The prevalence and pattern of myofascial trigger points in the shoulder girdles of swimmers as compared to non-swimmers in the greater Durban area.

By

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Dissertation submitted in partial compliance with the requirements for the Master's Degree in Technology: Chiropractic.

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I, Tim Graham Kinsman, do declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary).

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Dedication

To Dad and Dem, thank you for giving me the opportunity to study what is my passion, for providing for me and for travelling along this journey with me as I strove towards this goal.

To Sarah, you are the love of my life, my biggest fan and my constant supporter. I love you with all my heart.

To all swimmers, aspiring swimmers and athletes, I hope these findings will help you.

To my dear late mother, who knew I would be destined for this type of profession, your memory will live on forever.

‘’Never surrender, never give up and you will surely win.’’- Anonymous.

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Abstract

Objectives:

Myofascial pain dysfunction is a common musculoskeletal disorder, known to affect athletes. This research aimed to create a map of myofascial trigger points (MFTPs), to ascertain sport specific combinations.

Design and Setting:

This IRB approved study was a cross-sectional, observational study.

Participants: Forty swimmers and forty non-swimmers (soccer players).

Measurements:

All participants underwent one assessment, non-intervention session where primary measures included: shoulder disability index (SDI), myofascial diagnostic scale (MDS), algometer and numerical pain rating scale (NRS). Manual palpation, the MDS and an algometer assessed MFTPs and the SDI overall function. SPSS version 20 (IBM) using Pearson's chi square tests / Fisher's exact tests compared MFTP locations between the groups, and non-parametric Mann-Whitney tests compared continuous measures (due to significant non-normal distribution), with a *p*-value <0.05 level of significance.

Results: MFTP presence is very uncommon in swimmers, with associated pain and loss of function being very low on average. No evidence was found that swimmers were affected more than non swimmers by MFTPs related pain or loss of function, but has indicated that algometer measurements for infraspinatus MFTP 1, were significantly higher ($p<0.027$) (showing decreased tenderness) than the values in non swimmers.

Conclusions:

These results contradict the literature which suggests that unique activity specific patterns of MFTPs exist. This may be as a result of underlying systemic causes of MFTPs that obscured the pattern in this study. It is therefore suggested that larger trials with more participants per group be done in order to verify the results of this study.

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Abbreviations and Definitions

Myofascial trigger point(s) (***MFTP(s))***: A highly irritable spot in muscle (usually skeletal) that is associated with a hypersensitive palpable nodule in a taut band (Chaitow and DeLany, 2000). The band may cause a local twitch response on compression and be painful on compression, giving rise to characteristic referred pain, referred tenderness, motor dysfunction, and autonomic phenomena (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000).

An active MFTP(s):

A MFTP that causes a clinical complaint of pain. "It is a focus of hyperirritability in a muscle or it's fascia that is symptomatic with respect to pain; it refers to a pattern of pain at rest and/or in motion that is specific for the muscle. An active MFTP is always tender, prevents full lengthening of a muscle, weakens the muscle, usually refers pain on direct compression, mediates a local twitch response of the muscle fibers when adequately stimulated and often produces specific autonomic phenomena, generally in its referral zone" (Travell, Simons and Simons, 1999).

A latent MFTP(s):

It is defined as a focal point of muscle and / or fascia hyperirritability. It is classically clinically dormant with respect to spontaneous pain and only locally painful when palpated (Travell, Simons and Simons, 1999).

Chaitow and DeLany (2000) and Travell, Simons and Simons (1999), agree that the main difference between active and latent MFTP is that only active MFTP spontaneously refer pain.

Myofascial pain syndrome (***MPS)****:* The sensory, motor, and autonomic symptoms caused by MFTP (Moran, 1992; Lee *et al*., 1997; Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000). Both active and latent MFTPs can result in MPS (Hou *et al*., 2002).

Non-Swimmer: For purposes of this research, a non-swimmer was defined as an athlete that participated in any sports, with the provision that the athlete did not participate in swimming for more than two hours weekly.

Prevalence*:* According to Dagenais and Haldeman (2012), prevalence refers to the rate of individuals affected by a particular medical condition / disorder of interest compared to the broader population that is at risk. The type of prevalence also needs to stipulate the appropriate period of time for the prevalence (viz. point, period, lifetime) (Dagenais and Haldeman, 2012).

Swimmer: For purposes of this research, a swimmer was defined as an athlete that participated in predominantly swimming, with the provision that the athlete participated in swimming for more than four hours weekly.

Shoulder: The shoulder traditionally refers to the all the joints within the shoulder girdle complex (viz. the sternoclavicular, acromioclavicular, glenohumeral and scapula-thoracic joints) (Bergmann *et al.,* 1993; Bergmann and Petersen, 2011), however from an anatomical perspective the word shoulder refers only to the glenohumeral (shoulder joint proper) (Moore and Dalley, 1999; Standring, 2008). For the purposes of this research the shoulder referred to the traditional definition.

Shoulder dysfunction*:* Dysfunction or dyskinesia refers to “distortions of, difficultly with or impairment of voluntary movement” due to joint or muscle restriction (as a result of pain, disease or other disorder (Redwood and Cleveland, 2003). Therefore in the context of this research, shoulder dysfunction referred to the inability to use or move the shoulder joint as a result of the presence or absence of MFTPs.

Twitch response: (also known as a local twitch response). This is defined as a transient contraction of a group of muscle fibers (usually felt as a taut palpable band) that contain one or more MFTPs. Usually the twitch response occurs in response to stimulation (either in the forms of digital pressure or dry needling) of the taut band and / or the MFTPs within the band (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000).

Chapter One

Introduction

1.1 Introduction

Gatterman (1990) states that a significant portion of body pain will occur in muscle, as muscle (in particular skeletal muscle) constitutes over 40% of the total body mass. This suggests that myofascial pain syndrome (MPS) (resulting from myofascial trigger points (MFTPs) in muscle) is a common health problem affecting a large portion of the population in their everyday lives (Bruce, 1995; Han and Harrison, 1997; Chaiamnuay *et al.,* 1998). MPS seems to affect women more than men (Hou *et al*., 2002) and seems to present at any age, but is more prevalent in older people (Han and Harrison, 1997; Travell, Simons and Simons, 1999; Yap, 2007 and Perez-Palomares *et al.,* 2009).

The above studies indicate that MPS is common and that it can result from both latent and active MFTPs (Fishbain *et al*., 1986; Auleciems, 1995; Han and Harrison, 1997; Chaiamnuay *et al*., 1998; Travell, Simons and Simons, 1999; Hou *et al*., 2002; Perez-Palomares *et al.,* 2009 and Srbely, 2010), however, latent MFTPs are found far more commonly than active MFTPs (Travell, Simons and Simons, 1999). Both latent and active MFTPs cause stiffness, restricted range of motion and pain on manual compression. However, only active MFTPs points cause spontaneous pain referral (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000).

Table 1.1: Comparison of latent and active MFTPs
(Compiled from Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000; Chaitow and DeLany, 2003; Dippenaar, 2003; Wilks 2003).

Latent MFTPs	Active MFTPs
Similarities	
Decreased range of motion.	Decreased range of motion.
Muscular stiffness.	Muscular stiffness.
Local twitch response.	Local twitch response.
Decreased muscle stretch.	Decreased muscle stretch.
Non optimal muscle contraction.	Non optimal muscle contraction.
Pain on muscle contraction.	Pain on muscle contraction.
Differences	
Localized pain on ischemic compression.	Localized and referred pain on ischemic compression.
No spontaneous pain referral.	Spontaneous pain referral.
Recognition of a vague / previous pain.	Recognition of current pain.

One of the principle set of causes that result in MFTP formation and therefore MPS, is muscle overload, through repetitive action (stress), repetitive micro trauma (strain) and lack of appropriate muscle care, either as part of an occupation and / or a sporting or recreational activity (Baldry 1993; Fomby and Mellion, 1997; Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000; Rickards, 2006).

In this context, Gatterman (1990), Hubbard (1998), Travell, Simons and Simons (1999) and Chaitow and DeLany (2000) indicate that the most common sites for the development of MFTPs are the postural muscles of the back and neck (viz. trapezius muscle) and the rotator muscles of the shoulders, the quadratus lumborum muscle and the third finger (extensor (extensor digitorum longus (EDL) muscle). Of these the trapezius muscle is the most commonly affected (Travell, Simons and Simons 1999).

Therefore, if MFTPs are commonly caused by overload (Hsueh *et al.*, 1997; Lawrence *et al*., 1997) and swimmers regularly present with shoulder dysfunction (McMaster and Troup, 1993), which is principally believed to be as a result of muscle overload (Lawrence *et al*., 1997; Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000; Porterfield and de Rosa, 2004), then it stands to reason that swimmers should have a high proportion of MFTPs (particularly in the shoulder and upper back). These assertions are supported by the research of Ellenbecker, (1991); Koziris *et al*., (1991); Chandler *et al*., (1992); Lawrence *et al*., (1997); Garrick and Webb, (1999); De Stefano *et al.,* (2000); Rachlin and Rachlin, (2002) and Audie, (2005). These authors indicate that with MFTPs causing stiffness and restricted range of motion, are able to change the functional ability of a muscle (increased muscle weakness and fatigability, spasm of synergistic or antagonistic muscle groups, increased pain, decreased power and decreased performance) (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000; Bron *et al*., 2011).

These signs and symptoms are thought to result in muscle imbalance (in the medium to long term) which has been linked to shoulder compromise in the form of degenerative shoulder conditions (Ellenbecker, 1991; Koziris *et al*., 1991; Chandler *et al*., 1992; Porterfield and de Rosa, 2004) and / or overuse syndromes (Lawrence *et al*., 1997; Garrick and Webb, 1999; Rachlin and Rachlin, 2002; Porterfield and de Rosa, 2004; Audie, 2005).

Therefore, there appears to be a clinical relationship between the presences of the MFTPs as a precursor to the later development of more severe syndromes (Bron *et al*., 2011). It is, thus important, that clinicians and health care providers are made aware of MFTP patterns that are unique to swimmers and are efficiently able to assess a swimmer's needs (Chaitow and DeLany, 2000; Chaitow and DeLany, 2003).

However, with the paucity of literature in terms of the MFTP mapping unique to swimmers, health care providers are currently not in a position to provide this service to patients and this has a negative impact on the health care providers' ability to:

- Assist swimmers with appropriate immediate and long term treatment protocols aimed at avoiding "swimmer's shoulder" (Stocker *et al.,* 1995; Kammer *et al.,* 1999; Blanch, 2004; Porterfield and de Rosa, 2004; O'Donnell *et al.,* 2005; Tovin, 2006; Cooper *et al.*, 2007).
- Contribute effectively towards rehabilitation methods with particular focus on the specific muscle needs, so as to prevent future deterioration and / or pathological sequelae (Stocker *et al.,* 1995; Kammer *et al.,* 1999; Blanch, 2004; Porterfield and de Rosa, 2004; O'Donnell *et al.,* 2005; Tovin, 2006; Cooper *et al.*, 2007).
- Improve outcomes for the swimmer (swimming times and improved performances) (Chaitow and DeLany, 2000; Chaitow and DeLany, 2003).
- Decrease the immediate and long term health care expenditure by the swimmer (Rachlin and Rachlin, 2002).

Therefore the aim of this particular study was to map MFTPs in patients that swim and do not swim, in order to determine whether a unique map of MFTPs exists in swimmers. This would then facilitate an increased improvement in the overall management of swimmers and their shoulders complaints, with the possibility that long term severe sequelae could be avoided (Rachlin and Rachlin, 2002; Blanch, 2004; Porterfield and de Rosa, 2004; Hains *et al.,* 2010).

1.2 Aims and objectives

The aim of this study was to map MFTPs in participants that swim and do not swim, in order to determine whether a particular combination of MFTPs exists in swimmers.

The objectives were to:

- Determine specific descriptive data from the participants (viz. age, gender, ethnicity, hand dominance, stroke dominance, and type of shoulder dysfunction).
- Map MFTPs in terms of :
  - Location,
  - Tenderness,
  - Severity,
  - Type (active or latent) and
  - Subjective findings, outlining the participant's ability in terms of their activities of daily living.
- Compare the objective and subjective findings between the swimmer and non-swimmer groups.

1.3 Benefits / Rationale

The outcomes of this study were designed to be able to assist swimmers with appropriate immediate and long term treatment protocols, aimed at avoiding "swimmer's shoulder" and similar sequelae (Stocker *et al.,* 1995; Kammer *et al.,* 1999; Blanch, 2004; O'Donnell *et al.,* 2005; Tovin, 2006; Cooper *et al.*, 2007); through contributing effectively towards rehabilitation methods with particular focus on the specific muscle needs, as this would help to prevent future deterioration and / or pathological sequelae of the swimmer's shoulder (Stocker *et al.,* 1995; Kammer *et al.,* 1999; Blanch, 2004; O'Donnell *et al.,* 2005; Tovin, 2006; Cooper *et al.*, 2007). This correlated with Perez-Palomares *et al*., (2009), who indicated that, the confirmation of the existence of AMFTPs and LMFTPs in shoulder pain, by means of visualization with a simple diagnostic technique, which would allow the diagnosis and consequently, treatment to be improved.

If the suggested outcomes by Perez-Palomares *et al*., (2009), were to be achieved, then this research may help to improve outcomes for the swimmer in terms of swimming times and improved performances (Chaitow and DeLany, 2000; Chaitow and DeLany, 2003). Furthermore, the information obtained in this study could possibly assist in decreasing the immediate care expenditure by the swimmer (Rachlin and Rachlin, 2002).

1.4 Limitations

In terms of assessing the participants' activity of daily living disability score, the participants were required to be open and honest in order to have accurately reflected their pain and / or discomfort at the time of the assessment. The researcher was unable to control this, as the best controller was a request to the participant and an appropriate response was then anticipated. The comparison that this research makes is between two specific population groups and, therefore, the results thereof will only be generalisable to a similar population (with similar confounders) with similar demographic profiles.

1.5 Summary

Following onto the above introduction, is Chapter Two which highlights the literature review reflecting the shoulder girdle anatomy, myofascial pain syndromes and the commonality between shoulder complaints and the presentation of MFTPs, which supports that rationale for this study. Chapter Three then follows and presents the research design which consists of data collection, method and data analysis. The statistical findings of the research are then covered in Chapter Four. Chapter Five discusses the research findings in the context of the literature and the dissertation concludes with recommendations of further research.

Chapter Two

Literature Review

2.1 Introduction

This chapter outlines the anatomy of the shoulder girdle, particularly with regards to the musculature, responsible for movements in this complex set of joints that attach the upper extremity to the torso. This will then be followed by a discussion on muscle physiology and the pathogenesis of myofascial pain syndrome. The dynamics of swimming are discussed with a conclusion that compares the clinical presentation of "swimmers" shoulder to the clinical presentation of MFTPs within the shoulder muscles of the shoulder complex.

2.2 The shoulder girdle:

2.2.1 Joints of the shoulder girdle:

The shoulder girdle is characterized by four joints (Moore and Dalley, 1999; Calais-Germaine, 2007; Di Giacomo *et al.,* 2008):

- The *sternoclavicular articulation* is the only bony link between the upper limb and the axial skeleton. This plane type of synovial joint moves largely in a passive manner in that it occurs as a result of the active movements of the scapula. Movements that occur around this joint are horizontal abduction (opening), horizontal adduction (closing), elevation (tilt superiorly), depression (tilt inferiorly) (in the coronal plane) and rotation (around the x-axis) (Bergmann *et al*., 1993; Rockwood and Matsen, 2009).
- Through the diarthrodial *acromioclavicular articulation*, the clavicle can act as a strut maintaining the upper limb away from the thorax permitting a greater range of upper limb motion (Di Giacomo *et al.,* 2008). This plane type of synovial joint also helps provide static stability to the upper limb reducing the need to use muscle energy to keep the upper limb in its proper alignment. Movements that occur

around this joint are horizontal abduction (opening), horizontal adduction (closing), elevation (tilt inferiorly), depression (tilt superiorly) (in the coronal plane) and rotation (around the x-axis) (Bergmann *et al*., 1993; Rockwood and Matsen, 2009).

- The *glenohumeral articulation* (shoulder joint) has the greatest range of motion of any joint in the body, principally because it is a ball and socket type of synovial joint that has limited stability arising out of the glenoid fossa. The mobility of the shoulder joint is necessary for placement of the hand and functional upper limb movements. Movements that occur around this joint are horizontal abduction, horizontal adduction (around the y-axis), forward flexion, extension (around the x-axis), abduction and adduction (around the z-axis), medial and lateral rotation (around the x-axis or y-axis) and circumduction (Bergmann *et al*., 1993; Moore and Dalley, 1999; Rockwood and Matsen, 2009).
- Lastly the scapula is suspended on the thoracic wall by muscle forming a "functional joint" called the *scapulothoracic joint*. These muscles act to stabilize and/ or to actively move the scapula. Active movements of the scapula help increase the range of motion of the shoulder joint (Di Giacomo *et al.,* 2008). Movements that occur around this joint are related to movements of the scapula [viz. protraction, retraction (around the z-axis), elevation, depression (translation in the coronal plane) and tilt (around the x-axis)] (Bergmann *et al*., 1993; Moore and Dalley, 1999; Di Giacomo *et al.,* 2008; Rockwood and Matsen, 2009).

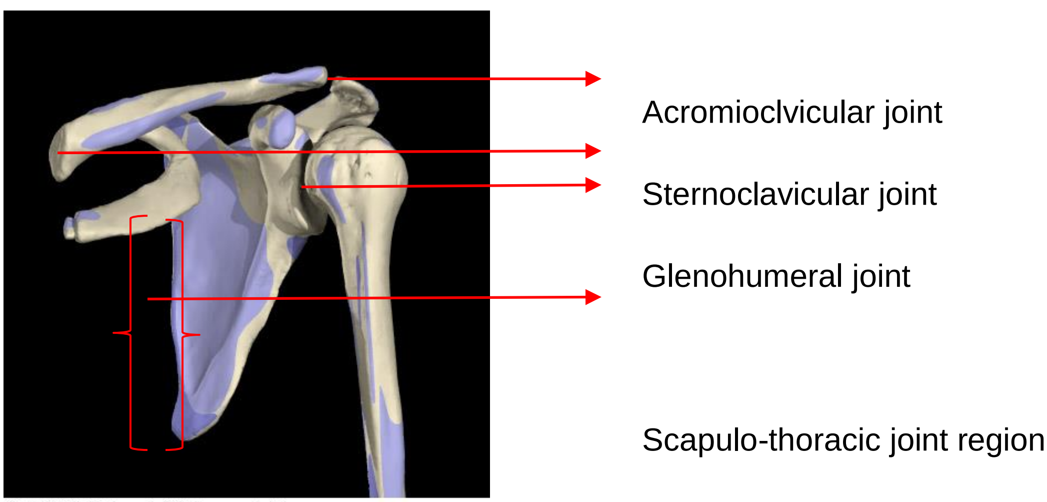


Figure 2.1: Bony anatomy of the shoulder

2.2.2 Ligaments

The bony articulations of the shoulder girdle are supported by multiple ligaments (Moore and Dalley, 1999; Di Giacomo *et al.,* 2008; McKinley and O'Loughlin, 2012) to include:

The capsular ligament, which supports the sternoclavicular joint (Moore and Dalley, 1999; Terry and Chopp, 2000; Di Giacomo *et al.,* 2008; McKinley and O'Loughlin, 2012), is reinforced anteriorly and posteriorly by the anterior sternoclavicular and posterior sternoclavicular ligaments respectively. Additionally, the sternoclavicular joints are re-inforced by the interclavicular ligaments (McKinley and O'Loughlin, 2012).

This is in contrast to the acromioclavicular joint which acts as a primary restraint for posterior displacement and posterior axial rotation of the clavicle. In order to achieve this, this joint is supported by the superior acromioclavicular ligament, which is a quadrilateral band covering the superior part of the joint and extends between the upper part of the acromial end of the clavicle and the adjoining part of the upper surface of the acromion (Moore and Dalley, 1999). In addition, the inferior acromioclavicular ligament is a thinner ligament than the superior acromioclavicular ligament, which covers the lower part of the joint and is attached to the adjoining undersurfaces of the two adjacent bones (Moore and Dalley, 1999; Terry and Chopp, 2000; Di Giacomo *et al.,* 2008).

The last acromioclavicular ligament (but a non joint supporting ligament), is the coracoacromial ligament, which forms part of the coracoacromial arch (a bony – ligamentous arch). Thus, the ligament attaches from the summit of the acromion immediately in front of the articular surface of the clavicle to its broad base, which runs the whole length of the lateral border of the coracoid process (Moore and Dalley, 1999; Terry and Chopp, 2000; Di Giacomo *et al.,* 2008). In this position, the coracoacromial ligament is required to prevent superior displacement of the humeral head from the glenoid cavity (Moore and Dalley, 1999).

In addition to the above, the trapezoid ligament augments the acromioclavicular joint and is a passive suspender of the scapula and upper limb from the clavicle (Moore and Dalley, 1999; Terry and Chopp, 2000). In order to achieve this, the trapezoid ligament is attached to the upper surface of the coracoid process and to the oblique ridge on the under surface of the clavicle. Its anterior border is free, whereas its posterior border is joined with the conoid ligament (Terry and Chopp, 2000; Di Giacomo *et al.,* 2008). In a similar manner, the conoid ligament is attached by its apex to a rough impression at the base of the coracoid process (medial to the trapezoid ligament) and runs to its expanded base at the coracoid tuberosity on the lower surface of the clavicle. The purpose of this ligament is to guide the synchronous scapulohumeral motion by attaching the clavicle to the scapula, in addition to, strengthening the acromioclavicular joint (Moore and Dalley, 1999; Terry and Chopp, 2000; Di Giacomo *et al.,* 2008). These two ligaments form the coracoclavicular ligament (Terry and Chopp, 2000; Di Giacomo *et al.,* 2008).

With regards to the costoclavicular joint, this joint is supported by the costoclavicular ligament which arises from the upper surface of the first rib to attach to the inferior surface of the medial clavicle (Moore and Dalley, 1999; Terry and Chopp, 2000; McKinley and O'Loughlin, 2012). In this position, its role is to anchor the inferior surface of the sternal end of the clavicle to the first rib and its costal cartilage, which assists in limiting pectoral girdle elevation. In contrast, the interclavicular ligament connects the superomedial aspect of the clavicle with the capsular ligaments of the costoclavicular joint and the superior border of manubrium. Thus, this ligament acts as a checkrein against excessive downward rotation of the clavicle and distraction of the clavicle from the manubrium (Di Giacomo *et al.,* 2008; McKinley and O'Loughlin, 2012).

The third and last bony articulation of the shoulder girdle is the glenohumeral joint, which is supported by the following ligaments (Moore and Dalley, 1999; Terry and Chopp, 2000; Veeger and van der Helm, 2007; Di Giacomo *et al.,* 2008):

- Superior Glenohumeral: In support of the coracohumeral ligament, the superior glenohumeral ligament stabilizes the humeral head from inferior translation in adduction and from posterior translation in forward flexion, adduction, and internal rotation. The superior glenohumeral ligament extends from the anterosuperior edge of the glenoid to the top of the lesser tuberosity. Together they constitute the rotator interval region between the anterior border of the supraspinatus and the superior border of the subscapularis.

- Middle Glenohumeral: in contrast, the middle glenohumeral ligament is the most variable of the three glenohumeral ligaments, being absent in 8% to 30% of patients. It originates from the supraglenoid tubercle, superior labrum, and / or the scapular neck and inserts on the medial aspect of the lesser tuberosity. Its function is to limit anterior translation of the humerus, particularly in the throwing position of abduction and external rotation. The inferior portion of this ligament, which is prone to repetitive micro trauma (as in pitching) or a single traumatic episode (dislocation), could play an integral role in recurrent instability (Terry and Chopp, 2000).
- Inferior Glenohumeral: In contrast to the above two ligaments, the inferior glenohumeral ligament is the thickest and most consistent of the three glenohumeral ligaments. It is often described as a complex containing an anterior band, axillary pouch, and posterior band. The anterior band extends from the anteroinferior labrum and glenoid lip to the lesser tuberosity of the glenohumeral joint and serves, along with the deltoid, to elevate the arm.
- Posterosuperior Glenohumeral ligament begins at the ridge on the posterosuperior aspect of the glenoid neck, medial to the glenoid labrum and ends on the medial aspect, posterior to the origin of the long tendon of the biceps. Laterally, these fibres fan out and merge with the “circular fibrous” structure, whereas a small part of them inserts posteriorly on the greater tubercle together with the tendon of the infraspinatus (Terry and Chopp, 2000).
- Coracoglenohumeral ligament with its components, which include (Moore and Dalley, 1999; Terry and Chopp, 2000; Di Giacomo *et al.,* 2008):
    a. Coracohumeral ligament, which is a thick band of capsular tissue originating from the base of the lateral coracoid and inserting into the lesser and greater tuberosities. This ligament is taut with the arm in the adducted position and constrains the humeral head on the glenoid.
    b. Superior humeral ligament arises from the supraglenoid tubercle, just anterior to the long tendon of the biceps muscle. Laterally, the coracohumeral and the superior humeral ligaments join each other at their mid-portion and insert into the fovea capitis humeri. Together these form a stabilizing network for the biceps tendon to stabilize the humeral head

from inferior translation in adduction and from posterior translation in forward flexion, adduction and internal rotation.

c. Coracoglenoid ligament, which extends from the coracoid process to the supraglenoid tubercle and along the insertion of the long tendon of the biceps muscle to the glenoid labrum.

In addition to the ligaments that support joints, there are also false ligaments of the shoulder girdle including the suprascapular / superior transverse ligaments (Moore and Dalley, 1999; Terry and Chopp, 2000; Di Giacomo *et al.,* 2008; Rockwood and Matsen, 2009), which attaches by one end to the base of the coracoid process and at the other to the medial end of the scapular notch. Secondly there is the spinoglenoid / inferior transverse ligament (Moore and Dalley, 1999; Terry and Chopp, 2000; Di Giacomo *et al.,* 2008), which runs from the lateral border of the spine to the margin of the glenoid cavity. It is thought that the ligament may limit the advancement of the infraspinatus tendon in injury.

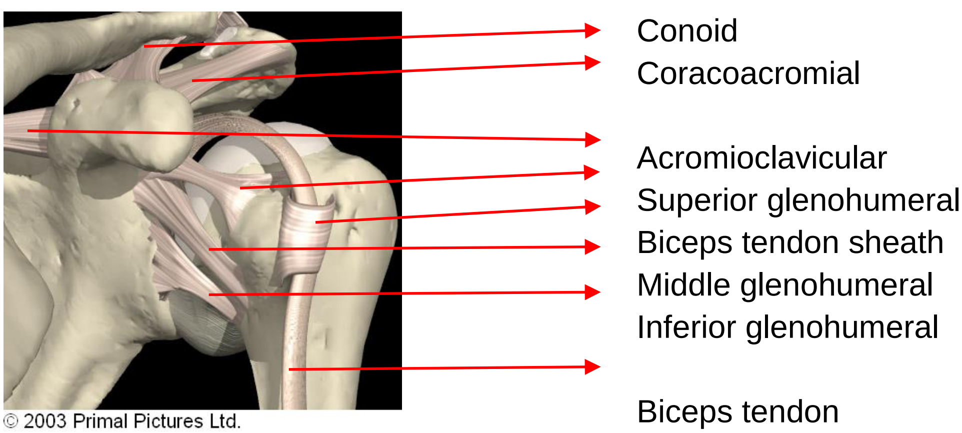


Figure 2.2: Ligaments of the shoulder girdle

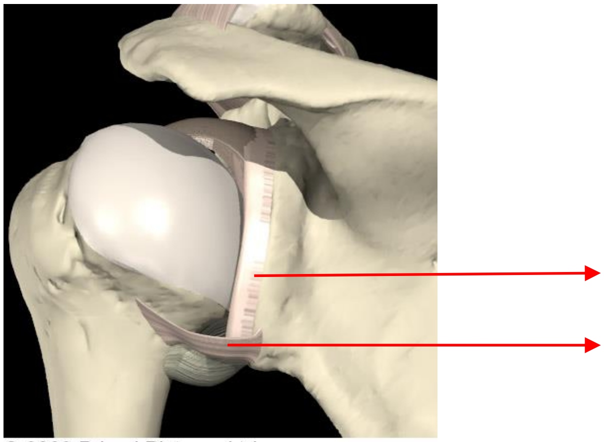
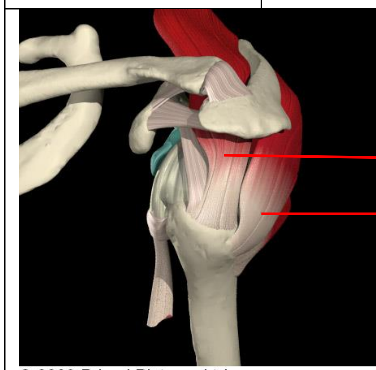
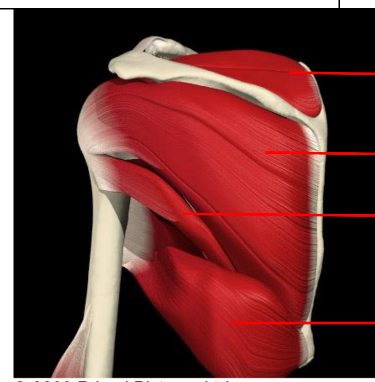


Figure 2.3: Ligaments of the shoulder joint

2.2.3 Muscles

Table 2.1 Muscles of the shoulder girdle

Table developed from Moore and Dalley (1999), Primal Pictures (2003),Myers, (2006); Calais-Germaine (2007); Di Giacomo *et al.*,(2008); Rockwood and Matsen (2009); McKinley and O'Loughlin (2012).

Muscle name	Origin	Insertion	Innervation	Action
Supraspinatus muscle	Supraspinous fossa.	Forward and laterally at the superior aspect of the greater tuberosity.	Suprascapular nerve.	Stabilizes the humeral head in the lower ranges of abduction (600 to 90°) and inferior translation in the adducted position at the side.
 Figure 2.4 Supraspinatus muscle (lateral view)		 Figure 2.5 Supraspinatus muscle (posterior view)		
Infraspinatus muscle	Infraspinous fossa.	Extends laterally to its tendinous insertion on the middle facet of the greater tuberosity.	Suprascapular nerve.	Provides the primary external rotation force and also stabilizes the glenohumeral joint against posterior subluxation.

2.2.3 Muscles continued …

Teres minor muscle	Originates from the mid to upper regions of the axillary border of the scapula.	Extends laterally and superiorly to its insertion on the most inferior facet of the greater tuberosity.	Axillary nerve.	External rotator and glenohumeral stabilizer.

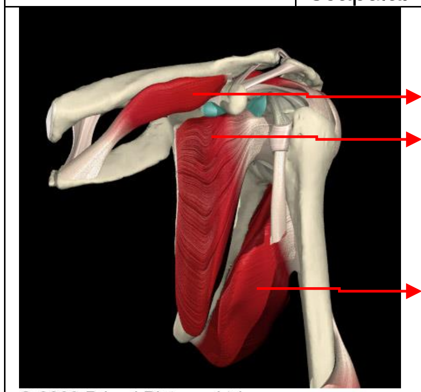


Figure 2.6 Subclavius and subscapularis muscle (anterior view)

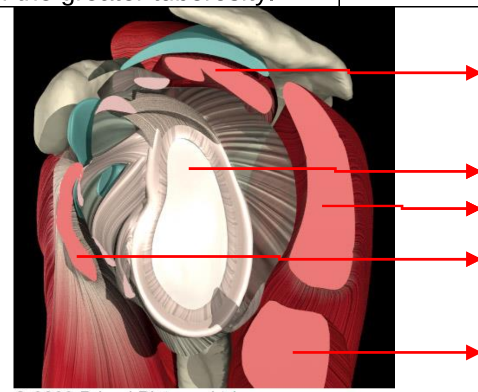


Figure 2.7 SITS muscles (lateral view)

Teres major muscle	Inferior angle of the scapula.	The medial lip of the intertubercular groove of the humerus.	Lower subscapular nerve.	Internal rotator and adductor of the shoulder and extender of the arm.
Trapezius muscle	Extensive origin from the base of the skull to the upper lumbar vertebrae.	Lateral aspect of the clavicle, acromion, and scapular spine.	Spinal accessory nerve.	Scapular retractor and elevator of the lateral angle of the scapula.

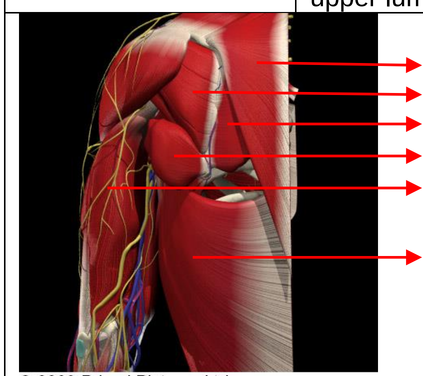


Figure 2.8 Superficial shoulder muscles (posterior view)

2.2.3 Muscles continued …

Subscapularis muscle	Subscapular fossa.	Extend laterally to its insertion on the lesser tuberosity of the humerus.	Upper and lower subscapular nerves.	Internal rotator, especially in maximum internal rotation.
The biceps brachii muscle (has two heads).	The long head originates from the supraglenoid tuberosity and superior labrum; the short head originates from the coracoid process.	Long head inserts into bicipital tuberosity of the radius. Short head inserts into coronoid process and ulnar tuberosity.	Musculocutaneous nerve.	Primary humeral head depressor during abduction.

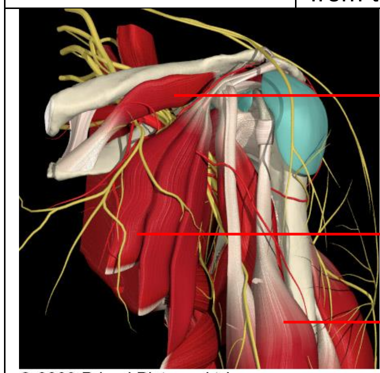


Figure 2.9 Pectoral muscles (antero-medial view)

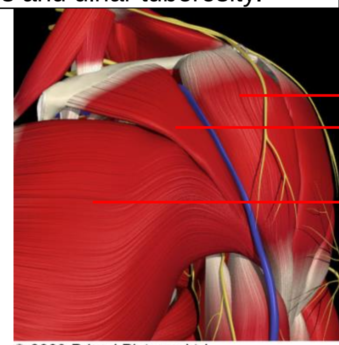


Figure 2.10 Deltoid and pectoral muscles (antero-lateral view)

Pectoralis minor muscle	Anterior portion of the second through fifth ribs.	Base of the coracoids.	Medial pectoral nerve.	Protracts and rotates the scapula inferiorly.
Pectoralis major muscle	Medially from the medial aspect of the clavicle, the sternum, and the fifth and sixth ribs.	Extends laterally to insert on the lateral lip of the bicipital groove.	Lateral and medial pectoral nerves.	Adduction and internal rotation of the humerus.

2.2.3 Muscles continued …

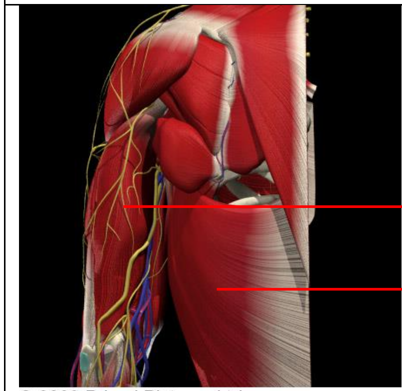


Figure 2.11 Triceps and latissimus dorsi muscles (posterior view)

Latissimus dorsi muscle	Spines of the lower 6 thoracic vertebrae and thoracolumbar fascia, through which it is attached to the lumbar and sacral vertebrae and to the supraspinous ligaments and posterior iliac crest.	Laterally around the lower border of the teres major, attaching to the intertubercular groove of the humerus.	Thoracodorsal nerve.	Adduct, extend, and internally rotate the humerus.
Triceps brachii muscle	Long head infraglenoid scapular tubercle; Medial head posterior humerus surface; Lateral head posterior humerus.	Proximal olecranon and forearm fascia.	Radial nerve.	Extend forearm. Long head stabilizes humeral head in abduction.

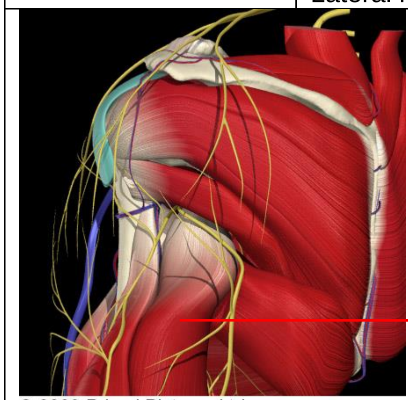


Figure 2.12 Triceps and latissimus dorsi muscles (postero-lateral view)

2.2.4 Blood supply / venous drainage

Branches of the anterior and posterior circumflex humeral (branches of the axillary artery) and suprascapular arteries supply the shoulder girdle, in particular the glenohumeral and acromioclavicular joints (Moore and Dalley, 1999: McKinley and O'Loughlin, 2012). The sternoclavicular joints are supplied posteriorly by the internal thoracic arteries and anteriorly by the perforating branches of the second intercostal artery and its collateral branch bilaterally (McKinley and O'Loughlin, 2012). The soft tissue scapulothoracic articulation is supplied principally supplied by the posterior intercostal arteries (two to eight) and their associated collateral branches as well as the branches of the dorsal scapula artery, subscapula artery, the thyrocervical trunk (viz. transverse cervical artery, suprascapular artery), thoracoacromial artery, thoracodorsal artery and the lateral thoracic arteries bilaterally (Moore and Dalley, 1999; Primal Pictures, 2003; McKinley and O'Loughlin, 2012).

2.2.5 Innervation

With respect to the glenohumeral joint, the suprascapular nerve (sensory nerve) supplies the dorsal portion of the joint capsule. A small portion of the joint capsule in the region of the recessus axillaris is supplied by a branch of the axillary nerve; and the ventral portion of the joint capsule is supplied by several nerve branches. These include the thoracic ventral cranial nerve, the subscapular and the axillary nerves (lower parts of the joint capsule) (Moore and Dalley, 1999; Porterfield and de Rosa, 2004; Di Giacomo *et al.,* 2008; Standring, 2008; Snell, 2009).

Around the glenohumeral joint, the rotator cuff muscles receive their innervation from amongst others (Moore and Dalley, 1999; Porterfield and de Rosa, 2004; Di Giacomo *et al.,* 2008; Standring, 2008; Snell, 2009):

- The subscapular nerve (C6-C7) for the subscapular muscle.
- The suprascapular nerve (C4–C6) for the supraspinatus and infraspinatus muscles.

- The axillary nerve for the teres minor muscle.
- The other muscles involved in movement of the shoulder joint are: the biceps brachii muscle (musculocutaneous nerve), the deltoid muscle (axillary nerve), the latissimus dorsi muscle (thoracodorsal nerve), the pectoralis major muscle (lateral and medial pectoral nerves), the pectoralis minor muscle (medial pectoral nerve), the triceps brachii muscle (radial nerve), the teres major muscle (lower subscapular nerve) and the trapezius muscle (spinal root of the accessory nerve and cervical nerves C3-C4 as well as segmental innervation from intercostal nerves).

All nerves innervating the joint capsule or the aforementioned muscles are involved in supplying information about the position of the joint. To a lesser extent, mechanoreceptors in the skin may also have a role (Terry and Chopp, 2000; Porterfield and de Rosa, 2004).

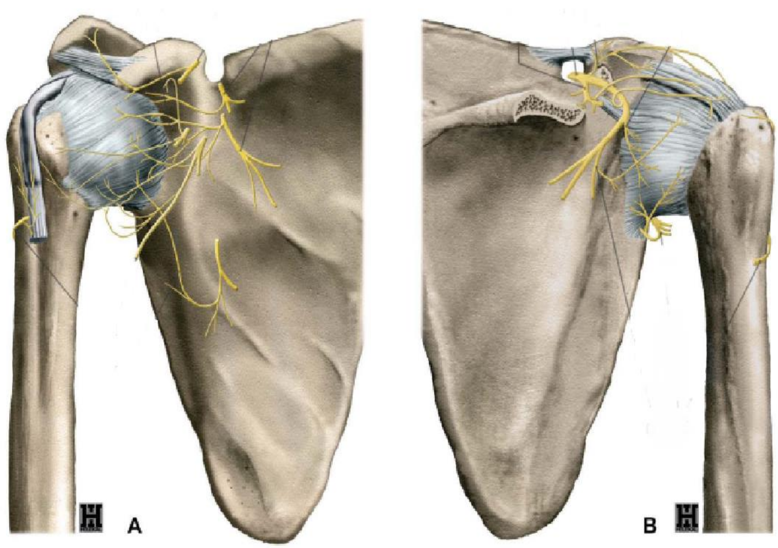


Figure 2.13 Nerves of the shoulder girdle (Di Giacomo *et al*., 2008)

2.3 Micro anatomy of muscles supporting the shoulder girdle.

When considering the shoulder girdle as a whole (viz. Section 2.2.3 regarding muscles, ligaments and joints, as discussed above), it becomes apparent that this girdle has sacrificed stability over mobility, making normal joint function reliant on appropriately functioning muscles (both alone and in unison) (Myers, 2006; Veeger and van der Helm, 2007; Moraes *et al.,* 2008; McKinley and O'Loughlin, 2012).

In order to achieve this balance and optimum function, the muscles are required to function optimally at a cellular level. Therefore, in essence it is necessary to look at the micro / cellular level of a muscle (Figure 2.14).

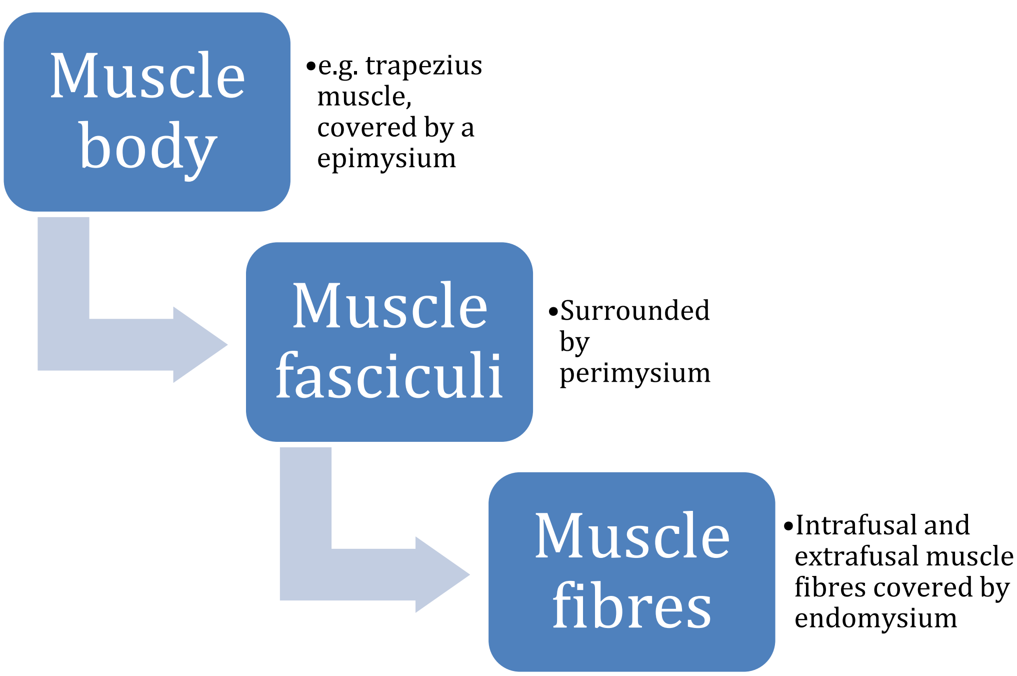


Figure 2.14 Muscle structure (schematic) (Adapted from Wheater, Burkitt and Daniels, 1982; Young *et al*., 2006; Tortora and Derrickson, 2011)

Each of the muscle fibers are encapsulated by sacromeres, which in turn contain contractile proteins known as myofilaments (actin and myosin), which are primarily responsible for the contraction process within the muscle fiber (Guyton and Hall, 2000;

Clancy and McVicar, 2002). This contraction process starts with the release of calcium (as a result of neurological stimulation or Acetylcholine release (Dommerholt *et al.*, 2006a) and depolarization of the muscle fibre) by the sacroplasmic reticulum into the sarcoplasm (Beck, 2009). This calcium binds with a substance referred to as troponin, which results in the movement of tropomyosin away from the myosin binding sites on the actin filaments. This then allows the actin and myosin to start the contractile cycle (Tortora and Derrickson, 2011). In addition, the binding of the actin and myosin enables the release of ADP and several other molecules, which strengthen the actin-myosin complex and shortening the sarcomere (Robergs and Roberts, 1997). The binding of ATP to the actin-myosin bond is then responsible to breaking the bond, which would then remain open if troponin were free in the sarcoplasm. However, if calcium is still highly available, there is little chance that the troponin will bind to the myosin, leaving the site open for the actin to re-engage. This means that the contraction will again occur, a sequence referred to as "contraction cycling" (Robergs and Roberts, 1997). This cycle continues as long as there is sufficient ATP and calcium in the region of the binding sites, as these two elements facilitate the contractile process within the muscle fiber (Clancy and McVicar, 2002).

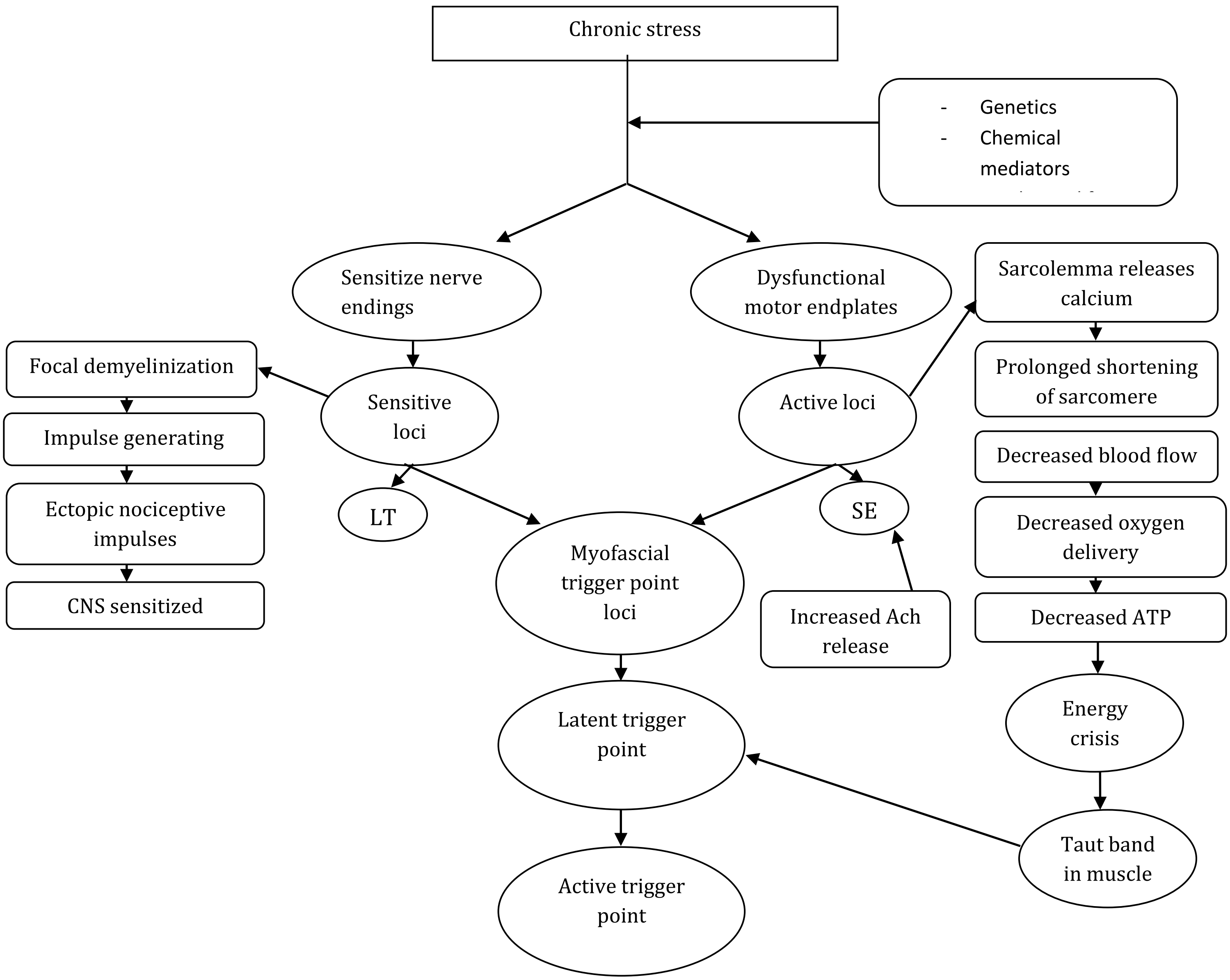


Figure 2.15 Effects of stress on muscle (Adapted from Lavelle *et al*., 2007)

However, to maintain this increased level of activity (ATP production and release of calcium) nutrients and oxygen need to be supplied to the area and waste products to be removed from the area (Clancy and McVicar, 2002; Beck, 2009). These latter processes that underpin the ability of a muscle to sustain a contraction are, however, negatively impacted by the fact that muscles, when contracting obstruct blood flow (relative ischemia) (Travell, Simons and Simons, 1999) to the area and, therefore, limit the muscles' ability to receive nutrients and oxygen and to remove waste products. Some authors (Gissel, 2006; Ge *et al*., 2011) see this as a self limiting factor – viz. the muscle will deplete of the required nutrients and therefore relax and allow for there to be replenishment. However, it poses a problem when the required nutrients needed to pump the calcium back into the sacroplasmic reticulum are insufficient in order to achieve the task (Robergs and Roberts, 1997). When this happens it is thought that the muscle stays within a state of continued hypertonia and feeds the process through a negative feedback loop (Gissel, 2006), which is particularly evident if there is abnormal depolarization of the motor end plates (McPartland and Simons, 2006). This is supported by Ge *et al.,* (2011), who indicate that muscle tissue disruption is observed immediately after the termination of any exercise (viz. muscle contraction). This is seen in the form of cytoskeletal disruptions, loss of myofibrillar registry and loss of cell integrity, hyper contracted regions and invasion of inflammatory cells as well as neuroaxonal degeneration and neuromuscular transmission disorders (Chang *et al*., 2008). In particular, muscle fiber hyper contraction occurs adjacent to fiber plasma membrane lesions and is associated with very short sarcomere lengths (Duncan and Jackson, 1987; Friden and Lieber, 1998). The development of the membrane lesions are further compounded by influx of calcium from the interstitium, mitochondrial overload and the development of reactive oxygen species (Gissel, 2006; Ge *et al.*, 2011); which all serve to increase the damage in a "self-reinforcing manner" (Gissel, 2006). These assertions seem to support the work of Shah *et al*., (2005), who indicated that there are elevations of substance P, CGRP, bradykinin, serotonin, and cytokines (all inflammatory mediators), in active MFTPs, as compared to the concentrations of the same substances in latent MFTPs and/ or normal muscle (Shah *et al*. 2005). These are thought to arise when the inflammatory reaction and hyper contractile phases are maintained (Simons, 2008). This together with Shah *et al*., (2005) suggested feedback loop connects the "energy crisis" within the MTFP and the changes that surround it, as responsible for the noxious stimulation of local nociceptors (which in turn are responsible for local and / or referred pain associated with the clinical phenomenon known as MFTPs which are associated with the development of MPS (Travel, Simons and Simons, 1999; Chaitow and DeLany, 2000)).

2.4 Myofascial pain syndrome (MPS)

In the context of muscle physiology as well as the fact that muscle constitutes a significant portion of body (Gatterman, 1990), it suggests that muscle pathophysiology is a common phenomenon (Chaitow and DeLany, 2000). Thus, several authors have indicated that MPS is an extremely common form of muscular disorder that frequently presents to health care practitioners and is of multi-factorial origin (Gatterman, 1990; Hubbard, 1998; Blyth *et al.,* 2001; Elliott *et al.*, 2002; Eriksen *et al*., 2003; Cote *et al.*, 2004; Porterfield and de Rosa, 2004; Dommerholt *et al.*, 2006a).

To support this, it has been noted that MPS is the most common work-related injury (Roffey *et al.*, 2010a; Roffey *et al*., 2010b; Roffey *et al.*, 2010c; Roffey *et al.*, 2010d; Roffey *et al*., 2010e; Wai *et al.*, 2010a; Wai *et al.,* 2010b) and has been noted as the second most common reason for visits to physicians (Hubbard, 1998; Cote *et al.*, 2004; Dommerholt *et al.*, 2006a). This concurs and supports review articles by Han and Harrison (1997) and Simons and Dommerholt, (2006), which indicated that the incidence of MPS was as high as 85% at certain USA Pain Clinics (Fishbain *et al.*, 1986).

2.4.1 Incidence and prevalence of MPS:

As a result, it would seem from the literature that there have been limited numbers of large epidemiological studies examining the prevalence of MFTPs and an emphasis on intervention studies (e.g. randomized and non-randomised controlled trials as well as case studies) (Baldry, 2001; Schneider, 2005; Vernon and Schneider, 2009). Nevertheless, anecdotal evidence indicates that MPS is a very common phenomenon (McCain, 1994; Picavet *et al*., 2003; Huguenin, 2004), especially if it is associated with trauma or sustained muscle fatigue (Table 2.3).

Table 2.2 Epidemiology of MFTPs

Author	Percentage of patients with MPS	Numbers of participants	Principle complaint
Sola, Rodenberger and Getty (1955)	Most common frequent problems	200	General patient complaint seen by physicians.
Skootsky, Jaeger and Oye (1989)	30% of patients	172	Patients at a university medical centre.
Fricton *et al*., (1990)	54% of patients	42	Patients complaining of head and neck pain.
Schiffman *et al*., (1990)	50% of patients	269	Patients with temporomandibular joint disorders.
Schneider (1995)	Most predominant soft tissue syndromes	Systematic review	Patients presenting to a clinical setting.
Han and Harrison (1997)	85% of patients	Systematic review	American studies based at pain clinics.
Rashiq and Galer (1999)	70% of patients	41	Complex regional pain syndrome patients.
Lucas (2007)	Common	42	Patients with a variety of pain complaints.

From the above (Table 2.2), it can be seen that while circumstantial evidence is increasing to support the notion that MFTPs are prevalent in those suffering from musculoskeletal pain / MPS; some have suggested that the prevalence of latent MFTPs in healthy individuals may even be higher (Simons, Travell and Simons, 1999), or even normal (Goldenberg, 1987; Gatterman, 1990; Hong, 2004). These assertions support an earlier study by Sola *et al*., (1955) who investigated the occurrence of “hypersensitive spots” in the posterior shoulder muscles of 200 healthy, young military recruits and found a high number of these spots. It was later suggested by Simons (1997) and Simons, Travell and Simons (1999) that the “hypersensitive spots” identified in 50 percent of the sample were most likely latent MFTPs. More recently Fernandez-de-Las-Penas *et al.*, (2010) and Fernandez-de-Las-Penas, Alonso-Blanco and Miangolarra (2006) conducted two well presented studies that reported the numbers of latent MFTPs in healthy controls, one in relation to patients with chronic tension type headache

(Fernandez-de-Las-Penas *et al.*, 2010) and the second observing patients with a mechanical cause of neck pain (Fernandez-de-Las-Penas, Alonso-Blanco and Miangolarra, 2006). It was found that an average of 3.9 MFTPs were found in the upper trapezius muscle, the sternocleidomastoid muscle and temporalis muscle of the 25 patients in the chronic tension type headache study (Fernandez-de-Las-Penas *et al*., 2010) and a mean of 4.3 latent MFTPs were found in the upper trapezius muscle, sternocleidomastoid muscle and levator scapulae muscles of 20 patients that had presented with mechanical neck pain (Fernandez-de-Las-Penas, Alonso-Blanco and Miangolarra, 2006).

In terms of the genders, it is noted that MPS occurs in both males and females (Treaster and Burr 2004; Ge *et al*., 2006) but appears to be more prevalent in females (2:1) (Bergenudd *et al*., 1988; Han and Harrison, 1997; Malleson *et al*., 2001; Delgado *et al*., 2009). Pressure pain thresholds also seem lower for women, indicating that they have a greater hypersensitivity to mechanical stimulation (Gerwin, 2010). This is supported by previous work in which Ge *et al*., (2006) found that injection of hypertonic saline in bilateral trapezius muscles, to simulate the real-life bilateral shoulder pain commonly experienced in certain work situations, resulted in greater pain inhibition in men than women (Cairns *et al*., 2002; Ge *et al*., 2006; Arendt-Nielsen *et al*., 2008a; Arendt-Nielsen *et al*., 2008b). In contrast, one study of gender differences in recalled and experimentally induced muscle pain showed little difference between male and female subjects however, there were differences in terms of the variables in this study (Dannecker *et al*., 2008).

Travell, Simons and Simons (1999) and Han and Harrison (1997), suggest that individuals in their midlife (30-49) are more likely to suffer from MPS (Delgado *et al.*, 2009; Freeman *et al.*, 2009).

In general therefore, it could be concluded that the available evidence supports the notion that MFTPs are a common phenomenon, with the active MFTPs more likely in patients presenting with pain and though the case for latent MFTPs is less convincing, there seems to be a tendency for them to be more prevalent in normal healthy subjects.

Notwithstanding this high incidence and prevalence, MPS remains one of the least understood conditions, being misdiagnosed, mistreated or simply unrecognized (Auleciems, 1995; Testa *et al.*, 2003; Simons and Dommerholt, 2006a; Cummings and Baldry, 2007). This confusion seems to stem from the fact that there seems to be (Fricton, 1990; Testa *et al.*, 2003; Perez-Palomares *et al.*, 2009):

- A lack of obvious organic / clinical findings,
- A lack of a single all encompassing theory to explain it, and
- Inconsistencies and contradictions in the literature MPS is mapped or defined.

.These inconsistencies may be related to various skill levels of the researchers / practitioners and / or the population groups under study.

2.4.2 Natural History of MPS

According to Travell, Simons and Simons (1999), with adequate rest and in the absence of perpetuating factors, an active MFTP may revert spontaneously to a latent state; as pain symptoms disappear. These findings are similar to the results of the research of Hains *et al.,* (2010), who investigated chronic shoulder pain of myofascial origin and Testa *et al.,* (2003) who reported a clinical update synopsis of MFTPs. However, reactivation of the MFTPs when the muscle stress tolerance is exceeded can account for the history of recurrent episodes of the same pain over a period of years (Testa *et al.*, 2003; Hains *et al.*, 2010).

2.4.3 Etiology of MPS

There is still uncertainty over the etiology of MPS as no studies conducted indicate positive predictive values for any one combination of factors (Cummings and Baldry, 2007; Delgado *et al*., 2009).

Table 2.3 Primary and secondary factors influencing MFTPs

Primary Factors	Secondary factors (Baldry, 1993):
These include biological/structural factors (Wedderkopp *et al*., 2005; Rechardt *et al*., 2010) such as • Mechanical abuse: acute sustained or repetitive muscle overload i.e.: prolonged muscle contraction (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000; Lavelle *et al*., 2007). • Trauma: this includes the precipitation of MFTPs by means of a local inflammatory response (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000). • Leaving the muscle in shortened position: for a prolonged period of time especially if the muscle is contracted in the shortened position (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000). • Nerve compression: this can cause identifiable neuropathic electromyography changes and results in disturbed microtubule communication between the neuron and the end plate (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000; McPartland and Simons, 2006). Anthropometric factors (Feldman *et al*., 2001; Rechardt *et al*., 2010) and psychological (Sherry *et al*., 1991; Vikat *et al*., 2000) factors • Systemic biochemical imbalances: this could include hormonal disturbances (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000). • Structural disharmony (Fricton *et al*., 1990) or skeletal imbalance, which Rosen (1994) feels is the primary cause of muscle imbalance between the	• Compensating synergistic or antagonistic muscles to those housing MFTPs may as a result develop MFTPs. • Satellite MFTPs can evolve in referral zone of primary trigger points. • Low oxygenation of tissues. • The developments of active and latent MFTPs occur as a result of the same factors mentioned above (primary and secondary) but to varying degrees (Travell, Simons and Simons, 1999).

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agonist and the antagonist muscles, which then become overloaded. This overload may be due to improper use and / or abnormal loads causing dysfunction to occur, especially when exceeding the critical load capacity of a muscle resulting in fatigue (Rosen, 1994).
• Hyper mobility or ligamentous laxity seems to be a relevant risk factor for the development of MFTPs (Malleson et al., 2001; Ferrell et al., 2004; Adib et al., 2005; Nijs, 2005; Ofluoglu et al., 2006).

Various life style factors (El-Metwally et al., 2007; Rechardt et al., 2010)
• Adverse environmental conditions: this includes but is not limited to excessive heat, cold or dampness (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000).
• Sedentary individuals have a higher tendency for the development of MFTPs (Delgado et al., 2009)
• Nutritional deficiencies, lack of exercise or sleep disturbances (Fricton et al., 1990). Although nutritional deficiencies are contested by Morgan (1997) and Van Aardenne (2002).
• Social deprivation (Malleson et al., 2001)
• Abuse and abusive environments (Malleson et al., 2001)
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Fricton et al., (1990), suggested a multi-factorial etiologic basis for MPS / MFTPS and advised that the development of MFTPs can be divided into two basic groups:
1) Factors that are directly traumatized by direct injury, repetitive microtrauma from habits that produce muscle tension.
2) Factors that weaken a muscle and predispose it to the development of MFTPs through such factors named as primary above.
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According to Auleciems (1995), the event that activates a trigger point is usually quite different from the factors that perpetuate them. Thus the long-term prognosis improves with treatment of perpetuating factors and not the symptomatic relief of initiating factors. Esenyl (2000) supports these findings and also found that once perpetuating factors are corrected pain, is more likely to be resolved.

2.4.4 Perpetuating factors

In addition to the primary and secondary etiological factors, there are also some factors that have been identified as perpetuating factors, which are responsible for maintaining MFTPs after they have been formed. These factors may include one or more of the following (Travell, Simons and Simons, 1999, Yap, 2007):

- Mechanical stresses (Huguenin, 2004; Srbely, 2010). These include structural inadequacies such as changes in shape (e.g. length or size), number (e.g. lumbarisation or cervical ribs), and agenesis (e.g. bifid spinous processes or lack of a thoracic rib formation). Additionally, mechanical stressors are possible from such sources as functional skeletal asymmetry, poor posture, prolonged immobility, constriction of muscles and/or muscular abuse.
- Nutritional inadequacies (Testa *et al.,* 2003; Rickards, 2006). These can occur for three reasons including decreased nutrient intake (malnutrition), decreased absorption (malabsorption) and / or increased utilization (as commonly occurs with mechanical stresses). Examples of more commonly associated nutrient deficiencies in patients with MFTPs include vitamins B1 (thiamine), B6 (pyridoxine), B12 (cobalamin), C (ascorbic acid), folates (folic acid), iron, calcium, potassium and several trace minerals have been associated with abnormal muscle functioning. Although the above literature suggests that nutrition plays a significant role in MFTPs, the studies by Morgan (1997) and Van Aardenne (2002) seem to contrast this.
- Metabolic and endocrine inadequacies (Testa *et al.*, 2003; Rickards, 2006; Srbely, 2010). These examples may also be reasons for or as a result of any nutritional deficiencies in the point above and may include: hypometabolism

(hypoglycemia, hypothyroidism) or hypermetabolism (hyperthyroidism, hyperuricemia) or general systemic derangements / diseases such as gout.

- Chronic infection of any origin (viz. viral infections, bacterial infections or parasitic infestations) (Rickards, 2006; Srbely, 2010).
- Psychological factors (Huguenin, 2004; Srbely, 2010), which may include but not be limited to anxiety / tension, hopelessness, depression or conversely “good sport” syndrome.
- Miscellaneous factors (Rickards, 2006) may include impaired sleep or chronic fatigue, cold or damp weather, allergy (unrelated to disease causation), chronic visceral disease or radiculopathies.

2.4.4.1 Presentation of MTPFs in the muscles related to this study

2.4.4.2 Presentation of MFTPs in the Supraspinatus muscle

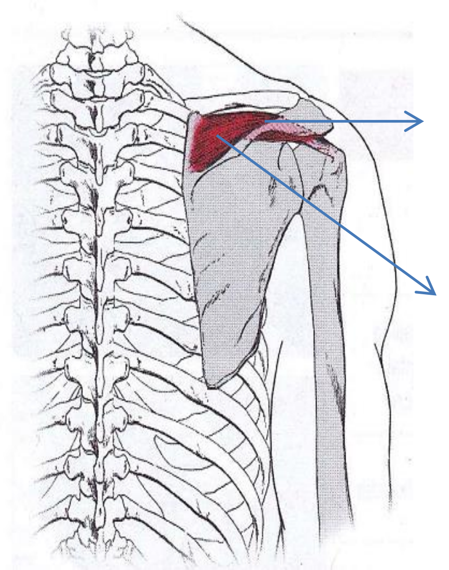


Figure 2.16 Supraspinatus muscle

The MFTPs in this muscle are located in the proximal belly and mid belly of the supraspinatus muscle.

The primary referral of pain includes a dull deep ache extending from the mid scapula region to the deltoid region of the shoulder or deep within the shoulder complex. The pain may extend down the arm and forearm. The pain may focus strongly on the lateral epicondyle, but rarely extends to the wrist and hand.

(Travell and Simons, 1983; Vizniak, 2010)

2.4.4.3 Presentation of MFTPs in the Infraspinatus muscle

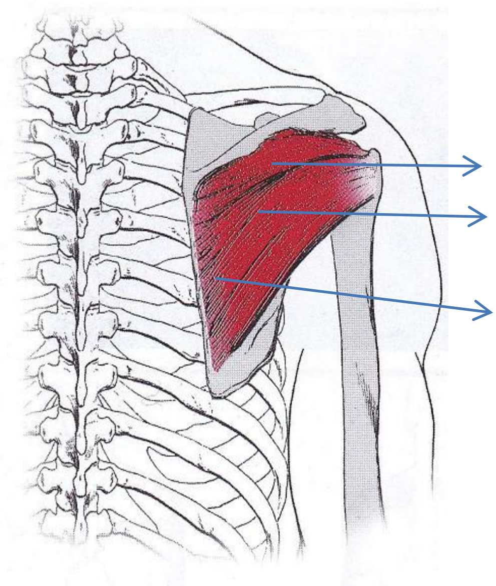


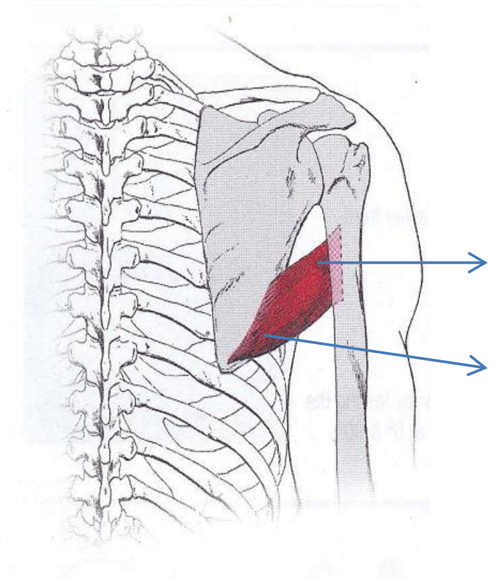
Figure 2.17 Infraspinatus muscle

The MTFPs are located in mid region of the muscle belly and rarely along the vertebral border.

The primary referral areas of this muscle include deep anterior shoulder complex pain, anterolateral arm pain, lateral forearm pain and pain over the radial aspect of the hand and on occasion the fingers. An infrequent MFTP close to the vertebral border of the scapula may produce pain over the rhomboid region ipsilaterally. Rare referrals have also been noted to the suboccipital region of the cervical spine.

(Travell and Simons, 1983; Vizniak, 2010)

2.4.4.4 Presentation of MFTPs in the Teres major muscle



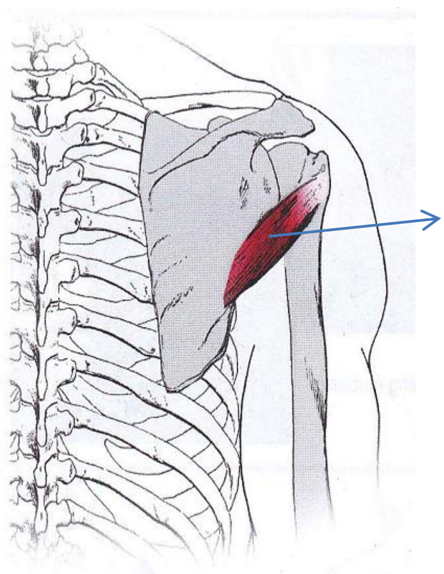
TP1

TP2

The MFTPs for this muscle are found close to its insertion with the scapula and near its insertion to the humerus. The pain referral pattern is described as involving the posterior deltoid region, the biceps brachii. Infrequently the pain also spreads to the dorsum of the forearm and hand.

Figure 2.18 Teres major muscle (Travell and Simons, 1983; Vizniak, 2010)

2.4.4.5 Presentation of MFTPs in the Teres minor muscle



TP

The MFTP is usually located mid belly and has a pain referral that is typified by a "silver dollar" on the posterior aspect of the deltoid muscle. On occasion the pain also radiates down the posterior aspect of the brachium and may be associated with pins and needles in the medial two digits.

Figure 2.19 Teres minor muscle (Travell and Simons, 1983; Vizniak, 2010)

2.4.4.6 Presentation of MFTPs in the Trapezius muscle

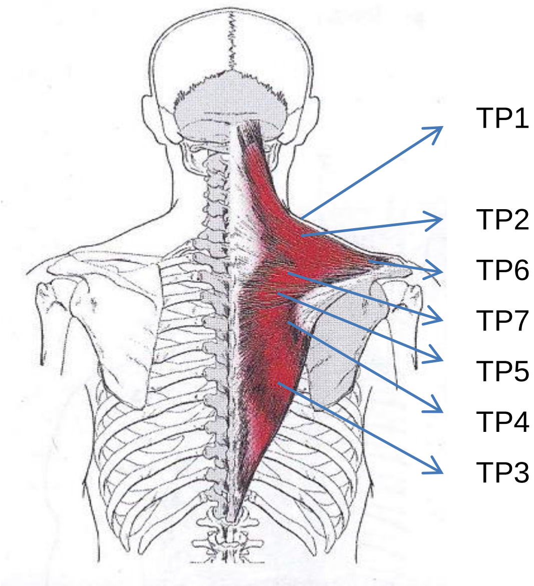


Figure 2.20 Trapezius muscle

The MFTPs are indicated as follows for the trapezius muscle :

TP1 – Upper trapezius fibers, close to the clavicle. Pain is referred to the angle of the jaw; up the neck unilaterally to the region posterior to the mastoid; in an arc over the ear to the temporal region of the lateral face and the back of the orbit.

TP2 – Also in the upper trapezius fibers. This refers pain to the suprascapular region and the neck unilaterally concentrating in the suboccipital region.

TP3 – In the lower fibers of the trapezius muscle, close to the vertebral border of the scapula, at the level of the T6-T7 spinous processes. Pain referral is similar to the TP2, except that there is also a concentration of pain over the acromion and diffuse pain from the MFTP to the suboccipital region.

TP4 – Found near the insertion of the trapezius muscle into the spine of the scapula. Its referred pain pattern is limited to the vertebral border of the scapula.

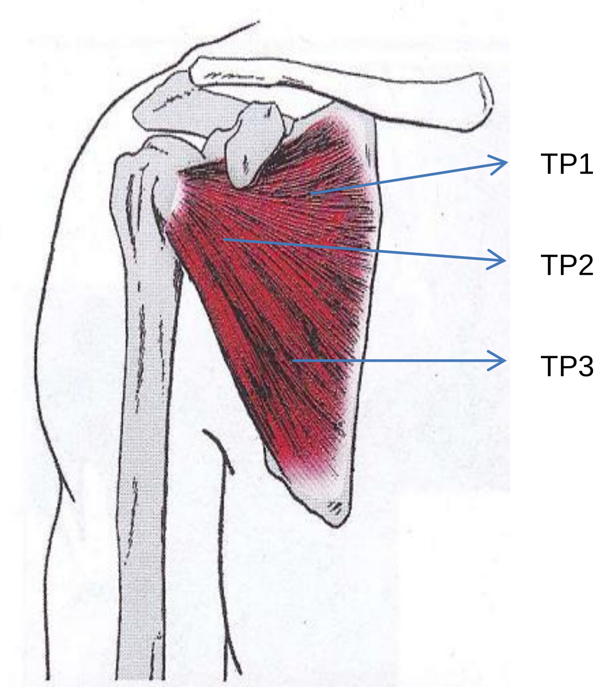
TP5 – Is found in the middle trapezius muscle fibers at the level T3–T4 spinous processes. It focuses pain on the region related to the serratus posterior superior muscle.

TP6 – Is located at the insertion of the trapezius muscle near the acromion. Pain is very local and highly concentrated to that region.

TP7 – this is a variable MFTP that is found near the medial aspect of the superior border of the scapula. It is usually associated with autonomic responses in the ipsilateral arm.

(Travell and Simons, 1983; Vizniak, 2010)

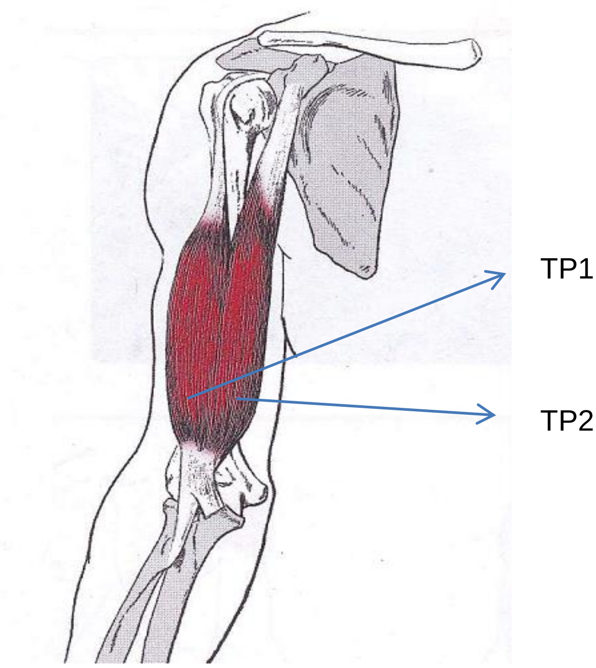
2.4.4.7 Presentation of MFTPs in the Subscapularis muscle



There are typically three MFTPs in this muscle, which seem to correlate with the superior, inferior and lateral attachments of the subscapularis muscle. The pain referral is therefore, extensive including the posterior deltoid region, the entire region of the scapula region, the posterior aspect of the brachium to the elbow. A characteristic pain when present is a “bangle” or wrist watch pain around the wrist and sometimes the dorsum of the hand.

Figure 2.21 Subscapularis muscle (Travell and Simons, 1983; Vizniak, 2010)

2.4.4.8 Presentation of MFTPs in the Biceps brachii muscle



The biceps brachii muscle usually has MFTPs in it distal muscle bellies. These MFTPs refer pain over the extent of the muscle (proximally and distally). In addition pain is often perceived over the anterior deltoid region, occasionally over the supraspinatus region. Rarely patients feel the pain in the cubital fossa.

Figure 2.22 Biceps brachii muscle (Travell and Simons, 1983; Vizniak, 2010)

2.4.4.9 Presentation of MFTPs in the Pectoralis major muscle

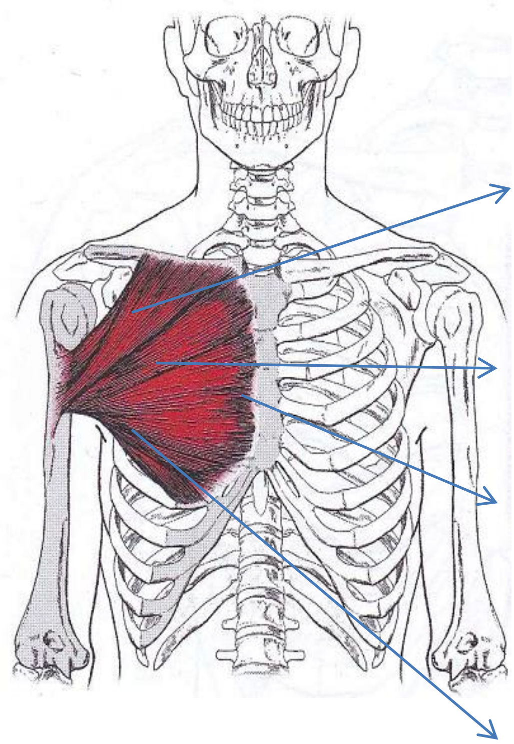


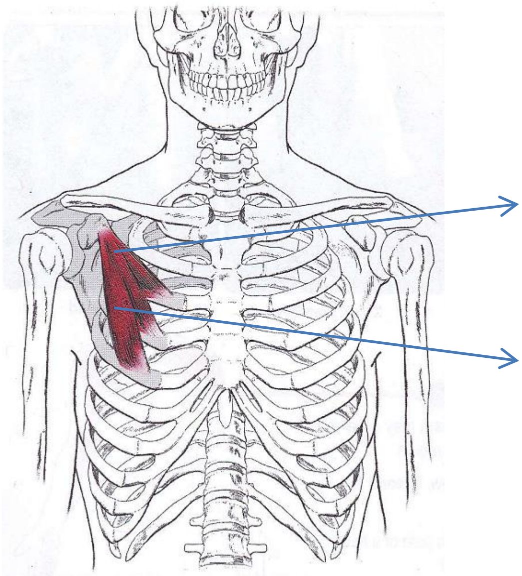
Figure 2.23 Pectoralis major muscle

The trapezius muscle has two MFTPs in its clavicular portion (CL), three in its sternal portion (ST) and two along its free margin (FE); additionally parasternal (P) MFTPs do also present in this muscle.

Pain referral is principally over the anterior deltoid for the clavicular MFTPs, the anterior chest wall (corresponding over the sternal portion of the muscle and including referral to the anteromedial brachium and elbow for the sternal portion of the muscle. Lastly, the lateral free edge MFTPs refer pain to the anterior chest wall, corresponding with the surface anatomy of the heart. The parasternal MFTPs do not refer pain beyond its immediate location which is where their pain is concentrated.

(Travell and Simons, 1983; Vizniak, 2010)

2.4.4.10 Presentation of MFTPs in the Pectoralis minor muscle

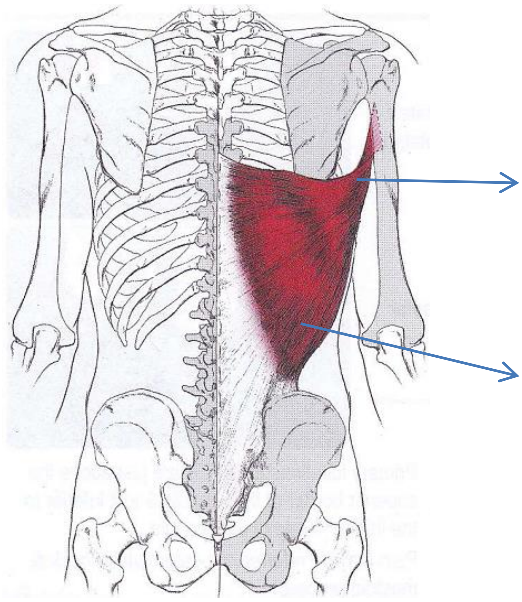


There are two regions where MFTPs are common in this muscle (as indicated on the Figure 2.24 alongside). These refer pain diffusely over the anterior chest wall and down the anteromedial arm to the anterior aspect of the medial three digits. The pain concentrates over the anterior aspect of the anterior shoulder (deltoid region).

Figure 2.24 Pectoralis minor muscle

(Travell and Simons, 1983; Vizniak, 2010)

2.4.4.11 Presentation of MFTPs in the Latissimus dorsi muscle



The position of the most common MFTP in the latissimus dorsi muscle is the one found in the posterior axillary fold created by the muscle as it leaves the torso and attached to the humerus. The second less common MFTP is found nearer the 11^{th} and 12^{th} ribs on the lateral aspect of the muscle. The referred pain is described as "mid back pain" that localizes around the inferior and medial borders of the scapula. Spill over patterns may however, include the back of the shoulder and the medial aspect of the brachium, forearm and hand (including the medial fingers). The lower MFTP may also give lateral flank discomfort.

Figure 2.25 Latissimus dorsi muscle

(Travell and Simons, 1983; Vizniak, 2010)

2.4.4.12 Presentation of MFTPs in the Triceps brachii muscle

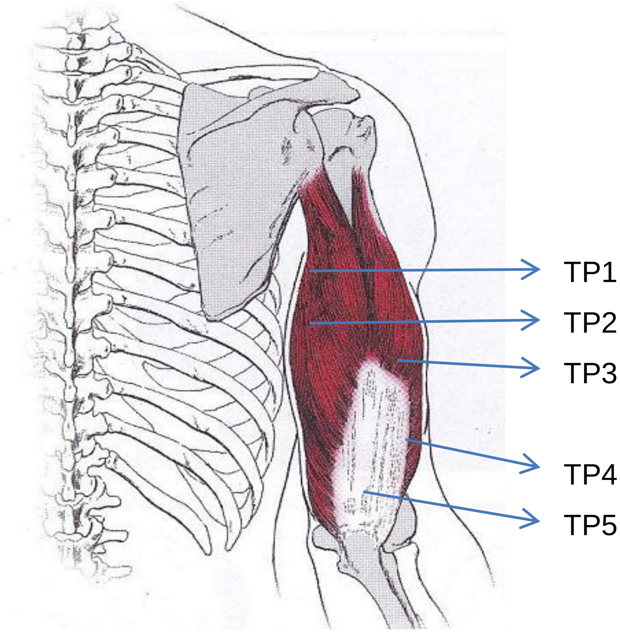


Figure 2.26 Triceps brachii muscle

With this muscle having three heads, MFTPs can be found in the long head muscle belly (TP1), the medial head (usually distal lateral border) (TP2), the mid belly of the lateral head (TP3), the central and distal aspect of the medial head (TP4) and the distal medial border of the medial head (TP5). As a result, the pain referral pattern is extensive, including to various degrees, pain referral to the supraspinatus region, the posterior deltoid, the posterior brachium, the elbow and posterior forearm as well as the hands and posterior aspect of the medial two fingers. Spill over can occur to the postero-medial and antero-medial forearm and on occasion the anterior aspect of the medial two fingers.
(Travell and Simons, 1983; Chaitow and DeLany, 2003; Vizniak, 2010)

2.4.5 Physical findings as related to MFTPs in the various muscles

Lee *et al*., (1997); Gerwin *et al*., (1997); Banks *et al*., (1997); Travell, Simons and Simons (1999); Chaitow and DeLany (2002), state that MFTPs can be identified clinically by the following clinical features (Al-Shenqiti and Oldham, 2005; Bron *et al.,* 2007; Cummings and Baldry, 2007):

1) *A palpable taut band*. By gently rubbing across the direction of the muscle fibers of a superficial muscle, the examiner can feel a ropelike induration. The taut band can be snapped or rolled under the fingers in accessible muscles. Gerwin and Shannon (2000), state that the presence of a taut band distinguishes MFTPs from other muscle pains such as fibromyalgia.
2) *Tender nodule*: Palpation along the taut band reveals a nodule exhibiting a highly localized exquisitely tender spot that is characteristic of MFTPs.
3) *Local twitch response*: Snapping palpation of the MFTPs frequently evokes a transient twitch response of the taut band fibers (Kuan *et al*., 2002; Kuan, 2009).
4) *Jump sign:* This is a patient's response to pressure, which induces a wince and patient movement away from the pressure stimulus over the MFTP (or jump sign) (Baldry, 2001).
5) Restricted stretch *range of motion* (Simons, 2000).
6) Increased *pain on active and /or passive stretch*: Passive stretching results in greater restrictions. This may be due to reciprocal inhibition.
7) *Referred pain* on manual compression: digital pressure on either an active or latent MFTPs can elicit a referred pain pattern characteristic for that muscle.
8) *Painful contraction*: When a muscle with an active MFTP is strongly contracted against resistance the patient feels pain. This effect is most marked when an attempt is made to contract the muscle in a shortened position.
9) *Weakness of the muscle*. This may reflect reflex inhibition of the muscle by the MFTPs (Borg-Stein and Stein, 1996).

The presence or absence of the *taut band*, *spot tenderness*, and *pain recognition* was noted as highly reliable between sessions and examiners, whereas the *referred pain* and *local twitch* responses reliability varied depending on the muscle being studied, but was unique to each muscle in its presentation (Al-Shenqiti and Oldham, 2005 and Bron *et al.,* 2007).

Therefore the criteria utilized in this study for the identification of MFTPs included, the minimal criteria for identification of a MFTP (Gerwin *et al.*, 1997; Travell, Simons and Simons 1999; Chaitow and DeLany, 2000; Rickards 2006). These are noted as:

Minimal criteria:

- Taut palpable band.
- Exquisite spot tenderness / focal tenderness of a nodule in a taut band.
- Participant's recognition of pain / referred pain in the zone of reference.

Confirmatory Observations:

- Visual or tactile identification of local twitch response.
- Pain or altered sensation on compression of the tender nodule.
- Painful limit to full range of motion.
- Pain on contraction of the muscle.
- Weakness of the muscle.

For the diagnosis of MFTPs to be conclusive, all minimum criteria had to be present (Murphy, 1989; Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000). The presences of the confirmatory signs served to reinforce the diagnosis.

2.4.6 Impact of MPS

From the foregoing literature, it can be seen that pain believed to be of musculoskeletal origin is a common complaint in primary care (Han and Harrison, 1997) and is a major public health concern (Magni *et al.,* 1990; Blyth *et al.,* 2001; Elliott *et al.,* 2002; Blyth *et al.,* 2003; Eriksen *et al*., 2003; Cote *et al.,* 2004; Silverstein *et al.,* 2006; Lucas *et al.,* 2009). One explanation for this high reporting of musculoskeletal complaints is that these pain symptoms have a high MPS component (Mense and Simons, 2001; Dommerholt *et al*., 2006b; Cummings and Baldry, 2007; Lavelle *et al*., 2007; Lucas *et al.,* 2009). Thus, MFTPs are a real and imposing problem for patients that experience the limitations of their presence. This can be seen in the work of Gerwin (2010), who found that the days absent from work and expenditures for health care are greater for women than men (Rollman and Lautenbacher, 2001), with particular reference to pain of MFTP origin. Thus, over time, several authors have indicated that MFTPs are extremely common presenters to health care practitioners and is of multi-factorial origin (Gatterman, 1990; Hubbard, 1998; Blythe *et al.,* 2001; Elliott *et al.*, 2002; Eriksen *et al*., 2003; Cote *et al.*, 2004; Porterfield and de Rosa, 2004; Dommerholt *et al.*, 2006b). This is particularly true of work-related injury (Roffey *et al.*, 2010a; Roffey *et al*., 2010b; Roffey *et al.*, 2010c; Roffey *et al.*, 2010d; Roffey *et al*., 2010e; Wai *et al.*, 2010a; Wai *et al.,* 2010b), which has been noted as the second most common reason for visits to physicians (Hubbard, 1998; Cote *et al.*, 2004; Dommerholt *et al.*, 2006b).

In the above context and when considering shoulder pain, it is noted that it is a significant cause of morbidity, and is the third most common cause of musculoskeletal consultation in primary care (Dinnes *et al.,* 2003). Surveys have estimated the prevalence of self-reported shoulder pain at 14.4% in adults of working age (Walker-Bone *et al.,* 2004; Hains *et al.,* 2010), 16% in the general UK population (Urwin *et al.*, 1998), at 21% in the Dutch population (Bongers, 2001) and up to 26% in the elderly populations (Vecchio *et al.,* 1995). Furthermore, it has been suggested that these figures may be an under-representation as it has been suggested that only 40–50% of people with shoulder pain consult a general practitioner (Bongers, 2001; Dinnes *et al.,* 2003), which agrees with Hains *et al.,* (2010) who indicate that at least 50% of people have shoulder pain at least once a year and more recently it has been estimated that the prevalence ranges from 5 to 47% (one year prevalence) (Luime *et al.,* 2004; Kuijpers *et al.,* 2006) and a lifetime prevalence of 7% – 67% (Luime *et al.,* 2004). Additionally, up to 12% of patients seen at chiropractic practices in New South Wales (Australia), were noted to have shoulder problems (Pribicevic *et al.,* 2009).

The prevalence was also noted to be more common in females (although marginally so (Luime *et al.,* 2004), which is in contrast to Silverstein *et al.,* (2006) findings. They noted that there was a higher prevalence in men (although slight), but that females reported higher symptoms. It is possible that the Silverstein *et al.,* (2006) study focused on signs and not symptoms as was evident from previous reviews (Luime *et* *al.,* 2004), or it may be related to the occupation(s) of patients under study which may preference a particular gender (van Rijn *et al.*, 2010).

Therefore, it is reasonable to assume that patients performing repetitive tasks involving the shoulder, would be more susceptible to reflecting a higher prevalence and, therefore, also a higher risk for associated morbidity (Bron *et al.,* 2011). It must also be considered that only 59% of shoulder complaints resolve in 12 months (van der Windt *et al.,* 1996). Thus, this researcher looked at swimmers as a focus for this study.

2.5 Swimming

Swimming is defined as movement or propulsion through water using one's arms and legs without the necessity for artificial apparatus (Oxford Dictionary, 2011). Thus, swimming is an activity that can be a useful cardiovascular exercise (Allegrucci *et al.,* 1994), recreational activity (Oxford Dictionary, 2011) and / or a competitive sport (Allegrucci *et al.,* 1994). In this context, the maximization of human swimming performance is dependent on three main goals, which include (Caspersen *et al.,* 2010):

- the ability to create propulsion,
- reduction of drag and
- The restraint of physiological cost to the swimmer.

In this context, competitive swimming is a very time intensive sport for which an elite swimmer must practice between 20–30 hours per week / or 3-4 hours per day (Bak, 1996). This converts to an elite swimmer performing on average about 500,000 strokes revolutions per arm per year (Richardson, 1999) / 35 000 to 40 000 arm strokes per week(Jones, 1999) or swimming an average distance of 8 000 to 20 000 metres per day, thus placing a swimmer at risk of repetitive strain injuries (Riemann, Witt and Davies, 2011). Thus it is common that shoulder pain is the most frequent musculoskeletal problem among these athletes (Ciullo and Stevens, 1989; Bak, 1996). The prevalence of shoulder pain has been reported to be as high as 80% in competitive swimmers (Rupp, 1995). The term ''swimmer's shoulder'' is commonly used to refer to the constellation of shoulder complaints in competitive swimmers without reference to aetiology (McMaster *et al.,* 1998). Although this term is usually synonymous with impingement syndrome/ instability (Wang and Flatow, 2005) and rotator cuff tendonitis, it is becoming increasingly more evident that swimmer's shoulder consists of a variety of conditions that affect swimmers and other overhead athletes (McMaster, 1999).

Recognizing range of motion and muscular imbalances in the upper extremities of competitive swimmers may aid in reducing and preventing injuries to the shoulder joint.

In general, swimming injuries tend to be predominately overuse injuries (Shamus and Shamus, 2001); with the shoulder complex being most commonly affected (Shamus and Shamus, 2001). This is attributed to the highly repetitive nature of swimming (usually irrespective of the swimming stroke), which places the shoulder joint in extremes of range of motion (Yanai and Hay, 2000; Blanch, 2004), while still generating significantly strong muscle contractions to sustain the forward propulsion through the water and its resistance (Johnson *et al.,* 1987; Moore and Dalley, 1999). In contrast to the above, Rodeo (1999) indicates that repetitive strain injuries also occur as a result of specific technique requirements within a particular swimming stroke. Thus, the unique factors associated with the stroke as well as the repetitive nature of the swimming actions seem to be the two most important factors that influence the type and degree of injuries with which patients present (Sutherland, 2008). Further to this and compounding the relationship of stroke and repetition (Shamus and Shamus, 2001) are factors related to the swimmer (intrinsic) (Lysens *et al.,* 1991) and those factors related to environment within which the swimmer trains (extrinsic) (Sutherland, 2008).

An example of the above can by cited from O'Donnell *et al.,* (2005), who indicated that shoulder pain in swimmers can be as a result of a number of contributing factors including (but not limited to):

- The swimmer's gender,
- The swimmer's experience,
- The swimmer's level of appropriate nutrition and other physical characteristics,
- The swimmer's psychological characteristics,
- The training distance,
- The workout intensity,
- The stroke choice,
- Concomitant upper extremity weight training,
- Concomitant stretching and /or
- Use of hand paddles or other aides in training regimes.

2.5.1 Intrinsic Factors

Generally the intrinsic injury risk factors relate to the swimmer's individual physical and psychological characteristics (Lysens *et al.,* 1991; O'Donnell *et al.,* 2005).

An example of a physical characteristic would be the age of the swimmer, as swimmers tend to vary between 9 and 41.5 years of age (Stocker *et al.,* 1995; Pieper and Schulte, 1996; Richardson, 1999; Capaci *et al.,* 2002; Fernandez and Pollard, 2004; Tovin, 2006; Cooper *et al.*, 2007). In these studies it has been noted that an increase in age is statistically significantly with regards to the clinical presentation of pain and related dysfunction (Rodeo, 1999; Capaci *et al.,* 2002). It has been suggested that this link is related to *muscle endurance*, as muscle endurance is important for swimming performance (Shamus and Shamus, 2001). This is supported by Pieper and Schulte (1996), Jones (1999), Grote *et al.,* (2004) and Fernandez and Pollard (2004), who indicate that rest is beneficial for pain and dysfunction, but also leads to deconditioning which may make the swimmer's dysfunction more complex, particularly if they are expected to suddenly increase their training time or demands. Furthermore, Pieper and Schulte (1996) and Fernandez and Pollard (2004) found a correlation between *muscle imbalances, muscle endurance and chronic musculoskeletal injuries* in older elite swimmers, which may be compounded in swimmers with pain and dysfunction particularly if they take periods of rest followed by sudden increases in demand (Sahrmann, 2001).

In addition to age, the unequal demands of the various swimming strokes, as well as the development of pain and dysfunction generally results in a swimmer developing protective posture (where some muscles are *taut* and others become *lax*) resulting in poor posture. Ferrell (1999) described the swimmer's posture as "broad-shouldered athletes with a hyperkyphosis, hyperlordosis and recurvaturm body habit". These musculoskeletal changes have been associated with pre-existing *muscle imbalances* and continued *muscle imbalances* re-inforced by the swimming action (Pieper and Schulte, 1996; Fernandez and Pollard, 2004). The incorrect posture is further developed through incorrect technique or errors in the stroke biomechanics, or through the development of "protective" responses to insulate themselves from pain or dysfunction, which further predisposes the swimmer to injury (Stocker *et al.,* 1995; Shamus and Shamus, 2001; Capaci *et al.,* 2002; O'Donnell *et al.,* 2005; Tovin, 2006; Cooper *et al.*, 2007). Correction of incorrect swimming technique is an adaptation by the swimmer to minimise drag and as a result, has been shown to aid in decreasing overuse injury (Jones, 1999; Kammer *et al.,* 1999; Sahrmann, 2001).

Another important key intrinsic risk factor is the swimmer's nutrition (Costill *et al.,* 1992; Ousley-Pahnke *et al.,* 2001; Litzenburg, 2006). Swimmers generally require a balanced diet with a sufficient energy intake that meets their activity demands (viz. competition versus normal daily activities) (Ousley-Pahnke *et al.,* 2001; Litzenberg, 2006). Without a balanced diet, *muscle fatigue* increases, which reduces *muscle function*, predisposes to injury and can negatively impact on a swimmers performance (Shamus and Shamus, 2001).

2.5.2 Extrinsic Factors

In contrast to the intrinsic factors, extrinsic risk factors relate to the type of activities that the swimmer is involved in (viz. training regime (both in pool and out of pool); the equipment they use and the environmental conditions the swimmer is exposed to whilst training (Lysens *et al.,* 1991)). This therefore includes but may not be limited to (Johnson *et al.,* 1987: McMaster and Troup 1993; Pieper and Schulte, 1996; Jones, 1999; Kammer *et al.,* 1999; Rodeo, 1999: Shamus and Shamus, 2001; Fernandez and Pollard, 2004):

- Training regimes; which include poorly planned and executed training programmes,
- Poor / uncorrected stoke biomechanics,
- To many swimming races / galas,
- Swimming at the incorrect events or in adverse conditions,
- Incorrect use of hand paddles and kickboards or other training aids,
- A sudden increase in the volume of training (distance swum) or the number of hours of training (duration) and / or
- A sudden change in the calibre of swimmer.

The development of pain and dysfunction are either precipitated by these factors in isolation or in combination (Johnson *et al.,* 1987; Stocker *et al.,* 1995; Capaci *et al.,* 2002; Tovin, 2006; Cooper *et al.*, 2007).

2.5.3 Swimming Injuries

With regards to the intrinsic and extrinsic factors, swimming injuries seem to be caused and perpetuated by the repetitive overuse of certain muscles (Johnson *et al.,* 1987: McMaster and Troup 1993; Pieper and Schulte, 1996; Jones, 1999; Kammer *et al.,* 1999; Rodeo, 1999; Shamus and Shamus, 2001; Fernandez and Pollard, 2004). The shoulder complex is the most common site of injury (McMaster and Troup, 1993; Riemann, Witt and Davies, 2011), where knee pain has been ranked as the second most common (although more common in breaststroke) (Rovere and Nichols, 1985; Rodeo, 1999). The least reported complaint is back pain (Ferrell, 1999), which according to Ferrell (1999), seems to be limited mostly to butterfly and backstroke swimmers. Such injuries are thought to be as a result of intrinsic factors such as *muscle imbalances, weakness, fatigue* and *poor flexibility*, which are compounded by extrinsic factors (predominately poor technique) (Johnson *et al.,* 1987; Kammer *et al.,* 1999; Rodeo., 1999; Capaci *et al.,* 2002; Sahrmann, 2001; Shamus and Shamus, 2001; Grote *et al.,* 2004).

2.5.4 Commonly reported injuries of the lower limb

Swimmers complain most often of knee pain, particularly the medial aspect of the knee (Rodeo, 1999). This can occur in any of the four swimming strokes but is commonly experienced by breaststroke swimmers and is principally as a result of repetitive action (Rodeo, 1999). Commonly referred to as “breaststroker’s knee”, usually represents a chronic medial collateral ligament sprain (Rodeo, 1999; Shamus and Shamus, 2001).

Following from knee pain, breaststroke and individual medley swimmers sometimes experience hip or groin pain due to the repetitive stress, particularly at the end of the powerful kick, which places stress on the hip adductor muscles (Grote *et al.,* 2004).

In terms of the foot, the degree of plantarflexion that is required during swimming determines the best position for the propulsive phase of different kicking styles (Johnson *et al.,* 1987). Therefore, a greater degree of ankle flexibility is required of swimmers, particularly breaststroke swimmers (Johnson *et al.,* 1987). With this stress, tendonitis of the foot and ankle is reported, but it is still not as common as shoulder or knee injuries; however, it may still considerably affect a swimmer's performance (Johnson *et al.,* 1987). As a result of compensation techniques in mild ankle sprains and foot contusions may result (Kammer *et al.,* 1999).

2.5.5 Commonly reported injuries of the upper limb

Although less common than shoulder injuries, elbow injuries in swimming are generally as a result of repetitive overuse and incorrect swimming techniques (Sutherland, 2008). The most common elbow injuries in swimmers are triceps muscle strains and synovitis. The latter generally results from the elbow being forced into full extension during backstroke (Kammer *et al.,* 1999), whereas the former, which presents as pain on resisted contraction of the triceps muscle (Shamus and Shamus, 2001), results from swimmers being encouraged to swim with a high elbow position during the pull phase (mostly in freestyle). These also predispose swimmers to increased stress on the medial collateral ligament of the elbow, principally as a result of aberrant shoulder and therefore elbow mechanics (Kammer *et al.,* 1999). However, by dropping the elbow in the pull through phase decreases the efficiency of the stroke and increases the stress on the shoulder joint (Kammer *et al.,* 1999; Richards 2008).

As a result, shoulder injuries are the most common musculoskeletal complaint in competitive swimmers (most commonly the freestyle, backstroke and butterfly stokes) (Johnson *et al.,* 1987; Ramsi, 2004; Riemann, Witt and Davies, 2011), associated with long-term overuse and repetitive microtrauma (Kammer *et al.,* 1999; Sein *et al.*, 2008). "Swimmer's shoulder" is the most common overuse injury in swimming and involves inflammation of the supraspinatus and biceps tendons with possible glenohumeral instability (Kammer *et al.,* 1999).

2.5.6 "Swimmer's shoulder"

According to Ramsi (2004), it has been documented that 38% to 75% of competitive swimmers have experienced shoulder pain in some form that has disrupted either practice or competition at least once in their swimming careers. Most of these injures have been linked to the *integrity and balance of the internal or external rotator muscles* of the shoulder.

With particular reference to freestyle (as an example), there seem to be *imbalances* as a result of the propulsive phase of the freestyle swimming action and includes the recruitment of muscles such as the pectoralis major and latissimus dorsi muscles. These muscles propel the body by producing internal shoulder rotation and shoulder extension simultaneously (Pink *et al.,* 1991). Whereas in the recovery phase of the swimming stroke, external rotation occurs with activation of the external shoulder rotators such as the infraspinatus muscle to place the arm in the appropriately for the next cycle (Pink *et al.*, 1991). These cycles and repetitive actions result in *imbalances* between the internal and external rotator muscles (Kibler *et al.,* 1996; Bak and Magnusson, 1997; Bigliani *et al.,* 1997; Kibler *et al.,* 2001; Ellenbecker, *et al.,* 2002; Ozcaldiran, 2002). This becomes particularly problematic when the swimmer favours one arm as a result of the stroke swum and / or the swimmer has a noted hand dominance (Potts *et al.,*2002) and / or as a result of the swimmer preferring a particular side for breathing (Potts, *et al.,* 2002; Whiteley, *et al.,* 2009; Riemann, Witt and Davies, 2011).

Thus the results of these studies suggest that despite equal repetitive movements in both limbs (right versus left; upper versus lower), swimmers *may not adapt bilaterally in terms of their power output*. Therefore, it is reasonable to speculate that competitive swimmers may show similar side imbalances for shoulder range of motion (Sahrmann, 2001; Ramsi, 2004) whether they are *symptomatic or not symptomatic* (Riemann, Witt and Davies, 2011).

2.5.6.1 Definition and characteristics

"Swimmer's shoulder" or shoulder ***pain*** in swimmers was initially referred to as an 'impingement syndrome' (Hawkins and Kennedy, 1980), which described the symptoms of a shoulder dysfunction as a result of impingement of the long head of biceps and/or supraspinatus tendons against the coracoacromial arch (Neer, 1972; Ciullo, 1986). This mechanical irritation and associated avascularity of the region is thought to lead to microtrauma (Sein *et al.*, 2008) resulting in focal degeneration (Rathbun and McNab 1970; Hawkins and Kennedy, 1980; Penny and Smith, 1980).

More recently, Belling-Sorensen and Jorgensen (2000), defined swimmer's shoulder / dysfunction as a primary impingement (when the subacromial space is decreased for anatomical reasons (viz os acromiale or osteophytes)) and secondary impingement (when the impingement that is related to 'instability' of the shoulder (or glenohumeral joint)) (Wang and Flatow, 2005). In this context, Belling-Sorensen and Jorgensen (2000) have adapted the definition of Matsen, Harryman, and Sidles (1991), who defined instability of the shoulder as a structural and / or functional deficit that causes pathological translation of the glenohumeral joint. The latter, then results in hyperangulation, and / or excessive rotation of the glenohumeral joint.

As a result of these definitions, it can be seen that most swimmers with shoulder pain will experience secondary rather than primary impingement (unless age related changes are present). This is principally because swimmers tend to use the extremes of shoulder motion during the swim strokes (Belling-Sorensen and Jorgensen, 2000; Yanai and Hay, 2000; Yanai, Hay and Miller, 2000) and, therefore, will be susceptible to problems of hyperangulation and excessive rotation at the glenohumeral joint. This contribution of excessive translation, rotation, or hyperangulation is also related to *change within the neuromuscular system*, which has to *compensate for this hypermobility* (McMaster *et al.,* 1998; McMaster, 1999; Weldon and Richardson, 2001). In the long term there are also changes in the neuromuscular system as seen in *muscle tightness*, the amount of *muscle activation* (Rouard and Clarys, 1995), and the temporal *patterning of muscle contraction*, which have subsequently all been implicated in shoulder pain (Rouard and Clarys, 1995; Blanch, 2004).

Along with the shoulder pain, swimmers often display a round-shouldered forward-headed posture. This colloquially is interpreted as the swimmer having increased strength and tightness of all the anterior musculature such as the pectorals muscles and subscapularis muscles (Sobel, 1995; Blanch, 2004) and a lengthening and weakness of all the posterior musculature such as the rhomboid muscles and the infraspinatus muscles (Ayub, 1991). This colloquial understanding however, is incorrect, in face of the fact that with scapular protraction and internal rotation, there are usually thoracoscapular (i.e. pectoralis minor muscle, rhomboid muscle) and thoracohumeral (i.e. pectoralis major muscle and latissimus dorsi muscle) shortening anteriorly and lengthened posteriorly (Blanch, 2004; Fernandez and Pollard, 2004). However, at the glenohumeral level, with the shoulder girdle internally rotating, the change in scapula position requires that the glenohumeral joint rotates externally, to maintain the swimmer's hands facing forward (Blanch, 2004). This means that the anterior glenohumeral muscles (i.e. subscapularis muscles) will be in a lengthened position and the posterior musculature (i.e. infraspinatus muscles) will be in a shortened position (Pink *et al.,* 1991; Scovazzo *et al.,* 1991; Fernandez and Pollard, 2004). Thus, the long term effect of this posture has implications to *tightening of the posterior shoulder* (not only the capsule but also the muscles) leading to *restrictions of glenohumeral internal rotation* and possibly causing anterior translations of the humeral head during movement (Ludewig and Cook, 2000). To complicate this, the shoulder girdle *muscle fatigue* has been shown to alter *scapulothoracic kinematics* (McQuade *et al.,* 1995; Tsai *et al.,* 2003). However, it is not clear whether muscle fatigue results in increased (McQuade *et al*., 1998) or decreased scapular upward rotation (McQuade *et al.,* 1995; Tsai *et al.,* 2003). These studies have been widely referred to in more recent studies (Bak and Magnusson, 1997), reviews (Weldon and Richardson, 2001), and have been used as a basis for clinical management (Pink and Tibone, 2000).

In addition to the above, even at the highest levels of swimming, whilst there will be similarities in presentation, different athletes will have quite distinctive and different stroke patterns (Blanch, 2004). With the variation in kinematics, it necessitates that there have to be differences in muscle activation and activity (Pink *et al.,* 1991).To this end; Scovazzo *et al.,* (1991) published a comparison with the data of Pink *et al.,*

(1991) which indicated *differences in muscle activity between normal and painful shoulders*. The painful shoulders in particular had (Blanch, 2004):

- Decreased activity in the rhomboid muscles, upper trapezius muscles, anterior and middle deltoid muscles at hand entry,
- Decreased activity in the serratus anterior muscles during pulling,
- Decreased activity in the anterior and middle deltoid muscles at hand exit, and
- Decreased activity in the subscapularis muscles in mid-recovery of the swimming cycle.

In contrast, there was increased activity of the painful shoulders in the rhomboid muscles during pulling and the infraspinatus muscles at hand exit of the swimming stroke (Scovazzo *et al.,* 1991). Most research seems to explain these changes as a result of swimmers avoiding the Neer impingement position due to pain (Blanch, 2004; Roy *et al.,* 2008). However, reviews have also indicated that *EMG changes in muscles* are seen between swimmers with and without shoulder pain and, therefore, muscle dysfunction may be the cause of the Neer impingement pain and not the inverse (David *et al.,* 2000; Pink and Tibone, 2000; Roy *et al.,* 2008). This would support the suspicion that MFTPs play a role in the development of swimmer's shoulder, particularly when one considers the concomitant scapular dysfunction (Wadsworth, 1997; Cools *et al.,* 2007). However, it must be remembered that these assertions are at this stage a hypotheses to still be tested.

2.5.6.2 Clinical diagnosis of "Swimmer's shoulder"

The clinical ability to assess the small variances in *muscle activation, activity* and therefore *function* is difficult in practice (Sahrmann, 2001). Therefore, when it comes to examining patients with regard to muscle dysfunction or pathology, the clinician needs to rely on "patterning" and observation of movement patterns often through assessing the scapulohumeral rhythm (Blanch 2004; McKenna *et al.,* 2004), shoulder motion (Reider, 1999; Magee, 2006), capsular patterns (Reider, 1999; Magee, 2006) and measures of muscle form (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000) with side to side component comparisons as a benchmark (Reider, 1999; Magee, 2006). Most of these assessments, therefore, require the clinician to observe the swimmer in different postures, poses and / or movements (Blanch, 2004; Reider, 1999; Magee, 2006). However, there has been limited research to support the outcomes of highly specific observational analysis (Blanch, 2004). Therefore, it must be questioned in the light of reliability and repeatability before even contemplating the validity (Bagg and Forrest, 1988; Sugamoto *et al.,* 2002) of these observational assessments. Thus, it has been suggested that assessing MFTPs may be a better and more reliable manner in which to determine muscle dysfunction (Sahrmann, 2001; Al-Shenqiti and Oldham, 2005), which can then be confirmed with the additional tests done (Blanch 2004; Reider, 1999; Magee, 2006; McKenna *et al*., 2004) to obtain a conclusive diagnosis. These latter suggestions seem to hold some validity when one compares the presentation of swimmer's shoulder to the presenting signs and symptoms of MFTPs (see Table 2.4 below).

Table 2.4 Comparison of MFTPs and the presentation of "Swimmer's shoulder"

Comparison of latent and active ***MFTPs*** (compiled from Travell, Simons and Simons, 1999; Chaitow and DeLany, 2003; Dippenaar, 2003; Wilks 2003).		***Swimmer's shoulder*** (compiled from Blanch 2004; Reider, 1999; Magee, 2006; McKenna *et al*., 2004)
Latent MFTPs	**Active MFTPs**	**Signs and Symptoms**
Similarities		
Decreased range of motion.	Decreased range of motion.	Changed kinematics, restrictions, altered muscle contraction patterns or muscle activation patterns.
Muscular stiffness.	Muscular stiffness.	Muscle tightness.
Local twitch response.	Local twitch response.	Usually not perceived by the patient.
Decreased muscle stretch.	Decreased muscle stretch.	Muscle tightness / muscle imbalances.
Non optimal muscle contraction.	Non optimal muscle contraction.	Altered power, increased muscle fatigue.
Pain on muscle contraction.	Pain on muscle contraction.	Altered power, perception of pain.
Differences		
Localized pain on ischemic compression.	Localized and referred pain on ischemic compression.	Patient could be symptomatic or asymptomatic: Pain / discomfort if present and is reliant on the stage of the swimmer's shoulder girdle dysfunction pathogenesis.
No spontaneous pain referral.	Spontaneous pain referral.	Patient could be symptomatic or asymptomatic: Pain / discomfort if present and reliant on the stage of the swimmer's shoulder girdle dysfunction pathogenesis.
Recognition of a vague / previous pain.	Recognition of current pain.	Patient could be symptomatic or asymptomatic: Pain / discomfort if present and reliant on the stage of the swimmer's shoulder girdle dysfunction pathogenesis.

With this large overlap between swimmer's shoulder and MFTPs, it is important to highlight the necessity of a precise diagnosis, and an accurate determination of the patient's current / presenting clinical symptoms. Differences in these parameters may or may not determine different treatment intervention programmes (Santos *et al.,* 2007), with resultant variations in the outcomes of the patients complaint, both in the short and the long term.

2.5.6.3 Treatment

With the statement of Santos *et al.,* (2007) in mind, as well as the forms of assessment (Wang and Flatow, 2005), both have a bearing on the treatment of swimmer's shoulder as it would imply that muscle dysfunction needs to be assessed and treated / managed in order to ensure that the swimmer does not develop pain and if they are in pain have a decreased chance of recurrence (Almeida *et al.,* 2011).

This is at odds with the treatment defined in the literature for swimmer's shoulder, which generally highlights conservative care (Allegrucci *et al.,*1994; Binder-Macleod *et al.,* 1998), with the main goals being to reduce the pain and control the inflammatory process in the first instance; prior to strengthening, stretching and improving the stability of the glenohumeral joint, returning the patient to the correct posture and then returning the athlete to their sport at a level comparable to their pre-injury level (Kenal and Knapp, 1996;Weldon and Richardson, 2001; Wang and Flatow, 2005; Almeida *et al.,* 2011). This is outlined in the tables below as taken from Kibler *et al.,* (2001) and Akuthotha *et al.,* (2004) and concurs with Bang and Deyle (2000), Coppieters *et al.,* (2003), Bergman *et al.,* (2011).

Management of shoulder dysfunction in elite athletes is very different due to techniques, training routines, activity level, fitness level etc. When compared to shoulder dysfunction in the general public, management strategies are different due to the factors mentioned above.

Table 2.5 Principles of shoulder rehabilitation (as taken from Kibler et al., 2001)

Table 1: General Principles of Shoulder Rehabilitation

- Make a specific diagnosis
- Identify biomechanical deficits
- Start pain reduction early and reduce compensation patterns
- Restore pain-free ROM
- Start pain-free exercise and avoid impingement
- Integrate the kinetic chain:
  - Initiate closed chain (early) with hand fixed; use cocontraction of scapular stabilizers
  - Initiate open chain (late) with hand moving; use resistive bands, free weights, machines
- Promote scapular stabilization
  - Serratus anterior
  - Trapezius
  - Rhomboids and levator scapulae
- Achieve 90° of abduction early and restore normal throwing motor patterns
- Think functionally
  - Use plyometrics and other sport-specific activities
  - Use isolated rotator cuff exercises should be used last

Table 2: Shoulder Rehabilitation Guidelines and Protocol

- Initial phase (pain control)
  - Reduce pain and inflammation; promote tissue healing
    - Relative rest
    - Modalities
    - Medications (NSAIDs, steroid injection)
    - Surgery
  - Reestablish passive ROM
    - Pendulum exercises
    - Manual treatments
    - Posterior capsule stretching and mobilization
  - Retard muscle atrophy and promote scapular control
    - Isometric to rotator cuff and scapular stabilizers (scapular pinch)
    - Closed kinetic chain exercises
  - Maintain fitness of the rest of the kinetic chain
- Reactivation phase (correct imbalance in flexibility and strength)
  - Reestablish active ROM
    - Active-assisted using wand
  - Promote scapular control and kinetic chain of upper extremity
    - Proprioceptive neuromuscular facilitation
    - Advance closed kinetic chain exercises
    - Modified push-ups
  - Promote force generation
    - Plyometrics
    - Open kinetic chain
    - Integrated exercise with lower limbs
- Maintenance phase (functional adaptations)
  - Add additional planes of movement (eg, diagonals)
  - Add high-level plyometrics
  - Promote sports-specific activity

NOTE. Data from Kibler et al.[11]
Abbreviation: NSAIDs, nonsteroidal anti-inflammatory drugs.

With particular reference to the shoulder strengthening exercises for swimmers (as noted in Table 2.5 above), it would seem that the exercises are mainly directed at the stabilizers of shoulder girdle and in particular the glenohumeral joint; particularly as muscle imbalance in the scapulohumeral musculature is believed to be an important contributing factor to injuries among swimmers (Allegrucci *et al.,* 1994; Johnson *et al.,* 2003; O'Donnell *et al.,* 2005). To this end, a number of studies report the effects of exercise on postural correction in swimmers. Kluemper *et al.,* (2006) and Lynch *et al.,* (2010) demonstrated that strengthening exercises combined with stretching are capable of improving posture in swimmers with regard to the forward head posture and protraction of the shoulders.

However, manual therapy is mainly based on the individual swimmer and overall status of the patient and does not merely consider the pathological condition (Almeida *et al.,* 2011). This implies that a significant portion of the treatment and rehabilitation process is directed at the dysfunctional muscles and according to Almeida *et al.,* (2011) further studies need to clarify the effects of manual therapy on shoulder pain and disability (Almeida *et al.,* 2011). This indicates that manual therapy and it's effects on shoulder pain and disability should be explored further.

Almeida *et al.,'s* (2011) concern for further studies raises the question of whether the current interventions are actually targeting the muscles as the principle cause of the problem or whether swimmer's shoulder is being targeted only when the swimmer presents with pain. This question, at this time point, cannot be fully explored, as it firstly needs to be determined whether MFTPs in muscles are actually part and parcel of the clinical picture or not; and in this context an entity that can be identified simply and expediently in clinical practice. Therefore, we need to effectively understand the role that the shoulder girdle muscles play at the various stages of pathogenesis of swimmer's shoulder (Almeida *et al.,* 2011).

Therefore, the aim of this research is to map MFTPs in participants that swim and do not swim, in order to determine whether a particular combination of MFTPs exists in swimmers. The data extracted from this study will be triangulated in order to assess the correlations between the clinical features of MFTPs (as measured by the features noted in literature (Al-Shenqiti and Oldham, 2005)), the clinical syndrome with which the patient presents (measured with the NRS and the shoulder disability questionnaire) and the patient's physical attributes (viz. swimmer versus non-swimmer).

Chapter Three
Materials and Methods

3.1 Introduction

This chapter is structured so as to outline the materials and methods utilized in obtaining the data for this study and the analysis of the data through various statistical methods.

3.2 Study Design

This study was a cross-sectional, observational study that required the comparison of two groups of participants with MFTPs. Participant self-selection (response to advertisements) was used in this study; however, strict criteria were used to ensure homogeneity of each group (swimmers and non-swimmers). Only those participants meeting the inclusion criteria were admitted into the study, based on a telephonic or face to face interview.

Once admitted into the study (by telephonic interview), the participants were required to attend an appointment at the Chiropractic Day Clinic (CDC) or at an agreed to off-site (non-campus) facility, in order for the researcher to take the required measurements (as outlined in Section 3.7 below). The research was a clinical assessment that contained both an objective (algometer readings, myofascial diagnostic scale and MFTP mapping) and subjective (Numerical Pain Rating Scale (NRS) and Shoulder disability index (SDI) readings) component.

Therefore, the approach to the study was an exploratory, mixed-method analysis and in this context it was approved by the Durban University of Technology, Faculty of Health Sciences Research Committee and the Ethics Review Board. This approval declared that the research conformed to the standards set by the Helsinki Declaration of 1975 (Johnson, 2005). To this end, an ethics clearance certificate form was issued by the Institutional Research and Ethics Committee (Appendix K).

3.3 Advertising

The researcher advertised (Appendix H) to recruit research participants. The advertisements were placed on public notice boards at the DUT, public libraries and other places of communal gathering, where there was a higher likelihood for people to be exposed to the advertisement.

3.4 Telephonic interview and preliminary screening

On response to the advertisement, the potential participant was asked the following questions:

Table 3.1 Telephonic interview

		Required response
1	“What is your age?”	Between 14-35 years of age.
2	“Do you classify yourself as a competitive swimmer or a recreational swimmer?”	Either answer is acceptable as this will be used to allocate the potential participant to their most appropriate group.
3	“What level of swimming do you participate in?”	Any answer is acceptable as this will be used to allocate the potential participant to their most appropriate group.
4	“How many galas (minor qualifying events) have you participated in the last year?”	Any answer is acceptable as this will be used to allocate the potential participant to their most appropriate group.
5	“Have you participated in any provincial, national or international galas?”	Any answer is acceptable as this will be used to allocate the potential participant to their most appropriate group.
6	“If you had to average the number of hours you swim over the year into the number of hours that you swim weekly. What would that average be?”	Any answer is acceptable as this will be used to allocate the potential participant to their most appropriate group.
7	“Do you do less than 2 hours per week of sporting activities?”	Swimmer >4 hours per week. Non-swimmer < 2 hours swimming per week (to delineate a recreational swimmer). Non-swimmer >4 hours per week (any athletic activity other than swimming).

3.5 Sample

3.5.1 Sample Size

A review of local swimming clubs indicated that on average each club had between 50 and 450 members of which it was estimated that between 20% and 30% were eligible for this study (viz. 10 – 90 per club in each of 5 clubs) (www.beaverswimclub.co.za/, 2011; www.swimmersden.com/, 2011; www.savagesac.co.za, 2011; www.vac.co.za, 2011). As a result of this as well as statistical (*a priori* power analysis) (Hammond, 2011) and budgetary considerations, a minimum of 80 participants were required for this study (40 swimmers and 40 non-swimmers). In addition, this number also made allowance for any participants that elected to withdraw from the study (Mouton, 2006).

3.5.1.1 Sample Allocation / Method

The participants were allocated to one of two groups – viz. a swimmers group or a non-swimmers group, according to their meeting the inclusion criteria outlined in Section 3.5.1.2.1. This was a purposive form of allocation (Mouton, 2002; Mouton, 2006) as the study requires these comparator groups.

3.5.1.2 Sample Characteristics

3.5.1.2.1 Inclusion criteria

- Both groups - 14 to 35 years of age for purpose of homogeneity (Mouton, 2002; Mouton, 2006).
- Swimmers group (Moreira, Palmares, Lopes and Delgado, 2011; Riemann, Witt and Davies, 2011):
  - Participants were required to be competitive swimmers, defined as participants having had competed in:
    - A minimum of three minor qualifying events (these included age group galas) and
    - Natal Championships (or any other equivalent event) and/ or
    - One National event or one International event, and / or a combination of the above.
  - Additionally swimmers were required to swim four hours or more per week throughout the year, or average of over four hours per week, if seasonal swimmers.

- Non-swimmers group
  - Anyone who did not participate in galas as noted for the swimmers group.
  - Anyone who did less than an average of two hours of swimming per week.
  - Anyone who participated in any other form of exercise except for swimming.
  - This group was required to be athletically active as this ensured that the group would have a comparable muscle tone and functionality (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000; Fernandez-de-las-Penas *et al.,* 2010), to compare against the swimmer group.

3.5.1.2.2 Exclusion criteria

- Anyone who had had surgery to the upper extremities and / or neck was excluded from the study (Chaitow and DeLany, 2000; Terry and Chopp, 2000; Chaitow and DeLany, 2003).
- Anyone who had had macro-trauma to the upper extremities and / or neck was excluded from the study (Chaitow and DeLany, 2000; Terry and Chopp, 2000; Chaitow and DeLany, 2003).
- Anyone who did no form of regular exercise.
- Swimmers (i.e. not the control group) who averaged less than four hours of swimming per week.

3.6 Procedure

After the potential participants, who had responded to the advert, were contacted by the researcher, a telephonic interview (or face to face interview - if the potential participant reported to the clinic to see the researcher) was carried out (as outlined in Section 3.4). If the telephonic criteria were met, then an appointment was made at the CDC or at an agreed to off-site (non-campus) facility to confirm their suitability for the study.

Chiropractic Day Clinic Procedure

On arrival at the CDC, the potential participant was attended to by the CDC reception staff and / or the researcher. Once the researcher and potential participant had made their way to the CDC consultation room, the researcher handed the potential participant the Letter of Information / Letter of Assent as was pertinent to this study (Appendix A1; Appendix A2; Appendix A3). Once the potential participant had read the letter and asked any questions with reference to their participation in the study, the researcher asked whether the potential participant was prepared to participate and if so, it was requested of them that the Letter of Information / Letter of Assent (Appendix A1; Appendix A2; Appendix A3) be signed. If not, the potential participant was thanked for their time and escorted back to the CDC reception in order that they were able to make an appointment as an outpatient or be able to leave the premises.

Off-site procedure

On arrival at the off-site venue, the potential participant was attended to by the researcher. Once the researcher and potential participant had made their way to the off-site facility, the researcher handed the potential participant the Letter of Information / Letter of Assent as was pertinent to this study (Appendix A1; Appendix A2; Appendix A3). Once the potential participant had read the letter and asked any questions with reference to their participation in the study, the researcher asked if the potential participant was prepared to participate and if so requested that the Letter of Information / Letter of Assent (Appendix A1; Appendix A2; Appendix A3) be signed. If not, the potential participant was thanked for their time and escorted from the off-site venue in order to leave the facility.

The off-site process was supervised by the research supervisor, as this is a requirement of the Allied Health Professions Council of South Africa (Act 63 of 1982 (as amended)).

Permission was sought from the Offices of the City Manager (Appendix N) (once the proposal was approved by the Institutional Research Ethics Committee), as was done by Sutherland (2008).

After either (CDC or off-site) procedure had been completed and once the Letter of Information / Letter of Assent (Appendix A1; Appendix A2; Appendix A3) was signed, the participant was screened utilising the case history (Appendix B), physical (Appendix C) and regional [Appendices – cervical (Appendix D), shoulder (Appendix E) and thoracic (Appendix F)] examinations in order to ensure that the participant met all the required inclusion criteria.
Thereafter, each participant had their muscles manually palpated for MFTPs by the researcher, which could be verified by the research supervisor (it was noted that this assessment process may have increased researcher bias in

the study and future studies are suggested to include an independent observer). Muscles of the shoulder that were assessed were as follows:

- Trapezius muscle;
- Supraspinatus muscle;
- Infraspinatus muscle;
- Latissimus dorsi muscle;
- Teres major muscle;
- Teres minor muscle;
- Pectoralis major muscle;
- Pectoralis minor muscle;
- Triceps brachii muscle;
- Subscapularis muscle and
- Biceps brachii muscle.

The MFTPs of these muscles were located and mapped as determined by Travell, Simons and Simons (1999) and noted on the attached data collection sheets (Appendix J1; Appendix J2; Appendix J3; Appendix J4) for data collection purposes. It must be understood, however, that the map of muscles and their respective MFTPs would in fact create a unique map as a result of this research and may vary from that of Travell, Simons and Simons (1999).

At both the CDC and the off-site facility the student was supervised in the completion of the above research procedures, by either the CDC clinical staff or the research supervisor (Allied Health Professions Council of South Africa (Act 63 of 1982 (as amended))).

3.7 Measurements

3.7.1 Measurement tools

3.7.1.1 MFTP criteria

When MFTPs were found, the following criteria had to have been met:

The minimal criteria for identification of a MFTP according to Gerwin *et al.*, (1997), Travell, Simons and Simons (1999), Chaitow and DeLany (2002) and Rickards (2006) are as follows:

Minimum criteria:

- Taut palpable band.
- Exquisite spot tenderness / focal tenderness of a nodule in a taut band.
- Participant's recognition of pain / referred pain in the zone of reference.

Confirmatory Observations:

- Visual or tactile identification of local twitch response.
- Pain or altered sensation on compression of the tender nodule.
- Painful limit to full range of motion.
- Pain on contraction of the muscle.
- Weakness of the muscle.

For the diagnosis of MFTPs all minimum criteria had to be present (Murphy, 1989; Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000). The presence of the confirmatory signs served to reinforce the diagnosis. It was noted by Al-Shenqiti and Oldham (2005) that the Kappa statistics for intra-examiner reliability for the identification of clinical signs of MFTPs in the rotator cuff muscles of 51patients with rotator cuff tendonitis were as follows:

Spot tenderness	=	1
Jump sign	=	1
Pain recognition	=	1
Taut band	=	1
Referred pain	=	0.79-0.88
Local twitch response	=	0.75-1

The collective mean of the Kappa scores for all values was 0.92-0.98. This means that the clinical identification is clinically relevant, reliable and valid.

It is, however, noted that Al-Shenqiti and Oldham (2005) referred to intra-examiner, whereas Simons and Skootsky (1989) found that inter-rater Kappa-values were lower and indicated as: taut band = 0.29; spot tenderness = 0.61; local twitch response = 0.16; referred pain = 0.40; and recognized pain = 0.30. Thus, the overall reliability for the identification of MFTPs between examiners was poor. Therefore, Simons and Skootsky (1989) indicated that specific training could lead to substantial increases in reliability between examiners but, this hypothesis has not been tested.

Therefore, once found, the following data were recorded for purposes of this research:

- MFTPs *location* was noted and recorded.
- MFTPS *characteristics (active / latent)* were noted and recorded (a myofascial diagnostic scale (Appendix M) was used by Chettiar (2001) and Vaghmaria (2005).

3.7.1.2 Pain perception

The participant's *perceived level of pain* was noted on the numerical pain rating scale (NRS) (Liggins, 1982; Jenson *et al.,* 1986; Bolton and Wilkinson, 1998) (Appendix G). Procedure for the use of the NRS included:

▪ This is a subjective questionnaire whereby the participant estimated their levels of pain, indicating their pain levels at that time. It was chosen due to the ease at which it was administered and scored and has been found to be an accurate tool for the measurement of pain intensity in clinical trials (Jenson *et al.,* 1986).

▪ Before the objective readings were taken, the participant was asked to mark off a point on a 10cm line, between 0 and 100 noting at what point the pain was at its worst and likewise when the pain was at its least (with 0 indicating no pain and 100 indicating the worst pain ever experienced).

- The worst pain score and the least pain score were then added together and divided by two to obtain an average level of pain intensity experienced by the participant.

The MFTPs level of *tenderness*. An algometer (Fischer, 1986; Williamson and Hoggart, 2005) was utilised to measure tenderness. The algometer [FDK20 force dial by Wagner Instruments (Address: P.O. Box 1217 Greenwich, CT, 06836, U.S.A.)] was utilized to assess the level of their sensitivity and pain threshold. Procedure for the use of the algometer included:

- The dial was set to zero.
- The algometer was then placed over the MFTP with the metal rod being perpendicular to the surface of the skin.
- The participant was then instructed to express the point at which first discomfort was felt / perceived.
- Pressure was then applied with an increasing rate of 1kg/second as recommended by Fischer (1986).
- The procedure was halted once the participant expressed the point at which the first discomfort was felt / perceived (the pain threshold).
- The reading on the algometer was then recorded in kg/cm^2 (Appendix J3 and Appendix J4).

3.7.1.3 Functional Ability

The participant's level of *functional ability* (FXN) was recorded, utilizing a Functional Disability Scale (FDS) (i.e. clinical outcomes assessment scale for the shoulder (Matsen *et al.,* 1994; Yeomans, 2000).

- The FDS showed the degree of disability the participant had on a daily basis and in terms of activities of daily living (Appendix L).

After the subjective and objective assessments were performed, the participant was able to accept the free treatment voucher that was offered to them as having had participated in the research). However, any further treatment options were explained to them and if so chosen by the participants, they could attend the CDC as out patients.

3.7.2 Increasing reliability and validity

Dommerholt and Huijbrechts (2011) indicated that for a meaningful estimate of reliably for the diagnosing of MFTPs, an optimal study would have the following design features:

3.7.2.1 Examiner blinding

Examiner(s) should be blinded as to the condition of the participant and to any clinical information other than that which they would derive from their examination. This should be done, as without blinding, the study would not be a test of the clinical signs in question, because the other information may have been able to influence the examiner(s) (Lucas, 2007). In this study, although the primary examiner was not blinded, the second examiner was blinded (viz. the research supervisor).

3.7.2.2 Examiner training

It was also noted that in terms of Simons and Skootsky (1989), the examiners (researcher and research supervisor) trained before the actual data collection phase in order to improve inter-examiner reliability and allow for each examiner to ensure an understanding of a common template of assessment of the patient. In this research both the researcher and supervisor were trained to ensure consistency of approach in assessing MFTPs.

3.8 Measurement frequency and statistics

3.8.1 Measurement frequency

A single assessment of the participants MFTPs was required, so to have an accurate picture of the MFTPs at that point in time. The study design required that the participants be seen prior to participating in any form of activity for that day.

3.8.2 Statistical analysis

SPSS version 20 (IBM) was used to analyse the data. A p value <0.05 was considered as statistically significant.

Demographics of the participants were described using summary statistics such as mean, standard deviation and range for quantitative variables.

The Pearson's Chi-square or Fisher's exact tests were used to compare the frequency of the various characteristics between the two groups. The test can be used for individual characteristics or combinations of characteristics. If the combined number of participants is less than 40 then a correction factor (e.g. Yate's correction) was applied. Non-parametric Mann-Whitney tests were used to compare the continuous outcomes between the groups, since the outcomes were all significantly non-normally distributed.

Chapter Four

Results and Discussion

4.1 Introduction:

This chapter is set out so as to reproduce the findings achieved in this study. Although uncommon and as a result of the potential length of this chapter, it was decided to present both the results and the discussion of the results in the following encapsulated units:

- Data sources
- Objectives
- Abbreviations
- Consort diagram
- Results
  - Objective One
  - Objective Two and Three
- Summary and conclusion

4.2 Data sources

However, in order to understand the context of the study, it is necessary to indicate that with respect to the data collected for this study, the primary data was extracted from the following examination tools:

- Cervical spine regional (Appendix D),
- Shoulder regional (Appendix E),
- Thoracic spine regional (Appendix F),
- Numerical pain rating scale (NRS) (Liggins, 1982, Jensen *et al.,* 1986; Bolton and Wilkinson, 1998 / Appendix G),
- Algometer (Fischer, 1986; Williamson and Hoggart, 2005 / Appendix J3 and Appendix J4),
- Shoulder functional disability index(SDI) (Matsen *et al.,* 1994; Yeomans, 2000 / Appendix L) and
- Myofascial diagnostic scale (Chettiar, 2001; Vaghmaria, 2005 / Appendix M).

The secondary data was obtained from books, journals, conference proceedings, dissertations, theses, commentaries, letters to editors as well as personal communications with researchers, statisticians and others who work within the domains covered within the context of this research.

4.3 Objectives

In addition, the results need to be seen in the context of the aim of this study, which was to map MFTPs in participants that swim (> 4 hours per week as per inclusion criteria) and participants that do not swim (< 2 hours per week as per inclusion criteria), to determine whether a particular combination of MFTPs exists in swimmers.

Thus, the objectives were to:

- Determine specific descriptive data from the participants (viz. age, gender, ethnicity, hand dominance, stroke dominance, and type of shoulder dysfunction).
- Map MFTPs in terms of :
    - Location,
    - Tenderness (algometer (Fischer, 1986; Williamson and Hoggart, 2005)),
    - Severity (NRS (Liggins, 1982, Jensen *et al*., 1986; Bolton and Wilkinson, 1998),
    - Type (active or latent) and
    - Subjective findings (SDI (Matsen *et al.,* 1994; Yeomans, 2000)), outlining the participant's ability in terms of their activities of daily living.

- Compare the objective and subjective findings between the swimmer and non-swimmer groups.

4.4 Abbreviations specific to Chapter Four

Abbreviations unique to this chapter and which require explanation prior to the results being presented:

- “%” percentage.
- “<” refers to a figure “less than” the figure reported.
- “=” implies “equals to.”
- Max maximum
- Med median
- Min minimum
- “*n*” refers to the to the sample size. Sample in this case is defined as *“A subset of a population”* (Tropper, 1998).
- “*p*” refers to the p-value which indicates the data statistical significance (Swinscow, 1996; Wright, 1998; Hinton, 2001; Campbell and Swinscow, 2009).

4.5 **Consort Diagram** (Moher, Schultz and Altman, 2001)

When reviewing any study, it is important to determine and reflect any and all biases that may be related to the inclusion of participants in the study (Mouton 2002; Mouton, 2006). This is usually done through the reflection of participant inclusion, exclusion, omission, drop outs and withdrawal in a CONSORT diagram (Moher *et al.*, 2001). For this study the CONSORT diagram is reflected in Figure 4.1

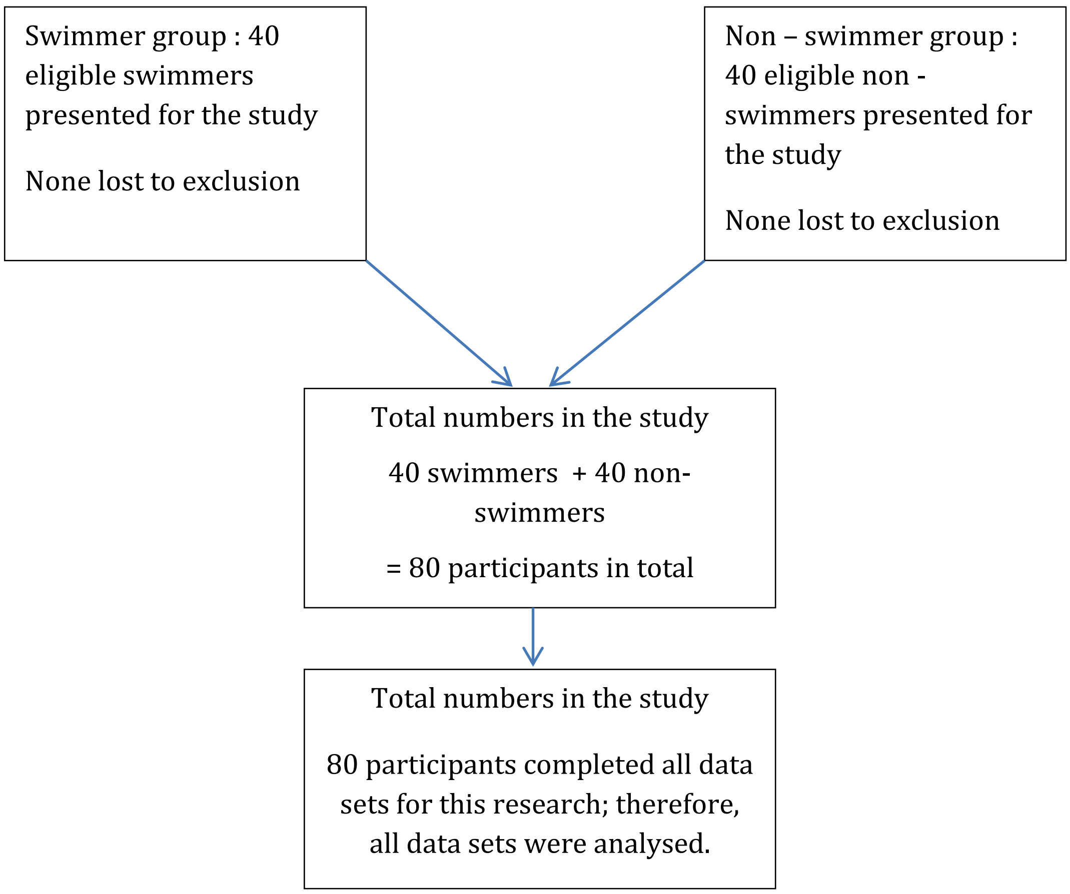


Figure 4.1 CONSORT diagram

As this study, was a one appointment visit, assessment study without clinical intervention, there were no drop outs in the study. Additionally, no participants withdrew from the study during the course of the assessment and no-one was found to require exclusion on review of their data when data capture occurred. This indicates that the participants met the study inclusion criteria.

Therefore, it is expected that the participant groups are reflective of their respective activity type (swimming group and non swimming group as per inclusion criteria), and thus it would be reasonable to assume that the data collected and results obtained from this study would be applicable to each activity type respectively. This is, however, advised with caution as the numbers of participants in this study were small and larger trials of a similar nature may indeed result in different outcomes. It is, thus, suggested that the results of this study be further validated.

4.6 Results

The objectives of the study are:

4.6.1 Objective One

To determine specific descriptive data from the participants (viz. age, gender, ethnicity, hand dominance, stroke dominance, type of shoulder dysfunction).

4.6.1.1 Outcomes

Table 4.1 shows the demographic characteristics of the two groups. There was a statistically significant difference between the two groups in terms of ethnicity ($p < 0.001$), gender ($p = 0.001$), and age ($p < 0.001$).

Table 4.1: Demographics of the study samples

		Swimmers		Non-swimmers	
		Count	%	Count	%
Ethnicity	Black	1	2.5%	39	97.5%
	Coloured	1	2.5%	0	0.0%
	Indian	3	7.5%	0	0.0%
	White	35	87.5%	1	2.5%
Gender	Female	10	25.0%	0	0.0%
	Male	30	75.0%	40	100.0%
Dominance (handedness)	Left	1	2.5%	0	0.0%
	Right	39	97.5%	40	100.0%
Stroke dominance / specialization	Non-swimmers	0	0.0%	40	100.0%
	Backstroke	1	2.5%	0	0.0%
	Freestyle	39	97.5%	0	0.0%
Age (mean, standard deviation)		15.6	1.9	21.4	4.2

4.6.1.2 Discussion

The findings indicated in Table 4.1, show that the demographic characteristics of the two groups, were statistically significant with respect to ethnicity ($p < 0.001$), gender ($p = 0.001$), and age ($p < 0.001$).

There is a paucity of information with regards to the prevalence of MFTPs in *different ethnic groups.* However, one could consider that factors related to particular ethnic groups might predispose them to different types, number and prevalences (point, period and lifetime). These factors may include but not be limited to factors outlined in Table 4.2 below.

Table 4.2 Factors related to ethnicity that may predispose particular groups to variances in MFTP presentation

Biological / structural factors (Wedderkopp *et al*., 2005; Rechardt *et al*., 2010) such as • Mechanical abuse (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000; Huguenin, 2004; Lavelle *et al*., 2007; Srbely, 2010) is more common in manual labourers than sedentary individuals (Raad, 2012). This predisposes the manual labourers to different MFTP presentations when compared to more sedentary workers. In the context of this study the soccer group (non-swimmers) presented predominantly with participants that were either unemployed, “toch” labour or manual workers as compared to the swimmer group which seemed to be predominantly scholars. Therefore, the significant differences in the ethnicity within the study participants may have influenced the outcomes of the study. • Trauma (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000) may be unique to the occupation or the recreation of the athlete and therefore, it is possible that this may have influenced the outcome of this study as a result of the significant difference between the two ethnic group representations. Anthropometric factors (Feldman *et al*., 2001; Rechardt *et al*., 2010) may be related

to ethnic / traditional lifestyle factors, including but not limited to (El-Metwally *et al*., 2007; Rechardt *et al*., 2010):

- Adverse environmental conditions, which are related to the living and work environment of the participants (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000). In this study it is anticipated that the living and work environments for the two groups is significantly different. Therefore, with the significant difference in the ethnic make up of the two study groups, it cannot be excluded that this would have had an influenced on the participant and his / her presentation of MFTPs.
- Lifestyle activity (Delgado *et al*., 2009). This factor it potentially less likely to have affected the outcomes of the study (even though there was a significant difference in ethnic distribution), in that although both groups of participants were active, they were grouped and allocated to their respective groups based on this criterion.
- Nutritional deficiencies, lack of exercise or sleep disturbances (Fricton *et al*., 1990; Testa *et al.,* 2003; Rickards, 2006), have been noted to variably affect / not affect MFTPs (Morgan, 1997 and Van Aardenne, 2002). In this study, this factor may have influenced the outcome of this study as a group of scholars that are still home based and dependent on their parents are more likely to receive better nutrition than older, unemployed persons that have less access to adequate food and therefore nutrition. It can therefore, not be excluded as a factor that may have had an impact on the presentation of MFTPs found in this study.
- In a similar manner to nutritional deficiencies, metabolic and endocrine inadequacies (Testa *et al.*, 2003; Rickards, 2006; Srbely, 2010), that are unique to particular ethnic groups (Haslett *et al.,* 2000), may also have influenced the outcome of the study based on the ethnic significant difference between the groups. The same could be argued for chronic infection of any origin (viz. viral infections, bacterial infections or parasitic infestations) (Rickards, 2006; Srbely, 2010).

In terms of the significant difference between the groups in terms of *gender,* it is noted that MFTPs occur in both males and females (Treaster and Burr 2004; Ge *et al*., 2006) but appear to be more prevalent in females (2:1) (Bergenudd *et al*., 1988;

Han and Harrison, 1997; Malleson *et al*., 2001; Delgado *et al*., 2009). It is therefore, not excluded that the significant difference ($p = 0.001$) between the groups in terms of gender could have influenced the outcome of the results of this study.

In terms of *age,* Travell, Simons and Simons (1999) and Han and Harrison (1997), suggest that individuals in their midlife (30-49) are more likely to suffer from MFTPs (Delgado *et al.*, 2009; Freeman *et al.*, 2009), than individuals that are younger or older. Thus, in terms of the significant difference ($p < 0.001$) between the groups, age differences between the two groups could have influenced the outcome of this study.

Based on the significant differences found between the two groups with respect to ethnicity, age and gender, it is suggested that future studies stratify the groups with respect to these variables, in addition to increasing the group sizes per variable, in order to be able to detect specific effects of each of these variables in the groups under study.

4.6.2 Objective Two and Three

Objectives 2 and 3 were analysed and reported together.

Objective Two: To map MFTPs in terms of:

- Location,
- Tenderness (algometer),
- Severity (NRS),
- Type (active or latent) and
- Subjective findings (shoulder disability scale (SDI)), outlining the participant's ability in terms of their activities of daily living.

Objective Three: To compare the objective and subjective findings between the swimmer and non-swimmer groups.

4.6.2.1 Location, type and characteristics:

There were no significant differences between the two groups in terms of location, type or referral of any of the trigger points.

Table 4.3a: Location and referral of trigger points by group - Trapezius muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Trapezius muscle TP 1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Trapezius muscle TP 1 Latent	None	31	77.5%	30	75.0%
	Left	**6**	**15.0%**	**6**	**15.0%**
	Right	**2**	**5.0%**	**4**	**10.0%**
	Bilateral	**1**	**2.5%**	0	0.0%
Referral	N	40	100.0%	40	100.0%

Table 4.3a: Location and referral of trigger points by group - Trapezius muscle continued…

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Trapezius muscle TP2 Active	None	40	100.0%	39	97.5%
	Left	0	0.0%	1	2.5%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Trapezius muscle TP2 Latent	None	28	75.0%	28	70.0%
	Left	**2**	**5.0%**	**2**	**5.0%**
	Right	**5**	**10.0%**	**5**	**12.5%**
	Bilateral	**5**	**10.0%**	**5**	**12.5%**
Referral	N	40	100.0%	40	100.0%
Trapezius muscle TP3 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Trapezius muscle TP3 Latent	None	35	87.5%	35	87.5%
	Left	**2**	**5.0%**	**3**	**7.5%**
	Right	**3**	**7.5%**	**2**	**5.0%**
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Trapezius muscle TP 4 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Trapezius muscle TP 4 Latent	None	39	97.5%	38	95.0%
	Left	**1**	**2.5%**	**2**	**5.0%**
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Trapezius muscle TP 5 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Trapezius muscle TP 5 Latent	None	40	100.0%	39	97.5%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	**1**	**2.5%**
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%

Table 4.3a: Location and referral of trigger points by group - Trapezius muscle continued…

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Trapezius muscle TP6 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Trapezius muscle TP6 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Trapezius muscle TP7 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Trapezius muscle TP7 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		27		30	

Table 4.3b: Location and referral of trigger points by group - Subscapularis muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Subscapularis muscle TP1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Subscapularis muscle TP1 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Subscapularis muscle TP2 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Subscapularis muscle TP2 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Subscapularis muscle TP3 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Subscapularis muscle TP3 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		0		0	

Table 4.3c: Location and referral of trigger points by group - Supraspinatus muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Supraspinatus muscle TP1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Supraspinatus muscle TP1 Latent	None	37	92.5%	32	80.0%
	Left	**2**	**5.0%**	**4**	**10.0%**
	Right	**1**	**2.5%**	**4**	**10.0%**
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Supraspinatus muscle TP2 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Supraspinatus muscle TP2 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Supraspinatus muscle TP3 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Supraspinatus muscle TP3 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		3		8	

Table 4.3d: Location and referral of trigger points by group - Infraspinatus muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Infraspinatus muscle TP 1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Infraspinatus muscle TP 1 Latent	None	31	77.5%	37	92.5%
	Left	**4**	**10.0%**	**1**	**2.5%**
	Right	**2**	**5.0%**	**2**	**5.0%**
	Bilateral	**3**	**7.5%**	0	0.0%
Referral	N	40	100.0%	40	100.0%
Infraspinatus muscle TP2 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Infraspinatus muscle TP2 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Infraspinatus muscle TP3 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Infraspinatus muscle TP3 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		9		3	

Table 4.3e: Location and referral of trigger points by group - Teres minor and major muscles

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Teres minor muscle Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Teres minor muscle Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Teres major muscle TP1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Teres major muscle TP1 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Teres major muscle TP2 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Teres major muscle TP2 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		0		0	

Table 4.3f: Location and referral of trigger points by group - Triceps brachii muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Triceps brachii muscle TP1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Triceps brachii muscle TP1 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Triceps brachii muscle TP2 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Triceps brachii muscle TP2 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Triceps brachii muscle TP3 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Triceps brachii muscle TP3 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Triceps brachii muscle TP4 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Triceps brachii muscle TP4 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%

Table 4.3f: Location and referral of trigger points by group - Triceps brachii muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Triceps brachii muscleTP5 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Triceps brachii muscleTP5 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		0		0	

Table 4.3g: Location and referral of trigger points by group - Latissimus dorsi muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Latissimus dorsi muscle TP1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Latissimus dorsi muscle TP1 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Latissimus dorsi muscle TP2 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Latissimus dorsi muscle TP2 Latent	None	39	97.5%	40	100.0%
	Left	**1**	**2.5%**	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Latissimus dorsi muscle TP 3 Active (irregular location)	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Latissimus dorsi muscle TP3 Latent (irregular location)	None	40	100.0%	39	97.5%
	Left	0	0.0%	**1**	**2.5%**
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		1		1	

Table 4.3h: Location and referral of trigger points by group - Biceps brachii muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Biceps brachii muscle TP 1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Biceps brachii muscle TP 1 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Biceps brachii muscle TP 2 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Biceps brachii muscle TP 2 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		0		0	

Table 4.3i: Location and referral of trigger points by group - Pectoralis major muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Pectoralis major muscle TP 1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis major muscle TP 1 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Pectoralis major muscle TP 2 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis major muscle TP 2 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Pectoralis major muscle TP 3 Active	None	40	100.0%	40	100.0%
	left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis major muscle TP 3 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Pectoralis major muscle TP 4 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis major muscle TP 4	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%

Table 4.3i: Location and referral of trigger points by group - Pectoralis major muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Pectoralis major muscle TP 5 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis major muscle TP 5 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Pectoralis major muscle TP 6 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis major muscle TP 6 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Pectoralis major muscle TP 7 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis major muscle TP 7 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Pectoralis major muscle TP 8 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis major muscle TP 8 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		0		0	

Table 4.3j: Location and referral of trigger points by group - Pectoralis minor muscle

		Swimmers		Non-swimmers	
		Count	Column N %	Count	Column N %
Pectoralis minor muscle TP1 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis minor muscle TP1Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Pectoralis minor muscle TP2 Active	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Pectoralis minor muscle TP2 Latent	None	40	100.0%	40	100.0%
	Left	0	0.0%	0	0.0%
	Right	0	0.0%	0	0.0%
	Bilateral	0	0.0%	0	0.0%
Referral	N	40	100.0%	40	100.0%
Total number of MFTPs irrespective of activity		0		0	

Table 4.4k: Summary table for numbers of MFTPs per muscle

Total number of MFTPs irrespective of activity		
	Swimmers	Non-swimmers
Trapezius muscle	27	30
Subscapularis muscle	0	0
Supraspinatus muscle	3	8
Infraspinatus muscle	9	3
Teres minor and major muscles	0	0
Triceps brachii muscle	0	0
Latissimus dorsi muscle	1	1
Biceps brachii muscle	0	0
Pectoralis major muscle	0	0
Pectoralis minor muscle	0	0
Total	40	43

4.6.2.2 Discussion

Irrespective of the significant differences in the ethnicity ($p < 0.001$), gender ($p = 0.001$), and age ($p < 0.001$) (Table 4.1), Table 4.3 indicates that there are no significant differences between the groups in terms of the location (muscle and trigger point number), type (active or latent) and referral (present or absent).

This would seem to indicate that the study has to consider two possible methodological issues:

- The sample size for this was underpowered to detect a difference. However, on consultation with a statistician (Hammond, 2011) and the processing of an *a priori* analysis before the approval of the study, it was noted that 40 participants per group would be sufficient in detecting differences between the groups if they did exist.
- Another possible reason for the inability to detect significant differences in regards of location, type and referral, was that the participants had to be asymptomatic in order to participate in this study (and therefore, not likely to have had significant numbers of active MFTPs and / or referred pain). Thus, future studies should consider patients that have discomfort (measured between particular points on the Shoulder Disability Index) (Matsen *et al.,* 1994; Yeomans, 2000) or pain (as measured on the Numerical Pain Rating Scale) (Liggins, 1982; Jenson *et al.,* 1986; Bolton and Wilkinson, 1998).
- Lastly, although limited in this study, is the possibility that persons swimming for even a small number of hours may have developed similar MFTP patterns. The reason for this being limited in this study is because a significant number of participants in the soccer only group were not able to swim and therefore did not swim at all.

Further to the above, it is also important to have future studies consider increasing the amount of specific data around factors that may affect the MFTP outcomes with particular reference to gender, age and ethnicity, to determine specific patterns within study groups.

4.6.2.3 Tenderness (algometer)

Median and range for the algometer readings are shown in Table 4.5, indicating that there was no statistical difference between the medians of the two groups for any of the algometer measurements. It was however, noted that the infraspinatus muscle TP 1 on the left showed an algometer reading that was significantly higher (i.e. increased ability to absorb kg/cm^2 pressure on the MFTP) in the swimmers than the non-swimmers (p = 0.027).

Table 4.5a: Median and range algometer reading by group – Trapezius muscle

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Trapezius muscle TP 1	Left	0	0	5	0	0	6
	Right	0	0	4	0	0	5
Trapezius muscle TP 2	Left	0	0	4	0	0	5
	Right	0	0	4	0	0	6
Trapezius muscle TP 3	Left	0	0	6	0	0	5
	Right	0	0	4	0	0	7
Trapezius muscle TP 4	Left	0	0	2	0	0	7
	Right	0	0	0	0	0	0
Trapezius muscle TP 5	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	6
Trapezius muscle TP 6	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Trapezius muscle TP 7	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0

Table 4.5b: Median and range algometer reading by group – Subscapularis muscle

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Subscapularis muscle TP 1	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Subscapularis muscle TP 2	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Subscapularis muscle TP 3	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0

Table 4.5c: Median and range algometer reading by group – Supraspinatus muscle

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Supraspinatus muscle TP 1	Left	0	0	4	0	0	6
	Right	0	0	2	0	0	6
Supraspinatus muscle TP 2	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Supraspinatus muscle TP 3	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0

Table 4.5d: Median and range algometer reading by group – Infraspinatus muscle

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Infraspinatus muscle TP 1	Left	0	0	6	0	0	4
	Right	0	0	5	0	0	8
Infraspinatus muscle TP 2	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Infraspinatus muscle TP 3	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0

Table 4.5e: Median and range algometer reading by group - Teres minor and major muscles

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Teres minor muscle TP 1	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Teres major muscle TP 1	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Teres major muscle TP 2	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0

Table 4.5f: Median and range algometer reading by group - Triceps brachii muscle

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Triceps brachii muscle TP 1	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Triceps brachii muscle TP 2	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Triceps brachii muscle TP 3	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Triceps brachii muscle TP 4	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Triceps brachii muscle TP 5	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0

Table 4.5g: Median and range algometer reading by group – Latissimus dorsi muscle

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Latissimus dorsi muscle TP 1	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Latissimus dorsi muscle TP 2	Left	0	0	3	0	0	0
	Right	0	0	0	0	0	0
Latissimus dorsi muscle TP 3 (irregular location)	Left	0	0	0	0	0	4
	Right	0	0	0	0	0	0

Table 4.5h: Median and range algometer reading by group – Biceps brachii muscle

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Biceps brachii muscle TP1	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Biceps brachii muscle TP 2	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0

Table 4.5i: Median and range algometer reading by group – Pectoralis major muscle

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Pectoralis major TP 1	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Pectoralis major TP 2	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Pectoralis major TP 3	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Pectoralis major TP 4	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Pectoralis major TP 5	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Pectoralis major TP 6	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Pectoralis major TP 7	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Pectoralis major TP 8	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0

Table 4.5j: Median and range algometer reading by group – Pectoralis minor muscle

		Swimmers			Non-swimmers		
		Med	Min	Max	Med	Min	Max
Pectoralis minor muscle TP 1	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0
Pectoralis minor muscle TP 2	Left	0	0	0	0	0	0
	Right	0	0	0	0	0	0

Table 4.6k: Summary table for numbers of MFTPs per muscle

Total number of MFTPs irrespective of activity	Swimmers	Non-swimmers	Significant difference in algometer reading
Trapezius muscle	27	30	
Subscapularis muscle	0	0	p = 1.00
Supraspinatus muscle	3	8	p = 0.052
Infraspinatus muscle	9	3	p = 0.027
Teres minor and major muscles	0	0	p = 1.00
Triceps Brachii muscle	0	0	p = 1.00
Latissimus dorsi muscle	1	1	p = 1.00
Biceps Brachii muscle	0	0	p = 1.00
Pectoralis major muscle	0	0	p = 1.00
Pectoralis minor muscle	0	0	p = 1.00
Total	40	43	

4.6.2.4 Discussion

When considering the outcomes of the numbers of MFTPs in the various muscles within the context of the algometer readings (Table 4.6k), it would seem to appear that the infraspinatus muscle in swimmers is more likely to have increased numbers of latent MFTPs, than in non-swimmers who are more likely to have fewer MFTPs but that these MFTPs are more severe in nature (i.e. are therefore, able to absorb less in terms of kg/cm^2 pressure.

This may suggest that the swimmers are presenting with an overuse presentation (Fricton *et al*., 1990; Rosen, 1994) as compared to the non-swimmers which seem to present with a clinical picture suggestive of mechanical trauma / direct trauma and not necessarily only overuse (Travell, Simons and Simons, 1999; Chaitow and DeLany, 2000; Huguenin, 2004; Lavelle *et al*., 2007; Srbely, 2010; Raad, 2012).

These implications agree with the work of Fricton *et al.,* (1990) and Rosen (1994) who indicated that structural disharmony or skeletal imbalance due to repetitive tasks is the primary cause of muscle imbalance between the agonist and the antagonist muscles, which then become overloaded. This overload may be due to improper use and / or abnormal loads causing dysfunction to occur, especially when exceeding the critical load capacity of a muscle resulting in fatigue (Rosen, 1994), therefore, leading to MFTP formation. This would be valid for the swimmer group in this study. This is further supported by Malleson *et al*., (2001); Ferrell *et al*., (2004); Adib *et al*., (2005); Nijs, (2005) and Ofluoglu *et al*., (2006), who suggest that hypermobility or ligamentous laxity seems to be a relevant risk factor for the development of MFTPs. It is not uncommon for swimmers to present with hypermobility (McMaster *et al.,* 1998; McMaster, 1999; Belling-Sorensen and Jorgensen, 2000; Yanai and Hay, 2000; Yanai, Hay and Miller, 2000; Weldon and Richardson, 2001). This, results in the sequelae which are most commonly, fatigued muscles and numerous latent MFTPs.

4.6.2.5 Severity (NRS)

Consistently with the requirement that all participants had to be asymptomatic, there was no value higher than 0 recorded for NRS, therefore, no analysis was undertaken on this outcome due to lack of variability in the data, and it can be concluded that neither the swimmer or the non-swimmer group were symptomatic. It is suggested that this study be redone with symptomatic population groups (viz. asymptomatic versus symptomatic groups or between two symptomatic groups).

4.6.2.6 Discussion

The results of the numerical pain rating scale are in keeping with the protocol of the study as outlined in the inclusion and exclusion criteria (Section 3.5.1.2.1 and 3.5.1.2.2).

4.6.2.7 Subjective findings (MDS)

No significant differences between the groups were found in any of the trigger points in terms of MDS scores (as noted in Table 4.7).

Table 4.7a: Median and range MDS score by group – Trapezius muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Trapezius muscle TP 1	0	0	11	0	0	15
Trapezius muscle TP 2	0	0	11	0	0	15
Trapezius muscle TP 3	0	0	11	0	0	11
Trapezius muscle TP 4	0	0	10	0	0	10
Trapezius muscle TP 5	0	0	0	0	0	10
Trapezius muscle TP 6	0	0	0	0	0	0
Trapezius muscle TP 7	0	0	0	0	0	0

Table 4.7b: Median and range MDS score by group – Subscapularis muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Subscapularis muscle TP 1	0	0	0	0	0	0
Subscapularis muscle TP 2	0	0	0	0	0	0
Subscapularis muscle TP 3	0	0	0	0	0	0

Table 4.7c: Median and range MDS score by group – Supraspinatus muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Supraspinatus muscle TP 1	0	0	14	0	0	10
Supraspinatus muscle TP 2	0	0	0	0	0	0
Supraspinatus muscle TP 3	0	0	0	0	0	0

Table 4.7d: Median and range MDS score by group – Infraspinatus muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Infraspinatus muscle TP 1	0	0	11	0	0	11
Infraspinatus muscle TP 2	0	0	0	0	0	0
Infraspinatus muscle TP 3	0	0	0	0	0	0

Table 4.7e: Median and range MDS score by group – Teres brachii muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Teres Minor muscle TP 1	0	0	0	0	0	0
Teres Major muscle TP 1	0	0	0	0	0	0
Teres Major muscle TP 2	0	0	0	0	0	0

Table 4.7f: Median and range MDS score by group – Triceps brachii muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Triceps brachii muscle TP 1	0	0	0	0	0	0
Triceps brachii muscle TP 2	0	0	0	0	0	0
Triceps brachii muscle TP 3	0	0	0	0	0	0
Triceps brachii muscle TP 4	0	0	0	0	0	0
Triceps brachii muscle TP 5	0	0	0	0	0	0

Table 4.7g: Median and range MDS score by group – Latissimus dorsi muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Latissimus Dorsi muscle TP 1	0	0	0	0	0	0
Latissimus Dorsi muscle TP 2	0	0	10	0	0	0
Latissimus Dorsi muscle TP 3 (irregular location)	0	0	0	0	0	11

Table 4.7h: Median and range MDS score by group – Biceps brachii muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Biceps brachii muscle TP 1	0	0	0	0	0	0
Biceps brachii muscle TP 2	0	0	0	0	0	0

Table 4.7i: Median and range MDS score by group – Pectoralis major muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Pectoralis major muscle TP 1	0	0	0	0	0	0
Pectoralis major muscle TP 2	0	0	0	0	0	0
Pectoralis major muscle TP 3	0	0	0	0	0	0
Pectoralis major muscle TP 4	0	0	0	0	0	0
Pectoralis major muscle TP 5	0	0	0	0	0	0
Pectoralis major muscle TP 6	0	0	0	0	0	0
Pectoralis major muscle TP 7	0	0	0	0	0	0
Pectoralis major muscle TP 8	0	0	0	0	0	0

Table 4.7j: Median and range MDS score by group – Pectoralis minor muscle

	Swimmers			Non-swimmers		
	Med	Min	Max	Med	Min	Max
Pectoralis minor muscle TP 1	0	0	0	0	0	0
Pectoralis minor muscle TP 2	0	0	0	0	0	0

4.6.2.8 Discussion (MDS)

As was reported in Table 4.7, no significant differences between the groups were found in any of the trigger points in terms of MDS scores obtained by the participants. This is consistent with the findings in terms of the type (active or latent MFTPs (Table 4.3k)). This lack of variance supports the discussion as presented in Section 4.6.2.2.

4.6.2.9 Subjective findings (FXN)

No variability was found for functional scores (Shoulder Disability Index) (Matsen *et al.,* 1994; Yeomans, 2000), as all MFTPs were without symptoms (average score 112) therefore, the data was not analysed further.

4.6.2.10 Discussion (FXN)

The findings of the Shoulder Disability Index (Matsen *et al.,* 1994; Yeomans, 2000) are consistent with the findings of the Numerical Pain Rating Scores (Section 4.6.2.5), indicating that the researcher complied with the requirements of recruiting outlined in Chapter Three.

4.7 Summary and conclusion

Based on the foregoing results that have been presented in this chapter, it is evident that this study has shown that presence of MFTPs in swimmers and non-swimmers is very uncommon in people that do not have symptoms. This is congruous with the fact that reported pain and loss of function associated with MFTPs was also very low on average.

The study therefore, did not provide any evidence that swimmers are affected more than non-swimmers by reported pain and loss of function due to MFTPs, which is inconsistent with the literature that indicates that swimmers have a greater likelihood of MFTPs based on fatigue and hypermobility which are usual consequences of the sport as noted in the literature (McMaster *et al.,* 1998; McMaster, 1999; Belling-Sorensen and Jorgensen, 2000; Yanai and Hay, 2000; Yanai, Hay and Miller, 2000;

Malleson *et al*., 2001; Weldon and Richardson, 2001; Ferrell *et al*., 2004; Adib *et al*., 2005; Nijs, 2005; Ofluoglu *et al*., 2006).

But, the study did find that swimmers did have an increased ability to absorb pressure through the algometer measures as compared to non-swimmers over more MFTPs which were latent. This may have been as a result of variable pain thresholds between the participants. This therefore suggests that a future study needs to look at differences between ages, gender and ethnicity in terms of their perception of pain threshold and response to the use of an algometer (Janal *et al.*, 1994). Notwithstanding this, these results go some way to support the presence of muscle dysfunction earlier than the painful clinical presentation, indicating that muscle fatigue, tone and strength, should be addressed in training, as compared to non-swimmers. This is supported by the only one significant difference that was found in algometer measurements for tenderness in the infraspinatus muscle TP 1, where swimmers had significantly higher values than non swimmers. As a result of these findings, it is suggested that this study be repeated comparing groups of participants before and after workload / activity, in order to determine what the effects of workload would be on the presentation (Janal *et al.*, 1994). This also re-inforces the earlier suggestion of comparison between symptomatic population groups (viz. asymptomatic versus symptomatic groups or between two symptomatic groups).

Chapter Five

5.1 Introduction

This chapter summarises the findings of the research project and outlines recommendations for the future.

5.2 Conclusion

Based on the results that have been presented in Chapter Four, it is evident that this study has shown that presence of MFTPs in swimmers and non-swimmers is very uncommon in people that do not have symptoms. This is congruous with the fact that reported pain and loss of function associated with MFTPs was also very low on average.

The study therefore, did not provide any evidence that swimmers are affected more than non-swimmers by reported pain and loss of function due to MFTPs, which is inconsistent with the literature that indicates that swimmers have a greater likelihood of MFTPs based on fatigue and hypermobility which are usual consequences of the sport as noted in the literature. It is therefore suggested that the role of fatigue in the presentation on MFTPs be studied in future research (viz. comparing the pattern of MFTPs pre activity to patterns post activity), additionally it is necessary that different measures of fatigue are utilized in conjunction with the development of a MFTP pattern for different sporting codes.

But, the study did find that swimmers did have an increased ability to absorb pressure through the algometer measures as compared to non-swimmers over more MFTPs which were latent. This is supported by the significant difference that was found in algometer measurements in the infraspinatus muscle TP 1, where swimmers had significantly higher values than non swimmers. This may explain the presence of muscle dysfunction earlier than the painful clinical presentation, indicating that muscle fatigue, tone and strength, should be addressed in training, before the repetitive nature of training results in clinical sequelae. Additionally it needs to be considered that athletes (runners in Janal *et al.*, (1994)) tend to be more stoical when being assessed for pain. Therefore a recommendation stemming from this study is one related to mapping pain thresholds of different sporting codes when compared to the normal population, in order the results from studies such as this dissertation can better be contextualized with regards to clinical severity of MFTPs or other clinical conditions under investigation.

5.3 Recommendations

As noted in the discussion, an increase in and specificity in demographic / descriptive details may have produced increased amounts of data, which may have been useful in identifying many other possible factors that contribute to MFTPs formation outside of sports activity. These include the participants' socio-economic factors, lifestyle, mental state and other factors, which all play a significant role in terms of its formation and subsequent consequences. These factors (in particular age, gender and ethnicity) need to be controlled for or stratified for in future research as Manning and Fillingim, (2002) suggest that the older, more experienced athlete may also have coping strategies that would influence the outcome of a study such as this.

Research methods:

- The sample size should be increased as it was found that the supraspinatus muscle TP 1 in the non-swimmer group had a *p*-value (0.052) that was very close to statistical significance. A larger sample would have increased the likelihood of significance if it was present.
- Utilising an off campus sports SOAPE would have decreased unnecessary paperwork and would still have achieved the same ends.
- Having a second blinded assessor would also have increased accuracy, decreased bias and assisted in obtaining greater differences between groups.

Clinical perspective:

- Practitioners should look at investigating the presence of latent MFTPs in patients that are using their shoulders intensively in order to eliminate the latent MFTPs and their negative sequelae.

Future studies should assess the presence of MFTPs in swimmers in the context of measuring the associated lifestyle parameters.

Further research could also investigate the effect of treatment on the active and / or latent MFTPs and how this affects / does not affect improvement in performance in terms of a better time over a set distance.

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Appendix A1: LETTER OF INFORMATION

Dear Participant,

Welcome to my research project and thank you for taking the time to consider participation.

Title of Research:

The prevalence and pattern of myofascial trigger points in the shoulder girdle of swimmers as compared to non-swimmers in the greater Durban area.

NAME OF RESEARCH SUPERVISORS

Dr G. Harpham	Contact Number	(031) 2056534
[MTech-Chiropractic]		
Dr A. Jones	Contact Number	(031) 9034467
[MDip-Chiropractic; MMedSci (Sports Sci)]		

NAME OF RESEARCH STUDENT

Tim Kinsman	Contact Number	(031) 3732511

Background:

Swimmers are known to suffer with shoulder problems, due to muscle overload. Myofascial trigger points (MFTPs) (commonly known as “knots” in the muscle) have been linked to muscle overload, therefore it is possible that MFTPs may be linked to shoulder problems. This research aims to map MFTPs in swimmers as compared to non-swimmers, in order to determine whether particular MFTP maps exist for swimmers. Therefore you will be assisting in determining whether there is a relationship between MTFPs and shoulder problems in swimmer. Eighty people will be required to complete this study. All participants, including you, will be specifically allocated into one of two groups. Group one will be comprised of swimmers and group two will be comprised of non swimmers. Each group will be assessed only once to gather the data required for the research.

Research process:

At the consultation you will be screened for suitability as a participant and a case history, physical examination, cervical spine and shoulder regional examination will be done. This consultation will take place at the Chiropractic Clinic at Durban University of Technology / or at an agreed to off-site (non-campus) facility. In this study we will be examining the presence of myofascial trigger points of the shoulder and back muscles as well as any discomfort they may cause in you. All investigations and your optional treatment will be performed under the supervision of a qualified chiropractor by the research student.

Inclusion and Exclusion:

Participants in this study must be between 14 and 35 years of age and either do purely swimming as their sport or activity of choice, or, does any other form of exercise or sport that excludes swimming.

Risks and discomfort:

The assessment is unlikely to cause any adverse side effects, however transient pain and tenderness may occur which will most likely subside within 24 hours.

Benefits of the study:

Your full co-operation will assist in determining patterns of “knots” in muscles related to the shoulder. This will assist manual therapists in more easily and specifically treat problems related to the swimmers shoulder girdle. Results of the study will be made available in the form of a dissertation at the Durban University of Technology library.

Withdrawal from the study:

You are free to withdraw at any stage. Participants that are found to be dishonest in the history provided by them and all participants that fail to comply with the informed consent form will be excluded from the study.

Remuneration and costs:

Treatment after the data collection process will be free of charge and the participant will not be expected to cover any costs to participate in the study. Participants taking part in the study will not be offered any form of remuneration for taking part in the study.

Confidentiality:

All participant information is confidential and will be kept in a participant file at the Chiropractic clinic for fifteen years after which it will be destroyed. Please do not hesitate to ask questions on any aspect of this study. Should you wish you can contact my research supervisor on the above details or alternatively you could contact the Institutional Research and Ethics Committee as per IREC Research Administrator: (031) 373 2900.

Statement of agreement to participate in the study:

I, …………………………………………….., ID number……………………………., have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by the researcher 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.

Participant's name:…………………….................Signature:..……………….Date:……..

Researcher's name:……………………………Signature……………….Date:………

Witness' name:…………………………………Signature…….………Date……….

Appendix A2 : LETTER OF ASSENT

Dear Participant,

Welcome to my research project and thank you for thinking about being a part of the study.

Title of Research:

The prevalence and pattern of myofascial trigger points in the shoulder girdle of swimmers as compared to non-swimmers in the greater Durban area.

NAME OF RESEARCH SUPERVISORS

Dr G. Harpham Contact Number (031) 2056534

[MTech-Chiropractic]

Dr A. Jones Contact Number (031) 9034467

[MDip-Chiropractic; MMedSci (Sports Sci)]

NAME OF RESEARCH STUDENT

Tim Kinsman Contact Number (031) 3732511.

Background:

Swimmers commonly suffer with shoulder problems that can often be linked to "knots" in the muscles of the shoulder joint. This study aims to find and record where these "knots" occur in the muscles around the shoulder joint in swimmers and non-swimmers in order to see if they occur more commonly in swimmers.

Research process:

In order to participate in the research you must be between 14 – 35 years of age, and either swim as your main activity of choice, or not swim and have other sporting interests. Once agreeing to participate, you will undergo a case history (asking you some questions about your health), physical examination (looking at your body to make sure you are healthy), neck and shoulder examination to ensure that you meet the inclusion criteria of the study. This will take place at either the Chiropractic Clinic at

Durban University of Technology or at an off campus site (e.g. swimming pool).During the examination I will ask you to tell me about any pain or other sensations that you might feel during the examination. All examinations will be performed under the supervision of a qualified chiropractor.

Risks and discomfort:

The assessment during the consultation is not meant to cause any discomfort or make your pain / sensation worse.

Benefits of the study:

This research will provide health care practitioners and swimming coaches with information as to which muscles in the shoulder area are more commonly affected by "knots" in swimmers. This information can then be used to improve swimming training and treatments of shoulder problems in swimmers. Results of the study will be made available in the form of a dissertation at the Durban University of Technology library.

Withdrawal from the study:

You are free to withdraw from the study at any stage. If you do not meet the study inclusion criteria you will not be allowed to participate in the study.

Remuneration and costs:

There is no cost to you or your family for you participating in this research. You will be offered one free treatment which can either be utilised now or at the Chiropractic Clinic at Durban University of Technology

Confidentiality:

All information that you give will be kept confidential (will be kept secret) and will be kept in your file at the Chiropractic Clinic for 15 years after which it will be destroyed. Please do not be afraid to ask questions at any time about anything that is worrying you (on any aspect of this study). Should you wish you can speak with my research supervisor on the above details or alternatively you could contact the Institutional Research Ethics

Committee Research Administrator: (031) 373 2900

Statement of agreement to participate in the study:

I, …….…………………………………………….., ID number……………………………………., have been able to read this assent form completely and understand what it says. Any questions or queries I had about the research and my involvement have been explained to me by the researcher. I therefore understand what is expected. Also, I fully understand that I may pull out of this study at any stage without any serious penalties for my future health care (treatment). I therefore, voluntarily agree to participate in this study.

Participant's (minor) name: ………………….............   Signature:………………. Date:……..

Parent / legal guardian name: ....   Signature:...................... Date............

Researcher's name: ………………………...........   Signature:………………. Date:………

Witness' name: …………………..............................   Signature: ….…..……… Date……….

Appendix A3: Parental consent form

Dear Parent,

Welcome to my research project and thank you for taking the time to consider the participation of your child.

Title of Research:

The prevalence and pattern of myofascial trigger points in the shoulder girdle of swimmers as compared to non-swimmers in the greater Durban area.

NAME OF RESEARCH SUPERVISORS

Dr G. Harpham Contact Number (031) 2056534

[MTech-Chiropractic]

Dr A. Jones Contact Number (031) 9034467

[MDip-Chiropractic; MMedSci (Sports Sci)]

NAME OF RESEARCH STUDENT

Tim Kinsman Contact Number (031) 3732511.

Background:

Swimmers are known to suffer with shoulder problems, due to muscle overload. Myofascial trigger points (MFTPs) (commonly known as “knots” in the muscle) have been linked to muscle overload, therefore it is possible that MFTPs may be linked to shoulder problems. This research aims to map MFTPs in swimmers as compared to non-swimmers, in order to determine whether particular MFTP maps exist for swimmers. Therefore your child will be assisting in determining whether there is a relationship between MTFPs and shoulder problems in swimmer. Eighty people will be required to complete this study. All participants, including your child, will be specifically allocated into one of two groups. Group one will be comprised of swimmers and group two will be comprised of non swimmers. Each group will be assessed only once to gather the data required for the research.

Research process:

At the consultation your child will be screened for suitability as a participant and a case history, physical examination, cervical spine and shoulder regional examination will be done. This consultation will take place at the Chiropractic Clinic at Durban University of Technology / or at an agreed to off-site (non-campus) facility. In this study we will be examining the presence of myofascial trigger points of the shoulder and back muscles as well as any discomfort they may cause in your child. All investigations and your child's optional treatment will be performed under the supervision of a qualified chiropractor by the research student.

Inclusion and Exclusion:

Participants in this study must be between 14 and 35 years of age and either do purely swimming as their sport or activity of choice, or, does any other form of exercise or sport that excludes swimming.

Risks and discomfort:

The assessment is unlikely to cause any adverse side effects to your child, however transient pain and tenderness may occur which will most likely subside within 24 hours.

Benefits of the study:

Your child's co-operation will assist in determining the patterns of “knots” in muscles related to the shoulder. This will assist manual therapists in more easily and specifically treat problems related to the swimmers shoulder girdle. Results of the study will be made available in the form of a dissertation at the Durban University of Technology library.

Withdrawal from the study:

Your child is free to withdraw from the research at any stage and should you wish your child to discontinue participating in the research you may with draw them without any prejudice to you or your child. If informed consent is not obtained, your child will be excluded from the study.

Remuneration and costs:

There is no remuneration or costs to you for participating in the study, however one free treatment will be offered to your child at the end of the study should he/she have a problem that they would like to be assessed at either the Chiropractic Day Clinic at the Durban University of Technology or the approved off site location. This free treatment is not part of the research and the normal clinical protocols will be followed with regards to parental consent.

Confidentiality:

All participant information is confidential and will be kept in a participant file at the Chiropractic clinic for 15 years after which it will be destroyed. Please do not hesitate to ask questions on any aspect of this study. Should you wish you can contact my research supervisor on the above details or alternatively you could contact the Institutional Research Ethics Committee Research Administrator on (031) 373 2900.

Statement of agreement to participate in the study:

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

Parent's/Legal guardian's name: …………………….......... Signature: ..……………. Date:……..

Researcher's name:……………………………Signature……………….Date:………

Witness' name:…………………………………Signature……..……….Date……….

Appendix A4 : Free treatment voucher

<table>
<tr><td colspan="3">VOUCHER
This voucher is to enable the participant of the study entitled as: “The prevalence and pattern of myofascial trigger points in the shoulder girdle of swimmers as compared to non-swimmers in the greater Durban area.” To receive free treatment for their condition, should they wish. Within a period of 30 days of the consultation for the research project.</td></tr>
<tr><td>Date of <u>research consultation</u> :</td><td colspan="2"></td></tr>
<tr><td>Name and signature of patient :</td><td></td><td></td></tr>
<tr><td>Name and signature of researcher:</td><td></td><td></td></tr>
<tr><td>Name and signature of supervisor:</td><td></td><td></td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>Date of <u>voucher redemption</u> :</td><td colspan="2"></td></tr>
<tr><td>Name and signature of clinician:</td><td></td><td></td></tr>
</table>

DURBAN UNIVERSITY of TECHNOLOGY

APPENDIX B: 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:

<u>Intern's Case History:</u>

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

3. **Present Illness:**

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

4. **Other Complaints:**

5. **Past Medical History:**

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

6. **Current health status and life-style:**

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

7. Immediate Family Medical History:

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

8. Psychosocial history:

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

9. Review of Systems:

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

DURBAN UNIVERSITY of TECHNOLOGY

APPENDIX C
Durban University of Technology
PHYSICAL EXAMINATION: SENIOR

DURBAN UNIVERSITY of TECHNOLOGY

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 :**

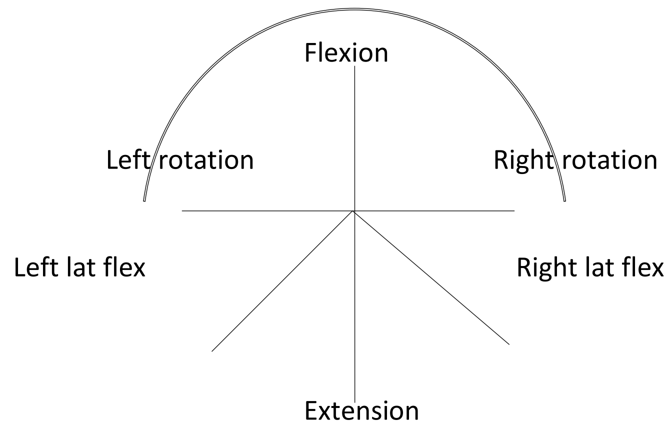
APPENDIX D: DURBAN UNIVERSITY OF TECHNOLOGY
REGIONAL EXAMINATION - CERVICAL SPINE

Patient: .... File No: ....
Date: .... Student: ....
Clinician: .... Sign: ....

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

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

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



PALPATION:
Lymph nodes Thyroid Gland Trachea

ORTHOPAEDIC EXAMINATION:

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

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

NEUROLOGICAL EXAMINATION:

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

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

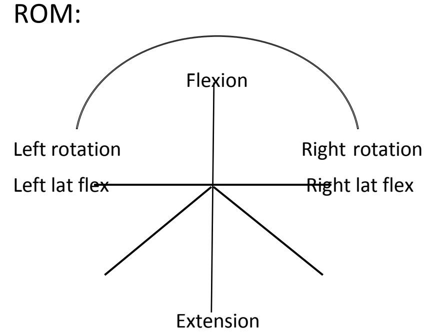
MOTION PALPATION & JOINT PLAY:

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

BASIC EXAM: SHOULDER:
Case History:

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

BASIC EXAM: THORACIC SPINE:
Case History:
ROM:



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

APPENDIX E : SHOULDER REGIONAL EXAMINATION

Patient: …………………………………………………… File No: …………………. Date: …………….
Intern: ……………………………………………Signature: ……………………………………………
Clinician: …………………………………………Signature: ……………………………………………..

Observation

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

Palpation

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

Active Movements (note ROM and pain)

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

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

Elevation through abduction (bone to bone or tissue stretch)……………………………………………………………………………

Elevation through forward flexion (tissue stretch)………………………………………………………………………………………….

Lateral rotation (tissue stretch)……….

Medial rotation (tissue stretch)……….

Extension (tissue stretch)…….

Adduction (tissue approximation) ………

Horizontal adduction (tissue stretch or approximation)……………………………………………………………………………….

Horizontal abduction (tissue stretch)……

Quadrant Test……….

Resisted Isometric Movements (note strength and pain)

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

Joint Play Movements (and motion palpation)

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

Glenohumeral Joint

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

Instability Tests

1. Anterior Instability Tests **R** **L**

	Pos	Neg	n/a	Pos	Neg	n/a
Anterior drawer Test						
Rowe Test						
Fulcrum Test						
Apprehension (crank) Test						
Clunk Test (tear of labrum)						
Rockwood Test						
2. Posterior Instability Tests						
	Pos	Neg	n/a	Pos	Neg	n/a
Posterior Apprehension Test						
Norwood Stress Test						
Push-pull Test						
Jerk Test						
3. Inferior and Multi-directional instability tests						
	Pos	Neg	n/a	Pos	Neg	n/a
Inferior Shoulder Instability Test						
Feagin Test (antero-inferior instability)						

A-C Joint Stress Test: ______________________________

S-C Joint Stress Test: ______________________________

Tests for Muscle or Tendon Pathology

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

Tests for neurological function

Brachial Plexus Tension Test	Radial Nerve	
	Median Nerve	
Tinel's Sign (Scalene triangle)		

Dermatones	C4		C5		C6		C7		C8		T1		T2	
Reflexes	Biceps(C5/6)						Triceps (C7/8)							

Thoracic Outlet Syndrome Tests

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

APPENDIX F: THORACIC SPINE REGIONAL EXAMINATION

Patient:______________________________________File:_________ Date:_______
Intern:______________________________________Signature:_____________________________
Clinician: ___________________________________Signature:_____________________________

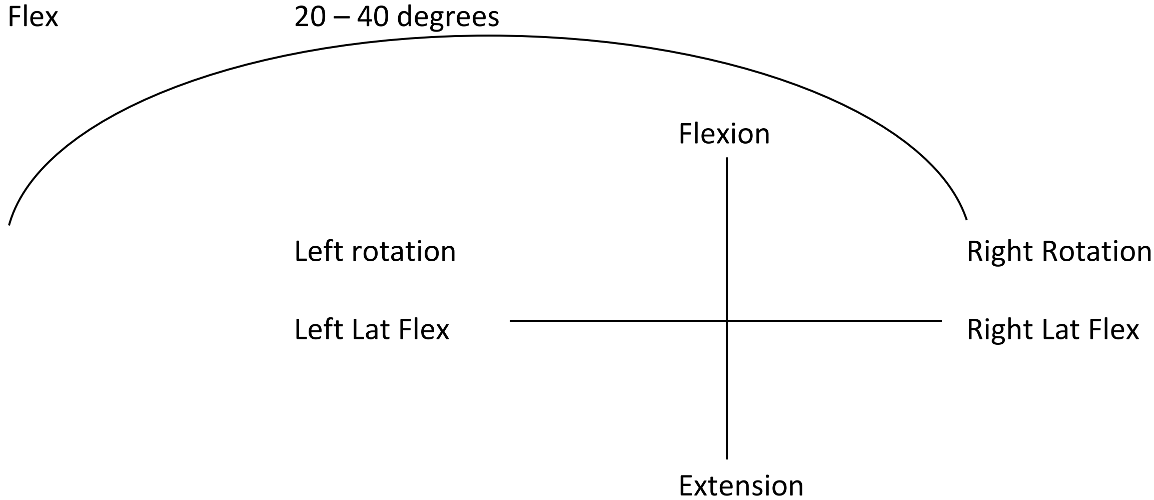
STANDING:

Posture (incl. L/S & C/S)
Muscle tone
Skyline view – Scoliosis
Spinous Percussion
Breathing (quality, rate, rhythm, effort)
Deep Inspiration

Scars
Chest deformity
(pigeon, funnel, barrel)

RANGE OF MOTION:

Forward Flexion	20 – 45 degrees (15cm from floor)
Extention	25 – 45 degrees
L/R Rotation	35 – 50 degrees
L/R Lat Flex	20 – 40 degrees



RESISTED ISOMETRIC MOVEMENTS: (in neutral)

Forward Flexion
L/R Rotation
Extension
L/R Lateral Flexion

SEATED:

Palpate Auxillary Lymph Nodes
Palpate Ant/Post Chest Wall
Costo vertebral Expansion (3 – 7cm diff. at 4th intercostal space)
Slump Test (Dural Stretch Test)

SUPINE:

Rib Motion (Costo Chondral joints)
Soto Hall Test (#, Sprains)
SLR
Palpate abdomen

PRONE:

Passive Scapular Approximation
Facet Joint Challenge
Vertebral Pressure (P-A central unilateral, transverse)
Active myofascial trigger points:

	Latent	Active	Radiation Pattern		Laten t	Active	Radiation Pattern
Rhomboid Major				Rhomboid			
Lower Trapezius				Spinalis			
Serratus Posterior				Serratus			
Pectoralis Major				Pectoralis			
Quadratus							

COMMENTS:____

NEUROLOGICAL EXAMINATION:

DERMATOMES												
	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T 10	T 11	T 12
Left												
Right												

Basic LOWER LIMB neuro:

Myotomes	
Dermatomes	
Reflexes	

KEMP'S TEST:

MOTION PALPATION:			Right	Left
Thoracic Spine				
Ribs	Calliper (Costo-transverse joints)			
	Bucket Handle	Opening		
		Closing		
Lumbar Spine				
Cervical Spine				

BASIC EXAM	History	ROM	Neuro/Ortho
LUMBAR			
CERVICAL			

APPENDIX G: DURBAN UNIVERSITY OF TECHNOLOGY

Patient Name: ***File #:*** ***Page:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: *Numerical Pain Rating Scale (Patient)* *Intern Rating* ***A:***
Least ***0 1 2 3 4 5 6 7 8 9 10*** *Worst*

0: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: *Numerical Pain Rating Scale (Patient)* *Intern Rating* ***A:***
Least ***0 1 2 3 4 5 6 7 8 9 10*** *Worst*

O: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature***

S: *Numerical Pain Rating Scale (Patient)* *Intern Rating* ***A:***
Least ***0 1 2 3 4 5 6 7 8 9 10*** *Worst*

O: ***P:***

E:

Special attention to: ***Next appointment:***

Appendix H

Advert

ARE YOU A SWIMMER ??

You are invited to participate in research being conducted at Durban University of Technology Chiropractic Day Clinic.

FREE TREATMENT

is available on completion of the study

For more information contact:

Tim Kinsman

0722173251 or 031-3732511

APPENDIX I

HITECH THERAPY

Rehabilitation and Exercise Products

P.O. Box 130299
Bryanston
2074
Telephone: +27 11 704-0002
Fax: +27 11 704-4999
E-mail: sales@htherapy.co.za
Website : www.htherapy.co.za
VAT Reg no : 4060142249

Quotation

TO: 11 RITSON ROAD FAX NO: 031 202 3632

ATTENTION: BEREA

FROM: PETER HORNE REF NO: QUC41886

DATE: 23/08/2011

RE: QUOTE

Dear Charmaine

Thank you for your interest in our products. Herewith the quotation as requested:

Item Code	Quantity	Description	Unit	Unit Price	Disc%	Tax	Nett Price
FDK20	1.00	WAGNER FDK 20 ALGOMTER	EACH	4,000.00		491.23	4,000.00

ZAR 4,000.00

The above prices are VAT inclusive Expiry date is 23/08/2011 Prices are subject to exchange rate fluctuations.

Prices Exclude Delivery Charges

Let me assure you of our continued commitment to both products and service excellence.

If you require any further information, please call me.

Regards

BANKING DETAILS: STANDARD BANK SANDTON
BRANCH CODE: 019205 ACC NO: 022688307

PETER HORNE
HiTECH THERAPY cc

APPENDIX J1

Pat no: Non-swimmers	Age	Ethnicity	Gender	Dominance (handedness)	Stroke dominance / specialization
1					
2					
3					
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36					
37					
38					
39					
40					

APPENDIX J2

Pat no: Swimmers	Age	Ethnicity	Gender	Dominance (handedness)	Stroke dominance / specialization
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
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40					

APPENDIX J3

Non-swimmers																
Pat no.	Trapezius	TP1							Trapezius	TP2						
	Active	Latent	Referral	Algo		Algo Av	NRS	FXN	Active	Latent	Referral	Algo		Algo Av	NRS	FXN
1																
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Pat no.	Trapezius	TP3							Trapezius	TP4						
	Active	Latent	Referral	Algo		Algo Av	NRS	FXN	Active	Latent	Referral	Algo		Algo Av	NRS	FXN
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Pat no.	Trapezius	TP5							Trapezius	TP6						
	Active	Latent	Referral	Algo		Algo Av	NRS	FXN	Active	Latent	Referral	Algo		Algo Av	NRS	FXN
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Pat no.	Trapezius	TP7							Subscapularis		TP1					
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APPENDIX K

DURBAN UNIVERSITY *of* TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)

8 October 2012

IREC Reference Number: **REC 4/11**

Mr T Kinsman
6 Princess Alice Avenue
Glenwood
Durban
4001

Dear Mr Kinsman

Application for Amendment of Approved Research Proposal

The prevalence and pattern of myofascial trigger points in the shoulder girdle of swimmers as compared to non-swimmers in the greater Durban area

I am pleased to inform you that your application for amendment to your existing research proposal has been approved.

In addition, please note that ethics approval has been reinstated. The original ethics approval number **IREC 002/11** will be retained for the project.

Yours Sincerely

[redacted]

Dr D. F. Naude
Chairperson: IREC

APPENDIX L

FORM C–18. RATING SCALE OF THE AMERICAN SHOULDER AND ELBOW SURGEONS

NAME__________________________ DATE__________ AGE_____ SCORE__________

PAIN: (5 = none; 4 = slight; 3 = after unusual activity; 2 = moderate; 1 = marked; 0 = complete disability: ________)

FUNCTION: (4 = normal; 3 = mild compromise; 2 = difficulty; 1 = with aid; 0 = unable, NA = not available)

Activity	Score	Activity	Score
1. Use back pocket		7. Carry 10 to 15 lbs with arm at side	
2. Reach behind back, fasten brassiere		8. Dress	
3. Wash opposite underarm		9. Sleep on the affected side	
4. Eat with utensil		10. Pulling	
5. Comb hair		11. Use hand overhead	
6. Use hand with arm at shoulder level		12. Lifting	
		TOTAL	

SPORTS:	**Points**
Same overhead sport, equal performance (normal)	4
Same non-overhead sport, equal performance (mild compromise)	3
Same sport, decreased performance (difficult)	2
Different sport (with aid)	1
Sports not possible (unable)	0

Modified from Gartsman GM. Arthroplastic acromioplasty for lesions of the rotator cuff. *J Bone Joint Surg* 1990;72A:169–180.

APPENDIX M

Trigger Point Signs:

1	Soft Tissue Tenderness		
	Grade: 0	No Tenderness	0
	Grade: I	Tenderness to palpation WITHOUT grimace or flinch	1
	Grade: II	Tenderness to palpation WITH grimace or flinch	2
	Grade: III	Tenderness with WITHDRAWAL (+ Jump sign)	3
	Grade: IV	Withdrawal (+ Jump sign) to non-noxious stimuli (i.e. Superficial palpation, gentle percussion)	4
2	Snapping palpation of the trigger point evokes a local twitch response		4
3	The trigger point is found in a palpable taut band.		4
4	Moderate, sustained pressure on the trigger point causes or intensifies pain in the reference zone.		5
	Total out of 17		

APPENDIX N

DURBAN UNIVERSITY of TECHNOLOGY

RECEIVED
2011 -11- 09
CITY HALL
ADMIN
SECRETARIAT

LETTER OF PERMISSION
To Whom It May Concern:

My name is Tim Kinsman; I am currently doing my Masters Degree in Chiropractic at the Durban University of Technology,

The title of my research project is: The prevalence and pattern of myofascial trigger points in the shoulder girdles of swimmers as compared to non-swimmers in the greater Durban area. .

Name of supervisor: Dr. C. Korporaal (031-2042094)
M.Tech: Chiropractic, CCSP, CCFC, ICSSD, FICS
Name of Research Student: Tim Kinsman (0722173251)
(Email - mwrkins@gmail.com)
Name of Institution: Durban University of Technology

The purpose of the study:
This study will involve research on competitive swimmers in the greater Durban area to determine the influence and prevalence of myofascial trigger points.

Procedures:
The swimmers will be required to undergo a non-invasive screening, where and how they occur. The average time for swimmer to complete the screening process will approximately take an hour.

Benefits:
Should they be suffering from any injuries during the course of their participation in this research, they are offered 1 optional free treatment at the Chiropractic Day Clinic at the Durban University of Technology. Also the results of this research will be forwarded to you as the Club leader of your swimming club to allow for improved recommendations with regard to training and treatment protocols.

Cost:
There is no cost involved from your participation in the study.

Based on the above-mentioned study, I am required to seek permission at those venues where swimming clubs are housed e.g.: King's Park. Therefore I would like to request tour permission to utilize any municipal venue that houses a swimming club within the confines of the greater Durban Area.

Yours in anticipation,

[redacted] [redacted]

Tim Kinsman (Chiropractic Intern) **Dr. C. Korporaal** (Supervisor)

I (name) [redacted] hereby give Tim Kinsman consent to conduct the above-mentioned research at any Municipal venue housing a swimming club, subject to him liaising with local supervisors to ensure there are mutually satisfactory arrangements on access.

Signature: [redacted] Date: __________