius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; refpain= Referred Pain; L=Left

*-The highlight figures demonstrate the improvement in phase two

Table 23 demonstrates the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements. Table 23 showed that improvements in the Kappa agreement and percentage agreement occurred for characteristics of the local twitch response and jump sign. The kappa agreement for local twitch response improved from -0.0352 in phase one to 0.2151 in phase two while the percentage agreement for this feature improved from 70.00% in phase one to 96.67% in phase two. The kappa agreement for jump sign improved from -0.0730 in phase one to 0.1280 in phase two while the percentage agreement for this attribute improved from 51.11% in phase one to 82.22% in phase two. The percentage agreement improved from 80.00% in phase one to 91.11% in phase two for the ability to determine the type of MTrP and 54.44% in phase one to 78.89% in phase two for the ability to determine the type of trigger point. The percentage agreement for tender point detection (71.11% to 91.11%), local twitch response (73.33% to 92.22%) pain recognition (71.11% to 91.11%) and referred pain (66.67% to 95.56%) also improved significantly in phase two.

4.4.7. Gluteus Medius MuscleTP1- Left

Table 24: Characteristics of Gluteus Medius MuscleTP1- Left

Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
GMed TP1 L pres/abs	0.1019	-0.0150	-0.1047 to 0.3085	-0.2216 to 0.1916	78.89%	86.67%*
Type of MFTP GM TP1 L	0.4727	-0.8997	0.0896 to 0.8558	-1.2584 to - 0.5409	41.11%	90.00%*
GMed TP1 L tenderpt	0.0500	0.0110	-0.1187 to 0.2186	-0.1956 to 0.2176	71.11%	87.78%*
GMed TP1 L LTR	0.0846	-0.0227	-0.0862 to 0.2554	-0.2293 to 0.1839	75.56%	97.78%*
GMed TP1 L painrecog	0.1029	0.0110	-0.0807 to 0.2865	-0.1956 to 0.2176	74.44%	87.78%*
GMed TP1 L refpain	0.2044	-0.0227	0.0475 to 0.3613	-0.2293 to 0.1839	74.44%	97.78%*
GMed TP1 L jumpsign	0.0274	0.1802*	-0.1208 to 0.1756	-0.0264 to 0.3868	58.89%	80.00%*

CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; GMed= Gluteus Medius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; refpain= Referred Pain; L- Left

*-The highlight figures demonstrate the improvement in phase two

Table 24 demonstrates the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements. Table 24 shows that significant improvement was noted in the kappa agreement and the percentage agreement for the characteristic jump sign detection in this MTrP. The kappa improved from 0.0274 in phase

one to 0.1802 in phase two while the percentage agreement improved from 58.89% to 80.00%. The percentage agreement improved from 78.89% in phase one to 86.67% in phase two for the ability to determine the type of MTrP and it improved significantly from 41.11% to 90.00% for the ability to determine the type of trigger point. The percentage agreement improved significantly for the following characteristics: tender point detection (71.11% to 87.78%), local twitch response (75.56% to 97.78%), pain recognition (74.44% to 87.78%) and referred pain (74.44% to 97.78%).

4.4.8. Gluteus Medius Muscle TP2- Right

Table 25: Characteristics of Gluteus Medius Muscle TP2- Right

Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
GMed TP2 R presab	0.0976	0.1346	-0.1090 to 0.3042	-0.0720 to 0.3412	83.33%	90.00%
Type of MFTPG Med TP2 R	0.0462	-0.2500	-0.1138 to 0.2063	-0.5389 to 0.0389	60.00%	90.00%
GMed TP2 R tenderpt	-0.0034	0.1346	-0.1642 to 0.1573	-0.0720 to 0.3412	70.00%	90.00%
GMed TP2 R LTR	-0.1491	-0.0112	-0.3199 to 0.0217	-0.2178 to 0.1954	60.00%	98.89%
GMed TP2 R painrecog	-0.0013	0.1715	-0.1607 to 0.1580	-0.0351 to 0.3781	65.56%	91.11%
GMed TP2 R refpain	0.0714	0.3647	-0.0795 to 0.2223	0.1581 to 0.5713	68.89%	96.67%
GMed TP2 R jumpsign	-0.1359	0.2257	-0.2816 to 0.0098	0.0191 to 0.4323	43.33%	81.11%

CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; GMed= Gluteus Medius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; refpain= Referred Pain; R=Right

*-The highlight figures demonstrate the improvement in phase two

Table 25 demonstrates the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements. Significant improvement was noted

in the kappa agreement and percentage agreement for the ability of the examiners in determining the presence/absence of the trigger point. The kappa agreement improved from 0.0976 to 0.1346 while the percentage agreement improved from 83.33% to 90.00%. The kappa and the percentage agreement improved significantly for the following characteristics: identifying a tender point within a taut band (improved from -0.0034 to 0.1346 and 70.00% to 90.00%), pain recognition (improved from 0.0013 to 0.1715 and 65.56% to 91.11%) and jump sign (improved from -0.1359 to 0.2257 and 43.33% to 81.11%). While only the percentage agreement improved for determining the type of MTrP (improved from 60.00% to 90.00%) and referred pain (improved considerably from 68.89% to 96.67%).

4.4.9. Gluteus Medius Muscle TP2- Left

Table 26: Characteristics of Gluteus Medius Muscle TP2- Left

Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
GMed TP2 L pres/abs	-0.0399	0.2308 *	-0.2465 to 0.1667	0.0242 to 0.4374	57.56%	91.11%*
Type of MFTP GMed TP2L	-0.0440	-0.7654	-0.2272 to 0.1391	-1.1137 to - 0.4172	42.53%	88.89%*
GMed TP2 L tenderpt	-0.0614	0.2308*	-0.2328 to 0.1100	0.0242 to 0.4374	45.56%	91.11%*
GMed TP2 L LTR	-0.0514	0.0396	-0.2428 to 0.1400	-0.1670 to 0.2462	65.56%	93.33%*
GMed TP 2L painrecog	-0.0299	0.2807*	-0.2186 to 0.1588	0.0741 to 0.4873	75.56%	91.11%*
GMed TP2 L retrain	0.1269	0.3103*	-0.0340 to 0.2878	0.1037 to 0.5169	72.22%	98.89%*
GMed TP2 L jumpsign	-0.1503	0.5325*	-0.2981 to - 0.0025	0.3259 to 0.7391	44.44%	88.89%*

CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; GMed= Gluteus Medius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; retrain= Referred Pain; L=Left

*-The highlight figures demonstrate the improvement in phase two

Table 26 demonstrates the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements. Table 26 shows that both the kappa and the percentage agreement improved significantly for the ability to determine the presence or absence in this MTrP after the intervention in phase two. The kappa agreement improved from -0.0399 to 0.2308 while the percentage agreement improved considerably from 57.56% to 91.11%. The kappa and the percentage agreement improved significantly for the following characteristics: identifying a tender point within a taut band (improved from -0.0034 to 0.1346 and 57.56% to 91.11%), pain recognition (improved from -0.0299 to 0.2807 and 75.56% to 91.11%), referred pain (improved from 0.1269 to 0.3103 and 72.22% to 98.89%) and jump sign (improved from -0.1503 to 0.5325 and 44.44% to 88.89%). While only the percentage agreement improved for determining the type of MTrP (improved from 42.53% to 88.89%) and local twitch response (improved from 72.22% to 98.89%).

4.4.10. Gluteus Medius Muscle TP3- Right

Table 27: Characteristics of Gluteus Medius Muscle TP3- Right

Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
GMed TP3 R pres/abs	-0.1561	0.3981*	-0.3627 to 0.0505	0.1915 to 0.6048	71.11%	85.56%*
Type of MFTP GMed TP3 R	-0.1590	0.3981*	-0.3344 to 0.0164	0.1915 to 0.6048	26.67%	85.56%*
GMed TP3 R tenderpt	-0.1559	0.3981*	-0.3353 to 0.0235	0.1915 to 0.6048	63.33%	81.16%*
GMed TP3 R LTR	0.0237	-0.0227	-0.1459 to 0.1934	-0.2293 to 0.1839	76.67%	97.78%*
GMed TP3 R painrecog	-0.1741	0.3981*	-0.3682 to 0.0200	0.1915 to 0.6048	65.56%	85.56%*
GMed TP3 R refpain	0.0173	-0.0227	-0.1407 to 0.1754	-0.2293 to 0.1839	74.44%	97.78%*
GMed TP3 R jumpsign	-0.1051	0.3116*	-0.2584 to 0.0482	0.1050 to 0.5182	53.33%	83.33%*

CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; GMed= Gluteus Medius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; retrain= Referred Pain; R=Right

*-The highlight figures demonstrate the improvement in phase two

Table 27 demonstrates the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements This MTrP showed significant improvement in the kappa and the percentage agreement after the intervention for determining the presence/absence of the trigger point (improving from -0.1561 to 0.3981 and 71.11% to 85.56%), identifying the type of trigger point (improving from -0.1590 to 0.3981 and 26.67% to 85.56%), a tender point within a taut palpable band (improving from -0.1559 to 0.3981 and 63.33% to 81.16%), pain recognition (improved from -0.1741 to 0.3981 and 65.56% to 85.56%) and jump sign detection (improved from -0.1051 to 0.3116 and 53.33% to 83.33%). Only the percentage agreement improved significantly for local twitch response (improving from 76.67% to 97.78%) and referred pain (improving from 53.33% to 83.33%).

4.4.10. Gluteus Medius Muscle TP 3- Left

Table 28: Characteristics of Gluteus Medius Muscle TP 3- Left

Site	Pre intervention Kappa	Post intervention Kappa	Pre intervention 95% CI	Post intervention 95% CI	(%) agreement between examiners in phase 1	(%) agreement between examiners in phase 2
GMed TP3 L pres/abs	-0.02217	0.4600*	-0.4283 to - 0.0151	0.2534 to 0.6666	67.78%	86.67%*
Type of MFTP GMedTP3 L	-0.2577	0.4203*	-0.4461 to - 0.0693	0.2263 to 0.6144	20.00%	71.42%*
GMed TP3 L tenderpt	-0.2582	0.4600*	-0.4270 to - 0.0894	0.2534 to 0.6666	57.78%	86.67%*
GMed TP3 L LTR	-0.0748	-0.0112	-0.2468 to 0.0973	-0.2178 to 0.1954	85.56%	98.89%*
GMedTP3 L painrecog	-0.2749	0.4991*	-0.4684 to - 0.0813	0.2991 to 0.6992	66.67%	88.89%*
GMed TP3 L retrain	-0.0926	-0.0588	-0.2529 to 0.0676	-0.2654 to 0.1478	83.33%	94.44%*

GMed TP3 L jumpsign	-0.1350	0.2257*	-0.2901 to 0.0201	0.0191 to 0.4323	60.00%	81.11%*
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CI=Confidence Interval; %=Percentage; pres/abs= Presence/ absence; MFTP= Myofascial trigger point; TP=Trigger point; GMed= Gluteus Medius Muscle; LTR=Local Twitch Response; painrecog= Pain Recognition; retrain= Referred Pain; L= Left

*-The highlight figures demonstrate the improvement in phase two

Table 28 demonstrates the pre and post intervention kappa, pre and post Confidence intervals and the pre and post percentage agreements. Table 28 shows significant improvement after the intervention for Kappa and percentage agreement for determining the presence/absence of the trigger point (improving from -0.2217 to 0.4600 and 67.78% to 86.67%) and identifying the type of trigger point (improving from -0.2577 to 0.4203 and 20.00% to 71.42%). The Kappa and the percentage agreement improve significantly for the following characteristics: a tender point within a taut palpable band (improving from -0.2582 to 0.4600 and 57.78% to 86.67%), pain recognition (improving from -0.2749 to 0.4991 and 66.67% to 88.89%) and jump sign (improving from -0.1350 to 0.2257 and 60.00% to 81.11%). Only the percentage agreement was shown to improved significantly for local twitch response (improving from 85.56% to 98.89%) and referred pain (improving from 83.33% to 94.44%).

CHAPTER FIVE

DISCUSSION OF RESULTS

The aim of this study was to determine if a training session and standardization of the MTrP palpation technique would improve the inter-examiner reliability of palpation for MTrPs. A high inter examiner reliability rate would therefore infer that there is a low error rate associated with MTrP examination (Gerwin *et al.*, 1997).

Data was collected after the examination of the Trapezius and Gluteus Medius for the five characteristics of MTrPs, the assessment whether a MTrP was present or absent and the distinction of whether the MTrP was an active or latent MTrP. The data collected from phase one and two was analyzed and the results from each phase were compared to determine if the intervention (i.e. the discussion/training session) improved the results.

In this study, although the kappa was calculated, more emphasis was placed on the percentage agreement. Kappa statistics are inappropriate in studies as this, where the positives and negative findings are not equally distributed (Esterhuizen, 2010; Bron *et al.*, 2007; Feinstein and Cicchetti, 1990; Cicchetti and Feinstein, 1990). In this study even asymptomatic patients had latent MTrPs in the Trapezius and Gluteus Medius muscles, which may have contributed to the high prevalence of positive findings, thus resulting in generally low kappa values despite having high percentage agreement values, therefore making the kappa statistic inappropriate for the statistical representation and interpretation of this study (Esterhuizen, 2010).

5.1. DISCUSSION OF RESULTS

5.1.1. Determining the Presence or Absence of Myofascial Trigger Points

According to Bennet (2007) finding a MTrP is a defining characteristic of myofascial pain and it is essential in the treatment of MTrPs since the treatment is directed at the MTrP.

Results showed an improvement in the percentage agreement in phase two. The percentage agreement determining the presence or absence of a MTrPs in phase one ranged from 57.56% to 88.89%. The percentage agreement considerably improved in phase two after the discussion/training session. Results for the percentage agreement from phase two varied between 85.56%- 97.78%. MTrPs were easily detected in the Gluteus Medius TP3 on the left and in the trapezius TP2 on the right as these MTrPs showed the highest percentage

agreement and kappa statistic. A moderate agreement ($\kappa = 0.4600$ and percentage agreement = 86.67%) in the gluteus medius TP3 on the left while the trapezius TP2 on the right showed the highest percentage agreement (97.78%) in phase two.

These results concurred with the results achieved by Gerwin *et al.*, (1997) who reported a percentage agreement of 81% in the trapezius muscle. Bron *et al.*, (2007) also showed an acceptable level of agreement between examiners for the ability to determine the presence or absence of MTrPs.

5.1.2. Determining the Type of Myofascial Trigger Points

After a MTrP is identified, examiners must determine if the MTrP is “active” or “latent”. Active MTrPs produce pain at rest and on activity while latent MTrPs produce pain only on palpation of the MTrP (Travell *et al.*, 1999).

The percentage agreement in phase one ranged from 20.00% - 63.33%. In phase one only gluteus medius TP1 on the left showed moderate kappa agreement, gluteus medius trigger point 3 on the left had the lowest percentage agreement (20.00%) between examiners, while trapezius trigger point 2 on the right had the highest percentage agreement (63.33%) between examiners.

During the discussion / training sessions the definitions and differences between active and latent MTrPs were explained to the examiners. Both the kappa statistic and percentage agreement showed significant improvement in phase two. The kappa agreement ranged from fair agreement to moderate, with the percentage agreement ranging from 71.42% to 90.00%. Gluteus medius TP3 on the left recorded the lowest percentage of 71.42% while trapezius TP2 on the right, gluteus medius trigger point 1 on the left and gluteus medius TP2 on the right recorded the highest percentage agreement of 90.00%. The clarification and explanation of these definitions were vital in achieving the superior results in phase two. In phase one the gluteus medius TP3 on the left showed the lowest percentage agreement of 20% however, after the intervention this percentage agreement to 71.42% while the kappa statistic also improved from -0.4461 to 0.4203 in phase two, showing a moderate agreement.

These results contrasted with those achieved by Lew, Lewis and Story (1997) who found that the agreement between examiners in determining the type of MTrP was poor. The results showed that the examiners only managed an agreement of 10% in locating non-referring latent trigger points and an agreement of 21% in referring latent trigger points.

In contrast other studies did not require a differentiation between active and latent MTrPs (Bron *et al.*, 2007; Hsieh *et al.*, 2000 and Gerwin *et al.*, 1997).

5.1.3. A Tender Point within a Taut Band

A taut band is described as a contracted group of muscle fibers running from one end of the muscle to another (Gerwin, 2001). According to Simons (1996), spot tenderness is always found in a taut band. Simons (1996) regards spot tenderness as a simple and important test to perform. Gerwin and Shannon (2000) regard identification of the taut band and a tender point the most imperative aspect of the physical examination because the taut band differentiates a MTrP from other causes of muscle pain, such as fibromyalgia and drug-induced myalgia. The identification of the taut band is essential as numerous clinical methods are directed towards inactivating the fibers within the taut band (Travell *et al.*, 1999).

In phase one, examiners showed a poor agreement in determining the presence of a tender point with a taut band as a result the percentage agreement ranged from 45.56% to 77.78%.

During the discussion/ training session considerable emphasis was placed on the ability to identify the presence of a tender point with a taut band as these features are imperative in the diagnosis of a MTrP (Gerwin *et al.*, 1997). The correct patient position and the appropriate palpation technique needed to identify a taut band within a tender point were demonstrated to the examiners.

In phase two the ability to detect the presence of a tender point with a taut band improved significantly with the percentage agreement varying between 81.16 to 97.78%. The lowest percentage agreement was recorded in the gluteus medius trigger point 3 on the right (81.16%) while the highest percentage agreement was recorded in the trapezius TP2 on the right (97.78%). gluteus medius TP3 on the left showed a moderate kappa agreement (kappa of 0.4203).

These results concur with the findings of Njoo and Van der Does (1994), Gerwin *et al.*, (1997) and Al- Shenqiti and Oldham (2005). Njoo and Van der Does (1994) reported a Kappa agreement of 0.5 for local tenderness. Gerwin *et al.*, (1997) reported a high agreement for the identification of a taut band and tender point, the percentage agreement ranged from 83% to 100%, while the kappa was 0.85, for different muscles among examiners. A percentage agreement of 90% was reported in the trapezius muscle (Gerwin *et al.*, 1997). Al- Shenqiti and Oldham showed a perfect agreement (a kappa value of 1) for the

detection of a palpable taut band and spot tenderness. However, the results reported in this study contrast with that of Bron *et al.*, (2007); Hsieh *et al.*, (2000) and Lew and Story (1997) who found that palpation of a taut band was unreliable.

5.1.4. Local Twitch Response

Travell *et al.*, (1999) describe a LTR as a transient contraction of a group of tense muscle fibers.

In phase one, the LTR produced a percentage agreement ranging from 60.00% to 85.56%. Trapezius trigger point 1 on the right and Gluteus Medius trigger point 2 on the right had the lowest percentage agreement (60.00%) between examiners while Gluteus Medius trigger point 3 on the left had the highest percentage agreement (85.56%) between examiners.

Simons (1996) regards the LTR as the most difficult characteristic to elicit during palpation. Therefore during the discussion / training session adequate time was allocated to discussing the appropriate definition of and demonstrating the appropriate technique of eliciting a LTR

In phase two, the results improved significantly. The percentage agreement ranged from 87.78% to 98.89%. The trapezius TP1 on the right, trapezius trigger point 2 on the right and the left achieved the lowest percentage agreement (87.87%) while gluteus medius trigger point 2 on the right gluteus medius trigger point 3 on the left achieved the highest percentage agreement (98.89%). Trapezius TP2 on the right showed a moderate agreement ($\kappa = 0.4404$), while trapezius TP1 on the right and left and gluteus medius TP1 on the left showed a fair agreement.

The LTR is commonly seen during dry needling when the needle penetrates the taut fibers of the MTrP (Simons, 1996) as a result very few LTRs were found by the examiners during the examination of patients and this may have affected the results.

Gerwin *et al.*, (1997) found that the LTR was the least reliable feature of a MTrP in their study. A percentage agreement of 68% and 0.44 kappa agreement was noted for the trapezius muscle (Gerwin *et al.*, 1997), while Bron *et al.*, (2007); Al- Shenqiti and Oldham, also found that the LTR was unreliable.

5.1.5. Pain Recognition

Compression of a MTrP may produce a pain pattern that the patient may have 'recognized' as a familiar occurrence (Travell et al., 1999). According to Simon (1996) pain recognition is a simple and useful diagnostic test for MTrPs.

During the first phase the percentage agreement varied from 62.22% to 75.56%. The kappa was poor. Trapezius TP1 on the right recorded the lowest percentage agreement of 62.22% while gluteus medius TP2 on the left recorded the highest percentage agreement of 75.56% between examiners. In phase one it was noticed that examiners did not inquire whether the patient recognized any pain sensation elicited during compression of the MTrP as their clinical complaint, also each examiner was using different magnitude of pressure, as a results examiners did not elicit the patients' recognized pain. These reasons may have contributed to the poor results achieved during phase one for this characteristic.

During the discussion/ training session a consensus regarding the amount of pressure used during palpation was made. This standardization of pressure is imperative in achieving good results as all examiners need to be uniform in their application of pressure to elicit the appropriate response from the patient. It was also important that the examiners inquired about the nature of the patient's pain and determine if the pain was similar to the patient's clinical complaint. This interaction between patient and examiner is imperative as it creates an environment similar to that of a clinical setting and can therefore improve the results achieved as seen in phase two of this study.

The percentage agreement in phase two improved significantly and ranged from 85.56% to 97.78%. The percentage agreement for pain recognition was lowest in the gluteus medius TP3 on the right (85.56%) while the highest score was recorded in the trapezius TP2 on the right (97.78%). Moderate agreement was achieved in the gluteus medius TP3 on the left, while fair agreement was found in the gluteus medius TP2 on the right and left.

The result reported in this study contrasted with that of Hsieh *et al.*, (2000) who reported that pain recognition either had "insufficient or contrasting" results. However the results achieved by this study concur with those shown by Njoo and Van der Does (1994) who demonstrated reliable agreement in the detection of pain recognition. Al- Shenqiti and Oldham (2005) also found that the detection of pain recognition as a reliable clinical sign.

5.1.6. Referred Pain

Referred pain is a pain sensation felt at a distance from the site of origin. It may be present spontaneously or may be elicited during palpation (Travell *et al.*, 1999). According to Alvarez and Rockwell (2002) referred pain pattern is a characteristic finding of a MTrP as it differentiates a MTrP from a tender point.

In phase one of the study the kappa agreement was poor with only a fair agreement noted in the gluteus medius TP1 on the left. The percentage agreement for referred pain varied from 64.44% to 74.44%. In phase one it was noticed that although examiners inquired about pain felt at a distance from the MTrP, each examiners had different patterns of pain referral for each MTrP. Again it was noticed that examiners used different magnitudes of pressure, which was sometimes insufficient to illicit a referred pain pattern. This may resulted in the poor results in phase one.

According to Simons (1996) the knowledge of the location of referred pain patterns of specific muscles may provide a lead to the location of the muscle concealing the MTrP. Therefore during the discussion/ training session emphasis was placed on the knowledge of the pain referral patterns of each MTrP. The use of pictures depicting the referral pain pattern of each MTrP made demonstrating, identifying and remembering the referral pain pattern for each MTrP easier. A consensus regarding the amount of pressure used during palpation to elicit referred pain was also made this, ensured that each examiner was uniform in their palpation technique.

Results improved significantly in phase two where the kappa agreement was fair. Moderate kappa agreement was achieved in the trapezius trigger point 2 on the right and left. The percentage agreement ranged from 92.22% to 98.89%. Trapezius trigger point 1 on the right, trapezius trigger point 2 on the right and left recorded the lowest percentage agreement (92.22%) while gluteus medius trigger point 2 on the left recorded the highest percentage agreement (98.89%).

The results found in this study differ with those achieved by Al- Shenqiti and Oldham (2005); Hsieh *et al.*, (2000) and Njoo and Van der Does (1994). Al- Shenqiti and Oldham (2005) showed that referred pain was an unreliable clinical finding of MTrPs. Hsieh *et al.*, (2000) and Njoo and Van der Does (1994) reported similar findings. Njoo and Van der Does (1994) demonstrated a kappa of 0.41 for referred pain, while Hsieh *et al.*, (2000) demonstrated a kappa agreement of 0.435 with training and a kappa of 0.32 without training.

Results from this study are similar to those reported by Bron *et al.*, (2007) and Gerwin *et al.*, (1997). Bron *et al.*, (2007) demonstrated a high percentage agreement for referred pain, which ranged from 63% to 93% while the kappa agreement varied between -0.13 and 0.64. The study conducted by Gerwin *et al.*, (1997) revealed a good agreement among examiners for referred pain. The researchers reported a high percentage agreement of 93% in the trapezius muscle.

5.1.7. Jump Sign

The jump sign is a typical behavioural reaction to pressure on a MTrP and is identified when a patient withdraws from digital pressure, when patient reacts to local pressure by grimacing or by a verbal response (Travell *et al.*, 1999).

In phase one, the kappa agreement for the jump sign was poor. The percentage agreement ranged from 43.33% - 60.00%. It was again noticed that during phase one each examiner did apply a uniform pressure as a result some examiners did not apply sufficient pressure to illicit the jump sign.

In the discussion/ training session the standardization of the magnitude of pressure was emphasized. During the discussion/ training session the definition of the jump sign and the other signs of the jump sign e.g. facial grimacing and wincing were also discussed. A greater understanding of the characteristic jump sign combined with the standardization of pressure used by examiners greatly improved results in phase two.

In phase two were the kappa agreement was fair. The percentage agreement was high and ranged from 92.22% to 98.89%. Trapezius trigger point 1 on the right, Trapezius trigger point 2 on the right and left recorded the lowest percentage agreement of 92.22% while gluteus medius trigger point 2 on the left recorded the highest percentage agreement of 98.89%.

Similarly, Bron *et al.*, (2007) found that the jump sign was the most reliable clinical characteristic, achieving a percentage agreement ranging from 67% to 77% (kappa= 0.07-0.68). Al- Shenqiti and Oldham (2005) and Njoo and Van der Does (1994) both found that the jump sign had good inter examiner reliability.

5.2. FACTORS CONTRIBUTING TO THE VARYING RELIABILITY OF RESULTS IN PHASE ONE

1. Technique of palpation

- During the years of practice, the student examiners might have developed their own unique style of palpation which may have come from different sources.
 - Examiners did not palpate the same sites for MTrPs within a specific muscle.
 - Examiners did not elicit the clinical characteristics of MTrPs in the same way e.g. when eliciting the LTR, examiners did not snap the taut band sufficiently to cause a LTR.
 - Examiners used different types of palpation e.g. when palpating for the trapezius TP1 and TP2 instead of using a pincer palpation, flat palpation with the thumb was used instead.
 - A difference in the duration, amount and angle of pressure used during palpation was noticed e.g. examiners did not apply adequate pressure on the tender point to cause jump sign.

2. Interpretation of findings

- In the first phase examiners were unaware of the MTrP criteria investigated. The examiners had to conclude which the criteria they felt were essential in the diagnosis of MTrPs and state whether the criteria was present or absent in the subject. This might have resulted in poor results as the examiners may have developed their own exclusive criteria for the identification of MTrPs during the years of practice and as a result, did not report on all the characteristics of MTrPs e.g. in phase one jump sign and patient recognition were the most poorly reported characteristic of MTrPs.
- Examiners did not interpret the clinical characteristics of MTrPs similarly.
 - The definition of the features of MTrPs varied significantly this was especially seen in the definitions of active and latent MTrPs.
 - Examiners did not interpret the size and the degree of tautness of the band similarly.

3. Patient Position

- Incorrect patient position was notice during palpation of MTrPs in the first phase. E.g. during palpation of the Gluteus Medius muscle patients were positioned in the supine position instead of side lying.

5.3. FACTORS THAT COULD HAVE AFFECTED THE STUDY IN PHASE TWO

1. Ischemic Compression

- Ischemic compression is a firm and direct pressure that is applied to the centre of a MTrP. This direct pressure is thought to mechanically break up the fibrous bands of MTrPs (Auleciems, 1995) and result in a decrease in muscle spasm and the deactivation of the MTrP. This may have affected the study, as the second and third examiners may have been at a disadvantage because the palpation or pressure used by the first examiner may possibly have deactivated the MTrP.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

This study was designed in the form of a pre and post intervention inter- examiner reliability study that used sixty patients. Every patient underwent a myofascial examination separately by three examiners in order to determine the reliability of palpation.

6.1. CONCLUSION

The aim of this research was to assess the inter- examiner reliability of palpation of MTrPs and the effect training and standardization of palpation techniques had on the results.

This study has shown that three examiners are able to attain acceptable agreement in the palpation of MTrPs, statistically showing that examiners can accomplish significant agreement regarding the presence and absence of a MTrP, differentiation between active or latent MTrP and in determining the presence or absence of the five characteristics of a MTrP, since these features were shown to improve considerably in phase two after the training session in which standardization of techniques was emphasized.

The good inter- examiner reliability statistics seen in phase two was due to meticulous methodological preparation implemented for MTrP assessments. These include standardized palpation techniques, correct patient position and appropriate amount and duration of pressure application during patient examination.

This study provides preliminary evidence that MTrP palpation is a useful and reliable diagnostic tool in the identification of MTrPs.

6.2. RECOMMENDATIONS

- 1. Local Twitch Response-** Although the results of this study show that the LTR demonstrated a good reliability it should be removed from the clinical criteria. It is a difficult sign to elicit and is commonly seen when a needle penetrates the trigger point during dry needling therapy (Simons, 1996). It is therefore more commonly seen during treatment rather than during the assessment. It could be used to confirm the diagnosis of MTrP.
- 2. Training session-** This study required examiners to attend two, one hour discussion sessions before the commencement of phase two of the study. It is recommended that a longer training session be utilized to familiarize examiners with all the features being identified in the myofascial examination. A longer training session will also provide the examiners with ample time to resolve any discrepancies with the myofascial examination.
- 3. Use of novice examiners-** All examiners used in this study were familiar with the criteria for the identification of MTrPs. A training programme was used to achieve uniformity among examiners in the myofascial examination. It is recommended that novice examiners (e.g. Chiropractic students in 1st/ 2nd year) be used, to determine the effects of such a training programme on the palpation of MTrPs.

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APPENDIX A

Are you between the ages of 18-35 years old?

DO YOU SUFFER FROM NECK OR LOWER BACK PAIN?

**IF YES, RESEARCH IS CURRENTLY BEING
CONDUCTED AT THE DURBAN UNIVERSITY OF
TECHNOLOGY CHIROPRACTIC DAY CLINIC**

ONE FREE TREATMENT

**IS AVAILABLE TO THOSE WHO QUALIFY
TO PARTICIPATE IN THE STUDY**

FOR MORE INFORMATION CONTACT

KUBASHNIE MOODLEY: 3732205/2511



APPENDIX B

**ARE YOU BETWEEN THE AGE
OF
18 TO 45?**

**HAVE NO
NECK AND LOW BACK
PAIN?**

**Interested in participating in
research?**

IF YES, RESEARCH IS CURRENTLY BEING CONDUCTED AT THE
DURBAN UNIVERSITY OF TECHNOLOGY CHIROPRACTIC DAY
CLINIC

CONTACT:

KUBASHNIE MOODLEY: 3732205/2511 to determine if you
qualify.

Appendix C



Dear patient.

Welcome to my research study. You have been invited to participate in this research study, which has been designed to assess effect of examiner training on the reliability of the palpation of myofascial trigger points in the trapezius and gluteus medius muscles between examiners.

Title of the Research Study: An investigation into the effect of examiner-training on the inter- examiner reliability of the palpation of myofascial trigger points.

Principle Investigator: Kubashnie Moodley **Tel:** (031)3732205

Co-Investigator/s: Dr. A. Docrat **Tel:** (031)3732589

Brief Introduction and Purpose of the Study: The purpose of this study is to determine the reliability of palpation of myofascial trigger points in the trapezius and gluteus medius muscles between examiners and whether examiner training affects these results. The results will be used to increase the validity and reliability of palpation as assessment tool in the treatment of patients with myofascial pain syndrome.

Outline of the Procedures:

You are requested to sign the informed consent form once you have read the letter of information and are willing to participate in this study.

Patients fitting the research criteria will come into the DUT Chiropractic Day Clinic to have a consultation. At this appointment patients will undergo a case history, physical, and a regional examination (a cervical and lumbar regional) which will be done by the researcher. After which you will be selected providing you fit the necessary criteria for the research. You will be examined by three examiners, a qualified chiropractor, a senior Chiropractic student and the researcher. Each examiner will examine alone and they will not be allowed to discuss their findings with each other. Patients will be encouraged interact with the examiners, however the patients will be instructed not to reveal whether they have neck or low back pain or no pain and the findings of the previous examiners.

After all examiners have examined the patient, the patient will receive one free treatment if the patient has neck or low back pain. Patients not presenting with a neck or low back complaint (asymptomatic patients) will receive one free treatment if they experience neck or low back pain within a month of completion of the study. This concludes your participation in the study.

Risks or Discomforts to the Subject: Patients may feel some discomfort after palpation of the myofascial trigger points.

Benefits: Your contribution to this study will be used to increase the validity and reliability of palpation as assessment tool in the treatment of patients with myofascial pain syndrome.

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

If you have changed any lifestyle habits during your participation in this study that may affect the outcome of this research (e.g. taking medication e.g. anti-inflammatory or muscle relaxant medication, or receiving neck or lower back treatment).

You are free to withdraw at any stage without any adverse consequences and your future health care will not be compromised.

Remuneration: Treatment for the duration of the research process will be free of charge. Subjects taking part in the study will not be offered any other form of remuneration for taking part in the study. Normal cost of consultations will be charged for those patients wanting further treatment after completion of the research.

Costs of the Study: The consultation and treatment is free of charge and your participation is voluntary. As a voluntary participant in this research study you are free to withdraw from the study at any time without giving a reason.

Confidentiality: All patient information is confidential. The results from this study will be used for research purposes only. Only individuals that are directly involved in this study will be allowed access to these records.

Research-related Injury: Contact myself, my supervisor or Mr. Vikesh Singh (031) 373 2701 should you have any further questions

Statement of Agreement to Participate in the Research Study:

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

Subject's name: _____

Subject's signature: _____ Date: _____

Researcher's name (print): Kubashnie Moodley

Researcher's signature: _____ Date: _____

Witness name (print): _____

Witness signature: _____ Date: _____

APPENDIX D
DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: _____ Date: _____

File # : _____ Age: _____

Sex : _____ Occupation: _____

Intern : _____ Signature _____

FOR CLINICIANS USE ONLY:

Initial visit

Clinician: _____ Signature : _____

Case History:

Examination:

Previous:

Current:

X-Ray Studies:

Previous:

Current:

Clinical Path. lab:

Previous:

Current:

CASE STATUS:

PTT:

Signature:

Date:

CONDITIONAL:

Reason for Conditional:

Signature:

Date:

Conditions met in Visit No:

Signed into PTT:

Date:

Case Summary signed off:

Date:

Intern's Case History:

1. **Source of History:**
2. **Chief Complaint : (patient's own words):**

3. Present Illness:

	Complaint 1	Complaint 2
<ul style="list-style-type: none">▶ Location▶ Onset : Initial: Recent:▶ Cause:▶ Duration▶ Frequency▶ Pain (Character)▶ Progression▶ Aggravating Factors▶ Relieving Factors▶ Associated S & S▶ Previous Occurrences▶ Past Treatment▶ Outcome:		

4. Other Complaints:

5. Past Medical History:

- ▶ General Health Status
- ▶ Childhood Illnesses
- ▶ Adult Illnesses
- ▶ Psychiatric Illnesses
- ▶ Accidents/Injuries
- ▶ Surgery
- ▶ Hospitalizations

6. Current health status and life-style:

- ▶ Allergies
- ▶ Immunizations
- ▶ Screening Tests incl. x-rays
- ▶ Environmental Hazards (Home, School, Work)
- ▶ Exercise and Leisure
- ▶ Sleep Patterns
- ▶ Diet
- ▶ Current Medication
- ▶ Analgesics/week:
- ▶ Tobacco
- ▶ Alcohol
- ▶ Social Drugs

7. Immediate Family Medical History:

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

8. Psychosocial history:

- ▶ Home Situation and daily life
- ▶ Important experiences
- ▶ Religious Beliefs

9. Review of Systems:

- ▶ General
- ▶ Skin
- ▶ Head
- ▶ Eyes
- ▶ Ears
- ▶ Nose/Sinuses
- ▶ Mouth/Throat
- ▶ Neck
- ▶ Breasts
- ▶ Respiratory
- ▶ Cardiac
- ▶ Gastro-intestinal
- ▶ Urinary
- ▶ Genital
- ▶ Vascular
- ▶ Musculoskeletal
- ▶ Neurologic
- ▶ Haematologic
- ▶ Endocrine
- ▶ Psychiatric

APPENDIX E

Durban University of Technology PHYSICAL EXAMINATION: SENIOR

Patient Name : _____ File no : _____ Date : _____

Student : _____ Signature : _____

VITALS:

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

GENERAL EXAMINATION:

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

SYSTEM SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION

NEUROLOGICAL EXAMINATION

COMMENTS

Clinician:

Signature :

APPENDIX F
DURBAN UNIVERSITY OF TECHNOLOGY
REGIONAL EXAMINATION - CERVICAL SPINE

Patient: _____ File No: _____

Date: _____ Student: _____

Clinician: _____ Sign: _____

OBSERVATION:

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

Shoulder position

Left :

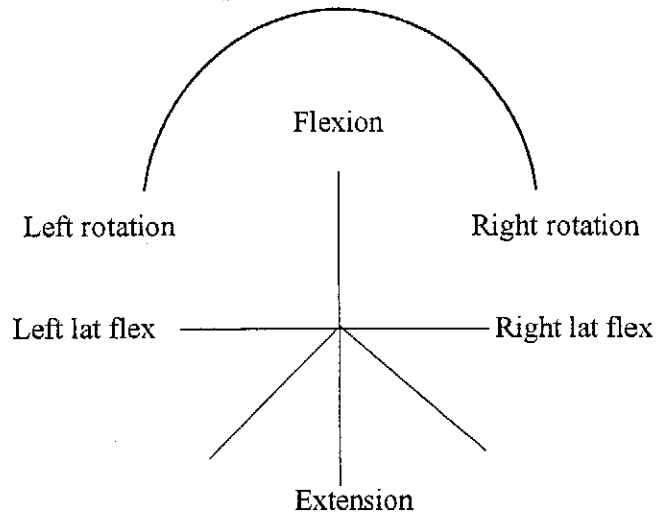
Right :

Shoulder dominance (hand):

Facial expression:

RANGE OF MOTION:

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



PALPATION:

Lymph nodes
 Thyroid Gland
 Trachea

ORTHOPAEDIC EXAMINATION:

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

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

NEUROLOGICAL EXAMINATION:

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

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

MOTION PALPATION & JOINT PLAY:

Left: Motion Palpation:

Joint Play:

Right: Motion Palpation:

Joint Play:

BASIC EXAM: SHOULDER:

Case History:

ROM: Active:

Passive:

RIM:

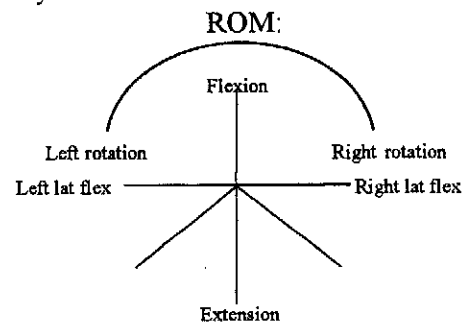
Orthopaedic:

Neuro:

Vascular:

BASIC EXAM: THORACIC SPINE:

Case History:



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

APPENDIX G

REGIONAL EXAMINATION - LUMBAR SPINE AND PELVIS



Patient: _____
Intern/Resident: _____

File#: _____ Date: ____/____/____
Clinician: _____

STANDING:

Posture— scoliosis, antalgia, kyphosis
Body Type
Skin
Scars
Discolouration

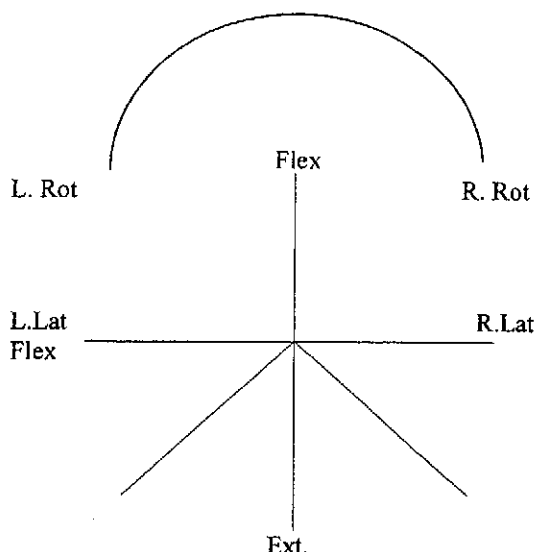
Minor's Sign
Muscle tone
Spinous Percussion
Schober's Test (6cm)
Bony and Soft Tissue Contours

GAIT:

Normal walking
Toe walking
Heel Walking
Half squat

ROM:

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



Which movt. reproduces the pain or is the worst?

- Location of pain
- Supported Adams: Relief? (SI)
- Aggravates? (disc, muscle strain)

SUPINE:

Observe abdomen (hair, skin, nails)
Palpate abdomen/groin
Pulses - abdominal
- lower extremity
Abdominal reflexes

		Degree	LBP?	Location	Leg pain	Buttock	Thigh	Calf	Heel	Foot	Braggard
SLR	L										
	R										

	L	R
Bowstring		
Sciatic notch		
Circumference (thigh and calf)		
Leg length: actual -		
apparent -		
Patrick FABERE: pos/neg – location of pain?		
Gaenslen's Test		
Gluteus max stretch		
Piriformis test (hypertonicity?)		
Thomas test: hip \ psoas? \ rectus femoris?		
Psoas Test		

SITTING:

Spinous Percussion
Valsalva
Lhermitte

TRIPOD Sl, +, ++		Degree	LBP?	Location	Leg pain	Buttock	Thigh	Calf	Heel	Foot	Braggard
	L										
	R										

Slump 7 test	L										
	R										

LATERAL RECUMBENT:

	L	R
Ober's		
Femoral n. stretch		
SI Compression		

PRONE:

	L	R
Gluteal skyline		
Skin rolling		
Iliac crest compression		
Facet joint challenge		
SI tenderness		
SI compression		
Erichson's		
Pheasant's		

MF tp's	Latent	Active	Radiation
QL			
Paraspinal			
Glut Max			
Glut Med			
Glut Min			
Piriformis			
Hamstring			
TFL			
Iliopsoas			
Rectus Abdominis			
Ext/Int Oblique muscles			

NON ORGANIC SIGNS:

Pin point pain
Axial compression
Trunk rotation
Burn's Bench test

Flip Test
Hoover's test
Ankle dorsiflexion test
Repeat Pin point test

NEUROLOGICAL EXAMINATION

Fasciculations

Plantar reflex

level	Tender?	Dermatomes		DTR		
		L	R		L	R
T12				Patellar		
L1				Achilles		
L2						
L3				Proprioception		
L4						
L5						
S1						
S2						
S3						

MYOTOMES

Action	Muscles	Levels	L	R	
Lateral Flexion spine	Muscle QL				
Hip flexion	Psoas, Rectus femoris				5+ Full strength
Hip extension	Hamstring, glutes				4+ Weakness
Hip internal rotat	Glutmed, min;TFL, adductors				3+ Weak against grav
Hip external rotat	Gluteus max, Piriformis				2+ Weak w/o gravity
Hip abduction	TFL, Glut med and minimus				1+ Fascic w/o gross movt
Hip adduction	Adductors				0 No movement
Knee flexion	Hamstring,				
Knee extension	Quad				W - wasting
Ankle plantarflex	Gastroc, soleus				
Ankle dorsiflexion	Tibialis anterior				
Inversion	Tibialis anterior				
Eversion	Peroneus longus				
Great toe extens	EHL				

BASIC THORACIC EXAM

History

Passive ROM

Orthopedic

BASIC HIP EXAM

History

ROM: Active

Passive : Medial rotation : A) Supine (neutral) If reduced - hard \ soft end feel
 B) Supine (hip flexed): - Trochanteric bursa

MOTION PALPATION AND JOINT PLAY

	L	R
Upper Thoracics		
Lumbar Spine		
Sacroiliac Joint		

FEB 2007

Appendix H



Patient Name: _____

File Number: _____

Examiner: A B C

Phase: One

Trapezius Muscle

Tick the appropriate box

TP1 – Right

Present- ☐

Absent- ☐

Active- ☐

Latent- ☐

Physical signs observed-

TP1- Left

Present- ☐

Absent- ☐

Active- ☐

Latent- ☐

Physical signs observed-

TP2- Right

Present- ☐

Absent- ☐

Active- ☐

Latent- ☐

Physical signs observed-

TP2- Left

Present- ☐

Absent- ☐

Active- ☐

Latent- ☐

Physical signs observed-

Gluteus Medius Muscle

TP1- Right

Present- ☐

Absent- ☐

Active- ☐

Latent- ☐

Physical signs observed-

TP1- Left

Present- ☐

Absent- ☐

Active- ☐

Latent- ☐

Physical signs observed-

TP2- Right

Present- ☐

Absent- ☐

Active- ☐

Latent- ☐

Physical signs observed-

TP2- Left

Present- ☐

Absent- ☐

Active- ☐

Latent- ☐

Physical signs observed-

TP3- Right

☐

Present-

Absent-

☐

Active-

☐

Latent-

☐

Physical signs observed-

TP3- Left

Present-

☐

Absent-

☐

Active-

☐

Latent-

☐

Physical signs observed-

Appendix I

Patient Name: _____

File Number: _____

Examiner: A B B C

Phase: TWO

The Trapezius Muscle

PLEASE CIRCLE THE APPROPRIATE ANSWER

Right

TP1 Present Absent **TP1** Present
Active Latent Active

TP2 Present Absent **TP2** Present
Active Latent Active

Right		Tender point within a taut palpable band present?		Local twitch response present		Is there patient recognition pain?		Is a char referred pattern pr
	TP1	Yes	No	Yes	No	Yes	No	Yes
	TP2	Yes	No	Yes	No	Yes	No	Yes

	Tender point within a taut palpable band present?		Local twitch response present		Is there patient recognition pain?		Is a char referred pattern pr	
Left	TP1	Yes	No	Yes	No	Yes	No	Yes
	TP2	Yes	No	Yes	No	Yes	No	Yes

THE GLUTEUS MEDIUS MUSCLE

Right

TP1 Present Absent **TP1**
Active Latent

TP2 Present Absent
 Active Latent

TP2

TP3 Present Absent
 Active Latent

TP3

Right

	Tender point within a taut palpable band present?		Local twitch response present		Is there patient recognition pain?		Is a char referred pattern pr
TP1	Yes	No	Yes	No	Yes	No	Yes
TP2	Yes	No	Yes	No	Yes	No	Yes
TP3	Yes	No	Yes	No	Yes	No	Yes

Left

	Tender point within a taut palpable band present?		Local twitch response present		Is there patient recognition pain?		Is a char referred pattern pr
TP1	Yes	No	Yes	No	Yes	No	Yes
TP2	Yes	No	Yes	No	Yes	No	Yes
TP3	Yes	No	Yes	No	Yes	No	Yes

Left

Absent
Latent

Absent
Latent

Characteristic pain present?	Is a jump sign present?	
	Yes	No
No	Yes	No
No	Yes	No

Characteristic pain present?	Is a jump sign present?	
	Yes	No
No	Yes	No
No	Yes	No

Left

Present Absent
Active Latent

Present Absent

Active Latent

Present Absent

Active Latent

Characteristic pain present?		
	Jump Sign Present	
	Yes	No
	No	Yes

Characteristic pain present?		
	Jump Sign Present	
	Yes	No
	No	Yes

Appendix J

Training Manual

DEFINITIONS

Active myofascial trigger points-“A myofascial trigger point that causes a clinical pain complaint. It is always tender, prevents full lengthening of the muscle, weakens the muscle, refers a patient-recognized pain on direct compression, mediates a local twitch response of muscle fibers when adequately stimulated, and, when compressed within the patient’s pain tolerance, produces referred motor phenomena and often autonomic phenomena, generally in its pain reference zone, and causes tenderness in the pain reference zone” (Travell *et al.*, 1999).

Jump Sign – “A general pain response of the patient who winces, may cry out and may withdraw in response to pressure applied on a trigger point” (Travell *et al.*, 1999).

Latent Myofascial Trigger Point- “A focus of hyperirritability in a muscle or its fascia that is clinically quiescent with respect to pain; it is painful only when palpated” (Travell *et al.*, 1999).

Local Twitch Response- “Transient contraction of the group of muscle fibers (usually a palpable band) that contains a trigger point. The contraction of the fiber is in response to stimulation of the same or nearby trigger point” (Travell *et al.*, 1999).

Myofascial Trigger Point – “A hyperirritable spot, usually within a taut band of skeletal muscle or in the muscle fascia, that is painful on compression and that can give rise to a characteristic referred pain, tenderness and autonomic phenomena” (Travell *et al.*, 1999).

Taut palpable band- “A group of taut muscle fibers that is associated with a myofascial Trigger Point and is identified by tactile examination of the muscle. A local twitch response is produced by contraction of these fibers” (Travell *et al.*, 1999).

Tender point -these are only a few millimeters in diameter and Compression may elicit local tenderness, referred pain, or local twitch response (Travell *et al.*, 1999).

Referred Pain- “Pain that arises in a trigger point, but is felt at a distance, often entirely remote from its source” (Travell *et al.*, 1999).

TYPES OF PALPATION

Flat palpation- “Examination by finger pressure that proceeds across the muscle fibers at right angles to their length, while compressing them against a firm underlying structure” (Travell *et al.*, 1999).

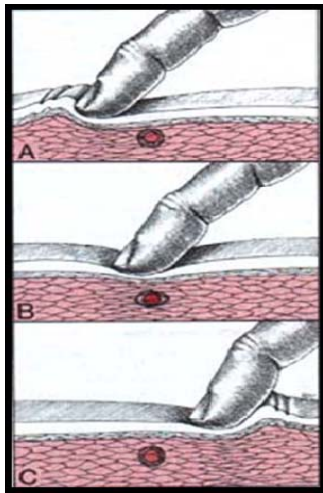


Figure1. Cross sectional schematic drawing showing flat palpation of a taut band (Travell *et al.*, 1999). The skin is pushed to one side of the area to be palpated (**Fig. A**) and the finger slid across the fibers to be examined (**Fig. B**) allowing the skin to bunch on the other side (**Fig. C**)

Pincer Palpation – “Examination of a part by holding it in a pincer grasp between the thumb and the finger. Groups of muscle fibers are rolled between the tips of the digits (Travell *et al.*, 1999).

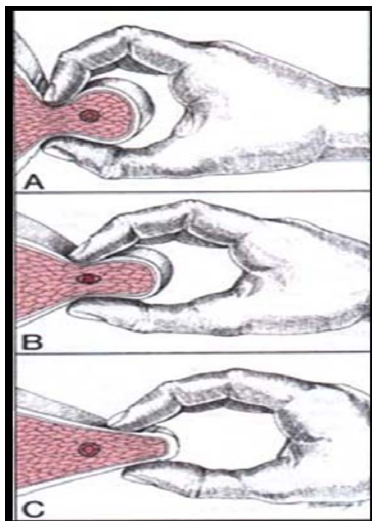
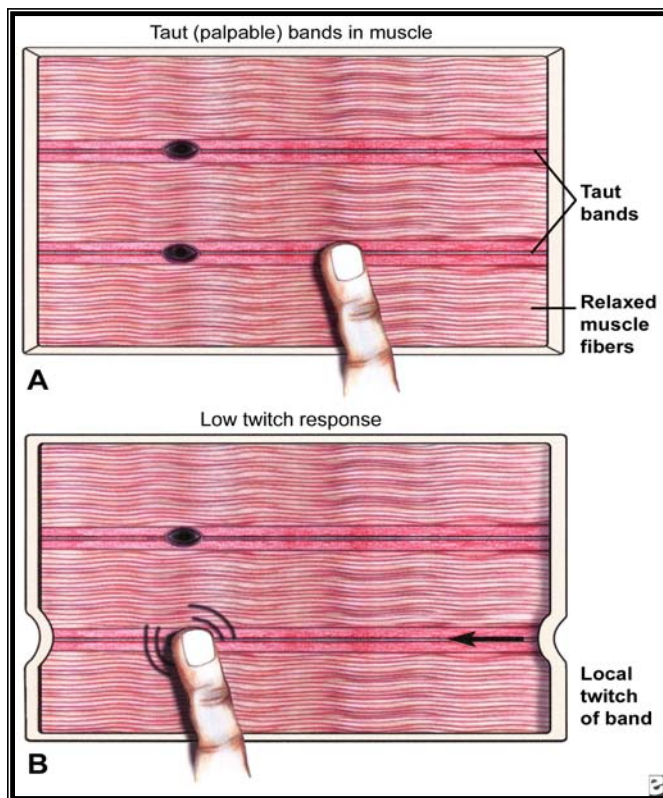


Figure2. Cross-sectional schematic drawing showing pincer palpation of a taut band (Travell *et al.*, 1999). The technique of pincer palpation is performed by grasping the belly of the muscle between thumb and finger (**Fig. A**) and squeezing the fibers between them with a back and forth rolling motion to locate taut bands (**Fig. B/C**).



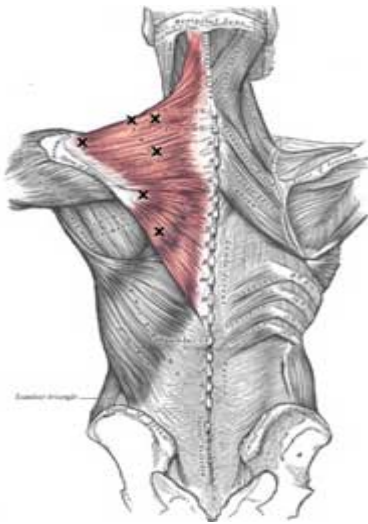
Snapping Palpation- a fingertip is placed against a taut band of muscle at right angles to the direction of the band and presses down while drawing the finger back so as to roll the underlying fibers under the finger (Travell *et al.*, 1999).

Figure 3:

A: Palpation of a taut band (straight lines) among normally slack, relaxed muscle fibers (wavy lines).

B: Rolling the band quickly under the fingertip (snapping palpation) at the trigger point often produces a local twitch response that usually is seen most clearly as skin movement between the trigger point and the attachment of the muscle fibers

THE TRAPEZIUS MUSCLE



Anatomical Attachments- The Trapezius muscle is attached proximally to the medial third of the superior nuchal line; external occipital protuberance, ligamentum nuchae and spinous processes of C7-T12 vertebrae. It is distally attached to the lateral third of the clavicle, acromion, and spine of the scapula (Moore, 1996). The Trapezius muscle is divided into upper, middle and lower fibres (Travell *et al.*, 1999).

Figure4. Attachments of the trapezius muscle (Travell *et al.*, 1999).

Location of trigger points

TP₁- is located in the free margin upper trapezius (Travell *et al.*, 1999).

TP₂- is located caudal and posterior to the free border of the upper trapezius. It is located at the level of C₅ to C₆, halfway between the acromion and the spinous processes (Travell *et al.*, 1999).

Referred pain patterns

TP₁- refers pain unilaterally upward along the posterolateral aspect of the neck to the mastoid process. The referred pain extends to the side of the neck, centering in the temple and the back of the orbit and may also include the angle of the jaw (Travell *et al.*, 1999).

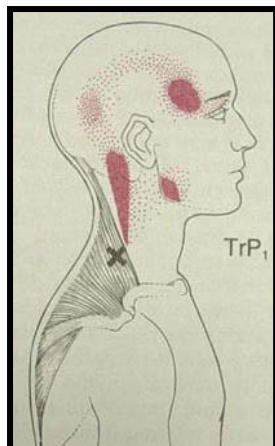


Figure5.

Referred pain patterns and location of TP₁ in the upper trapezius (Travell *et al.*, 1999).

TP₂- the referred pain pattern of TP₂ lies posterior to the essential reference of TP1 in the cervical region (Travell *et al.*, 1999).

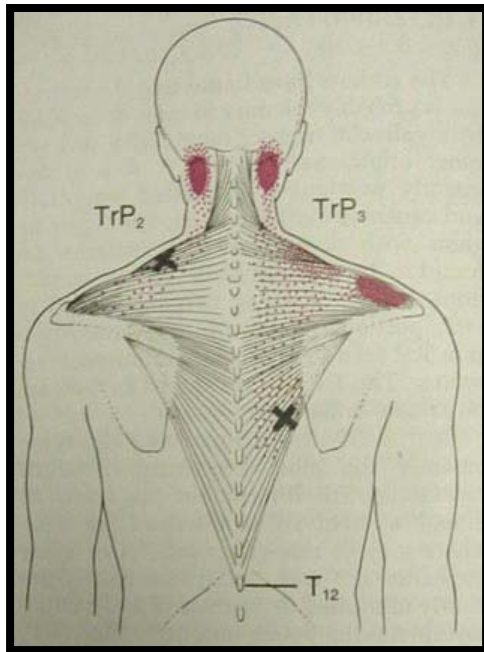


Figure6.

Referred pain pattern and location of TP₂ in the upper trapezius (Travell *et al.*, 1999).

Trigger point examination

TP1- the patient is seated with the ear slightly toward the same shoulder this decreases the slack on the muscle. Using a pincer grasp the entire mass of the free margin of the upper trapezius is lifted off the underlying supraspinatus muscle. The muscle is then rolled between the fingers and thumb to palpate taut bands (Travell *et al.*, 1999).

TP2-the patient is seated the trigger point is identified using pincer palpation in the deeper fibers posterior to TP1 (Travell *et al.*, 1999).

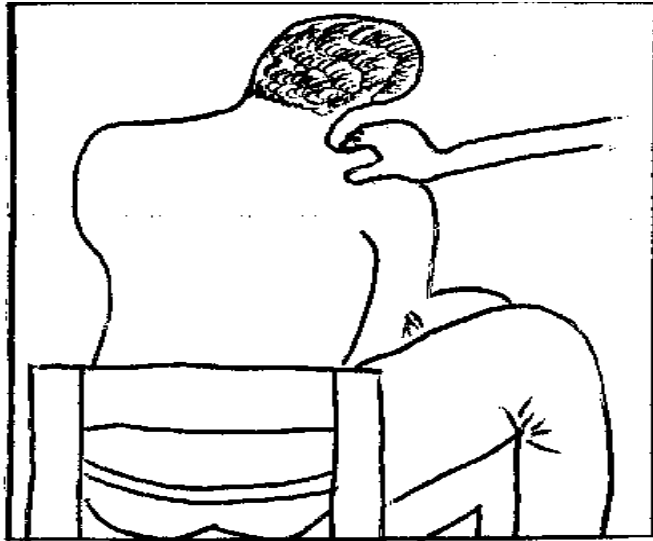
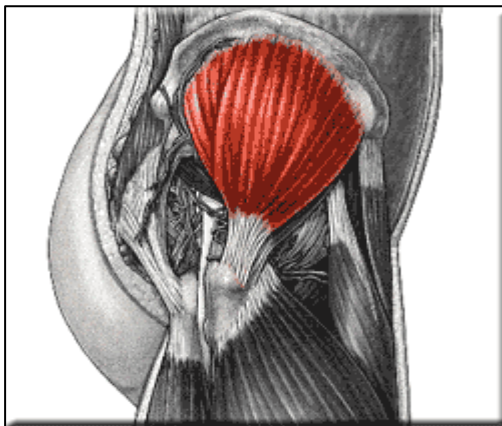


Figure 7.Positioning of the patient and the technique used in examining the upper trapezius muscle

THE GLUTEUS MEDIUS MUSCLE



Anatomical attachments- the gluteus medius muscle originate at the outer surface of ilium from iliac crest and posterior gluteal line above to the anterior gluteal line below, gluteal aponeurosis and inserts at the lateral surface of greater trochanter (Travell *et al.*, 1992).

Location of trigger points

TP₁- is located near the iliac crest in the posterior part of the muscle close to the sacroiliac joint (Travell *et al.*, 1992).

TP₂- is located just inferior to the iliac crest, centered along the length of the iliac crest (Travell *et al.*, 1992)

TP₃- is located just inferior to the iliac crest close to the anterior superior iliac spine (Travell *et al.*, 1992).

Referred pain pattern

TP₁- refers pain and tenderness along the posterior crest of the ilium, to the region of the sacroiliac joint and over the sacrum on the same side, the pain may also extent over much of the buttock (Travell *et al.*, 1992).

TP₂- refers pain laterally and to the mid gluteal region. The pain and tenderness may extend into the upper thigh posteriorly and laterally (Travell *et al.*, 1992).

TP₃- refers pain over the iliac crest, over the lowest lumbar region and bilaterally over the sacrum (Travell *et al.*, 1992).

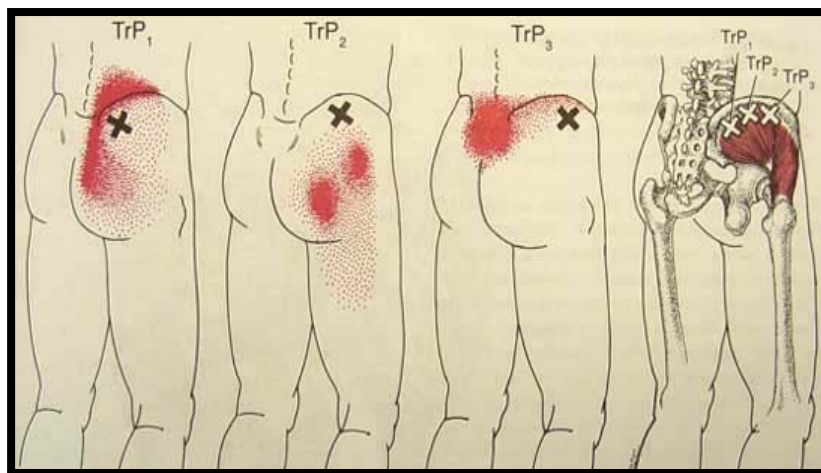


Figure8. Referred pain patterns and location of TP in the gluteus medius muscle (Travell *et al.*, 1992).

Trigger point examination: All trigger points in the gluteus medius muscle is examined while the patient lies on the side opposite to the affected muscle. Flat palpation is used to identify **TP₁** which is has the most posterior location. **TP₂** and **TP₃** are the most anteriorly located MTrPs. The taut band of **TP₂** and **TP₃** is located by rolling the muscle fibers against the underlying bone and rubbing the fingertip across the fibers (Travell *et al.*, 1992).

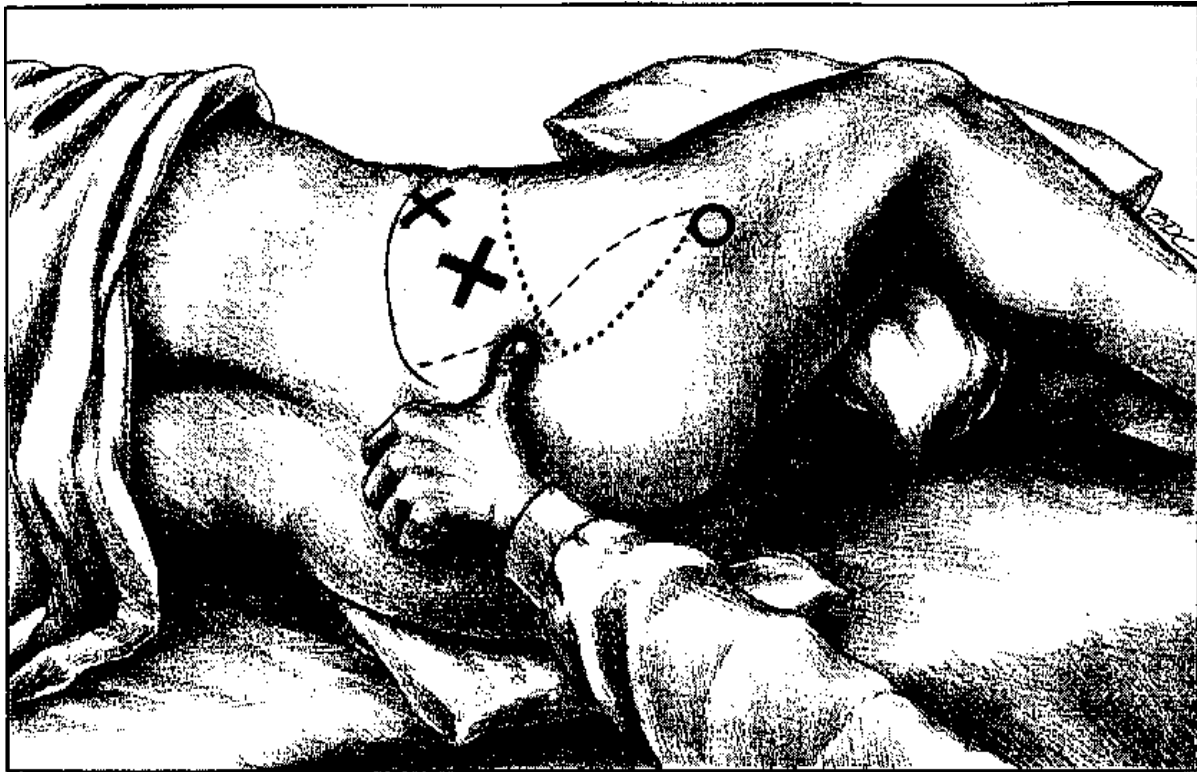


Figure9. Positioning of the patient and the technique used in examining the gluteus medius muscle (Travell *et al.*, 1992).

Examination Technique

MTrPs are located within a taut band of contracted muscle fibers and therefore palpation of MTrPs should start with identifying a taut band by palpating perpendicular to the fiber direction. Once the taut band is located, the clinician moves along the taut band to find a localized spot of intense pain. Compression of the localized spot should produce local or referred pain. A local twitch response is elicited by snapping palpation. The band is palpated and snapped at the trigger point with the muscle in a relaxed position (Travell *et al.*, 1999). According to Friction (1994) the patient's reaction to firm palpation termed a "jump sign". This reaction may include withdrawal of the head, wrinkling of the face or forehead, Patient recognition of pain is elicited by compression of the trigger point. According to Cummings and Baldry (2007) if an active MTrP is palpated the patient will give a verbal indication that they recognize the pain which may include responses such as "That's it" or "Oh yes" Friction (1994). Referred pain in this study will be defined as any pain that arises in a trigger point, but is felt at a distance

from the trigger point and is elicited by applying manual pressure on the trigger point (Travell *et al.*, 1999).

A standardized amount of pressure during palpation will be used. A 3kg/cm of pressure will be applied over the trapezius muscle and a 5kg/cm of pressure will be applied over the gluteus medius muscles. This will be done by applying the appropriate pressure to an algometer placed against a hard surface and approximating that pressure when palpating muscles (Hsieh *et al.*, 2000).

References

Cummings, M., Baldry, P. 2006. *Best Practice and Clinical Rheumatology*, 21(2): 367-387.

Fricton, J.R. 1994: Myofascial pain. *Balliere's Clinical Rheumatology*, 8 (4): 858-880.

Hsieh, C-Y.J.; Hong, C- Z; Adams, A.H.; Platt, Danielson, C.D., Hoehler., Tobis, J.S. 2000: Interexaminer reliability of the palpation of trigger points in the trunk and lower limb muscles. *Archives of Physical Medicine and Rehabilitation*, 81:258-264.

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Travell, J. G., Simons, D. G. and Simons. L. S. 1992. *Myofascial Pain and Dysfunction: The Trigger Point Manual, Volume 2*. Baltimore: Williams and Wilkins.

Appendix I

Training Manual

DEFINITIONS

Active myofascial trigger points—“A myofascial trigger point that causes a clinical pain complaint. It is always tender, prevents full lengthening of the muscle, weakens the muscle, refers a patient-recognized pain on direct compression, mediates a local twitch response of muscle fibers when adequately stimulated, and, when compressed within the patient’s pain tolerance, produces referred motor phenomena and often autonomic phenomena, generally in its pain reference zone, and causes tenderness in the pain reference zone” (Travell *et al.*, 1999).

Jump Sign – “A general pain response of the patient who winces, may cry out and may withdraw in response to pressure applied on a trigger point” (Travell *et al.*, 1999).

Latent Myofascial Trigger Point- “A focus of hyperirritability in a muscle or its fascia that is clinically quiescent with respect to pain; it is painful only when palpated” (Travell *et al.*, 1999).

Local Twitch Response- “Transient contraction of the group of muscle fibers (usually a palpable band) that contains a trigger point. The contraction of the fiber is in response to stimulation of the same or nearby trigger point” (Travell *et al.*, 1999).

Myofascial Trigger Point – “A hyperirritable spot, usually within a taut band of skeletal muscle or in the muscle fascia, that is painful on compression and that can give rise to a characteristic referred pain, tenderness and autonomic phenomena” (Travell *et al.*, 1999).

Taut palpable band— “A group of taut muscle fibers that is associated with a myofascial Trigger Point and is identified by tactile examination of the muscle. A local twitch response is produced by contraction of these fibers” (Travell *et al.*, 1999).

Tender point -these are only a few millimeters in diameter and Compression may elicit local tenderness, referred pain, or local twitch response (Travell *et al.*, 1999).

Referred Pain- “Pain that arises in a trigger point, but is felt at a distance, often entirely remote from its source” (Travell *et al.*, 1999).

TYPES OF PALPATION

Flat palpation- “Examination by finger pressure that proceeds across the muscle fibers at right angles to their length, while compressing them against a firm underlying structure” (Travell *et al.*, 1999).

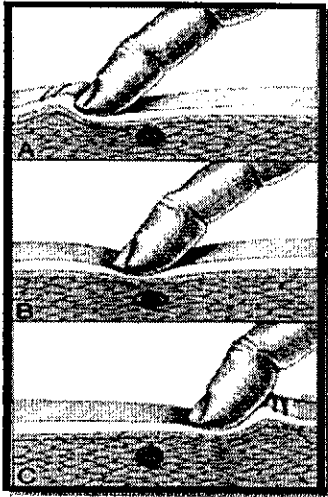


Figure1. Cross sectional schematic drawing showing flat palpation of a taut band (Travell *et al.*, 1999). The skin is pushed to one side of the area to be palpated (**Fig. A**) and the finger slid across the fibers to be examined (**Fig. B**) allowing the skin to bunch on the other side (**Fig. C**)

Pincer Palpation – “Examination of a part by holding it in a pincer grasp between the thumb and the finger. Groups of muscle fibers are rolled between the tips of the digits (Travell *et al.*, 1999).

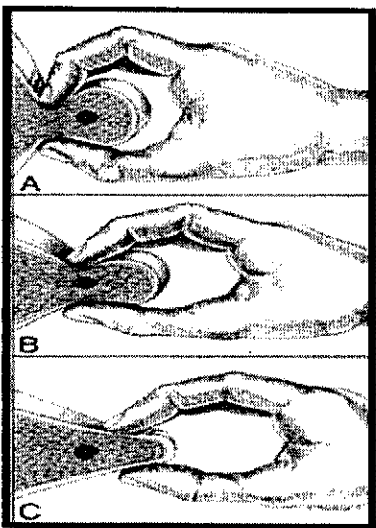
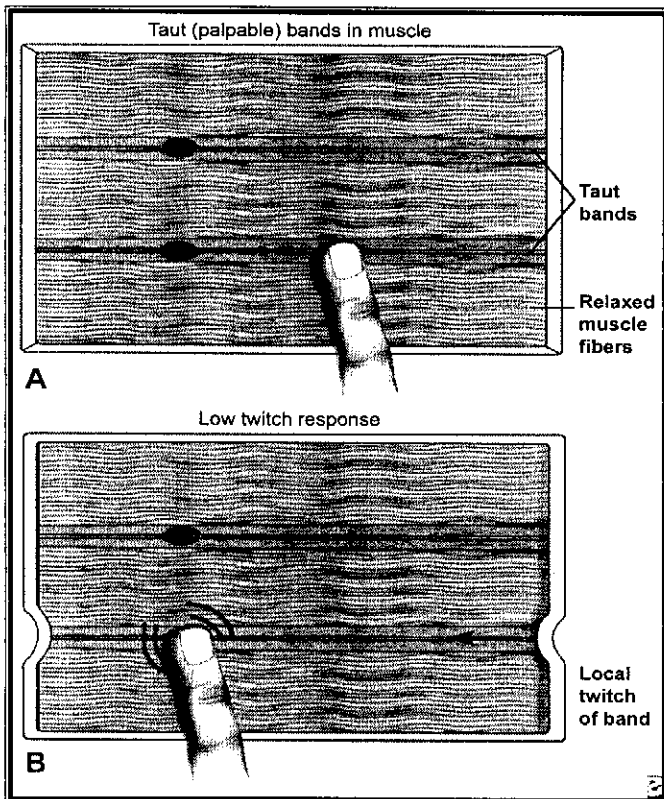


Figure2. Cross-sectional schematic drawing showing pincer palpation of a taut band (Travell *et al.*, 1999). The technique of pincer palpation is performed by grasping the belly of the muscle between thumb and finger (**Fig. A**) and squeezing the fibers between them with a back and forth rolling motion to locate taut bands (**Fig. B/C**).



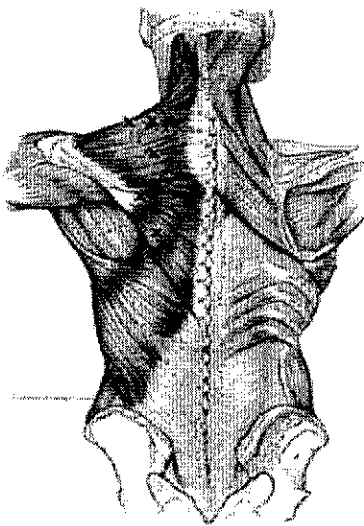
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Figure 3:

A: Palpation of a taut band (straight lines) among normally slack, relaxed muscle fibers (wavy lines).

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Figure4. Attachments of the trapezius muscle (Travell *et al.*, 1999).

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TP₁- refers pain unilaterally upward along the posterolateral aspect of the neck to the mastoid process. The referred pain extends to the side of the neck, centering in the temple and the back of the orbit and may also include the angle of the jaw (Travell *et al.*, 1999).

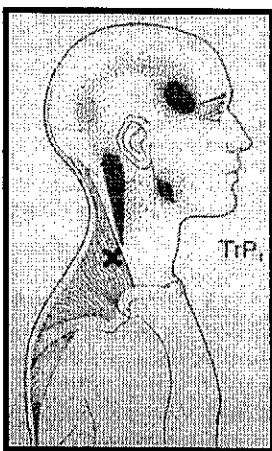


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Referred pain patterns and location of TP₁ in the upper trapezius (Travell *et al.*, 1999).

TP₂- the referred pain pattern of TP₂ lies posterior to the essential reference of TP₁ in the cervical region (Travell *et al.*, 1999).

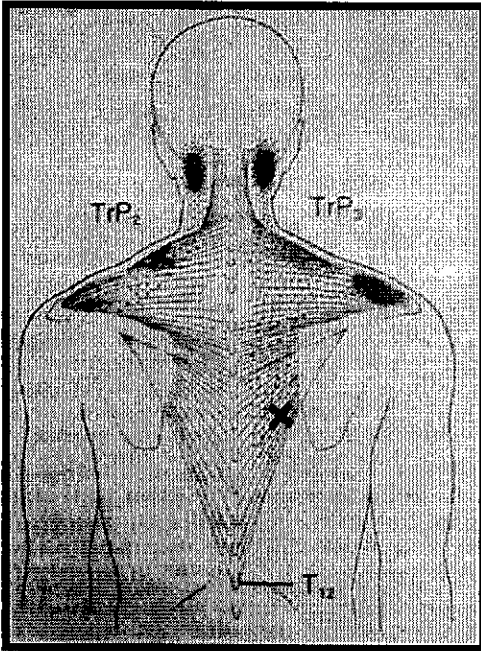


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Referred pain pattern and location of TP₂ in the upper trapezius (Travell *et al.*, 1999).

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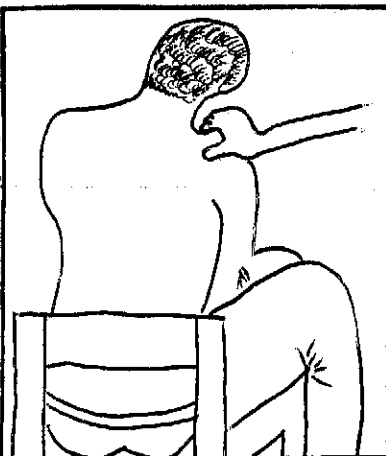
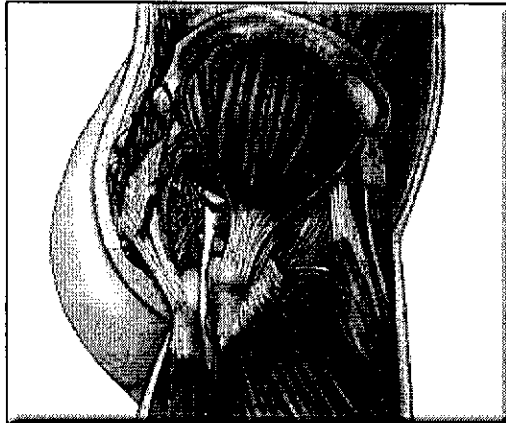


Figure 7.Positioning of the patient and the technique used in examining the upper trapezius muscle

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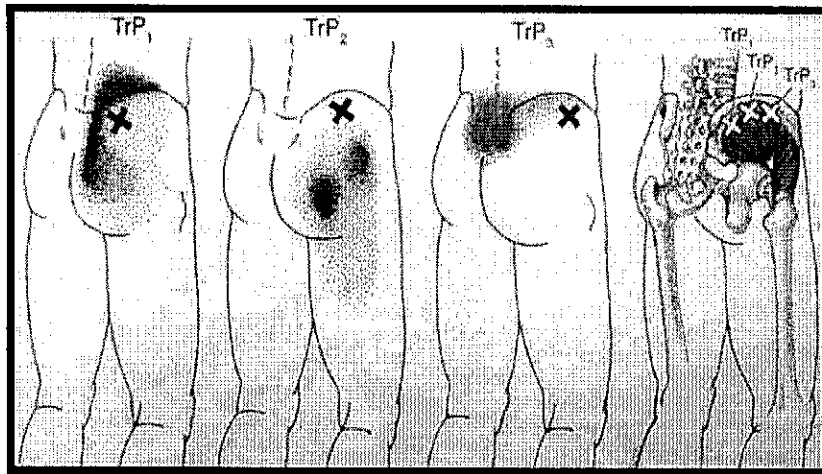


Figure 8. Referred pain patterns and location of TP in the gluteus medius muscle (Travell *et al.*, 1992).

Trigger point examination: All trigger points in the gluteus medius muscle is examined while the patient lies on the side opposite to the affected muscle. Flat palpation is used to identify **TP₁** which has the most posterior location. **TP₂** and **TP₃** are the most anteriorly located MTrPs. The taut band of **TP₂** and **TP₃** is located by rolling the muscle fibers against the underlying bone and rubbing the fingertip across the fibers (Travell *et al.*, 1992).

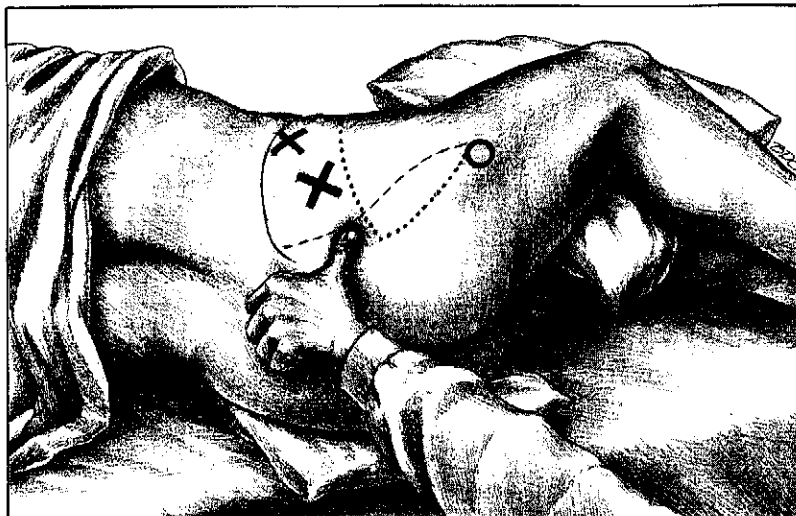


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A standardized amount of pressure during palpation will be used. A 3kg/cm of pressure will be applied over the trapezius muscle and a 5kg/cm of pressure will be applied over the gluteus medius muscles. This will be done by applying the appropriate pressure to an algometer placed against a hard surface and approximating that pressure when palpating muscles (Hsieh *et al.*, 2000).

References

Cummings, M., Baldry, P. 2006. *Best Practice and Clinical Rheumatology*, 21(2): 367-387.

Friction, J.R. 1994: Myofascial pain. *Balliere's Clinical Rheumatology*, 8 (4): 858-880.

Hsieh, C-Y.J.; Hong, C- Z; Adams, A.H.; Platt, Danielson, C.D., Hoehler., Tobis, J.S. 2000: Interexaminer reliability of the palpation of trigger points in the trunk and lower limb muscles. *Archives of Physical Medicine and Rehabilitation*, 81:258-264.

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APPENDIX L

Title:	Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction	Logged in as:	KUbashnie Moodley
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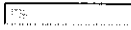
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APPENDIX O

		  
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Author:	Siddhartha Sikdar, Jay P. Shah, Tadesse Gebreab, Ru-Huey Yen, Elizabeth Gilliams, Jerome Danoff, Lynn H. Gerber	
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APPENDIX P

<div></div>		<div></div>	<div></div>
<div></div>	Title:	Uncovering the biochemical milieu of myofascial trigger points using in vivo microdialysis: An application of muscle pain concepts to myofascial pain syndrome	Logged in as: KUbashnie Moodley Account #: 3000288317
	Author:	Jay P. Shah, Elizabeth A. Gilliams	<div></div>
	Publication:	Journal of Bodywork and Movement Therapies	
	Publisher:	Elsevier	
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Elsevier VAT number	GB 494 6272 12
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