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THE EFFECT OF CHIROPRACTIC ADJUSTMENT OF INNERVATION VERSUS ATTACHMENT SITE IN THE TREATMENT OF CHRONIC, ACTIVE MYOFASCIAL TRIGGER POINTS OF INFRASPINATUS

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

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DEDICATION

To my parents, Kenneth and Sjanny, thank you for giving me all that I needed to make my dreams come true and reach my full potential. You have been by my side through all the difficult times and given me your full support through all the good times. Without you, I would never have achieved all that I have and for that I am forever grateful and appreciative. Once again thank you.

To my sister, Erin, thank you for all your encouragement, support and assistance for the duration of this dissertation, throughout all my years of studying and through life. You have been my strength through bad times, always encouraging me to push through and strive to achieve my best. Thank you for being an amazing sister and best friend.
ACKNOWLEDGEMENTS

To Dr Chris Yelverton, not just my supervisor but my mentor. You have always pushed me to be the very best I can be. Your constant guidance, advice and support has taught me to be true to myself and to stand up for my beliefs no matter what the circumstances. Thank you for all your hard work and dedication over the duration of this course, it has helped mould me to the person I am today.

To Dr Darryn Whelan, my co-supervisor. Thank you for all you time and effort, your guidance, advice and support in assisting me in the completion of my chiropractic dissertation. You have been a good friend over the years, always helping me where needed and building me up to become a better chiropractor. Thank you for helping me fulfil my achievement to become a chiropractor.
ABSTRACT

PURPOSE: Shoulder pain has been identified to be one of the most common musculoskeletal problems found in a variety of different countries, showing characteristics of chronicity and recurrence. It is considered to be a main contributor towards nontraumatic upper limb pain. One of the identifiable causes of chronic or reoccurring shoulder pain may be attributed to myofascial pain syndrome which is caused by MTrP’s and produces symptoms that are similar to that of other shoulder pain syndromes. The infraspinatus muscle as an integral component of the rotator cuff complex is subject to high tension biomechanical strain as well as neuromuscular tension. While therapeutic interventions have been devised to treat varying degrees of biomechanical and neuromuscular tension, little evidence exists establishing which of these treatment regimes is most effective in treating myofascial trigger points. The purpose of this study was to compare different regional chiropractic adjustments relative to the attachment site and the innervation segment of the infraspinatus muscle and to identify the most effective treatment protocol with regard to chronic, active infraspinatus myofascial trigger point dysfunction.

DESIGN: A selection of thirty participants were recruited for this study. The participants were divided into two groups of fifteen participants each. Group A received a chiropractic adjustment to the glenohumeral joint, the attachment site for infraspinatus muscle. Group B received a chiropractic adjustment to the cervical spine segments associated with the innervation to the infraspinatus muscle. Cervical spine restrictions specific to levels C4/C5 and/or C5/C6, and glenohumeral joint restrictions were determined using motion palpation techniques. All participants received a total of six treatments over a three-four week period.

MEASUREMENTS: Subjective measurements were obtained by the Functional Rating Index Questionnaire and the Numerical Pain Rating Scale. Objective measurements were obtained using the hand-held pressure algometer and counting the number of active infraspinatus myofascial trigger points. The data was collected on the first, fourth and seventh consultations.

OUTCOME: With regards to the subjective readings, the results from the Functional Rating Index Questionnaire for the intragroup analysis indicated that the glenohumeral joint adjustment group showed the greatest improvement over time (15.5%). No statistically significant differences were noted for the intergroup analysis. The intragroup analysis of the Numerical Pain Rating Scale indicated that the glenohumeral joint adjustment group showed the greatest improvement over time (68.8%). The intergroup analysis indicated that there were no statistically significant differences.
With regard to the objective measurements, the intragroup analysis of the pressure algometer readings indicated that the glenohumeral joint adjustment group showed the greatest improvement over time (21.7%). There were no statistically significant differences with the intergroup analysis. The intragroup and intergroup analysis of the number of active infraspinatus myofascial trigger point dysfunction showed no statistically significant differences between the groups or within each of the groups over time.

CONCLUSION: The results showed that both treatment groups protocols were effective in reducing chronic, active infraspinatus myofascial trigger point dysfunction. Small differences were noted between the two treatment groups with regards to the subjective and objective findings. The glenohumeral joint adjustment group showed the greatest clinical and statistical improvements over the three-four week trial period.
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1.1 The Problem and its Setting

Broadly characterized as a regional pain syndrome, myofascial pain syndrome is the resultant effect of a myofascial trigger point producing pain within muscle groups throughout the body (Kuan, 2009). As a facilitator of myofascial pain syndrome, a myofascial trigger point may be classified as a localised area of pain within a taut band of muscle, which may either be in a latent or active state of functioning. In general both latent and active trigger points may be distinguished by the overall presentation of pain associated with each type of trigger point. Latent trigger points are easily recognised by the localised presentation of pain associated with the area of muscle undergoing palpation. Conversely, the type of pain broadly associated with active trigger points, largely manifests as a referred pain not localised to the area of palpation. Additionally pain associated with active trigger points may arise regardless of the state of mobility of the area undergoing treatment (Criscuolo, 2001). In general myofascial pain may be a symptom of possible underlying biomechanical malfunctioning and often manifests after prolonged periods of stress, poor posture or erratic sleep patterns (Graff-Radford, 2004).

The association between myofascial pain syndrome and stress often manifests in the form of persistent recurrences of headaches as well as muscular pain associated with the neck and shoulder regions. This has resulted in attempts being made through the application of randomised clinical trials to investigate the efficacy of current treatment regimes for myofascial pain syndrome. However, there still remains a lack of general understanding surrounding the mechanisms associated with this syndrome. To date some of the more effective and commonly used means of treatment for this syndrome includes pain pressure threshold assessments, which make use of the algometer and visual analogue scale (Fernandez de las Penas, Campo, Carnero and Page, 2005).

In addition, the chiropractic adjustment has emanated as a possible avenue for the effective treatment and management of symptoms associated with myofascial pain syndrome. Mechanically, the chiropractic adjustment is proposed to have the ability to restore optimal functioning to joint motion, restoration of joint alignment and change the dynamic movement within the vertebral column. Furthermore the chiropractic adjustment may also affect the tone and strength of the musculature and subsequently manifests in changes in the dynamics of the supporting capsule-ligamentous tissue around the joint. Neurologically, the chiropractic adjustment has been proposed to have the ability to improve and restore spinal and peripheral nerve conduction, which manifests in a reduction in pain through the stimulation of the mechanoreceptors within the synovial joint. It furthermore may alter both the motor and sensory functioning within the body as well as influences the regulation of the autonomic nervous system (Gatterman, 2005).
Myofascial pain syndrome may be the result of either direct or indirect trauma, a variety of spinal pathologies, exposure to either a relapse or cumulative form of strain, bad postural dynamics or physical deconditioning (Bergmann and Peterson, 2011).

The chiropractic vertebral subluxation complex (VSC) is best described as multifaceted complex pathological entity presented in the form of a chiropractic subluxation. It is considered to be a theoretical model involving dysfunction within a particular motion segment, which in turn starts a complex interaction of pathological changes across a variety of body systems which include: the nervous, the musculoskeletal and the vascular systems (Bergmann and Peterson, 2011). The vertebral motion segment associated with the vertebral subluxation complex consists of two adjacent vertebrae and may involve up to three joint complexes. These joint complexes comprise two facet joints posteriorly and the intervertebral disc anteriorly, together forming the functional unit of the spine (Gatterman, 2005).

Subsequently the chiropractic adjustment administered to areas affected by the vertebral subluxation complex, including the cervical spine, has been established to effectively relieve the pain caused by myofascial trigger points (MTrP) within the infraspinatus muscle. The mechanism involved is suspected to be a connection between the sensory pathways from facet nociceptors and the nociceptors found within MTrP's located within the infraspinatus muscle. This connection is found to exist within the spinal cord or may use the same nociceptive pathway to the higher center (Hong, 2006). Furthermore it is hypothesised that adjustment of the joint associated with the muscle spasm may result in stretching of the mechanoreceptors within the joint capsule. The residual stretching of the mechanoreceptors further influences an inhibitory effect on the activity initiated by the type 4 nociceptive endings. This concept is widely regarded as the pain gate theory and may lead to a reduction in muscle spasticity as well as in the pain potentially associated with the muscle spasm (Gatterman, 2005).

The shoulder region, particularly the glenohumeral joint is subjected to a high degree of biomechanical functioning and movement. As a result of the high mobility of the region and its overall reliance on the rotator cuff muscle group for general stability, general shoulder pain has been identified as a highly prevalent musculoskeletal problem showing characteristics of chronicity and relapse across a variety of different countries. Furthermore it is considered to be the primary contributor towards upper limb pain. Myofascial pain syndrome and its overall association with myofascial trigger points has largely been identified as a primary cause of chronic shoulder pain, often mimicking symptoms commonly associated with other shoulder pain syndromes (Bron, de Gast, Dommerholt, Stegenga, Wensing and Oostendorp, 2011). The infraspinatus muscle is an example of this, which, as an integral component of the rotator cuff complex is subject to high tension biomechanical strain as well as neuromuscular tension. The
infraspinatus muscle has been found to refer pain deep within the anterior aspect of the glenohumeral joint as well as down the anterolateral aspect of the arm to the lateral aspect of the forearm and in severe cases into the fingers or the upper posterior cervical region (Simons, Travell and Simons, 1999).

While therapeutic interventions have been devised to treat varying degrees of biomechanical and neuromuscular tension, little evidence exists establishing which of these treatment regimes is most effective in treating myofascial trigger points. Additionally a small cohort of case studies have attempted to provide clarity on the overall efficacy of the treatment of MTrP's as a means of resolving or contributing to the overall resolution of shoulder pain (Bron et al., 2011).

There remains a persistent paucity in terms of understanding which of these two prevalent approaches i.e. a neurophysiological (which addresses the function of the neural tissue components and the nervous system as a whole as defined by Dorland and Newman (2007)) or biomechanical approach is the most effective (Bron et al., 2011).

1.2 The Aim of the Study

The aim of this study was to explore the relative effects of chiropractic adjustments on the clinical activity of chronic, active MTrP's, specifically of the infraspinatus muscle, by correcting spinal articular dysfunction at the lower cervical spine segments versus correcting articular dysfunction at the glenohumeral joint.

1.3 Benefits of the Study

In the overall assessment of MTrP dysfunction neurophysiologically, this study may provide valuable insight into possible mechanisms involved in myofascial pain dysfunction. Additionally by assessing a spinal intervention versus the articular attachment site, a better understanding of which treatment approach is provided. Subsequently providing clarity on which treatment regime is the most effective in treating the clinical presentation of chronic, active infraspinatus MTrP's.

This study attempts to refine the chiropractic profession’s knowledge as to the most suitable region to apply chiropractic adjustments to when clinically addressing chronic, active infraspinatus MTrP dysfunction.
2.1 Introduction

The purpose of this chapter is to discuss the relevant anatomy and biomechanics of the cervical spinal column and the glenohumeral joint, and the effects of chiropractic manipulation on the infraspinatus muscle. This chapter also provides an insight into the relationship between the innervation versus the attachment site of the infraspinatus muscle.

2.2 Anatomy of the Cervical Spine and the Glenohumeral Joint

2.2.1 The osteology of the cervical spine

The cervical spine is considered as one of the most complicated articular structures of the human body encompassing a total of 76 separate joints and a complex network of neurovascular structures. In addition the cervical spine complex offers the highest degree of movement when compared to the thoracic and lumbar regions. In its general configuration, the cervical spine adopts a convex curvature anteriorly (lordosis). This curvature becomes accentuated with age and can be accurately measured with the use of plain x-rays. While the lordosis (convex anterior curvature) is seen to intensify with age across both sexes, females are far more affected than males (Cramer and Darby, 2014).

The overall anatomy of cervical curvature comprises a superior and inferior curve. The superior curve extends from the base of the occiput to the axis, and is widely considered to be the primary curve. In addition the superior curve adopts a concave alignment anteriorly. In contrast the inferior curve, which is largely associated with the lordosis of the cervical spine, extends from C2 to C7. The superior and inferior cervical curves collectively contribute significantly to the kinematics that occur at both curves and to the overall movement of the cervical spine (Cramer and Darby, 2014).

The cervical spine includes a combination of typical and atypical vertebrae. The typical vertebrae, as illustrated in Figure 2.1, broadly include C3 to C6, while the atypical vertebrae associated with the cervical spine include C1, C2, and C7. In general C7 is considered to be particularly unique owing to its general location on the precipice between the cervical and thoracic spines. The body of the typical cervical vertebrae is small and rectangular in shape (Cramer and Darby, 2014). The anteroposterior diameter and height of the vertebrae are much smaller than the transverse diameter (Meiring and Scheepers, 1999). The superior surface of the body is concave across the transverse plane accommodating the raised lateral lips known as uncinate processes and convex along the sagittal plane because of its bevelled anterior aspect. Conversely the inferior surface is convex across the transverse plane and concave along the sagittal plane.
The anterior lip of the inferior surface is a big contributing factor to this concavity (Cramer and Darby, 2014; Moore and Dalley, 2006). The concavity associated with the inferior surface of the vertebral body is accentuated at the levels of C3 and C4 and then reduces, becoming shallower moving downwards from C5 to C7. The inferior aspects of C5 and C6 contain the greatest anteroposterior dimension (Cramer and Darby, 2014).

The uncinate processes become more prominent posteriorly in the lower cervical vertebrae region, allowing for more flexion and extension in the cervical spine while limiting lateral flexion. These processes also serve to limit and prevent protrusion of the intervertebral disc posteriorly and laterally. The uncinate processes of the cervical vertebrae are also considered as integral components of the uncovertebral joints or alternatively known as the joints of Von Luschka. The uncovertebral joints are formed by an articulation between the uncinate processes of each vertebra articulating with a small indentation on the inferior surface of the vertebra above creating two small synovial joints on either side of each vertebral body. The uncinate processes are significantly elevated across the vertebral levels of C4 to C6 and to a lesser degree at the levels of C3 and C7. The elevation of the uncinate processes across the levels of C4 to C6 coupled with the presence of the nerve roots of the cervical and brachial plexi respectively, would easily explain the increased incidence of neural compression at these levels (Cramer and Darby, 2014).

In addition to the uncinate processes, the pedicles occur as short lateral extensions of bone extending from the bodies of the cervical vertebrae (White, Black and Folkens, 2012). The pedicles of the typical cervical vertebrae are small and project posterolaterally, at an angle of 60 degrees to the coronal plane. They are situated midway between the superior and inferior margins of the vertebral body. Located just superior to the pedicles of the vertebrae, there are spinal nerves exiting at each spinal segment and are enclosed in a sleeve of dura mater (Cramer and Darby, 2014).

Continuous with the pedicles antero-laterally, the transverse processes of each cervical vertebra consist of two bars extending laterally, which end in an anterior and posterior tubercle. The overall extended lateral protrusion of the anterior tubercle at the level of C5/6 distinguishes it from the posterior tubercle. In addition the two tubercles are joined together by an intertubercular lamella. Between the anterior and posterior tubercles, there is a groove present which serves as a canal through which the spinal nerve and its ventral ramus may exit. The spinal nerve and its ventral ramus are secured in the groove by means of tough connective tissue attachments (Cramer and Darby, 2014).

The collective contributions of the intertubercular lamella, the anterior and the posterior tubercles of the transverse process as well as the pedicles associated with each cervical vertebra collectively form the
foramen transversarium. The transverse foramen is a constant feature of all cervical vertebrae and serves to transmit the vertebral artery in its course. The vertebral artery forms a valuable component of the vasculature of the neck. The vertebral artery enters the foramen of the tranverse process of C6, it then ascends superiorly through the transverse foramina associated with C1 to C5. It then winds medially around the superior articular process of C1 and passes beneath the posterior atlanto-occipital membrane. It then pierces through the dura and arachnoid mater as it ascends through the foramen magnum where the left and right vertebral arteries unite to form the vertebrobasilar artery. The vertebrobasilar artery gives rise to the Circle of Willis, which then supplies the different parts of the brain with its tributaries (Cramer and Darby, 2014).

In addition to the general osteology of each cervical vertebra, these vertebrae are collectively connected by means of the zygopophysial / facet joints. The zygopophysial / facet joints are made up of two articular processes; these include the superior and inferior articular processes. The superior articular process with its hyaline lined cartilage facet faces postero-superiorly with a slight medial orientation. Conversely the articular facets of the inferior articular process are directed antero-inferiorly with a slight lateral orientation. The facets in their overall contribution to the zygopophysial joints are directed at approximately 45 degrees to each other, this orientation may best be likened to that of the arrangement of tiles on a roof. Surrounding these joints are synovial capsules with synovial folds, which serve to lubricate the joint, act as a passive space filler and also serves to stabilise the joint and dissipate the forces along the joint (Cramer and Darby, 2014).

Extending in a posterior direction, the laminae of each vertebra adopts a slender appearance along the sagittal plane with the ligamentum flavum running between each laminae of the cervical spinal segments. The left and right laminae continue posteriorly to join and form the spinous process. The spinous processes of the typical cervical vertebrae are short and bifid posteriorly (Cramer and Darby, 2014).

The vertebral canal of the cervical spine is large and triangular in shape to allow for any enlargement of the cervical part of the spinal cord. This canal is at its largest at C3 segment and narrows as it descends towards C6. In addition to the vertebral and transverse foramina of the cervical vertebrae, the intervertebral foramina of the cervical spine each lie at the junction of the inferior and superior vertebral notches of the adjacent cervical vertebra. The general orientation of each of the intervertebral foramina may be described as facing obliquely anterior at an angle of 55 degrees to the mid-sagittal plane for the lower cervical segments (Cramer and Darby, 2014).
2.2.2 Neuroanatomy of the cervical spine

At each segment of the cervical spine, a spinal nerve branches off from the spinal cord and courses its way through the intervertebral foramina of each cervical vertebral segment. Each spinal nerve is predominantly comprised of a dorsal rootlet and a ventral rootlet, which then unite into dorsal and ventral roots. This unity occurs within the region of the intervertebral foramina (IVF) to form the spinal nerve. The short spinal nerve almost immediately divides into a dorsal and ventral ramus. The dorsal ramus is known as the posterior primary division and the ventral ramus is known as the anterior primary division (Cramer and Darby, 2014). This is illustrated in Figure 2.2.
The dorsal ramus is much smaller than the ventral ramus and exits the spinal nerve lateral to the IVF. It then courses posteriorly close to the anterolateral aspect of the articular pillar. At the levels of C4 and C5, the dorsal ramus courses through a groove on the lateral aspect of the articular pillars of the above mentioned vertebrae. Once reaching the posterolateral aspect of the superior articular process, the dorsal ramus divides into a medial and a lateral branch. The medial branch along its course innervates the deeper segmentally orientated muscles as well as the zygapophyseal joints and the interspinous ligaments. The lateral branch of the dorsal ramus innervates the more superficial muscles of the neck and back regions. The dorsal ramus of C6, however does not divide into a medial and lateral branch and only consists of a deep medial branch. The superficial lateral branches will also serve to supply sensory innervation to the skin of the posterior neck (Cramer and Darby, 2014).
Conversely the ventral ramus exits the spine posterior to the vertebral artery and then courses its way between the anterior and posterior inter-transversarii muscles. In addition the ventral ramus also innervates the muscles of the anterior cervical spine, the vertebral bodies and the anterior longitudinal ligament as well as sensory innervation to the anterior aspect of the intervertebral disc (IVD). The ventral ramus also makes a valuable contribution to the brachial plexus, which innervates the anterior neck and the upper extremities (Cramer and Darby, 2014).

Subsequently the recurrent meningeal nerve, a branch off the ventral ramus, courses medially through the IVF and supplies the posterior aspect of the IVD, the posterior longitudinal ligament, the anterior spinal dura mater, the posterior vertebral bodies and the uncovertebral joints. Furthermore it supplies the structures occurring at the level of the cervical spine where it originates. In addition it courses superiorly to innervate the same structures of the vertebral level above (Cramer and Darby, 2014).

The ventral rami of the spinal nerves associated with vertebral levels C5 and C6 contribute to the roots of the brachial plexus, as illustrated in Figure 2.3. They unite to form the superior trunk of the brachial plexus, which then gives rise to anterior and posterior divisions. The suprascapular nerve subsequently branches from the superior trunk. In its overall course its way traverses through the suprascapular notch of the scapula beneath the superior transverse scapular ligament and innervates the supraspinatus and infraspinatus muscles. The suprascapular nerve also gives off articular branches to the glenohumeral and the acromioclavicular joints (Cramer and Darby, 2014).
2.2.3 Mechanoreceptors of the cervical facet joint capsule

In general within the cervical spine facet capsule region there are 3 commonly identified mechanoreceptors in addition to the nociceptors, which are widely regarded as unencapsulated free nerve endings. The mechanoreceptors associated with the cervical spine facet capsule region broadly include type I, II and III mechanoreceptors which are capable of detecting motion and tissue distortion within and around the associated joint. The presence of the mechanoreceptors and nociceptors demonstrates that the cervical facet capsules are monitored by the central nervous system and subsequently implies that neural input from the facets is vital in the overall functioning of the cervical spine (McLain, 1993).

2.2.4 The anatomy of the glenohumeral joint

Broadly classified as a synovial ball and socket joint, the glenohumeral joint allows for the greatest amount of mobility when compared to the other joints of the human body. In its general configuration the glenohumeral joint includes three rotary and three translatory degrees of freedom. In addition the joint consists of a capsule and several associated ligaments and bursae (Levangie and Norkin, 2011).
The bony components of the glenohumeral joint include the head of the humerus and the glenoid fossa of the scapula, as illustrated in Figure 2.4. The proximal articulating surface of the glenohumeral joint includes the glenoid fossa of the scapula, this is a shallow concave fossa that is tilted slightly superior when the arm is in anatomical position at the side of the body. The concavity of the fossa is increased by articular cartilage that is thinner in the centre and thicker at the periphery. This increases the congruency with the humeral head. The distal articulating surface of the glenohumeral joint is the proximal head of the humerus. The humeral head has a larger surface area when compared to the glenoid fossa of the scapula, contributing anything between 30% and 50% of the sphere. When the arm is in anatomical position at the side of the body the humeral head faces medially, superiorly and posteriorly. As a result of the decreased level of articular congruency of this joint and increased level of mobility of the upper extremity, the glenohumeral joint is very prone to degenerative changes, instability and general joint derangement (Levangie and Norkin, 2011).

The articular surface of the glenoid fossa is surrounded by a glenoid labrum, which lines the periphery of the glenoid fossa. The increased depth created by the glenoid labrum helps to augment the concavity of the glenoid fossa, which further enhances the congruency of the joint. The labrum is composed of fibrous connective tissue and this further facilitates its overall functioning. General functions of the glenoid labrum include; the provision of resistance to the translations of the humeral head; protection of the bony edges of the labrum; overall reduction of joint friction and dissipation of the contact forces on the joint. The labrum also serves as an attachment site for the glenohumeral ligaments and the tendon of the long head of biceps brachii muscle (Levangie and Norkin, 2011).

![Figure: 2.4: Anatomy of the glenohumeral joint (Auerbach, 2012)](image)
In addition to the bony and cartilaginous contributions to the glenohumeral joint, the joint is also surrounded by a large loose capsule, which is taut superiorly and slacks anteriorly and inferiorly with the arm in its anatomical position. The glenohumeral capsule functions to provide a relative amount of laxity ultimately allowing for the large excursions of the joint. It offers limited stability due to the latter and therefore needs the reinforcement of the ligaments and the muscles surrounding the joint. The ligaments that serve to assist in reinforcing the joint include the superior, middle and inferior glenohumeral ligaments as well as the coracohumeral ligament; this is demonstrated in Figure 2.5 (Levangie and Norkin, 2011).

The superior glenohumeral ligament passes from the superior glenoid labrum to the upper neck of the humerus. This ligament forms part of the rotator interval capsule, along with the superior capsule and the coracohumeral ligament, as it bridges the gap between the tendons of the supraspinatus muscle and the subscapularis muscle. The superior glenohumeral ligament functions to limit anterior and inferior translation of the humeral head when the arm is in anatomical position. The middle glenohumeral ligament runs obliquely from the superior anterior labrum to the anterior aspect of the proximal humerus. The primary function of this ligament is to limit anterior humeral translation with the arm in anatomical position and up to 60 degrees of abduction. The inferior glenohumeral ligament is known as the inferior glenohumeral ligament complex as it consists of three components, namely: the anterior and the posterior ligament bands and the axillary pouch, which runs in between the anterior and posterior bands. This ligament functions to limit inferior translation of the humeral head. The coracohumeral ligament attaches to the base of the coracoid process of the scapula and has two bands. The first band attaches to the supraspinatus muscle and the greater tubercle of the humerus joining the superior glenohumeral ligament, while the second band inserts onto the subscapularis muscle and the lesser tubercle of the humerus. This ligament functions to limit inferior translation of the humeral head dependant on the position of the arm (Levangie and Norkin, 2011).

The glenohumeral ligaments collectively are considered to be thickened regions within the tissue capsule. These ligaments all contribute to the static stabilisation of the glenohumeral joint. The dynamic stabilisation for the glenohumeral joint stems from support provided by the rotator cuff muscles and their tendons namely: supraspinatus; infraspinatus; teres minor and subscapularis muscles (Levangie and Norkin, 2011).
2.2.5 Mechanoreceptors of the glenohumeral joint

The glenohumeral joint is thought to contain mechanoreceptors in both the capsule and the labrum. These mechanoreceptors play a significant role in the functioning of the static stabilisers of the glenohumeral joint and have been classified as type II mechanoreceptors originating from the Pacinian corpuscles. In addition, the glenohumeral joint contains an average of 652 sensory nerve endings, which contribute largely to the nociceptive and mechanoreceptive input of the glenohumeral joint. The mechanoreceptors of the glenohumeral joint are located very near to the ligaments of the joint within the capsule and the labrum assisting in the control of the static stabilisers (Jerosch, Steinbeck, Claiahsen, Schmitz-Nahrath and Grosse-Hackmann, 1993).

2.3 Biomechanics of the Cervical Spine and Glenohumeral Joint

2.3.1 Biomechanics of the cervical spine

There is approximately 100 to 110 degrees of flexion and extension of the cervical spine (Kapandji, 1974). In adults, the greatest range of flexion and extension occurs at vertebral segments C4/C5 or C5/C6, this movement is accompanied by translation along the z-axis and rotation about the x-axis (Gatterman, 2005).

During flexion the upper cervical vertebral body tilts and slides anteriorly over the vertebral body below. This causes compression of the intervertebral space anteriorly, driving the nucleus pulposus posteriorly.
and causing tension and stretching of the posterior fibers of the annulus fibrosus (Kapandji, 1974). This is illustrated in Figure 2.6 part A.

During extension the superior vertebral body tilts and slides posteriorly over the inferior vertebra. The intervertebral space posteriorly becomes compressed causing the nucleus pulposus of the disc to move anteriorly, resulting in stretching of the anterior fibers of the annulus fibrosus (Kapandji, 1974). This is illustrated in Figure 2.6 part B.

During flexion and extension collectively, the uncovertebral joints slide relative to each other with the movement of the vertebral body sliding anteriorly or posteriorly. The uncovertebral joints therefore guide the vertebral body into the anterior-posterior movements (Kapandji, 1974).

![Figure 2.6: A) Flexion with B) Extension of the lower cervical spine (Levangie and Norkin, 2011)](image)

Due to the orientation of the cervical facet joints, it is not possible to achieve pure rotation or lateral flexion in the cervical spine therefore the motion is a combination of rotation and lateral flexion, as demonstrated in Figure 2.7 part A and B. Extension also forms part of this coupled motion from the vertebral levels of C2 to T1 (Kapandji, 1974).

The degree of coupled motion decreases caudally in the cervical spine due to the change in orientation of the facet joints, in terms of obliquity, from C2/C3 where they are angled at 40 to 45 degrees to the transverse plane, to C7/T1 where they are angled closer to 10 degrees (Gatterman, 2005).
Figure 2.7: A) Coupled rotation with B) lateral flexion of the lower cervical spine (Levangie and Norkin, 2011)

The interspaces (space between the vertebra above and the vertebra below) of the uncovertebral joints open and tilt during lateral flexion. Considering lateral flexion is coupled with rotation, especially in the lower cervical spine, the joint gap is thought to open superiorly and inferiorly but may also open anteriorly as the superior vertebra moves in a posterior direction (Kapandji, 1974).

Rotation of the cranium varies from 80 to 90 degrees from left to right with the majority of movement occurring in the upper cervical segments. Unilateral flexion is approximately 45 degrees (Kapandji, 1974).
2.3.2 Biomechanics of the glenohumeral joint

The glenohumeral joint is functionally classified as a multi-axial joint with three rotational degrees of freedom namely: flexion/extension, abduction/adduction and medial/lateral rotation (Kreighbaum and Barthels, 1996). Flexion and extension are largely associated with the coronal axis, with 120 degrees of flexion and 50 degrees of extension, while medial and lateral rotation is associated with the long axis. The degrees of motion associated with medial and lateral rotation vary and depend largely on the position of the arm (Levangie and Norkin, 2011).

When the arm is in the anatomical position, medial and lateral rotation is limited as a result of the orientation and alignment of the greater tubercle with the lesser tubercle of the humerus creating a mechanical block. The limitation of medial and lateral rotation may also be due to tightness of the capsule or surrounding musculature, when the arm is placed in adduction versus an abducted position. When the arm is abducted to 90 degrees, this opens the arc of rotation, increasing the range of motion to approximately 130 degrees (Levangie and Norkin, 2011).

Abduction and adduction of the glenohumeral joint is predominantly associated with the anterior-posterior axis. Abduction of the arm at the glenohumeral joint depends on the relative position of the arm i.e. medially or laterally rotated or in a neutral position. When the arm is in a neutral position or medially rotated and in an abducted position, the greater tubercle becomes impinged on the coracoacromial arch limiting the range of motion of the glenohumeral joint. When the humerus is laterally rotated 35 to 40 degrees, the greater tubercle is able to pass easily inferior to or posterior to the arch without the possibility of impingement so that further abduction is possible. When the arm is laterally rotated this allows a range of 90 to 120 degrees of abduction (Levangie and Norkin, 2011).

2.4 The Infraspinatus Muscle

The infraspinatus muscle forms a valuable contribution in the functioning of the upper limb, on its own and as a part of the rotator cuff muscle complex. Assisted by the teres minor muscle, this lateral rotator muscle, although weak, has the ability to act on the hand as it lies anterior to the trunk of the body and moves the hand anteriorly and laterally. The proximity and influence of the infraspinatus muscle is essential for movement in some day to day functioning of the upper limb such as writing and therefore may easily become dysfunctional due to overuse (Kapandji, 1982).
2.4.1 Anatomy and function of the infraspinatus muscle

The infraspinatus muscle lies deep to the trapezius and latissimus dorsi muscles (Simons et al., 1999). It originates from a large fossa situated below the spine of the scapula on the posterior aspect of the scapula, with the upper fibers of the muscle, running laterally and the lower fibers running superolaterally to the tendon of the muscle. The tendon of the muscle passes posterior to the glenohumeral joint and inserts on the middle facet of the greater tubercle of the humerus. The infraspinatus muscle forms part of the rotator cuff muscles and functions to laterally rotate the arm at the glenohumeral joint (Drake, Vogl and Mitchell, 2005).

The infraspinatus muscle is innervated by the suprascapular nerve, which branches off the superior trunk of the brachial plexus, formed by the union of the nerve roots of C5 and C6. The suprascapular nerve courses its way through the scapular notch of the scapula beneath the superior transverse scapular ligament and then innervates the supraspinatus muscle. The nerve then swings around the lateral border of the spine of the scapula to innervate the infraspinatus muscle. As the nerve passes beneath the superior transverse ligament or alternatively where it swings over the lateral border of the spine of the scapula, there is the possibility of entrapment (Simons et al., 1999).

As previously stated, the infraspinatus muscles are responsible for the lateral rotation of the arm at the glenohumeral joint. In a study conducted by Inman, Saunders and Abbott (1944) under electromyography, the infraspinatus muscle activity was tested through varying ranges of motion of the glenohumeral joint, it was identified that with increasing abduction and flexion of the arm at the glenohumeral joint, the level of activity of the infraspinatus muscle increased simultaneously.

The infraspinatus muscle forms part of the rotator cuff muscles along with supraspinatus, teres minor and subscapularis muscles, to help stabilize the humeral head in the glenoid cavity during the motions of abduction and flexion of the arm at the glenohumeral joint. It works antagonistically to the pectoralis major, subscapularis and anterior deltoid muscles in the rotation of the arm (Simons et al., 1999).

2.4.2 Infraspinatus muscle trigger point examination, location and pain referral

The infraspinatus muscle is best examined for myofascial trigger points (MTrP’s) with the patient in a seated position. The hand and the arm of the affected side of the patient are brought across the front of the chest to grasp the armrest of the chair of the unaffected side. This puts the infraspinatus muscle under tension. Flat palpation is used to reveal multiple spots of tenderness that are indicative of MTrP’s.
MTrP's within the infraspinatus muscle may even reveal joint restriction of the glenohumeral joint and should therefore be examined accordingly (Simons et al., 1999).

The most common trigger point may be located caudal to the junction of the most medial and adjacent quarter of the length of the scapular spine. The second most common trigger point may be identified caudal to the midpoint of the scapula spine, it may even extend as far lateral as the lateral border of the scapula. Trigger points may also be found along the vertebral border of the scapula, this is illustrated in Figure 2.8 (Simons et al., 1999).

Upon palpation of a painful infraspinatus MTrP's, a pain referring deep within the glenohumeral joint or anterior to the shoulder, is the most indicative referral pattern to identify infraspinatus MTrP's. The pain may also refer inferior to the anterolateral aspect of the arm to the lateral forearm and possibly as far as the radial aspect of the hand and into the fingers. It may also refer superiorly to the upper posterior cervical region; this is illustrated in Figure 2.8 (Simons et al., 1999; Vizniak, 2011).

![Figure 2.8: A) Location and referral of common infraspinatus MTrP's, B) location and referral of additional infraspinatus MTrP (Simons et al., 1999)](image)

2.4.3 Activation, perpetuation and symptoms of infraspinatus muscle trigger points

Infraspinatus trigger points are usually activated by one of two mechanisms: acute stress or multiple overload stresses. This activation of the trigger points often occurs in situations such as reaching out and back (extension) with the affected arm and may be further aggravated in cases of illness when the muscle is not at its optimal functioning; a motion whereby the affected arm is placed behind the body in an attempt
to regain balance or twisting motions of the arm behind the body in sports such as ice skating, skiing and tennis (Simons et al, 1999).

The shoulder pain usually develops a few hours after the trauma. The patient may also complain of limited range of motion at the glenohumeral joint such as being unable to reach into the back pocket of their pants or not being able to fasten their brassiere strap or zip up their dress behind their back. There is a specific limitation of medial rotation and adduction at the glenohumeral joint, which is noted in the identification of infraspinatus MTrP's. The patient may also complain of pain in the shoulder joint while performing daily routines such as brushing their hair or their teeth. In addition there is also the possibility of fatigue and weakness in the arm with weakness in grip and loss of mobility at the shoulder and associated hyperhydrosis in the referred pain region (Simons et al, 1999).

The referred pain associated with infraspinatus MTrP's may render the patient unable to sleep on the affected side or on their back at night due to compression of the trigger points from the thorax. However the patient may also find it difficult to sleep on the unaffected side, as the affected arm may cross over the chest and put the infraspinatus muscle under tension causing further pain. The patient may find it best to sleep propped up or sitting in a chair (Simons et al, 1999).

2.4.4 Infraspinatus muscle attachment site

Myofascial trigger points within the infraspinatus muscle may reveal joint restriction of the glenohumeral joint. Due to the function of the infraspinatus muscle as a rotator cuff muscle securing and stabilising the humeral head in the glenoid cavity of the scapula, this forms a very firm connection over the glenohumeral joint and assists with dynamic stabilisation of the shoulder complex (Bergmann and Peterson, 2011).

Tight muscles that restrict the mobility of a joint are likely to compromise the function of that joint and vice versa (Mense and Simons, 2001). Myofascial trigger points within the infraspinatus muscle causes tension within the muscle and tautness of the fibers of the muscle which then puts pressure on the capsule of the glenohumeral joint as it compresses the articular surfaces of the glenohumeral joint and therefore limits the range of motion in the shoulder (Bergmann and Peterson, 2011).

2.4.5 Infraspinatus muscle innervation segment

In the cervical region the spinal nerves exit the spine through the IVF and are named according to the inferior vertebral segment (Magee, 2006). As the myopathological component of the subluxation complex is
interconnected with all the other components and vice versa, restoring the mobility and freeing restrictions (kinesiopathology) at the infraspinatus muscles' innervating segments (neuropathology) by means of a chiropractic adjustment may address the myofascial dysfunction (myopathology) in the form of active MTrP's (Gatterman, 2005; Mense and Simons, 2001).

2.5 Myofascial Trigger Points

To date information regarding myofascial trigger points (MTrP's) is exceptionally limited. Myofascial trigger points are complex in nature, as the symptoms produced by MTrP's are often confused with those of radiculopathy, fibromyalgia and articular dysfunctions. In addition their overall co-existence with these conditions adds to further uncertainty in diagnoses (Simons, 2004).

2.5.1 Definition

The MTrP can be described as a localized painful area within a taut band of skeletal muscle or hyperirritable spots (Desai, Saini and Saini, 2013). They may be described as active or latent. Active trigger points are painful regardless of the associated level of mobility. Where as latent trigger points are only painful on palpation (Criscuolo, 2001).

2.5.2 Epidemiology

The prevalence of musculoskeletal pain being identified as myofascial pain is considered to be greater in women than in men, with 65% of women to 37% of men (Graff-Radford, 2004). In a study conducted by Sola, Rodenberger and Gettys (1955), 200 asymptomatic young adults were found to have local tenderness representing latent trigger points in the shoulder girdle muscles, of these 200 adults 54% were identified as females and 45% were identified as males.

2.5.3 Diagnostic features

a) Patient history

The clinical history will reveal regional pain caused either by an acute muscle overload or chronic repetitive muscle activity. Chronic overload is also associated with prolonged, sustained muscle contraction and with muscle-pain-producing work situations (Simons, 2004). Pain appears to be the most common presenting complaint (Cummings and Baldry, 2007).
The pain from MTrP's is most commonly described as deep, aching and poorly localised, as well as cramp-like and diffuse with associated stiffness. The patient’s pain complaint may be aggravated by, psychological stressors, anxiety, cold, postural imbalances and high occupational demands (Bennett, 2007; Charlton, 2005; Huguenin, 2003). The transition from acute to chronic pain is associated with anxiety, depression, general stresses perceived by the patient, substance abuse, poor coping mechanisms and lack of social support, perceptions of health and increased occupational demands (Charlton, 2005; Huguenin, 2003; Shah and Gilliams, 2008; Simons et al., 1999).

Paraesthesia commonly associated with MTrP's may often be described with the pain, as well as various autonomic changes, including lacrimation, regional pilomotor activity, proprioceptive dysfunction and excessive coldness of an extremity. Motor dysfunction including restricted range of motion, weakness, reduced co-ordination and hypertonicity in other muscles in the presence of MTrP's is also reported (Cummings and Baldry, 2007; Simons et al., 1999).

b) Examination findings

The trigger point is located by means of loss of range of motion over the joint, over which the muscle involved crosses, as well as tender spots within the muscle involved. These tender spots may be identified by means of palpation. Active trigger points may be identified by the patient as the recognised pain that they have been experiencing when pressure is applied directly to the trigger point. Latent trigger points may be experienced as a pain that is unrecognisable to the patient (Simons et al., 1999).

Often the muscle may respond to snapping palpation or dry needling by means of a local twitch response (LTR). Snapping palpation may be described as a sudden transverse pressure applied perpendicularly to the muscle fibers (Bennett, 2007; Simons et al., 1999). The LTR is one of the most important confirmatory signs in the clinical diagnosis of MTrP's. LTR is commonly described as a ‘jump sign’ either by the muscle itself or the patient's whole body in response to deep pressure applied to the MTrP’s (Shah and Gilliams, 2008; Huguenin, 2003). With the application of deep pressure to the muscle, in addition to the local tenderness felt by the patient, referred pain and tenderness may also be experienced in more remote regions of the body. The pain may range from a mild ache to excruciating and will not follow a dermatomal pattern or nerve root distribution (Han and Harrison, 1997).

Myofascial trigger points may be palpated centrally within the muscle belly or at the attachment sites of the affected muscle; this is demonstrated in Figure 2.9. Attachment trigger points will often limit extreme stretch and range of motion due to severe pain felt by the patient (Simons, 2004). The most accurate form of
diagnosis for active MTrP’s is manual palpation and patient feedback for the latter. Studies have revealed that inter-rater reliability is largely dependent on the clinician’s skill and experience (Bennett, 2007; Simons et al., 1999). In addition Cummins and Baldry (2007) broadly stated that the clinical examination findings carrying the greatest inter-rater reliability are patient recognition, the presence of a taut band and tender point, the elicitation of referred pain and the local twitch response. The minimal diagnostic criteria for diagnosing active MTrP’s is the presence of spot tenderness in a palpable band and the pain reproduction that is recognised by the patient (Charlton, 2005; Simons, 2004).

Figure 2.9: A) Diagram of the relationship between attachment (ATrP) and central (CTrP) trigger points. B) Diagram of a microscopic view of the CTrP illustrating several contraction knots of individual muscle fibers with normal fibers interspersed (Simons, 2004)

2.5.4 Theories of pathogenesis

The overall understanding of the pathophysiology of myofascial pain syndrome is in its infancy owing to the enormous complexity involved (Shah and Gilliams, 2008). Limited scientific theory exists that may serve to explain the precise physiological nature of these clinical entities. Although several theories have been
suggested, the paucity of data regarding MTrP pathophysiology has made the diagnosis and management of this disorder clinically challenging (Rickard, 2006).

Several promising studies have revealed objective abnormalities in histology, neurophysiology and biochemistry. These findings suggest that myofascial pain is a complex form of neuromuscular dysfunction consisting of motor and sensory abnormalities of both peripheral and central nervous systems (Shah and Gilliams, 2008; Simons et al., 1999). The components involved in a MTrP are illustrated in Figure 2.10.

![Figure 2.10: Diagram of a MTrP showing two motor end plates (MEP) and contraction knots (CK); as well as a neurovascular bundle (NB) containing motor nerves (MN), nociceptive and sensory afferents (SAs) and blood vessels (BV) with closely associated sympathetic nerves (Simons, 2004)](image_url)

a) The Integrated Hypothesis

Simons et al. (1999) proposed a hypothesis, which considered all the major clinical characteristics of MTrP's and combined the electrodiagnostic and histopathological evidence as a means of establishing a credible aetiology for MTrP's (Mense, 2002). In this hypothesis, a six-link chain of events is described. This is demonstrated in Figure 2.11. The key initial feature involves the spontaneous release of Acetylcholine (Ach) from the motor endplates under resting conditions. The exact mechanism for the spontaneous release remains unknown. However electromyographic (EMG) studies have significantly associated endplate noise, which is associated with the excessive release of Ach from the endplates, with MTrP's (Simons, 2004).
1. Abnormal Ach release  ➔ 2. Increased fiber tension

3. Local Hypoxia

local ischaemia  ⇔ TAUT BAND

& ↑metabolism

4. Tissue Distress (↓ ATP)

5. Sensitizing Substances

PAIN ↓

6. Autonomic Modulation

Abnormal Ach release

Figure 2.11: Schema of the six step positive feedback loop of the Intergrated Hypothesis, explaining the aetiology of MTrP’s (Simons, 2004)

In contrast Bennett (2007) questioned whether the presence of endplate noise and spontaneous electrical activity detected electromyographically in the region of MTrP’s is pathognomonic of MTrP’s or whether this is more representative of a normal endplate potential, muscle spindle activity or a manifestation of focal dystonia. However, Bennett (2007) did agree that when a needle examination is performed under high conditions of amplification, a greater degree of spontaneous electrical activity is observed in MTrP locations compared to muscle sites beyond the confines of the MTrP.

The second step involved, the abnormal release of Ach results in increased muscle fiber tension causing taut bands. Biopsies of MTrP’s confirm regional sarcomere shortening for a distance of several hundred microns, in contracted knots. Sarcomeres in the same fiber beyond the contraction knot are lengthened and both the contracted and stretched sarcomeres in one fiber would increase its tension. Involvement of sufficient muscle fibers could produce a palpable taut band (Simons, 2004).

The third step involved hypoxic conditions and local ischaemia ensued and prevailed in the centre of the MTrP. This is largely due to the unusually high oxygen demands of the severely shortened sarcomeres within the contracted knots and local circulation compromise as a consequence of the increased fiber tension. The next step involved, both step one and step two, resulting in tissue distress by compromising the glycolytic and aerobic energy supplies. The latter results in a reduction of adenosine triphosphate (ATP).
and stimulation of tissue distress reactions, which sensitises local nociceptors. Additionally, muscle hypoxia alone can excite nociceptors. The fifth step involved the accumulation of sensitizing substances, which, helped to explain the local tenderness and referred pain of MTrP's. Biochemical differences between normal control of muscles and muscles with active MTrP's exist for a number of substances (Simons, 2004).

Shah and Gilliams (2008) studied the biochemical setting of MTrP's by using a micro analytical system and demonstrated that the concentrations of substance P, calcitonin gene related peptide, bradykinin, serotonin, noradrenaline, tumor necrosis factor and interleukin-1β were higher in active trapezius MTrP's when compared with latent trapezius MTrP's and a control trapezius site. Active MTrP's were found to be far more acidic in comparison to the latent MTrP and control muscle site. Local muscle acidity increases and stimulates the firing of nociceptive nerve endings (Han and Harrison, 1997).

Sustained contraction of the sarcomere is secondary to sustained increase in calcium concentration at the contractile elements. The sarcoplasmic reticulum calcium pump operates on ATP and is more sensitive to low ATP concentrations than the actin-myosin release function that is essential for contractile activity. This 'energy crisis' is postulated to be responsible for the sustained muscle contraction within the taut band (Simons, 2004), as there is insufficient energy to return calcium to the sarcoplasmic reticulum and restore a polarised membrane potential (Shah and Gilliams, 2008). The contractile units are in a continuous state of contraction, serving to further deplete ATP reserves, which reinforces the sustained tension within the contractile units (Simons et al., 1999).

The sixth step is speculative in nature, but postulates that the spontaneous release of Ach from motor endplates is modulated by autonomic influences, but stops short of ascribing the complete regulation of clinical activity (spontaneous release of Ach) of active MTrP's to autonomic influences. Exposure of normal subjects and headache patients to stressful psychological tasks for example has been shown to increase the endplate noise of MTrP's in the upper trapezius muscle, recorded electromyographically. This helps to explain why anxiety and nervous tension, which increases autonomic activity, are associated with MTrP symptom aggravation (Simons, 2004).

b) The Radiculopathic Hypothesis

The Radiculopathic Hypothesis rejects the notion that the primary MTrP dysfunction is muscular and attempts to provide a credible alternative to the Intergrated Hypothesis. This theory attempts to explain the
genesis of MTrP's in relation to a primary neural stimulus with the muscular response being a secondary manifestation (Huguenin, 2003).

In previous studies the neuropathic nerves were observed, to be found at the rami of segmental or spinal nerves (radiculopathy). Furthermore it has been suggested that if the neural injury and partial denervation is the site of the pathology for MTrP development, this would explain the relative lack of pathology seen in the affected muscle and the sensory, motor and autonomic phenomena associated with myofascial pain syndrome. It has also been postulated that myofascial pain most often relates to IVD degeneration and the resultant nerve root compression or angulation associated with the reduced IVD height and IVF encroachment, resulting in paraspinal muscle spasm. The radiculopathy then sensitises structures distally in the distribution of the nerve root causing muscle spasm and trophic changes in ligaments and tendons. This theory could also explain the genesis of tendinopathy and enthesopathy in addition to MTrP's (Huguenin, 2003).

The theory has been argued that muscular pain is indistinguishable from neural pain and that a primary neural cause is far more likely to explain the local and referred pain phenomena associated with myofascial pain syndrome. There are anatomical and physiological grounds to indicate that the MTrP is better understood as a region of secondary hyperalgesia of peripheral nerve origin. However, muscular pain may be the pathological mechanism of the MTrP that causes the development of the peripheral nerve sensitisation. However, there is no substantial evidence to support either theory (Rickard, 2006). According to Mense (2002) the local tenderness of MTrP pain is peripheral in origin, but the referred pain phenomena remains central in origin.

2.5.5 The role of central sensitisation in myofascial trigger point dysfunction

Central facilitation or sensitisation, refer to the increased excitability or enhanced responsiveness of the dorsal horn neurons to an afferent input. Central sensitisation can be manifested in the following manner:

- Increased spontaneous central neural activity, and/or
- Discharge of central neurons to an afferent input, and/or
- A change in the receptive field properties of central neurons (Pickar, 2002).

There are three possible mechanisms associated with central sensitisation and these include:

- Altered sensory processing in the brain, and/or
• Malfunctioning of descending pain inhibitory pathways, and/or
• Sensitisation at the level of the dorsal horn of the spinal cord (Nijs and Van Houdenhove, 2008).

Central sensitisation may play a prominent role in chronic musculoskeletal pain conditions including inflammatory (arthritis and myositis) and non-inflammatory (fibromyalgia and myofascial pain) conditions (Hoeger Bement, Skyba, Radhakrishnan and Sluka, 2003). The persistence of active MTrP pain via activated C-fibers may lead to neuroplastic changes at the dorsal horn of the spinal cord within wide-dynamic range (WDR) neurons (functional and connectivity changes). These neuroplastic changes may lead to amplification of the pain sensation with a tendency to spread beyond its original boundaries (expansion of receptive fields). In the general consideration of intense impulses both nociceptive and non-nociceptive neurons are activated so that even a non-painful stimulus such as touch is perceived as painful (Bennett, 2007; Shah and Gilliams, 2008). These mechanisms may partly explain the pressure sensitivity and perpetuation or the spread of active MTrP's. It has been suggested that alpha-motor neurons are held in a facilitated state because of sensory bombardment from segmentally related spinal structures. The change in motor reflex thresholds is correlated with changes in pressure pain, suggesting that some sensory pathways are sensitised or facilitated in the abnormal segment. One mechanism underlying the clinical effects of spinal adjustment or manipulation may be the removal of subthreshold stimuli induced by changes in joint movement or joint play (Pickar, 2002).

2.6 Chronic Myofascial Pain Syndrome

Myofascial pain syndrome has become widely accepted as a clinical condition based upon recent studies on MTrP's. It may be defined as a regional pain syndrome characterised by muscle pain caused by MTrP's (Kuan, 2009). Myofascial pain is a common cause of persistent regional pain such as neck pain, shoulder pain, headaches and orofacial pain, this concept may be demonstrated in Figure 2.12. However, there is, no clear etiological explanations for the cause of myofascial pain. Some theories suggest that the overall etiology may be associated with developmental (stress or oral habits) and perpetuating (poor sleep, postural abnormalities and depression) factors as possible causes. Myofascial pain syndrome becomes chronic once it has persisted for a term of at least three months or more in duration (Graff-Radford, 2004).
2.7 Chiropractic Vertebral Subluxation Complex

The vertebral subluxation complex (VSC) is a theoretical model involving a subluxation, not described as a condition with one or two characteristics, but rather as a complex of multifaceted pathology. It’s a model of motion segment dysfunction incorporating a complex interaction of pathological changes involving the nerves, muscles, ligaments, local blood supply and the connective tissues. This is in great contrast to the perceived view of the chiropractic subluxation, which is defined as a motion segment in which alignment, movement integrity, or physiological function is altered, although the contact between the articular surfaces remains intact (Bergmann and Peterson, 2011). The chiropractic subluxation complex has the potential to alter the mechanism of neural homeostasis, thus causing malfunctioning of the nervous system, which may then perpetuate the subluxation complex (Gatterman, 2005).

The VSC may only exist if all the components of the complex are present. This encompasses pathological changes relative to the spinal biomechanics, biochemistry, physiology or anatomy and generates symptoms such as pain and visceral or autonomic symptoms (Gatterman, 2005).
2.7.1 Theoretical components

The vertebral subluxation complex consists of five theoretical components namely: neuropathophysiology; kinesiopathology; myopathology; histopathology and inflammatory sub-components. All components are thought to interact with one another but yet each representing its own distinct pathophysiological process contributing to the overall picture (Gatterman, 2005).

a) Neuropathophysiology

The neuropathophysiology component of VSC refers to the neural consequences associated with the VSC, thus resulting in muscle hypertonia, increased sympathetic facilitation and sensory dysaesthesias or muscle atrophy, sympathetic atonia and anaesthesia (Gatterman, 2005).

b) Kinesiopathology

The kinesiopathology component refers to disordered movement involved in the VSC, which involves articular hypomobility, hypermobility or the loss of joint play (Gatterman, 2005). A functional imbalance such as the above mentioned may result in an alteration of stress distribution within the vertebral motion segment. This functional imbalance may then result in a mechanical irritation, which further leads to the genesis of neurogenic and non-neurogenic pain. The individual structural elements such as the disc, facets, ligaments, nerves or muscles may experience concentrations of local stresses that involve functional consequences and tissue-specific symptom production. The final result is a state of dysfunction that leads to local inflammatory or biochemical changes. If the neural elements become inflamed or compromised, this sets off a chain of symptoms remote to the affected area that may involve the peripheral distribution of the nerve (Triano, 2001).

c) Myopathology

The myopathology component of VSC may manifest as muscle hypertonicity, which may be a postural compensatory mechanism or secondary to the neuropathophysiological component of the VSC.

d) Histopathology

The histopathology component refers to the cellular flow associated with the inflammatory process. There may be the presence of oedema that surrounds the IVF due to the inflammatory process, which then
results in the blockage and build up of circulating fluids. This then compounds the neuropathological component of the subluxation complex (Gatterman, 2005).

e) Biochemical

The biochemical component of the VSC then ensues resulting in an accumulation of substances such as prostaglandin E-2, histamines, bradykinin, potassium ions, leukotriene B-4, 5-hydroxytryptamine and cytokines, within the stressed tissues (Bergmann and Peterson, 2011; Gatterman, 2005).

Mechanical and chemical irritants stimulate the local nociceptors, which then results in a barrage of afferent input to the dorsal horn of the spinal cord, resulting in somato-autonomic and somato-somatic reflexes via the autonomic and motor nervous systems. Myofascial trigger points, muscle imbalances and spinal muscle deconditioning are hypothesised to result from reflex stimulation of the anterior and lateral horn cells of the spinal cord, resulting in reflex muscle spasm and sympathetic hyperactivity respectively. This merely presents just one of the very many proposed causes and effects of the VSC that exist. Furthermore it is proposed that an effective treatment protocol of the myopathological component of the subluxation complex in the form of active infraspinatus MTrP's should therefore include the restoration of segmental mobility (kinesiopathological component) at the innervating segments within the cervical spine, and at the attachment site at the glenohumeral joint (Gatterman, 2005).

2.8 The Chiropractic Adjustment

The presence of the diversified Chiropractic technique in a clinical setting, establishes the presence of joint restrictions by means of comprehensive pre-treatment assessments, which include history, palpation, specialised investigations and tests. Diversified practitioners are considered full spinal chiropractors that dedicate additional time to focus on the extremities. Their treatment is focused on restoring nerve function and reducing interference, and therefore stimulating the body to heal itself. The treatment procedure includes a variety of techniques, which may be combined with a variety of adjunct procedures, such as manipulation which is considered a high velocity low amplitude adjustment, as well as mobilisation which refers more to the low velocity adjustment potentially combined with modalities such as soft tissue and myofascial work, orthotic devices, rehabilitation programs as well as patient ergonomics (Cooperstein and Gleberzon, 2004).

The cervical spine particularly C5-C6 level is considered the most mobile segment of the vertebral column due to the multi-directional movements produced by the associated facets (Bergmann and Peterson, 2011).
Mechanical dysfunction of the cervical spine has been identified as a cause in a number of clinical presentations, which range from cervicogenic headaches to shoulder and arm pain (Byfield, 2005).

The chiropractic adjustment has the ability to elicit a reflex response in the body, which may be expressed as reflex inhibition of a spastic muscle, reduction in pain and temporary activation of the skeletal musculature of the back and the upper and lower extremities (Herzog, 2000). Biomechanically, the chiropractor’s aim is to penetrate the elastic barrier of resistance, at which point joint play or segmental end feel of the joint can be felt. Joint play can best be described as the elasticity or “give” in the joint experienced at the end of passive range of motion. Any alteration in joint play will be indicative of a dysfunctional segment and effectively a segment requiring a chiropractic adjustment. The diversified adjustive procedure mainly works within the paraphysiological zone of movement; this is illustrated in Figure 2.13 (Leach, 1994).

![Figure 2.13: Range of motion of a joint (Esposito and Philipson, 2005)](image)

**Clinically the Chiropractic adjustment has the ability to:**

- Increase both active and passive range of motion by restoring the joint to its normal axis of rotation.
- Reduce muscle tension and muscle electrical activity.
- Release entrapped meniscoid or synovial tissue and synovial folds.
Break down contractile adhesions and collagen adhesions that accumulate in the soft tissue and provide consistent reliable reflex responses in the muscles surrounding the spine and the upper and lower extremities (Esposito and Philipson, 2005).

2.8.1 Biomechanical effects of glenohumeral adjustment on myofascial trigger points via attachment site

As previously discussed, the infraspinatus muscle originates from the infraspinous fossa of the scapula and inserts onto the middle facet of the greater tubercle of the humerus. The main function of the infraspinatus muscle is external rotation of the brachium at the glenohumeral joint and assists in holding the humeral head in the glenoid fossa of the scapula (Moore and Dalley, 2006). The glenohumeral joint’s capsular pattern has the most limitation in external rotation followed by abduction, flexion and then internal rotation.

The capsular pattern restrictions are as follows:
- Posterior capsule: decreased horizontal adduction, internal rotation and end range flexion, therefore a decrease in posterior glide.
- Posterior inferior capsule: decreased elevation, internal rotation and horizontal adduction.
- Posterior superior capsule: decreased internal rotation.
- Anterior superior capsule: decreased end range flexion and extension, decreased external rotation and horizontal abduction.
- Anterior capsule: decreased abduction, extension, external rotation and horizontal adduction (Carnes and Vizniak, 2011).

Muscle contraction, in its own capacity may become a source of pain and muscle hypotonicity. Reactive splinting within the infraspinatus muscle may further emphasize the process of hypotonicity and pain by blocking passive range of motion within the glenohumeral joint as well as blocking the pain-inhibiting behaviour of the stimulated mechanoreceptors within the glenohumeral joint. Persistent contraction of the infraspinatus muscle may then lead to contracture of the infraspinatus muscle, which is due to continuous shortening and loss of elasticity from disuse. Potential causes contributing to infraspinatus muscle contraction may include: trauma, emotional stress, structural inadequacies, visceral disease and exposure to cold (Bergmann and Peterson, 2011).

Additionally it has been suggested that through the somatosomatic reflex innervated soft tissue around a specific joint, such as muscle, can potentially become irritated, which may result in changes in postural tone. These changes may further result in the muscle becoming hypertonic. It is also hypothesised that
manipulation of the joint associated with muscle hypertonicity causes stretching of the mechanoreceptors within the joint capsule, which then results in an inhibitory effect on the activity initiated by the type 4 nociceptive endings. This concept is better known as the pain gate theory. This may lead to a reduction in muscle hypertonicity as well as a reduction in pain, which may potentially have been associated with the muscle hypertonicity (Gatterman, 2005).

2.8.2 Neurophysiological effects from stimulation of C4-C5 and C5-C6 nerve roots via cervical spine adjustment on myofascial trigger points

As previously discussed, the suprascapular nerve innervates the infraspinatus muscle. The suprascapular nerve is considered to be a neurological branch arising from the superior trunk of the brachial plexus, arising from the convergence of the ventral rami of nerve roots C5 and C6 (Hansen and Lambert, 2005).

Irritants, such as internal toxins and chemicals and external environmental toxins, stimulating the nociceptors and pain receptors within the infraspinatus muscle create a reflex mechanism, which sends signals along the afferent spindle pathway. These signals then enter the spinal column via the dorsal roots and through interneuronal connections. These signals are transmitted to various spinal levels, specifically C4, C5 and C6, and then to the alpha motor neurons and via the efferent pathway to the motor units located within the infraspinatus muscle, resulting in muscle contraction and spasm (Herzog, 2000).

The chiropractic adjustment stimulates the mechanoreceptors found in the spinal facet joint capsule at a specific segment as well as pain receptors, cutaneous receptors and the proprioceptors of the infraspinatus muscle, which include the Golgi tendon organs and the muscle spindles (Herzog, 2000). This may have the ability to interrupt and reverse the reflex mechanism of the infraspinatus muscle and may cause relaxation of the muscle. This could restore motion and reduce the number of trigger points located within the infraspinatus muscle (Plaugher, 1993).

a) The nerve compression theory of the chiropractic adjustment

Haldeman (2000) examined the strengths and weaknesses of each proposed neurological effect of the chiropractic adjustment. The nerve compression theory proposes that the primary effect of the adjustment is to correct a chiropractic subluxation. The subluxation may be defined as a change in relationship between vertebrae, which causes compression of the spinal nerve roots, resulting in interference of normal nerve root function.
However, Haldeman (2000) found no evidence to suggest that the change in the relation of adjacent vertebra could result in nerve root or spinal cord compression. Additionally there was little evidence to support the chiropractic adjustment’s ability to relieve any existing compression of nerve roots. It was concluded that the chiropractic adjustment might not be considered to have an established effect on the reduction of nerve root compression.

Gatterman (2005) agreed that there is very little evidence to suggest that the ‘bone out of place’ theory of subluxation can compromise neural tissue in the IVF. Furthermore the intervertebral encroachment theory with subsequent nerve compression possessed a simple appeal. Pickar (2002) makes the point that spinal nerve roots within the IVF possess unusual anatomical properties having less connective tissue support and protection compared with peripheral nerves.

There is substantial evidence that dorsal roots and dorsal root ganglia are more susceptible to mechanical compression than the axons of peripheral nerves. Increased neural activity may be associated with distal neurological effects. The chiropractic adjustment is suggested to correct these effects by restoring normal biomechanical movement of the vertebral segment thereby reducing pressure within the IVF, relieving dysfunction of the dorsal root ganglion (Gatterman, 2005).

b) The reflex theory of the chiropractic adjustment

The reflex theory of the adjustment is of particular interest to this study. The chiropractic subluxation is considered a biomechanical abnormality within a vertebral motion segment. Such a relationship is proposed to stimulate sensory receptors in the spinal and paraspinal structures such as muscles, ligaments, and facet joint capsules, the impulses of which presumably activate neural reflex centres within the spinal cord or higher centres. These receptors are responsive to mechanical (position, motion and tissue tension), inflammatory (pain) and temperature changes. Impulses generated from these receptors then cause somato-somatic responses resulting in muscle spasm, or somato-visceral responses in sympathetic and parasympathetic nerves resulting in autonomic phenomena (Haldeman, 2000; Bergmann and Peterson, 2011).

These reflexes activate central reflex pathways and specific somato-somatic reflexes in experimental animals. It has been demonstrated that these reflexes may be brought about by the chiropractic adjustment at the spinal level. However there remains minimal evidence that these reflexes persist for sufficient time to bring about long-term relief (Haldeman, 2000). Reflex relaxation of hypertonic muscles by sudden stretching is a theory of particular interest to the present study. It has long been believed that adjustments
can normalise abnormal muscle tone, which is often attributed to the stimulation of inhibitory afferents to the dorsal horn from mechanoreceptors (Evans, 2002). However, the evidence regarding the effect of the chiropractic adjustment on somatomotor activity reveals both excitatory and inhibitory effects (Pickar, 2002).

Several studies appear to provide evidence that the chiropractic adjustment produces a decrease in resting paraspinal electromyographic (EMG) activity. Resting EMG activity levels within the tight muscle bundles immediately decreased in the majority of cases after receiving a chiropractic adjustment to the associated vertebral dysfunction (Fryer, Morris and Gibbons, 2004).

However, Evans (2002) holds a different view stating that sudden stretch of musculature produced by adjustments will excite rather than inhibit the motor neuron. Studies have been performed where the facet joints of anaethetised cats at the C3/C4 level were distracted and an increase in the EMG activity of cervical and upper limb musculature was recorded. This is likely a protective role initiated by the facet capsule mechanoreceptors and affected by the muscles, elicited by way of reflex arcs. A synergy of the passive capsulo-ligamentous and active muscular joint restraints are therefore achieved. Due to the rich innervation of the facet capsules in humans, it is reasonable to suggest that a similar synergistic relationship occurs in humans (Evans, 2002). Central motor excitability was additionally demonstrated to increase after a spinal adjustment in four cases in the study conducted by De Vocht, Pickar and Wilder (2005), where resting EMG was higher after delivering a chiropractic adjustment, although the increase was small in three of the four cases.

Further evidence to support a motor excitatory effect of the chiropractic adjustment was demonstrated by transcranial magnetic stimulation activation of descending corticospinal tracts, which resulted in large motor activity of the gastrocnemius muscle when preceded by a lumbar spine chiropractic adjustment. Once more, this mechanism is presumably reflexive in nature (De Vocht et al., 2005).

Lastly, Dunning and Rushton (2008) demonstrated an excitatory effect of a C5/C6 chiropractic adjustment on the motor activity of the biceps brachii muscle, which is not attached to the spine at its origin or insertion. The C5/C6 segment corresponds with the segmental innervation of the biceps brachii muscle. The resting EMG activity ipsilateral to the side of the application of the chiropractic adjustment was higher than the contralateral side, but EMG increases from the resting state were observed bilaterally. These studies therefore indicate that spinal manipulation can both increase the excitability of motor pathways in the spinal cord and depress the inflow of sensory information from muscle spindles (Pickar, 2002).
c) The pain relief theory of the chiropractic adjustment

The pain relief theory proposes that the chiropractic adjustment can bring about hypoalgesia by stimulating spinal structures, which reduces muscular pain thresholds via central facilitation. There is no evidence to suggest, that patients undergoing treatment with spinal adjustments may describe a type of pain relief that may exceed the same pain relief obtained and described with other treatment methods. However, the observed changes may also be due to psycho-physiological mechanisms and may not be due to the effects of the adjustment on spinal pain (Haldeman, 2000).

Ruiz-Sáez, Fernandez-de-las-Penas, Blanco, Martinez-Segura and Garcia-Leon (2007) investigated the immediate effect of a single cervical spine adjustment (applied to C3 and C4) on the pain pressure threshold of latent trigger points in the upper trapezius muscle. The treatment group received a cervical adjustment at C3 and C4 and the control group received a placebo adjustment at the above-mentioned levels. Subjects receiving the adjustment intervention showed a trend toward an increase in pain pressure thresholds versus those subjects receiving the placebo adjustment, whom showed a trend towards a decrease in pain pressure threshold levels.

Terrett and Vernon (1984) quantified the reduction in pain sensitivity after spinal manipulation. They established a model of pain sensation using graded, electrical stimulation of cutaneous paraspinal tissues. A blinded observer assessed the minimal current necessary to evoke pain, described as pain threshold, and the maximal tolerable current that evoked pain, described as pain tolerance, in subjects with tender regions of the thoracic spine. Spinal manipulation significantly increased pain tolerance levels by 1.5 times within 30 seconds. Over the next 9.5 minutes, tolerance levels progressively increased 2.4 fold (Pickar, 2002).

The neurophysiological mechanisms by which spinal adjustment therapy may evoke changes in pain pressure thresholds in MTrP’s remain to be fully elucidated. Reduction of chemical algogenic mediators; activation of segmental inhibitory pathways and or central descending inhibitory pathway activation mechanisms have been suggested (Ruiz-Sáez et al., 2007).

The effect of spinal manipulation on pain could also be mediated by the neuroendocrine system. The endogenous opiate system, which is known to modify pain processes. Vernon, Dhami, Howley and Annett (1986) reported an 8% increase in plasma-endorphin levels five minutes after spinal manipulation but not after control interventions. On the other hand, Sanders, Reinert, Tepe and Maloney (1990) did not find any
change in plasma-endorphin levels despite a reduction in the visual analogue pain scale in a group receiving spinal manipulation (Pickar, 2002).

d) Korr’s theory of joint fixation

During muscle shortening, there is a cancellation effect between the extrafusal fiber shortening and the intrafusal fiber polar region shortening, this leads to an equal length of fibers and thus a steady state spindle afferent output through all the ranges of muscle length. This is known as gamma-gain which Korr then stated the greater the gain, the greater the steady state spindle output at all muscle lengths (Gatterman, 2005).

Korr hypothesized that segmental muscles may have possibly acquired an increased gamma-gain. This means that during the high gamma activity, the spindles encourage their own muscle, which is already in a shortened state to contract and further shorten creating restriction of the involved motion segment. The spindle then reports the extrafusal fiber length relative to that of the polar region length of the intrafusal fibers. This mean that the increased gamma-gain is ultimately an increase in the steady state of the spindle discharge through all the ranges in the muscle length. The greater the gamma gain, the more increase in spindle afferent output and the corresponding facilitated alpha motor neurons, which then causes a greater contraction of the extrafusal fibers in an attempt to silence the spindle output. There are two possible causes for this increase in gamma-gain:

1. An unanticipated giving way of a load during an isometric contraction of the muscle.
2. An abrupt approximation of two muscular attachments (Gatterman, 2005).

In both cases, the equatorial region of the spindle slackens, which leads to a silencing of the spindle. The central nervous system acknowledges this and demands feedback from the spindle. This occurs in the form of increasing gamma gain to the intrafusal fibers and therefore restoring the spindle afferent output discharge. The two muscular attachments naturally oppose each other to try regain their normal anatomical relationship in response to the increased gamma-gain. The more stretch applied to the muscle, the greater the resistance to stretch caused by the increased spindle afferent output (Gatterman, 2005).

Korr further hypothesized that the high velocity, low amplitude thrust of the chiropractic adjustment stretches the hypertonic muscles responsible for the restricted joint motion. He explained that the rapid stretch, of the chiropractic adjustment, induced rapid stretching of the extrafusal fibers, which then generated a rapid stretch of the intrafusal fibers equatorial region, which was already under a significant tension set by the gamma efferents. This spindle stretch would generate such an intense number of
afferent impulses it would cause the central nervous system to respond by decreasing the gamma efferents. This would cause the normal gamma-gain to be re-established with a return of normal muscle tonicity (Gatterman, 2005; Leach, 2004).

e) Muscle hypertonicity

Muscles not only function to create movement but also function to limit movement. This theory supports the concept that restricted joint movement may result in an increase in segmental muscle tone or muscle spasm. Joint movement is regulated by, a balance between agonist and antagonist muscles, thus when there is a disruption in this balance and antagonist muscles are unable to elongate due to hypertonic agonist muscles, the joint involved may become restricted and reflect a reduced range of motion. The increased muscle tone or hypertonicity may be a result of direct myofascial trauma or indirectly by overstimulation or injury of the articular structure involved. Direct overstretching of the muscle may lead to tearing of the muscle, which will then stimulate the nociceptors located within the muscle and the protective muscle splinting. Thus resulting in muscle hypertonicity (Bergmann and Peterson, 2011).

Chiropractic manipulation may have the ability to reverse the effects stated in the latter, thus reducing the muscle spasm and restoring joint motion to its optimal range of function (Bergmann and Peterson, 2011).

f) The myofascial cycle

All the articular soft tissues are richly innervated with mechanoreceptors and nociceptors; therefore any form of traction or injury to these structures may initiate local muscle splinting. Over a period of time, continuous contraction of the muscle then results in fatigue of the muscle, which causes ischaemia to the muscle followed by pain and maintenance of muscle spasm and joint locking as illustrated in Figure 2.14 (Bergmann and Peterson, 2011).

The high velocity, low amplitude chiropractic adjustment is said to be an effective form of treatment in interrupting this cycle by inducing a reflex response in the muscle. During the administration of the chiropractic adjustment, the quick tractional force causes excitation of the Golgi tendon organ, which is located in the muscle tendon junction. This serves as a brake to limit excessive joint movement and possible injury by inhibiting motor activity. It performs this function by forming a strong stretch on the muscle tendon complex, which activates the Golgi tendon organ and through autogenic inhibition, induces reflex muscle relaxation (Bergmann and Peterson, 2011).
However, it has also been found that through stimulation of the mechanoreceptors and nociceptors, there was a remarkable inhibitory effect on segmental motor activity. It has been shown that a chiropractic adjustment has the ability to induce enough force to stimulate these structures and therefore induce a burst of somatic afferent receptor activity (Bergmann and Peterson, 2011).

Based on the latter information, it is possible to assume that the joint and soft tissue mechanoreceptors and nociceptors have the potential to play a role in the inhibition of muscle hypertonicity by means of interruption of the painful myofascial cycles and the associated joint locking (Bergmann and Peterson, 2011).

Figure 2.14: The myofascial pain cycle (Bergmann and Peterson, 2011)
CHAPTER 3

METHODOLOGY

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3.1 Introduction

This chapter is concerned with subject selection, the group allocation process, the involved groups, the manner by which subjective (Functional Rating Index Scale; Numerical Pain Rating Scale) and objective (pressure-pain threshold; number of active infraspinatus myofascial trigger points) measurements in response to the treatment were assessed, the treatment protocol and a description of the follow up treatments.

3.2 Study Design

This study was a quantitative comparative study with random group allocation.

3.2.1 Participant recruitment

Voluntary male and female participants presenting to the University of Johannesburg Chiropractic Day Clinic with active infraspinatus myofascial trigger points (MTrP’s) were utilized for the purposes of this study and were recruited by word of mouth and by means of advertisements (Appendix A) displayed in and around the Chiropractic Day Clinic at the University of Johannesburg, Doornfontein Campus.

3.2.2 Sample selection and size

Prior to participant inclusion in this study, thirty participants had to satisfy the inclusion criteria with the exclusion criteria also being taken into account. Each participant received an explanation of the specific study details, verbally and in writing (Appendix B), after which the consent form was completed (Appendix C).

3.2.3 Inclusion criteria

To be included in the study, participants had to comply with the following inclusion criteria:

- The participants could be male or female, as both genders are affected by chronic, active MTrP dysfunction. The prevalence of myofascial pain is 37% in males and 65% in females (Graff-Radford, 2004).
- The participants had to be between the ages of 18-45 years as after 45 years degeneration occurs, thus potentially altering the measurements and giving an inaccurate result (Division of Adult and Community Health, National Center for Chronic Disease Prevention and Health Promotion, 2014).
The participants had to present with chronic (longstanding referring to months or years but not necessarily permanent as it may be reversible) intermittent shoulder or scapular pain for at least three months duration (Simons et al., 1999).

Pain had to be referred from active infraspinatus MTrPs to the shoulder joint, the anterior deltoid and anterolateral aspect of the arm and forearm upon manual palpation of the muscle (Simons et al., 1999).

The participant had to present with restrictions at the cervical nerve root level C4/C5 and/or C5/C6, this being the innervation to infraspinatus muscle. This was determined using the motion palpation technique.

The participant needed to present with restrictions of the glenohumeral joint as determined by the motion palpation technique.

**3.2.4 Exclusion criteria**

Participants were excluded if they had the following:

- Cervical spinal chiropractic adjustive therapy and glenohumeral chiropractic adjustive therapy were contra-indicated (Appendix D).
- Neurological deficit of the upper limb and/or trunk resulting in sensory or motor deficits and reflex changes.

**3.2.5 Group allocation**

Two groups of fifteen participants each were assigned to either Group A or Group B by randomly drawing a number from a box. Group A received chiropractic adjustment to any restrictions detected at the glenohumeral joint corresponding to the site of attachment of the infraspinatus muscle and Group B received chiropractic adjustment to any restrictions detected at the vertebral levels C4/C5 and/or C5/C6 facet joints corresponding to the innervation of the infraspinatus muscle.

**3.3 Treatment Approach**

**3.3.1 First and follow up consultations**

A total of seven consultations took place over a 3-4 week period, depending on participant availability. During all the consultations, dynamic motion palpation techniques were employed to locate specific restrictions at the site of attachment or the site of innervation for the infraspinatus muscle for each group respectively.
During the first consultation, before the administration of chiropractic adjustment, a complete case history (Appendix E) was taken along with a full physical examination (Appendix F) and a cervical (Appendix G) and shoulder regional examination (Appendix H) were performed. Information was recorded on a S.O.A.P. note (Appendix I). Each participant independently completed part A of a subjective pain and discomfort questionnaire, which included the Numerical Pain Rating Scale (NPRS) (Appendix J) and the Functional Rating Index Scale (FRI) (Appendix K). Pain-pressure threshold measurements were recorded using the algometer over the active infraspinatus muscle trigger points and the number of active infraspinatus muscle trigger points were recorded by the researcher (Appendix L). Participants in group A then received glenohumeral adjustment pertaining to restrictions located at the glenohumeral joint and group B received cervical adjustment pertaining to C4/C5 and/or C5/C6 facet joint restrictions.

During the second, third, fifth and sixth consultations, the relevant restricted areas were reassessed for restrictions, the information was recorded on a S.O.A.P. note (Appendix I) and chiropractic adjustment were applied to the restricted areas only. Upon the fourth consultation, the objective and subjective data were measured and recorded on a S.O.A.P. note (Appendix I) prior to the application of chiropractic adjustment: these included pain-pressure threshold and measurements of the number of active infraspinatus muscle trigger points as well as each participant independently completing Part B of the NPRS (Appendix J) and FRI scale (Appendix K).

At the seventh and final consultation, objective and subjective data were measured and recorded on a SOAP note (Appendix I) only: these included pain-pressure threshold and measurements of the number of active infraspinatus muscle trigger points as well as the completion of Part C of the NPRS (Appendix J) and FRI scale (Appendix K).

Group A received diversified chiropractic adjustment to the site of attachment of the infraspinatus muscle, specifically to restrictions found in the glenohumeral joint. Diversified chiropractic adjustment were delivered to the innervation of the infraspinatus muscle at specific restricted cervical vertebral levels to all participants in group B. This was specifically at the cervical vertebral levels of C4/C5 and/or C5/C6.
3.4 Subjective Data

3.4.1 The Numerical Pain Rating Scale

Pain intensity can be defined as the magnitude or severity of pain perceived by an individual. Within a clinical setting, pain intensity becomes the most preferred measurement of the pain domain as it is a primary target for the treatment of pain (Jansen, 2011).

Pain intensity is influenced by the patient’s interpretation of the pain as well as the duration it is expected to last for. There are many varying contributing factors to the experience of pain, some of which include external environment, an individual’s beliefs and attitude as well as emotional factors such as fear, anxiety and depression. As such pain, be it chronic or acute can influence an individual’s behaviour. It may cause dysfunction, and in severe cases, even disability (Williamson and Hoggart, 2005). Chronic pain has been described as a prevalent, disabling and poorly managed condition. Studies have found a correlation between a patient’s pain intensity and the influence it has on a patient’s lifestyle and functional abilities (Fraenkel, Falzer, Fried, Kohler, Peters, Kerns, and Leventhal, 2011).

The Numerical Pain Rating Scale (NPRS) is one of many pain scales that measure the intensity of an individual’s pain (Williamson and Hoggart, 2005). It is considered as the standard instrumentation used to measure chronic pain in clinical studies (Farrar, Young, LaMoreaux, Werth and Poole, 2001).

The NPRS is an 11 point scale. At the extreme ends of the scale there is a measure of no pain and the worst possible pain felt by the individual. The scale is graphically represented by a point box ranging from 0, where no pain is felt, increasing to 10, where the individual experiences the worst pain imaginable. The patient crosses the box that’s most relevant to their pain intensity at that point in time (Williamson and Hoggart, 2005).

When compared to other pain rating scales, which would include the Verbal Rating Scale (VRS) and the Visual Analogue Scale (VAS), all three scales were found to be reliable and valid however with regard to sensitivity of these scales, the NPRS and VAS showed the greatest sensitivity to change. This could be attributed to the number of levels each scale contained, the more levels a scale has the more sensitive it becomes to change (Williamson and Hoggart, 2005).

The NPRS is commonly used for its simplicity as well as its low failure rate when compared to other pain rating scales (Williamson and Hoggart, 2005). The NPRS is therefore proven to be reliable, responsive and
valid in its measure of a patient's pain intensity (Ferreira-Valente, Pais-Ribeiro and Jensen, 2011). Hence the NPRS was utilised for the purpose of this clinical study.

3.4.2 The Functional Rating Index Scale

The therapeutic aim of any study involved in physical medicine is to determine the most effective approach in reducing pain and restoring function to the human body. With regards to the following it may be deduced that function is a measure of severity and pain is the ideal means of measurement. There are many instruments used to measure severity of pain and function of the body, but most are time consuming for both the patient to answer as well as the clinician to score. The patient may also be experiencing pain in multiple regions of the body.

Feise and Michael Menke (2001) stated that the Functional Rating Index (FRI) is an instrument specifically designed to quantitatively measure the subjective perception of function and pain of the spinal musculoskeletal system in a clinical environment. This questionnaire has the ability to measure and determine subjectively, a patient's range of motion as well as static movement in the neck and the back and the effect it has on a patient's daily activities. It takes into consideration function as well as the patient's attitude and beliefs and self perception of disability. This instrument therefore becomes very easy and fast for both the patient and the clinician to use. It also quantifies the patient's pain and dysfunction in a reliable and valid manner for any spinal condition (Feise and Michael Menke, 2001).

The FRI was designed based on the highly validated Oswestry Low Back Disability Questionaire (OLBDQ) used for low back pain and the Neck Disability Index (NDI) for pain relating to the neck. The FRI is a combination of these two questionaires, taking seven scale items from the NDI and eight from the OLBDQ, totalling to nine scale items from the two instruments. The tenth item relating specifically to the frequency of the patient's pain. The sensitivity of the FRI is determined on its 5 response options. It has been determined that the more response options available on a questionaire, the more sensitive the instrument becomes to changes, however a 5 response option is the easiest to use, with the least frequency of item omission and becomes an essential tool in measuring health status (Feise and Michael Menke, 2001).

The FRI comprises of ten items used to measure pain and function of spinal musculoskeletal conditions. Most of the items relate to the effects on activities of daily living and two items relate to the pain specifically caused by spinal conditions. The FRI makes use of a 5 point response per item listed, ranging from zero which represents no pain or full function to 4 which represents the worst possible pain or unable to perform
the function. The patient ranks his/her perception of ability to perform each function or rate the pain felt specifically at that point in time.

The FRI has been shown to be a practical, easy and an inexpensive tool used to measure a patient's physical function and pain severity relating to any spinal condition. Research has shown that this questionnaire is not influenced by gender, age or level of education (Ferreira, Borges, Rezende, Carvalho, Soares, Dabes, Carvalho, Drummond, Machado and Ferreira, 2010). This instrument has proved to be psychometrically stable and has proved to be very reliable, responsive and valid in its measures, it also demonstrates a high degree of sensitivity to change (Ferreira et al., 2010; Feise and Michael Menke, 2001). Based on the following grounds, it was utilised in this clinical study.

3.5 Objective Data

3.5.1 Pressure-pain threshold

The generation of pain can be categorized into one of three mechanisms of injury, namely: thermal, chemical or mechanical (Haussler and Erb, 2003). Pressure-pain threshold is accurately defined as the minimal amount of pressure applied to tissue, that is able to produce pain in that specific tissue (Azavedo, de Lima Pires, de Souza Andrade and McDonnell, 2008; Ylinen, 2007). The ideal tool of measurement for this process is a pressure algometer. It is able to accurately quantify the patient’s subjective assessment of pressure-pain threshold or tenderness within the muscle being tested. Therefore proving to be very useful in the diagnosis and treatment of myofascial pain syndromes and collectively in the clinical management of pain (Haussler and Erb, 2003).

There are a range of pressure algometers available from simplistic to electrical devices. The device used for this study was a simple hand-held spring device consisting of a pressure gauge attached to a rubber tipped plunger (Haussler and Erb, 2003) as seen in Figure 3.1.
In this study, the researcher located active infraspinatus myofascial trigger points (MTrP). The researcher then placed the pressure algometer perpendicularly on each active infraspinatus MTrP and gradually applied a pressure at 0.1kg of force per second (Affaitati, Fabrizio, Savini, Lerza, Tafuri, Constantini, Lapenna, and Giamberardino, 2009) as seen in Figure 3.2. The measurements were then recorded as kilograms of pressure per centimeter squared (kg/cm$^2$). This was taken from the point where the participant first perceived the pain and verbally indicated discomfort and/or tenderness with the application of the pressure algometer. The measurement was repeated three times at each active infraspinatus MTrP, the readings were then averaged and recorded. The readings were then further averaged to provide a single pressure pain threshold measurement.
Pressure algometry has been proven to have good repeatability with regard to intraclass correlation coefficients (ICC), good validity through assessment by pain and disability questionaires and has demonstrated intra and inter-rater reliability (Azavedo et al., 2008; Ylinen, 2007; Goolkasian, 2002).

3.5.2 Number of active infraspinatus myofascial trigger points

The number of active infraspinatus MTrP's within the infraspinatus muscle of the affected side of each participant was recorded (Appendix L). Each participant had the potential to harbour four active MTrP’s. The infraspinatus muscle consists of at least three MTrP’s (see Figure 3.3). There are two MTrP’s that may be palpated medially, one cephalad and one caudal respectively and one MTrP that may be palpated lateral and cephalad (Simons et al., 1999).

![Figure 3.3: Referral pattern and location of infraspinatus Myofascial trigger points (Davies, 2010)](image)

Each participant having a referral pattern specific to infraspinatus muscle: deep within the glenohumeral joint, in the front of the shoulder possibly projecting down the anterolateral aspect of the arm to the lateral forearm and possibly including the lateral aspect of the hand. Possibly also referring to the upper portion of the posterior cervical region and along the vertebral border of the scapula as identified and indicated by the participant (Simons et al., 1999) as seen in Figure 3.3.

The number of each active infraspinatus MTrP’s was recorded on the first and fourth consultation before a chiropractic adjustment was administered and then finally on the seventh consultation when only measurements were taken, for comparitive purposes.
Each participant was placed in a seated position with the arm and hand of the affected side brought across the chest to rest on the opposite arm thus placing the infraspinatus muscle under tension. The muscle was then manually palpatated via flat palpation for local trigger point tenderness (Simons et al., 1999).

3.6 Patient Assessment

The patient was assessed by means of motion palpation for restrictions located in the lower cervical spine, specifically at the levels of C4/C5 and/or C5/C6, and the glenohumeral joint.

3.6.1 Motion palpation

Motion palpation of the cervical spine and the glenohumeral joint were carried out with the participant in a supine position.

Motion palpation of the glenohumeral joint was performed in the following manner:

- The affected arm was slightly abducted away from the body, the doctor stood at the side of the table of the affected arm and used both hands to grasp the participant's proximal humerus.
- The humerus was stressed internally and externally and assessed for internal and external rotary restrictions (Bergmann and Peterson, 2011).

Motion palpation of the cervical spine was performed in the following manner:

- The doctors palmer surface of the middle fingers were placed over the posterior articular pillars of the cervical spine;
- For rotation, the participant's head was passively rotated away from the side of evaluation;
- At the end of passive motion, the joint was sprung from posterior to anterior along the facet planes to assess the joint play motion;
- For lateral flexion, the participant's head was passively laterally flexed towards the side of evaluation;
- At the end of passive motion, additional overpressure was applied by pushing towards the midline from the side of lateral flexion to assess the joint play motion (Bergmann and Peterson, 2011).

Each segment of the cervical spine was motion palpated to feel for any rotary or lateral flexion restrictions. The glenohumeral joint was also motion palpated to feel for any internal or external rotary restrictions. Each restriction of the cervical spine and the glenohumeral joint was recorded with careful consideration to C4/C5 and C5/C6 segments as these were the levels in the cervical spine that received the adjustment.
3.7 Diversified adjustment

After motion palpation had been performed, restrictions were found in the cervical spine and glenohumeral joint and were recorded. Group A received an adjustment delivered to the glenohumeral joint specific to the restriction found. Group B received an adjustment delivered to the cervical segments C4/C5 and/or C5/C6 specific to the restriction found.

The glenohumeral adjustment was performed in the following manner:
- The participant was in a supine position with the affected arm slightly abducted away from the patient’s body;
- The doctor was standing on the involved side facing a cephalad direction and straddling the participant’s affected arm, gently grasping the distal humerus, just above the humeral epicondyles, between the doctors knees;
- The doctor grasped the participant’s proximal humerus with interlaced fingers of both hands;
- Depending on the type of restriction, with an external rotary restriction, the doctor turned the participant’s proximal humerus into external rotation with interlaced fingers of both hands. With an internal rotary restriction, the doctor turned the participant’s proximal humerus into internal rotation with interlaced fingers of both hands. This was done to remove joint slack;
- The doctor then applied a long-axis distraction to the glenohumeral joint by straightening both knees, and depending on the type of restriction, adjusted further into external rotation for an external rotary restriction or into internal rotation for an internal rotary restriction (Bergmann and Peterson, 2011).

The cervical spine adjustment was performed in the following manner:
- The participant was in a supine position;
- The doctor was standing at the head of the table, on the side of the adjustive contact, angled at a 45 to 90 degree angle to the participant;
- The doctor contacted the posterior articular pillar of the superior vertebrae of the participant’s cervical spine corresponding to the restricted segments, with a ventrolateral contact of the distal index finger of the hand corresponding to the side of the segmental contact. The thumb or thenar aspect of the doctor’s hand rested on the patient’s cheek as the remaining fingers reinforced the contact;
- The doctor’s indifferent hand cradled the participant’s head, supporting the contralateral occiput and upper cervical spine;
- The doctor rotated the participant’s head away from the side of the dysfunction;
- Depending on the type of restriction, for a rotary restriction, the participant’s head was rotated away from the side of dysfunction while lateral flexing towards the side of contact ensuring minimal lateral
flexion so as to avoid compressing and locking the joint being distracted. At point of tension the thrust was delivered through the wrists and forearms in a clockwise or anti-clockwise direction along the planes of the facet joint. For a lateral flexion restriction, the participant’s head was laterally flexed towards the side of contact, ensuring minimal rotation and the thrust was delivered in a medioinferior direction (Bergmann and Peterson, 2011).

3.8 Data Analysis

A statistician from STATKON (located at the University of Johannesburg, Kingsway campus) analysed the results from the subjective and objective parameters and documented the information in the following manner:

1. Compared the two groups by means of descriptive statistics in the form of frequencies and percentages as well as means for all continuous variables;
2. Performed a descriptive statistical analysis of the Numerical Pain Rating Scale and the Functional Rating Index Questionaire;
3. Performed an intra-group analysis of the pain rating (NPRS), pressure algometry and the number of active infraspinatus MTrP’s with the use of the Friedman test which made use of the Wilcoxon Signed Rank Test for both group A and group B;
4. Performed an inter-group analysis of the pain rating (NPRS), pressure algometry and the number of active infraspinatus MTrP’s with the use of the Mann-Whitney U-test for both group A and group B.

3.9 Ethical Considerations

It was required that all participants, taking part in the study, read the information form (Appendix B) and signed the consent form (Appendix C) specific to this study. The information form specified particulars with regard to the name of the researcher, the purpose of the study, the benefits involved in partaking in the study, a full participant assessment and treatment procedure; all risks, benefits and discomforts pertaining to the treatment administered was carefully explained to each participant with emphasis placed on the safety of each participant in the prevention of all possible harm to the patient. The information and consent form also explained that the participant’s privacy was protected as only the doctor, patient and clinician were in the treatment room and that anonymity was ensured as the patient information was converted into data and therefore could not be traced back to the individual. The form also stated that standard doctor/patient confidentiality was adhered to at all times when compiling the research dissertation. The participants were informed that their participation was on a completely voluntary basis and they reserved
the right to withdraw from the study at any given stage. The researcher was available and open to answering any questions the participants may have had during any stage of the study. Contact details of the researcher were made available to each participant. The participants were then required to sign the consent form, stating that they understood all the requirements of the particular study. The results were made available on request of the participant. The study was conducted as originally approved by the Higher Degrees (HDC01-03-2014) and Ethics Committee (AEC01-03-2014).
CHAPTER 4

RESULTS
4.1 Introduction

This chapter was used to present the results obtained during the clinical trial of the study.

The sample group consisted of 30 participants, 15 participants were in group A, they received chiropractic adjustments to the attachment site of the infraspinatus muscle, and 15 participants were in group B, they received chiropractic adjustments to the innervation segments of the infraspinatus muscle. The statistical results therefore only represent a small group of subjects and therefore no assumptions or conclusions can be made with respect to the population as a whole.

The probability level (p-value) was set at $p \leq 0.05$. If the p-value is $\leq 0.05$, a statistically significant finding was observed. If the p-value is $> 0.05$, it can be stated that there was no statistically significant finding.

The analyses included:
1. Demographic data analysis consisting of frequency tables;
2. Subjective measurements (Functional Rating Index and the Numerical Pain Rating Scale);
3. Objective measurements (pain-pressure threshold and the number of active MTrP’s).

<table>
<thead>
<tr>
<th>Table 4.1: Key abbreviations used in the text, figures and tables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
</tr>
<tr>
<td>Group B</td>
</tr>
<tr>
<td>Visits</td>
</tr>
<tr>
<td>Pain Pressure threshold</td>
</tr>
</tbody>
</table>
4.2 Demographic Data Analysis

4.2.1 Gender distribution

The gender distribution for participants in group A was distributed with a percentage of 46.7% males and 53.3% females, group B was distributed with a percentage of 53.3% males and 46.7% females, therefore the distribution of each group between males and females were evenly distributed with 50% for each group. This is illustrated in Table 4.2.

4.2.2 Age distribution

The age distribution for participants in group A ranged from 21 to 30 years with a mean age of 24.93 years, as illustrated in Table 4.3.

The participant’s ages in group B ranged from 22 to 31 years with a mean age of 24.67 years, as illustrated in Table 4.3.
4.3 Subjective Data Analysis

The subjective data of this study included the Functional Rating Index questionnaire and the Numerical Pain Rating Scale.

The Friedman test was used for the intragroup analysis. Further intragroup analysis was required by using the Wilcoxon Signed Ranks test.

The Mann-Whitney U-test was used for the intergroup analysis to detect where differences in results took place.

4.3.1 Functional Rating Index Scale

The Shapiro-Wilk test was performed to test for normality and to determine if both groups started at the same level of discomfort and had the same effect on daily living and activity.

Intragroup analysis

![Line graph representing the mean value for the Functional Rating Index scale as a percentage for both groups](image)

Figure 4.1: Line graph representing the mean value for the Functional Rating Index scale as a percentage for both groups
Figure 4.1 illustrates that the initial mean percentage for group A for the Functional Rating Index scale was 24.00% and final mean percentage was 8.50%. This showed a 15.5% reduction in discomfort and disabling effect on daily living and activity.

The Friedman test showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001 within group A. Therefore there was a statistically significant difference ($p \leq 0.05$) in this group.

The initial mean percentage for group B for the Functional Rating Index scale was 21.42% and the final mean percentage was 8.08%. This showed a 13.34% reduction in discomfort and disabling effect on daily living and activity.

The Friedman test showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001 within group B. Therefore there was a statistically significant difference ($p \leq 0.05$) in this group.

**Intergroup analysis**

**Table 4.4: Table representing the initial and final p-values of both groups in the intergroup analysis**

<table>
<thead>
<tr>
<th>Visits</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>0.261</td>
</tr>
<tr>
<td>Final</td>
<td>0.572</td>
</tr>
</tbody>
</table>

Table 4.4 illustrates the p-values at the initial visit ($p=0.261$) and the final visit ($p=0.572$) when both groups were compared with each other using the Mann-Whitney U-test to detect between group differences for the Functional Rating Index scale. There was no statistically significant difference between the groups ($p>0.05$).
4.3.2 Numerical Pain Rating Scale

Intragroup analysis

Figure 4.2: Line graph representing the mean values for the NPRS for both groups

Figure 4.2 illustrates that the initial mean value for the NPRS for group A was 4.27 and the final mean value was 1.33, this showed a 68.8% reduction in pain intensity.

The Friedman test, used to detect within group changes showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001. Therefore there was a statistically significant difference within group A (p≤0.05).

The initial mean value for the NPRS for group B was 4.33 and the final mean value was 1.73, this showed a 60.0% reduction in pain intensity.

The Friedman test, used to detect within group changes showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001. Therefore there was a statistically significant difference within group B (p≤0.05).
Intergroup analysis

**Table 4.5: Table representing the initial and final p-values of both groups in the intergroup analysis**

<table>
<thead>
<tr>
<th>Visits</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>0.797</td>
</tr>
<tr>
<td>Final</td>
<td>0.684</td>
</tr>
</tbody>
</table>

Table 4.5 illustrates the p-values at the initial visit (\(p=0.797\)) and the final visit (\(p=0.684\)) when both groups were compared with each other using the Mann-Whitney U-test to detect between group differences for the Numerical Pain Rating Scale. There was no statistically significant difference between the groups (\(p>0.05\)).
4.4 Objective Data Analysis

The objective data of this study included the pain pressure threshold measured by means of algometry and recording the number of active infraspinatus trigger points.

The Friedman test was used for the intragroup analysis. Further intragroup analysis was required by using the Wilcoxon Signed Ranks test.

The Mann-Whitney U-test was used for the intergroup analysis to detect where differences in results took place.

4.4.1 Pain pressure threshold

Intragroup analysis

Figure 4.3: Line graph representing the mean values for the pain pressure threshold for both groups

Figure 4.3 illustrates that the initial mean value for the pain pressure threshold for group A was 4.07 kg/cm² and the final mean value was 5.20 kg/cm², this showed a 21.7% increase in pain threshold.
The Friedman test, used to detect within group changes showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001. Therefore there was a statistically significant difference within group A \( (p \leq 0.05) \).

The initial mean value for the pain pressure threshold for group B was 3.90 kg/cm\(^2\) and the final mean value was 4.80 kg/cm\(^2\), this showed a 18.7\% increase in pain threshold.

The Friedman test, used to detect within group changes showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001. Therefore there was a statistically significant difference within group B \( (p \leq 0.05) \).

**Intergroup analysis**

**Table 4.6: Table representing the initial and final p-values of both groups in the intergroup analysis**

<table>
<thead>
<tr>
<th>Visits</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>0.967</td>
</tr>
<tr>
<td>Final</td>
<td>0.407</td>
</tr>
</tbody>
</table>

Table 4.6 illustrates the p-values at the initial visit \( (p=0.967) \) and the final visit \( (p=0.407) \) when both groups were compared with each other using the Mann-Whitney U-test to detect between group differences for pain pressure threshold. There was no statistically significant difference between the groups \( (p>0.05) \).
4.4.2 Number of active infraspinatus myofascial trigger points

**Intragroup analysis**

![Line graph representing the mean values for the number of MTrP's for both groups](image)

**Figure 4.4: Line graph representing the mean values for the number of MTrP’s for both groups**

Figure 4.4 illustrates that the initial mean value for the number of MTrP’s for group A was 3.47 and the final mean value was 3.07, this showed a 11.5% reduction in active infraspinalus MTrP’s. There was no statistically significant difference within group A as the p-value was 0.412 (p>0.05).

The initial mean value for the number of MTrP’s for group B was 3.53 and the final mean value was 3.33, this showed a 5.7% reduction in active infraspinalus MTrP’s. There was no statistically significant difference within group B as the p-value was 0.116 (p>0.05).

**Intergroup analysis**

The differences detected between the 2 groups at the initial and final visits were as follows:

**Visit 1**: There were a total of 52 trigger points for group A and 53 trigger points for group B, thus totaling at 105 active infraspinalus myofascial trigger points for the initial visit with an average of 52.5%.

**Visit 7**: There were a total of 42 trigger points for group A and 50 trigger points for group B, thus totaling at 92 active infraspinalus myofascial trigger points for the final visit with an average of 46%.
The following values showed a 6.5% reduction in active infraspinatus myofascial trigger points from the initial visit to the final visit.
5.1 Introduction

This chapter deals with the discussion of the demographic data, subjective data and the objective data obtained in the research study, with reference to the aim presented in Chapter 1. The subjective data consisted of the Functional Rating Index (FRI) scale and the Numerical Pain Rating Scale (NPRS). The objective data consisted of algometry measurements (pressure-pain threshold) and recording the number of active infraspinatus myofascial trigger points (MTrP’s) over the treatment period.

5.2 Demographic data

The gender in this study was evenly distributed with a 50% male and 50% female distribution for both groups. This may be compared to a similar study performed by Blikstad and Gemmell (2008), where an equal ratio of male to females were used to determine the immediate effect of activator trigger point therapy and myofascial band therapy on non-specific neck pain in patients with upper trapezius trigger points compared to sham ultrasound in a randomised controlled trial.

The largest percentages of participants in this study were from the ages of 21 to 31 years. Nearly 88% of participants in group A were 26 years or younger. Similarly, 93.4% of participants in group B were 27 years or younger. The mean age for group A was 25 years, while the mean age for group B was 24 years. This is due to the fact that the majority of participants recruited for the study were students at the University of Johannesburg, Doornfontein campus, as advertisements for the research study were placed in and around the campus. The majority of the participants were therefore drawn from the campus itself. This is comparable to the study by Oliveira-Campelo, Rubens-Rebelatto, Vallejo, Alburquerque-Sendí and Fernández-de-Las-Peñas (2010) where the mean age of the participants were 25 and 24 years, respectively, comparable to both groups in this study. The study by Oliveira-Campelo et al., (2010) is similar in that their study pertained to MTrP dysfunction.
5.3 Subjective Data

The subjective data consisted of the Functional Rating Index scale questionnaire and the Numerical Pain Rating Scale. The above was used to record what the patient was experiencing with regard to chronic, active infraspinatus myofascial dysfunction.

5.3.1 Functional Rating Index Scale

Intragroup analysis

Figure 4.1 illustrates that the initial mean percentage for the group receiving chiropractic adjustments to the attachment site (group A), for the Functional Rating Index scale was 24.00% and final mean percentage was 8.50%. This showed a 15.5% reduction in discomfort and disabling effect on daily living and activity. The Friedman test showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001 within this group. Therefore there was a statistically significant difference (p≤0.05) in this group. The initial mean percentage for the group receiving chiropractic adjustments to the innervation segments (group B), for the Functional Rating Index scale was 21.42% and the final mean percentage was 8.08%. This showed a 13.34% reduction in discomfort and disabling effect on daily living and activity. The Friedman test showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001 within this group. Therefore there was a statistically significant difference (p≤0.05) in this group.

This may be compared to a study by Pak (2012) whereby Functional Rating Index Scale was also used, as a subjective tool, to measure discomfort and the effects on daily living and activity. The results revealed a significant improvement of 50% after treatment was administered, reducing from 15% at the beginning of the study to 7% at final treatment, over a 6 month period, as demonstrated in the study: Autologous adipose tissue-derived stem cells induce persistent bone-like tissue in osteonecrotic femoral heads.

The glenohumeral joint (attachment site) chiropractic adjustments show a small advantage over the use of lower cervical specifically C4/C5 and/or C5/C6 (innervation segment) chiropractic adjustments in terms of daily living and activity function and reduction in discomfort experienced, secondary to chronic, active infraspinatus MTrP’s. With only a 2.16% advantage to the above mentioned, there is no clinical difference between the two groups demonstrating one group to be superior over the other group.
It has been shown by Feise and Michael Menke (2001), that the Functional Rating Index Scale is an inexpensive and practical tool to use to quantify a patients physical function and pain. Due to its combination of the Oswestry Low Back Disability Questionnaire (OLBDQ) for lower back pain and the Neck Disability Index (NDI) for neck pain, and based on its scoring for reliability and validity, the FRI scale has been proven to be more time efficient compared to other discomfort and disability questionnaires which in turn, became easier and quicker, for the participants in the study, to complete which lead to less frequent item omission and was most useful in the measurement of health status for each participant (Feise and Michael Menke, 2001).

**Intergroup analysis**

There was no statistical evidence at the conclusion of treatment with a p-value of 0.572 (p>0.05) to suggest that chiropractic adjustments applied to neither the attachment site nor innervation segments of the infraspinatus muscle are superior to the other in terms of improving the daily living and activity function and reduction in discomfort which may be influenced by chronic active infraspinatus MTrP dysfunction. It is therefore not possible to draw any statistical conclusions as to the most appropriate region to apply chiropractic adjustments to in terms of daily living and activity function and reduction in discomfort.

It can however, be clinically recommended that both the attachment site and innervation segment chiropractic adjustments be delivered when indicated by motion palpation, as both have displayed value over time in the present study in improving daily living and activity function and reducing discomfort as measured using the FRI.
5.3.2 Numerical Pain Rating Scale

**Intragroup analysis**

Figure 4.2 illustrates that the initial mean value for the NPRS for group A was 4.27 and the final mean value was 1.33, this showed a 68.8% reduction in pain intensity. The Friedman test, used to detect within group changes showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001. Therefore there was a statistically significant difference within group A (p≤0.05). The initial mean value for the NPRS for group B was 4.33 and the final mean value was 1.73, this showed a 60.0% reduction in pain intensity. The Friedman test, used to detect within group changes showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001. Therefore there was a statistically significant difference within group B (p≤0.05). A 2-point change on the NPRS (20%) has been reported to be clinically meaningful (Farrar et al., 2001).

The latter proves to be statistically significant when compared to a similar study conducted by Hua Lin, Shen, Chi Keung Chung and Tai Wing Chiu (2013) exploring, the effectiveness of Long’s manipulation on patients with chronic mechanical neck pain. In this study it was found on statistical analysis, the Numerical Pain Rating Scale had a p-value of 0.002 immediately after treatment was administered and a p-value of 0.040 after a 3 month follow up treatment. The statistically significant level was set at less than 0.05.

The results seem to show a small advantage of using glenohumeral joint (attachment site) chiropractic adjustments relative to the use of lower cervical specifically C4/C5 and/or C5/C6 (innervation segment) chiropractic adjustments in terms of shoulder pain reduction, secondary to chronic, active infraspinatus MTrP’s. With only 8.8% advantage to the above mentioned, the advantage is not clinically significant to show a definite superiority of one group over the other group.

Analgesic effects obtained for the group receiving attachment site adjustments is similar to the results obtained by Russell (2003), who demonstrated a statistically significant positive effect of extremity chiropractic adjustments conducted in a clinical case study for ulnar tunnel syndrome.

The analgesic effect is postulated to be caused by sudden stretch of the shortened infraspinatus muscle fibres (secondary to the MTrP formation), resulting in the activation of central descending inhibitory pain mechanisms by afferent impulses from stimulation of mechanoreceptors within the capsule of the glenohumeral joint (Gatterman, 2005).
The analgesic effects obtained with applying chiropractic adjustments to the innervation segments of the infraspinatus muscle are similar to the results obtained by Oliveira-Campelo et al., (2010) who demonstrated the immediate analgesic effects of an atlanto-occipital chiropractic adjustment on masticatory muscle pain in the distribution of the trigeminal nerve as measured by NPRS.

It is hypothesized that the sensory pathways from the facet nociceptors and the MTrP nociceptors share the same pathway in the spinal cord or to the higher centre. By suppressing the facet pain within the cervical spine, there is believed to be a suppression of MTrP pain at the same time therefore a chiropractic adjustment administered to the innervation segment of the infraspinatus muscle has the ability to relieve the MTrP pain within the infraspinatus muscle (Hong, 2006).

Afferent nociceptive barrage on the dorsal horn neuron of the spinal cord may explain the neurophysiological mechanism of adjustive therapy, by which a spinal adjustment provokes an afferent bombardment from the articular and myofascial receptors, which produces pre-synaptic inhibition of segmental pain pathways and possibly activation of the endogenous systems (Fernández-de-las-Peñas, Campo, Carnero and Page, 2009).

The analgesic effect for both groups may be attributed to the chiropractic adjustments ability to modify the neuro-endocrine system as well as the endogenous opiate system which could in turn modify the central or peripheral pain processes (Vernon, Humphreys and Hagino, 2007).
Intergroup analysis

There is no statistical evidence at the conclusion of treatment ($p=0.684$) to suggest that chiropractic adjustments applied to either the attachment site or the innervation segments of the infraspinatus muscle are superior than the other in terms of reducing shoulder pain intensity secondary to chronic active infraspinatus MTrP dysfunction. It is therefore not possible to draw any statistical conclusions as to the most appropriate region to apply chiropractic adjustments to, in terms of shoulder pain reduction.

5.4 Objective data

5.4.1 Pain-pressure threshold

Intragroup analysis

Figure 4.3 illustrates that the initial mean value for the pain pressure threshold for group A was 4.07 kg/cm$^2$ and the final mean value was 5.20 kg/cm$^2$, this showed a 21.7% increase in pain threshold. The Friedman test, used to detect within group changes showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001. Therefore there was a statistically significant difference within group A ($p\leq0.05$). The initial mean value for the pain pressure threshold for group B was 3.90 kg/cm$^2$ and the final mean value was 4.80 kg/cm$^2$, this showed a 18.7% increase in pain threshold. The Friedman test, used to detect within group changes showed a p-value of 0.000, further analysis using the Wilcoxon Signed Ranks test showed a p-value of 0.001. Therefore there was a statistically significant difference within group B ($p\leq0.05$).

In a study conducted by Ezell, Hoffman and Holmes (2012), the pain pressure threshold was evaluated and the effects on pain pressure threshold by means of spinal manipulation delivered to the thoracic spine were determined. The results of the study showed the pain pressure threshold to have a p-value of 0.002 over the treatment period, since the statistically significant level was set at $p\leq0.05$, the study showed a statistically significant difference within the group receiving the spinal adjustment to the thoracic spine. This finding suggested that a doctor of chiropractic might be able to rely on pain pressure threshold as a pre-treatment indicator of segmental dysfunction. It also suggested that the chiropractor might be able to utilize pain pressure threshold measurements immediately following chiropractic manipulation as a reliable means of determining treatment efficacy. The findings of the latter study may easily be compared to the current study.
As it was previously stated, there was a small increase difference of mean PPT associated with the attachment site chiropractic adjustments versus innervation segment chiropractic adjustments, however not clinically significantly superior to the innervation segment chiropractic adjustment.

The high velocity low amplitude chiropractic adjustment is said to disrupt the reflex response in a muscle that is responsible for causing MTrP’s within the muscle. The attachment site chiropractic adjustment is able to achieve this through distraction of the articular surfaces which in turn stretches the muscle fibres and excites the Golgi tendon organ located in the muscle tendon junction, thus inducing reflex muscle relaxation, this is an autogenic inhibition. The high velocity low amplitude adjustment is also said to stimulate the mechanoreceptors and nociceptors found within the articular capsule, which induces a burst of somatic afferent receptor activity. Thus also contributing to the inhibition of muscle spasm and interruption of the painful myofascial cycle (Bergmann and Peterson, 2011).

It is hypothesized that when administering the innervation segment chiropractic adjustment, it has the ability to induce a reflex muscle relaxation by modifying the proprioceptive afferents, it also has the ability to activate the segmental inhibitory pathways and the central descending inhibitory pathway activation mechanisms and thus induces reflex muscle relaxation. It is furthermore hypothesized to activate the periaqueductal gray substance resulting in central hypoalgesic effects. It has thus been demonstrated that a chiropractic adjustment administered to the cervical segments responsible for the innervation of the infraspinatus muscle (C4/C5 and/or C5/C6) evoked changes in pain-pressure sensitivity in MTrP’s as similarly compared to the research study which explored changes in pressure pain sensitivity in latent myofascial trigger points in the upper trapezius muscle after a cervical spine adjustment in pain free subjects conducted by Ruíz-Sáez, Fernández-de-las-Penás, Rodríguez Blanco, Martínez-Segura and García-León (2007).

**Intergroup analysis**

It was not possible to draw any statistical conclusions as to the relative efficacy of the attachment site to innervation segment chiropractic adjustments in terms of increasing chronic active infraspinatus MTrP pressure tolerance at the end of the treatment period, \( p=0.407 \). Conclusions cannot be drawn as to whether chiropractic adjustments applied to the glenohumeral joint or to the cervical spinal segments specifically C4/C5 and/or C5/C6, are superior to the other in terms of increasing chronic, active infraspinatus MTrP PPT. It can be seen that there is a small advantage of attachment site chiropractic adjustments over innervation segment chiropractic adjustments, this advantage is however, not clinically significant, as previously discussed.
5.4.2 Number of active infraspinatus MTrP's

Intragroup analysis

Figure 4.4 illustrates that the initial mean value for the number of MTrPs for group A was 3.47 and the final mean value was 3.07, this showed a 11.5% reduction in active infrapsinatus MTrP’s. There was no statistically significant difference within group A as the p-value was 0.412 (p>0.05). The initial mean value for the number of MTrP’s for group B was 3.53 and the final mean value was 3.33, this showed a 5.7% reduction in active infrapsinatus MTrP’s. There was no statistically significant difference within group B as the p-value was 0.116 (p>0.05).

Gatterman (2005) stated that all palpable muscles and the zygapophyseal joint capsule are innervated by the dorsal ramus of the spinal nerves. It is the sensory nerve fibres that are mainly responsible for innervating the musculoskeletal tissue’s, more specifically group 1 afferents from the muscle spindles and group 1b afferents from the Golgi tendon organs. Group 2 afferents provide all innervation to the corpuscular mechanoreceptors found in the skin, joints and muscles. These mechanoreceptors respond to normal movement, vibration, joint position and joint motion.

By means of an attachment site chiropractic adjustment, the mechanoreceptors found in the joint being adjusted and the musculature crossing that same joint are activated which then influences the joint position and motion of the joint as well as the musculature crossing the joint, which may in turn induce reflex muscle relaxation. The innervation segment chiropractic adjustment has the ability to further affect the muscle by stimulating the group 1 and 2 afferents responsible for the innervation of the Golgi tendon organ and muscle spindles which in turn may induce a reflex muscle relaxation of the muscle and would therefore reduce the number of MTrP’s within the muscle (Leach, 2004). This may be applied to the infraspinatus muscle with regard to chronic, active MTrP dysfunction.

It is a possibility that a greater sample size may yield statistically significant within-group results.
Intergroup analysis

The differences detected between the 2 groups at the initial and final visits were as follows:

Visit 1: There were a total of 52 trigger points for group A and 53 trigger points for group B, thus totaling at 105 active infraspinatus myofascial trigger points for the initial visit with an average of 52.5%.

Visit 7: There were a total of 42 trigger points for group A and 50 trigger points for group B, thus totaling at 92 active infraspinatus myofascial trigger points for the final visit with an average of 46%.

The following values showed a 6.5% reduction in active infraspinatus myofascial trigger points from the initial visit to the final visit.

The results showed there was no clinically significant difference between the group receiving the attachment site chiropractic adjustment and the group receiving the innervation segment chiropractic adjustment in terms of reducing the number of chronic, active infraspinaus MTrP’s over time as previously discussed.

5.5 Conclusion

In conclusion, the results showed a significant improvement for both groups with regards to the FRI, NPRS, PPT and the number of chronic, active infraspinatus MTrP. There was, however, no statistically significant difference in terms of superiority of one group over the other. On the basis of these results, it may be concluded that on a neurophysiological level there are changes that occur spinally and peripherally as shown by both groups when chiropractic adjustment is administered to the attachment site as well as the innervation segment with regards to the treatment approach for chronic, active infraspinatus MTrP dysfunction.
CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

OF

JOHANNESBURG
6.1 Conclusion

The aim of this study was to explore the relative effects of attachment site to innervation segment chiropractic adjustments on the clinical activity of chronic, active MTrP dysfunction of the infraspinatus muscle. Chiropractic adjustments delivered to the glenohumeral joint correspond with the attachment site of the infraspinatus muscle, and chiropractic adjustments delivered to the cervical segment(s) C4/C5 and/or C5/C6 correspond to the innervation segment of the infraspinatus muscle.

According to the results of the FRI, both the attachment site and innervation segment chiropractic adjustments showed a statistically significant improvement in daily living and activity function and reduction in discomfort for participants in the study. There is however no significant advantage of attachment site over innervation segment chiropractic adjustments or vice versa in the management of chronic, active MTrP dysfunction of the infraspinatus muscle.

Based on the NPRS, chiropractic adjustments delivered to the attachment site as well as the innervation segment of the infraspinatus muscle both significantly reduced the intensity of shoulder pain and referring pain associated with chronic, active MTrP dysfunction of the infraspinatus muscle. Statistically, no conclusions could be drawn as to whether chiropractic adjustments delivered to the attachment site or innervation segment were more effective than the other.

The attachment site chiropractic adjustments and the innervation segment chiropractic adjustments showed a statistically significant improvement over time with regard to the pain pressure threshold showing improvement in pain tolerance. Although the attachment site chiropractic adjustment displayed a more superior value to that of the innervation segment chiropractic adjustment, the difference was not statistically significant to show a statistically significant clinical superiority in terms of decreasing chronic, active MTrP dysfunction of the infraspinatus muscle.

Statistically, no conclusion can be drawn as to the relative superiority of the attachment site to innervation segment chiropractic adjustments in terms of reducing the number of chronic, active infraspinatus MTrP’s over the treatment period.

To conclude, it was not statistically apparent whether chronic shoulder pain with associated referral patterns secondary to active infraspinatus MTrP’s responds more favourably to chiropractic adjustments delivered to the attachment site versus the innervation segments of the infraspinatus muscle with regard to shoulder pain intensity, infraspinatus MTrP pain pressure threshold and the number of active infraspinatus
MTrP’s. As no definitive between the group statistical conclusions may be reached, it is suggested that both the attachment site and innervation segment chiropractic adjustments be included in the chiropractic treatment protocol for chronic, active infraspinatus MTrP dysfunction.

6.2 Recommendations

- A larger sample size may yield statistically significant results, as some of the results in this study were encouraging, yet more representative and statistically insignificant due to the very small sample size.
- A questionnaire more specific to shoulder pain and disability may additionally be used in the subjective assessment of the treatment response. These may include: The Disability of Arm, Shoulder and Hand (DASH) questionnaire and the Oxford Shoulder Score (OSS) questionnaire. These have shown exceptional reliability, validity and responsiveness to change. The OSS has also proven to show good sensitivity with its results (Desai, Dramis, and Hearnden, 2010). In terms of assessing referral patterns associated with chronic, active infraspinatus MTrP dysfunction, the Neck Disability Index questionnaire may be included with the above mentioned in the subjective assessment of the treatment response. The Neck Disability Index questionnaire is known for its good validation, reliability and self-report when compared to other questionnaires and therefore comes highly recommended (Howell, 2011).
- A follow-up assessment after 3 months followed by 6 months and then 12 months may yield a difference between the group results. The Global Perceived Effect Questionnaire would be useful as a long-term follow-up measurement tool (Evans, 2014). In terms of validity and reliability, it has an excellent reputation (Kamper, Ostelo, Knol, Maher, de Vet and Hancock, 2010).
- A longer course of treatment is recommended for a follow-up study on chronic shoulder pain, which may yield different between group results.
- A study assessing acute shoulder pain as opposed to chronic shoulder pain should be considered for a similar study. A protocol of 7 treatment sessions over a 3-4 week period, as utilized for the current study, would be appropriate.
- A combined attachment site and innervation segment group would also be a valuable addition to the study, to measure the combined effects of attachment site and innervation segment chiropractic adjustments on chronic, active infraspinatus MTrP dysfunction.
- A study focusing on the immediate effect of attachment site and innervation segment chiropractic adjustments may also be performed and may have a different result from the current study performed when assessing a treatment protocol for chronic, active infraspinatus MTrP dysfunction.
- A study that focuses on testing the effect of chiropractic adjustment on innervation versus attachment site for a healthy, normal infraspinatus muscle using EMG as an objective measuring tool may also be performed.
REFERENCES


FREE CHIROPRACTIC TREATMENT FOR SHOULDER, ARM OR NECK PAIN

Do you suffer from shoulder pain, pain referring down the arm or into the neck?
If you are between the ages of 18 and 45, come and visit me in the University of Johannesburg Chiropractic Day Clinic and participate in a supervised chiropractic research study. The study will take place between: November 2013 - March 2014 under the supervision of a qualified chiropractor.

Are you interested? Call Melissa Hutchinson: 0828823311 or the UJ Chiropractic clinic: 0115596495
APPENDIX B: INFORMATION FORM

DEPARTMENT OF CHIROPRACTIC

INFORMATION FORM

My name is Melissa Hutchinson and I am currently a Chiropractic student, completing my Masters Degree at the University of Johannesburg. I would like to thank you for volunteering to participate in this study entitled “The effect of chiropractic adjustment on the innervation versus attachment site in the treatment of chronic, active myofascial trigger points of the infraspinatus muscle”.

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose of the study, the study procedures, benefits, risks, discomforts and precautions as well as the alternative procedures that are available to you, and your right to withdraw from the study at any time.

The information leaflet is to help you to decide if you would like to participate. You need to understand what is involved before you agree to take part in this study. You may find this form may contain words that you do not understand. If you have any questions, do not hesitate to ask me. You may also take home a copy of this form before signing the consent form to think about or discuss with family or friends before making your decision.

The aim of this study is to determine the effectiveness of adjusting the cervical spine nerve (neck) root innervation of the infraspinatus muscle versus adjusting the shoulder joint which is the attachment site. This will then establish the most effective approach to adjusting in the management of chronic active infraspinatus myofascial trigger points.
Should you decide to take part in this study, you will first be screened for what we call “inclusion and exclusion criteria”. The inclusion criteria for this study is:

- The participants need to be between the ages of 18-45 years as after 45 years degeneration occurs.
- They can be male or female.
- The participants need to present with chronic (this refers to weeks, months or years but not necessarily permanent, as it may be reversible) intermittent shoulder or scapular pain for at least three months duration (Simons et al., 1999).
- Pain has to be referred from infraspinatus muscle trigger points to the shoulder joint as well as the frontal part of the upper arm and side aspect of the arm and forearm.
- The participant needs to present with restrictions at the cervical nerve root level C4/C5 and/or C5/C6 (lower levels of the neck), which is the innervation to the infraspinatus muscle. This will be determined using the motion palpation technique.
- The participant needs to present with restrictions of the shoulder.

The exclusion criteria is that you cannot have any contraindications to a chiropractic adjustment, as well as any neurological deficits to the upper limb which may result in sensory, motor or reflex deficits.

I would especially like you to take note that you may not participate in another research study, nor take any medications (anti-inflammatory drugs) that may influence the outcome of this study. Not all medications may be a problem, so please be open with me regarding any medication or supplements you are using. Also please be open with me regarding your health history, since you may otherwise harm yourself by participating in this study.

The research will be conducted at the Chiropractic Day Clinic on the Doornfontein campus of the University of Johannesburg. A complete case history with a full physical examination will be conducted followed by a cervical and shoulder regional examination.

After screening you will be randomly allocated to either group A or group B. Diversified Chiropractic adjustment(s) will be delivered to the innervation of the infraspinatus muscle (the muscle assisting the lifting of the arm while turning the arm outward) at specific restricted cervical vertebral levels to all participants in group A. This would be specifically at the cervical vertebral levels of C4/C5 and/or C5/C6 (lower levels of the neck). Group B will receive diversified Chiropractic adjustment(s) to the site of attachment of the infraspinatus muscle, specifically to restrictions found at the shoulder joint.
The Chiropractic adjustment involves the restoration of normal joint motion. Abnormal joint motion will be detected by the researcher via motion palpation. The Chiropractic adjustment is a safe, non-invasive treatment technique.

Thirty participants will participate in this study and it will only be performed in South Africa. The entire study, including all treatments will take place at the University of Johannesburg’s Chiropractic day clinic. The total amount of time required for your participation in this study will be seven treatments. You will be asked to visit me seven times over a three to four week period during the study. On the seventh and final visit no treatment will take place only measurements.

All procedures will be explained to you and all participation is entirely on a voluntary basis; withdrawal at any stage will not cause you any harm. With regards to this particular study, the following benefits, risks and discomforts are: relieving your complaint of shoulder and/or scapular pain with relief of pain following the referral pattern of infraspinatus muscle and increasing your shoulder and cervical range of motion thus promoting a better and more optimal quality of life. It is a less invasive method than myofascial dry needling and thus a more patient friendly approach. Slight discomfort may be experienced upon palpation of the infraspinatus trigger points and you may experience temporary stiffness and soreness after your treatment, possibly from the adjustments received. As this study is untested there may be other risks or side effects which are unforeseen or unknown. You should immediately contact me if any side effects occur throughout your participation in this study.

As your participation is entirely voluntary you can decline to participate, or stop at any time, without stating any reason. Your withdrawal will not affect your access to other medical care. If you decide not to take part in this study you will still receive the best current care, from your usual practitioner, which may or may not include this study treatment.

If it is deemed to be in your best interest, I retain the right to withdraw you from the study. Injuries that result in damage to bone, ligaments or other soft tissue would be contraindicated to this type of treatment. If you get diagnosed by another medical practitioner during this trial for any medical condition that was not stated in your original history, please notify me. Some conditions may be contraindicated to this treatment.

If you want any information regarding your rights as a research participant or complaints regarding this research study, you may contact Prof Marie Poggenpoel, Chairperson of the University of Johannesburg’s Academic Ethics committee which is an independent committee established to help protect the rights of research participants (Tel: 011 559 2860).
This study protocol has been admitted to the University of Johannesburg’s Academic Ethics Committee and written approval has been granted by that committee. The study has been structured in accordance with the Declaration of Helsinki of 2008, which deals with the recommendations guiding doctors in biomedical research involving human participants. Should any injuries occur as a result of this study, you will be referred to the appropriate medical professional.

Your privacy will be protected as only the doctor, patient (you) and clinician will be in the treatment room. Your anonymity will be ensured as your personal information will be converted into data and therefore cannot be traced back to you. Standard doctor/patient confidentiality will be adhered to at all times when compiling the research dissertation.

Results of this study will be made available to you on request.

University of Johannesburg ethics clearance number: AEC01-03-2014

Thank you for taking the time to read this form and consider participation in this study.

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

Researcher: Melissa Hutchinson 0828823311
Supervisor: Dr C. Yelverton 0115596218
Co-supervisor Dr D. Whelan 0832949946
CONSENT FORM

Dear participant

Before signing this consent please take your time and read the information form.

Personal doctor/specialist notification option.

Please indicate below, whether you want me to notify your personal doctor or your specialist of your participation in this study:

- YES, I want you to inform my personal doctor/specialist of my participation in this study.
- NO, I do not want you to inform my personal doctor/specialist of my participation in this study.
- I do not have a personal doctor/specialist.

Do you have any questions related to this study?

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

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

Date: _______________________  Participant: _________________________
APPENDIX D: CONTRA-INDICATIONS TO CHIROPRACTIC ADJUSTMENTS (Gatterman, 1990)

Vascular complications

- Vertebral artery syndrome
- Aneurysms

Tumours

- Primary to the bone
- Secondary (metastasis to the bone)

Bone infections

- Tuberculosis of the spine
- Osteomyelitis of the spine

Traumatic injuries

- Fractures
- Instabilities
- Dislocation
- Unstable spondylolisthesis

Arthritis

- Ankylosing spondylitis
- Rheumatoid arthritis
- Psoriatic arthritis
- Reiter's syndrome
- Osteoarthritis

Psychological considerations

- Malingering
- Hysteria
- Hypochondriasis
- Pain intolerance
- Dependant personality
- Disability Syndromes

Neurological complications

- Cervical disc lesions and myelopathy
- Nerve root damage
APPENDIX E: CASE HISTORY

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

CASE HISTORY

Date: ________________

Patient: ____________________________________ File No: _________

Age: ______ Sex: _______________ Occupation: ______________________

Student: ____________________ Signature: ______________________

Complies with Inclusion criteria of the research:

Clinician: _______________________
Signature: ______________________

Examination:

Previous: UJ Current: UJ
Other Other

X-ray Studies:

Previous: UJ Current: UJ
Other Other

Clinical Path. Lab:

Previous: UJ Current: UJ
Other Other

Case status:

PTT: Conditional: Signed off: Final sign out:
Recommendations:
1. Source of history:

2. Chief complaint: (patient’s own words)

3. Present illness:
   - Location
   - Onset
   - Duration
   - Frequency
   - Pain (character)
   - Progression
   - Aggravating factors
   - Relieving factors
   - Associated Sx’s and Sg’s
   - Previous occurrences
   - Past treatment and outcome

4. Other complaints:
5. Past history

- General health status
- Childhood illnesses
- Adult illnesses
- Psychiatric illnesses
- Accidents/injuries
- Surgery
- Hospitalisation

6. Current health status and lifestyle

- Allergies
- Immunizations
- Screening tests
- Environmental hazards
- Safety measures
- Exercise and leisure
- Sleep patterns
- Diet
- Current medication
- Tobacco
- Alcohol
- Social drugs

7. Family history:
   
   Immediate family:
Cause of death
DM
Heart disease
TB
HBP
Stroke
Kidney disease
CA
Arthritis
Anaemia
Headaches
Thyroid disease
Epilepsy
Mental illness
Alcoholism
Drug addiction
Other

8. Psychosocial history:
Home situation
Daily life
Important experiences
Religious beliefs

9. Review of systems:
General
Skin
Head
Eyes
Ears
Nose/sinuses
Mouth/throat
Neck
Breasts
Respiratory
Cardiac
Gastro-intestinal
Urinary
Genital
Vascular
Musculoskeletal
Neurologic
Haematologic
Endocrine
Psychiatric
APPENDIX F: PHYSICAL EXAMINATION

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

Underline abnormal findings in RED. Date: ____________________

Patient: ______________________ File No: ______________

Clinician: ______________________ Signature: ______________

Student: ______________________ Signature: ______________

Height: ________ Weight: _______ Temp: _________

Rates: Heart: _______ Pulse: _______ Respiration: _______

Blood pressure: |
<table>
<thead>
<tr>
<th>Arms:</th>
<th>L</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legs:</td>
<td>L</td>
<td>R</td>
</tr>
</tbody>
</table>

General Appearance:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
STANDING EXAMINATION

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

5. Romberg’s sign
6. Pronator drift
7. Trendelenburg’s sign
8. Gait: - rhythm
   - balance
   - pendulousness
   - on toes
   - on heels
   - tandem

9. Half squat
10. Scapular winging
11. Muscle tone
12. Spasticity/Rigidity
13. Shoulder: skin
    symmetry
    ROM - glenohumeral
    - scapulo-thoracic
    - acromioclavicular
    - elbow
    - wrist

/ = pain-free limitation  // = painful limitation
14. Chest measurement:
   - inspiration
   - expiration

<table>
<thead>
<tr>
<th>cm</th>
<th>cm</th>
</tr>
</thead>
</table>

15. Visual acuity

16. Breast examination:
   Inspection: - skin
   - size
   - contour
   - nipples
   - arms overhead
   - hands against hips
   - leaning forward
   Palpation - axillary lymph nodes
   - breast incl. tail

**SEATED EXAMINATION**

1. Spinal posture
2. Head - hair
   - scalp
   - skull
   - face
   - skin
3. Eyes:
   Observation - conjunctiva
   - sclera
   - eyebrows
   - eyelids
   - lacrimal glands
   - nasolacrimal duct
   - position and alignment
   - corneas and lenses
   - corneal reflex
   - ocular movement
   | L | R |
   | III | IV | VI | III | IV | VI |

   - visual fields
   - accommodation
   - Ophthalmoscopic
   - Examination - iris
     - pupils
     - red reflex
     - optic disc
- vessels
- general background
- macula
- vitreous
- lens

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

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

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

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

9. Neck
   - posture
   - size
   - swelling
   - scars
   - discolouration
   - hair line
Ranges of motion (cervical spine)

The following are normal ranges of motion

<table>
<thead>
<tr>
<th>Movement</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward flexion</td>
<td>45 ° chin to larynx or sternum</td>
</tr>
<tr>
<td>Extension</td>
<td>55 ° forehead parallel to ground</td>
</tr>
<tr>
<td>L/R Rotation</td>
<td>70 °</td>
</tr>
<tr>
<td>L/R Lat Flexion</td>
<td>40 °</td>
</tr>
</tbody>
</table>

- lymph nodes
- trachea
- thyroid
- carotid arteries (thrills, bruit)
- Cranial Nerves
  - CN V
  - CN VII
  - CN VIII (nystagmus)
  - CN IX
  - CN XI
  - CN XII
9. NEUROLOGICAL EXAMINATION (CERVICAL SPINE)

<table>
<thead>
<tr>
<th>DERMATOMES</th>
<th>Left</th>
<th>Right</th>
<th>MYOTOMES</th>
<th>Left</th>
<th>Right</th>
<th>REFLEXES</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td>Neck Flexion</td>
<td>C1/2</td>
<td></td>
<td>Biceps</td>
<td>C5</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
<td>Lat. Neck Flexion</td>
<td>C3</td>
<td></td>
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9. Peripheral vasculature:
   • Inspection - skin
     - nail beds
     - pigmentation
     - hair loss
   • Palpation - pulses: - femoral
     - popliteal
     - post. Tibial
     - dorsalis pedis
     - brachial
     - radial
     - lymph nodes  - epitrochlear
     - femoral (horizontal & vertical)
     - temperature (feet and legs)
   • Manual compression test
   • Retrograde filling (Tredelenburg) test
   • Arterial insufficiency test

10. Musculoskeletal:
    (i) ROM
    • hip
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- knee
- ankle

(ii) leg length
- Co-ordination - point to point
  - dysdiachokinesia

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

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

* Auscultation
  (i) breath sounds
    - vesicular
    - bronchial
  (ii) adventitious sounds
    - crackles (rales)
    - wheezes (rhonchi)
    - rubs
  (iii) voice sounds
    - broncophony
    - whispered pectoriloquey
    - egophony

* Cardiovascular - auscultation (aortic murmurs)
  - Allen’s test

**SUPINE EXAMINATION**

1. JVP
2. PMI
3. Auscultation heart
   (L. lat. Recumbent)
4. Respiratory excursion
5. Percussion chest (anterior)
6. Breast palpation
7. Abdominal Examination
   * Inspection - skin
     - umbilicus
     - contour
     - peristalsis
     - pulsations
     - hernias (umbilical/incisional)

* Auscultation - bowel sound
  - bruit

* Percussion - general
  - liver
  - spleen

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

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

**MENTAL STATUS**

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

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

(ii) Mood

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

(v) Higher cognitive functions
  - information and vocabulary
  - (general and specialised knowledge)
  - abstract thinking
**NEUROLOGICAL EXAMINATION (LUMBAR SPINE)**

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APPENDIX G: CERVICAL SPINE REGIONAL

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

REGIONAL EXAMINATION
CERVICAL SPINE

Date: ____________________

Patient: ___________________________ File No: ______________________

Clinician: ___________________________ Signature: ______________________

Student: ___________________________ Signature: ______________________

OBSERVATION

• Posture
• Size
• Swellings
• Scars
• Discolouration
• Hairline
• Bony and Soft Tissue Contours
• Shoulder level
• Muscle Spasm
• Facial Expression

RANGE OF MOTION

Flexion = 45° - 90°
Extension = 55° - 70°
L/R Rotation = 70° - 90°
L/R Lat Flexion = 20° - 45°
PALPATION

- Lymph nodes
- Trachea
- Thyroid gland
- Pulses/thrills
- Tenderness
- Muscle tone
- Active MF trigger points

ORTHOPAEDIC EXAMINATION

1. Doorbell Sign
2. Max. Cervical Compression
3. Spurling’s Manoeuvre
4. Lateral Compression (Jackson’s Test)
5. Kemp’s Test
6. Cervical Distraction
7. Shoulder Abduction Test
8. Shoulder Depression Test
9. Dizziness Rotation Test
10. Lhermitte’s Sign
11. O'Donoghue Manoeuvre
12. Brachial Plexus Tension
13. Carpal Tunnel Syndrome:
   ▪ Tinel's Sign
   ▪ Phalen's Test
14. TOS:
   ▪ Halstead's Test
   ▪ Adson's Test
   ▪ Eden's (traction) Test
   ▪ Hyperabduction (Wright’s) Test – Pec Minor
   ▪ Costoclavicular Test

Remarks:

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COMMENTS:
## MOTION PALPATION

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## NEUROLOGICAL EXAMINATION

### DERMATOMES Left Right
- C2: Neck Flexion (C1/C2)
- C3: Lat. Neck Flexion (C3)
- C4: Shoulder Elevation (C4)
- C5: Shoulder Abduction (C5)
- C6: Elbow Flexion (C5)
- C7: Elbow Extension (C7)
- C8: Elbow Flexion at 90˚ (C6)
- T1: Forearm Pronation (C6)
- Forearm Supination (C6)
- Wrist Extension (C6)
- Wrist Flexion (C7)
- Finger Flexion (C8)
- Finger Abduction (T1)
- Finger Adduction (T1)

### MYOTOMES Left Right
- Biceps (C5)
- Brachioradialis (C6)
- Triceps (C7)

### REFLEXES Left Right
- Neck Flexion (C1/C2)
- Shoulder Elevation (C4)
- Shoulder Abduction (C5)
- Elbow Flexion (C5)
- Elbow Extension (C7)
- Elbow Flexion at 90˚ (C6)
- Forearm Pronation (C6)
- Forearm Supination (C6)
- Wrist Extension (C6)
- Wrist Flexion (C7)
- Finger Flexion (C8)
- Finger Abduction (T1)
- Finger Adduction (T1)
APPENDIX H: SHOULDER REGIONAL

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

REGIONAL EXAMINATION
THE SHOULDER GIRDLE

Date: __________________________ File No: __________________
Patient: __________________________ Signature: __________________
Clinician: __________________________ Signature: __________________
Student: __________________________ Signature: __________________

OBSERVATION

ANTERIOR AND POSTERIOR VIEWS

• Posture
• Skin
• Congenital deformities (e.g. Sprengel’s)
• Developmental deformities (e.g. winging of scapula)
• Traumatic deformities (e.g. step, sulcus, dislocation)
• Asymmetry

REMARKS:
_________________________________________
_________________________________________
_________________________________________
_________________________________________
PALPATION

ANTERIOR STRUCTURES

- Clavicle
- Coracoid
- Sternum
- Humerus
- Sternoclavicular joint
- Acromioclavicular joint
- Ribs and costal cartilages
- Rotator cuff muscles
- Axilla

POSTERIOR STRUCTURES

- Scapula
- Spine of Scapula
- Triceps tendon
- Spinous processes of the lower cervical
- And upper cervical spines

REMARKS:
### ACTIVE MOVEMENTS

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<td>Painful arc with abduction</td>
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<td>Elevation through forward flexion (160 – 180 degrees)</td>
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<td>Elevation through scapula plane (170 – 180 degrees)</td>
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<td>Circumduction (200 degrees)</td>
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### REMARKS:

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### PASSIVE MOVEMENTS (determine range and end feel)

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### RESISTED ISOMETRIC MOVEMENTS

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<tr>
<td>Flexion of the elbow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extension of the elbow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### REMARKS:

---

### SPECIAL TESTS

#### Tests for Anterior Shoulder Instability
- Rockwood Test
- Apprehension (Crank) Test

#### Tests for Posterior Shoulder Instability
- Norwood Stress Test
- Posterior Apprehension Test
- Push-Pull Test

#### Tests for Inferior and Multi directional Instability
- Feagin Sign
- Sulcus Sign

#### Tests for Muscle Tendon Pathology
- Speed’s Test (Bicipital Tendinitis)
- Drop Arm Test (Rotator Cuff)
• Ludington’s Test (Biceps Tendon)
• Supraspinatus Test
• Pectoralis Major Contracture Test

Tests for Neurological Function
• Brachial Plexus Tension
• Tinel’s Sign
• Phalen’s

Tests for Other Shoulder Joints
• Acromioclavicular Shear Test

REFLEXES AND CUTANEOUS DISTRIBUTION

<table>
<thead>
<tr>
<th>REFLEXES</th>
<th>LEFT</th>
<th>RIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps (C5 – C6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triceps (C7 – C8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pectoralis Major – Clavicular Portion (C5 – C6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pectoralis Major – Sternocostal Portion (C7 – C8 and T1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dermatomes

C4______________________________ T1________________________
C5______________________________ T2________________________
C6______________________________ T3________________________
C7______________________________ T4________________________
C8______________________________ T5________________________
                                T6________________________
JOINT PLAY MOVEMENTS

- Backward glide of humerus
- Forward glide of humerus
- Lateral distraction of humerus
- Caudal glide of humerus
- Backward glide of humerus in abduction
- Lateral distraction of humerus in abduction

Anteroposterior and cephalocausal movements of the clavical at the:

- Acromioclavicular joint
- Sternoclavicular joint
- General movement of the scapula

REMARKS:

MYOFASCIAL DYSFUNCTION SYNDROME

- Levator Scapula
- Supraspinatus
- Teres Minor
- Teres Major
- Rhomboid Minor
- Rhomboid Major
- Scalene Muscles
- Infraspinatus
- Lattissinus Dorsi
- Subscapularis
- Deltoid
- Biceps Brachii
- Pectoralis Major
- Pectoralis Minor
- Sternum
- Serratus Anterior
- Coracobrachialis
- Triceps Brachii
- Serratus Posterior Superior

REMARKS:

RADIOGRAPHIC EXAMINATION:

DIAGNOSIS:
### APPENDIX I: S.O.A.P. NOTE

**RESEARCH**

**CHIROPRACTIC DAY CLINIC**

**SOAP NOTE:**

<table>
<thead>
<tr>
<th>Patient:</th>
<th>Visit No:</th>
</tr>
</thead>
<tbody>
<tr>
<td>File No:</td>
<td>Student:</td>
</tr>
<tr>
<td>Date:</td>
<td>Clinician:</td>
</tr>
</tbody>
</table>

**S:**

**O:**

**A:**

**P:**

**Comments:**

---

**Patient:**

<table>
<thead>
<tr>
<th>File No:</th>
<th>Visit No:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td>Student:</td>
</tr>
<tr>
<td>Clinician:</td>
<td>O:</td>
</tr>
</tbody>
</table>

**S:**

**O:**

**A:**

**P:**

**Comments:**
APPENDIX J: NUMERICAL PAIN RATING SCALE

How much pain have you had since your last treatment?

Please mark in one of the boxes to indicate how severe your pain has been: 0 being no pain and 10 being the worst pain you've ever had.

<table>
<thead>
<tr>
<th>Visit 1: No pain</th>
<th>Moderate pain</th>
<th>Severe pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Visit 4: No pain</th>
<th>Moderate pain</th>
<th>Severe pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Visit 7: No pain</th>
<th>Moderate pain</th>
<th>Severe pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
## APPENDIX K: FUNCTIONAL RATING INDEX SCALE

### Functional Rating Index

For use with **Neck and/or Back Problems** only.

In order to properly assess your condition, we must understand how much your **neck and/or back problems** have affected your ability to manage everyday activities. For each item below, please circle the number which most closely describes your condition right now.

1. **Pain Intensity**

   - **0**: No pain
   - **1**: Mild pain
   - **2**: Moderate pain
   - **3**: Severe pain
   - **4**: Worst possible pain

2. **Sleeping**

   - **0**: Perfect sleep
   - **1**: Mildly disturbed sleep
   - **2**: Moderately disturbed sleep
   - **3**: Greatly disturbed sleep
   - **4**: Totally disturbed sleep

3. **Personal Care** (washing, dressing, etc.)

   - **0**: No pain; no restrictions
   - **1**: Mild pain; no restrictions
   - **2**: Moderate pain; need to go slowly
   - **3**: Moderate pain; need some assistance
   - **4**: Severe pain; need 100% assistance

4. **Travel** (driving, etc.)

   - **0**: No pain on long trips
   - **1**: Mild pain on long trips
   - **2**: Moderate pain on long trips
   - **3**: Moderate pain on short trips
   - **4**: Severe pain on short trips

5. **Work**

   - **0**: Can do usual work plus unlimited extra work
   - **1**: Can do usual work; no extra work
   - **2**: Can do 50% of usual work
   - **3**: Can do 25% of usual work
   - **4**: Cannot work
6. Recreation

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Can do all activities</td>
<td>Can do most activities</td>
<td>Can do some activities</td>
<td>Can do a few activities</td>
<td>Cannot do any activities</td>
</tr>
</tbody>
</table>

7. Frequency of pain

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No pain</td>
<td>Occasional pain; 25% of the day</td>
<td>Intermittent pain; 50% of the day</td>
<td>Frequent pain; 75% of the day</td>
<td>Constant pain; 100% of the day</td>
</tr>
</tbody>
</table>

8. Lifting

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No pain with heavy weight</td>
<td>Increased pain with heavy weight</td>
<td>Increased pain with moderate weight</td>
<td>Increased pain with light weight</td>
<td>Increased pain with any weight</td>
</tr>
</tbody>
</table>

9. Walking

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No pain; any distance</td>
<td>Increased pain after 1 mile</td>
<td>Increased pain after 1/2 mile</td>
<td>Increased pain after 1/4 mile</td>
<td>Increased pain with all walking</td>
</tr>
</tbody>
</table>

10. Standing

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No pain after several hours</td>
<td>Increased pain after several hours</td>
<td>Increased pain after 1 hour</td>
<td>Increased pain after 1/2 hour</td>
<td>Increased pain with any standing</td>
</tr>
</tbody>
</table>

Patient's Signature ___________________________ Date ___________________________

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www.chiroevidence.com
APPENDIX L: OBJECTIVE DATA INFORMATION SHEET

FILE NUMBER:

<table>
<thead>
<tr>
<th>VISIT NUMBER</th>
<th>ALGOMETER READING</th>
<th>NO. TRIGGER POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>VISIT 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VISIT 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VISIT 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>