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A COMPARATIVE STUDY BETWEEN MOBILIZATION AND ADJUSTMENT OF THE CERVICAL SPINE IN IMPROVING POSITION SENSE IN PATIENTS WITH CHRONIC CERVICAL FACET SYNDROME

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

Dimpho Charlotte Majeng
Student number: 802014236

Supervisor: _______________________                 Date: ___________________________  
Name: DR. C. PYPER  (M. Tech: Chiropractic
DECLARATION

I, Dimpho Charlotte Majeng, declare that this dissertation is my own, unassisted work. It is being submitted to the University of Johannesburg for the completion of my Master’s degree in Technology of Chiropractic. It has not been submitted before for any degree or examination to any other Technikon or University.

__________________________
Dimpho Charlotte Majeng

On the _____ day of the month of_______________2015
AFFIDAVIT: MASTER’S AND DOCTORAL STUDENTS
TO WHOM IT MAY CONCERN

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Affidavit certified by a Commissioner of Oaths

This affidavit conforms to the requirements of the JUSTICES OF THE PEACE AND COMMISIONERS OF OATHS ACT 16 OF 1963 and the applicable regulations published in the GG GNR 1258 of 21 July 1972, GN 903 of 10 July 1998, GN 109 of 02 February 2001 as amended.
DEDICATION

This research dissertation is dedicated to my late grandmother, my mother and my sister, who gave me all the support that I needed throughout my studies. I thank you for not giving up on me and mostly your belief in me.
ACKNOWLEDGEMENTS

I would like to say thank you to Dr Pyper for all the assistance, support and not giving up on me. Without your guidance this dissertation would not have been possible.

Thank you Statkon for your help with statistics.

A special thanks goes to all the people who participated in my research study.
Purpose: The aim of this study was to compare the effects of chiropractic adjustment versus mobilization to the cervical spine in participants with chronic cervical facet syndrome with regards to neck pain, cervical spine range of motion and position sense.

Method: Thirty participants, male or female between the ages of 18 and 45 years, diagnosed with cervical facet syndrome were used in the study. The thirty participants were divided into two groups consisting of fifteen individuals each, ensuring equal male to female and age ratios. Group 1 received chiropractic adjustments over the restricted joints to the cervical spine. Group 2 received mobilization over the restricted joints to the cervical spine. The trial consisted of seven visits over a treatment period of three weeks, of which the first six visits the participants received treatment and the seventh visit served the purpose of obtaining the final data. The data was gathered on the first, fourth and seventh visits. Subjective data was obtained by using the Vernon-Mior Neck Pain and Disability Index and the Visual Analogue Scale for pain intensity. Objective data consisted of measuring cervical spine range of motion with a CROM instrument and Laser Pointer Device to measure head repositioning accuracy (position sense).

Results: Subjective results indicated that group 1 (chiropractic adjustment) proved to be the most effective treatment protocol in decreasing neck pain intensity by 92%, and neck pain disability index by 65.7%. Group 2 (mobilization), also showed good results with a decrease in neck pain intensity by 53.9%, and neck pain disability index by 23.8%. Subjective results produced statistically significant results with VAS score (p= 0.000) for both groups and NDI score (p=0.000) for group 1 and (p=0.002) for group 2. Objective results also proved that chiropractic treatment was most effective in increasing cervical spine range of motion by 21.9% (right rotation) and 21.07% (left rotation). In group 2 by 9.93% (right rotation) and 12.72% (left rotation). Results were statistically significant for both groups with CROM score (p=0.002) for group 1 (right rotation) and (p= 0.000) (left rotation). Group 2 CROM score (p=0.040) (right rotation) and (p= 0.007) (left rotation). Objective results also proved that chiropractic adjustment was most effective in improving position sense by 76.54% (right rotation) and 72.06% (left rotation). In group 2 by 38.01% (right rotation) and 13.03% (left rotation). Results were statistically significant for group 1 with Kinesthetic Sensibility Test score (p=0.000) (right rotation) and (p=0.002) (left rotation). In group 2, the result for right rotation was statistically significant with (p=0.019) and not statistically significant for left rotation with (p=0.167).

Both subjective and objective results showed that although group 2 produced statistically significant results, group 1 showed the best clinical results overall. Thus it was noted that in order to obtain a
lasting increase in range of motion of the cervical spine, a decrease in neck pain and disability and an improvement in position sense, the treatment protocol used for group 1 should be the treatment of choice.

**Conclusion:** Based on the results of the study, it was concluded that chiropractic adjustment was more effective than mobilization in the treatment of cervical facet syndrome. This conclusion is based on the results that chiropractic adjustment was more effective in all the objective and all the subjective measurements. However, this does not rule out mobilization as a treatment for neck pain, because mobilization treatment did show improvement in cervical spine ROM, a decrease in pain and slight improvement in position sense although not as efficiently as chiropractic treatment.
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CHAPTER ONE - INTRODUCTION

1.1 Problem Statement

Neck pain is a common condition and is experienced by up to 50% of adults in any given year. Most people with non-traumatic neck pain do not experience complete resolution of symptoms. Patients with neck pain have altered abilities to perceive vertical orientation and have poorer posture control when compared with patients without neck pain (Rogers, 1997).

Several studies have found evidence that suggest spinal dysfunction may lead to altered afferent input to the central nervous system (CNS) (Rogers, 1997).

Mechanically dysfunctional, hypomobile joints found in cervical facet syndrome, can act as a source of altered afferent impulses. Hypomobile joints reduce mechanoreceptor activity, because the adequate stimulus required for proper mechanoreceptor function, is movement. Hypomobile joints will produce altered afferent input, inducing a persistent nociceptive input, as well as an altered and reduced proprioception (Young, 2008).

Mechanoreceptors within the upper cervical area play a key role in movement control and postural adaptations. Receptors are adversely affected by spinal dysfunction and disruption of mechanoreceptors can cause proprioceptive disturbances and result in uncoordinated, painful cervical muscle contraction and guarding (White, Hudgins and Alleva, 2009).

Reduction of pain due to cervical facet dysfunction, by an adjustment or mobilization, occurs by removing the potential source of mechanical pain and inflammation and alteration in the receptor balance within joints (Plaugher, 1993).

1.2 Aim

The aim of this study is to compare the effects of mobilization to the cervical spine versus the chiropractic adjustment to the cervical spine in participants suffering from chronic cervical facet syndrome with regards to neck pain, cervical spine range of motion and position sense (Ma and Kim, 2010).

Changes in quality of proprioceptive information from the cervical spine region may affect postural control, as well as head movement reduction of cervical spine (Palmgren, Lindenberg, Nath and
1.3 Benefits of the Study

The benefits of this study is to restore normal alignment, increase the joint range of motion and affect modulation of sensory input which is proprioception, to the nervous system, the motor control system and the pain processing system (Ma and Kim, 2010).

It should also add to the current body of chiropractic knowledge and provide information as to whether adjustment or mobilization is more effective thereby establishing an effective treatment protocol of cervical facet syndrome (Jin Ho Choi et al, 2010).
CHAPTER TWO - LITERATURE REVIEW

2.1 Introduction

This chapter serves to provide important information regarding the structure and function of the cervical spine, causes of cervical facet syndrome, and the effects of cervical facet syndrome on position sense. The chapter also provides information about the two different types of treatments, which are the adjustment and the mobilization that were received by the participants that were involved in the study. It describes the adjustment and the mobilization, how they both work and how they both affect the pain and position sense in participants that are suffering with cervical facet syndrome.

2.2 Anatomy of the Cervical Spine

2.2.1 Cervical vertebrae

The cervical spine forms the bony skeleton of the neck. It is located between the skull and thorax. The cervical vertebrae are small bones that bear less weight than do the vertebrae inferior to them (Moore and Dalley, 1999).

The cervical spine is composed of seven cervical vertebrae, intervertebral discs (IVD), facet joints, ligaments, muscles, neural structures and vasculature (Moore and Dalley, 1999).

The cervical spine has two types of vertebrae referred to as typical and atypical vertebrae with different characteristics. The first, second and seventh vertebrae are atypical vertebrae. The third to sixth cervical vertebrae are referred to as typical cervical vertebrae. The first cervical vertebra is known as the atlas, the second cervical vertebra is known as the axis and the seventh cervical vertebra is referred to as vertebra prominens (Moore and Dalley, 1999).
Figure 2.1: Cervical vertebrae (Netter, 2003)
Figure 2.2: Typical vertebra superior view (Middleditch and Olivier, 2005)

Figure 2.3: Atlas (Middleditch and Olivier, 2005)
2.2.2 Joints of the cervical spine

a. Facet joints

Facet joints are located between two articular processes and are classified as synovial joints. A joint capsule encloses the joint cavity, except on its medial aspect where the ligamentum flavum encloses the cavity. The articulating surfaces of the joint are covered with hyaline articular cartilage, a connective tissue specialized to allow movement between the articulating bones and to provide shock absorption (Leach, 2004).

The facet joint capsule is composed of three layers. The outer layer is the fibrous joint capsule, which is made up of primarily collagen. It attaches to the inferior and superior articular processes, thereby enclosing the joint. The synovial membrane makes up of the middle and inner layers. The middle layer, called the subintima, joins the fibrous joint capsule. It is composed of adipose and areolar tissue in varying proportions. Blood vessels and lymphatics course through the subintima. The inner layer, called the synovial intima, lines the joint space and, where the fibrous capsule encloses the articular processes, lines both the fibrous capsule and the periosteum of the articular pillars. Together, the synovial membrane’s two layers produce synovial fluid for lubrication of the joint and nutrition (Leach, 2004).
The capsules are longer and looser in the cervical region than in the lumbar and thoracic regions to compensate for the greater amount of movement that occurs. The synovial folds are synovium-lined extensions of the capsule that protrude into the joint space to cover part of the hyaline cartilage (Gatterman, 1995).

b. The intervertebral disc

The intervertebral disc (IVD) is composed of three parts known as the annulus fibrosus, the nucleus pulposus and the vertebral end plate. Together they make up the intervertebral symphysis (Gatterman, 1995).

The annulus fibrosus is made up of several fibrocartilaginous lamellae or rings which are convex externally. The lamellae are formed by closely arranged collagen fibers and a smaller percentage of elastic fibers. The fibers forming each lamella run obliquely from one vertebra to another, the fibers of one lamella typically running at right angles to those of the adjacent ones (Moore and Dalley, 1999). The most superficial lamellae send thick bundles of collagen into the bone of the vertebral rims in the region of the ring apophysis. These bundles are known as Sharpey’s fibers. They form firm attachments between the intervertebral discs and the vertebral body. The inner lamellae of the annulus fibrosus attach to the cartilaginous vertebral end plate (Gatterman, 1995).

The nucleus pulposus is the central core of the intervertebral disc. It is more fluid than the annulus fibrosus. The nucleus pulposus is avascular and it receives its nourishment by diffusion from blood vessels at the periphery of the annulus fibrosus and vertebral body. It is responsible for absorbing most of the fluid received by the disc (Moore and Dalley, 1999).

The vertebral end plates are considered to be an integral portion of the disc. Vertebral end plates are cartilaginous plates that limit the disc superiorly and inferiorly and are attached to the nucleus pulposus, annulus fibrosus and to the adjacent vertebral body. The end plates are approximately 1mm thick peripherally and are thicker centrally. They are composed of both hyaline cartilage and fibrocartilage. The hyaline cartilage is located against the vertebral body and the fibrocartilage is found adjacent to the remainder of the IVD. The end plates help to prevent the vertebral bodies from undergoing pressure atrophy and, at the same time, contain the annulus fibrosus and nucleus pulposus within their normal anatomic borders (Gatterman, 1995).
2.2.3 Muscles of the cervical spine

The upper cervical spine, which supports the cranium from above, and the vertebrae below, requires muscles that are able to produce motion and provide stability for the area. Support of the head on the neck is provided primarily by the upper cervical muscles. It is the responsibility of the muscles to form patterns of motion in the upper cervical spine and to provide much of the stability (Plaugher, 1993).

Figure 2.5: Muscles of the neck (Marieb, 2003)

In the list below, the muscles are described in groups according to the movements they produce.

Table 2.1: Muscles of the neck (Marieb, 2003)

<table>
<thead>
<tr>
<th>Muscles which flex the neck</th>
<th>Longus colli, sternocleidomastoid (SCM), scalenus anterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscles which flex the head on the neck</td>
<td>Rectus capitis anterior</td>
</tr>
<tr>
<td>Muscles which flex the head and neck</td>
<td>SCM, Longus capitis</td>
</tr>
<tr>
<td>Muscles which laterally flex the neck</td>
<td>Scalenus anterior, scalenus medius,</td>
</tr>
</tbody>
</table>
Muscles which laterally flex the head on the neck | Rectus capitis lateralis  
---|---  
Muscles which laterally flex the head and neck | SCM, splenius capitus, trapezius, erector spinae  
Muscles which extend the neck | Levator scapulae, splenius cervicis  
Muscles which extend the head on the neck | Rectus capitis posterior major, rectus capitis posterior minor, obliquus capitis superior  
Muscles which extend the head and neck | Trapezius, splenius capitus, erector spinae  
Muscles which rotate the neck | Semispinalis cervicis, multifidus, scalenus anterior, splenius cervicis  
Muscles which rotate the head on the neck | Obliquus capitis inferior, rectus capitis posterior major  
Muscles which rotate the head and neck | SCM, splenius capitus

From the above mentioned muscles, concentration is more on the multifidi muscles, which form part of the deeper layer of the cervical muscles. The cervical multifidi attach above to the spinous processes of vertebrae C2 to C5. They attach below to the articular processes of the last four cervical vertebrae, C4 to C7; multifidus fibers cross two to four vertebrae (Travell and Simons, 1999).

The intersegmental multifidus account for 40-80% of the increased intersegmental stability during flexion-extension, 45% during axial rotation and 10-20% during lateral bending. This suggests that neuromuscular mechanisms controlling multifidus muscle activity alone could functionally affect segmental stability, especially during flexion-extension and axial rotation (Leach, 1994).

The proprioceptors in the zygapophyseal joints and the deep intrinsic multifidi muscles of the cervical spine have the greatest influence on the motor responses (Janda and Va’vrova, 1996).
2.3 Function of the Cervical Spine

2.3.1 Facet joints

The facet joints function mainly to guide and limit movement of the motion segment. The mid cervical spine has facets that support a greater proportion of the axial compression load. The compressive loads of the cervical region are not normally high. Because of the minimal strength of the region, compression injuries to the cervical spine can take the form of fracture, partial and full dislocations, and severe soft tissue disruptions (Plaugher, 1993).

Proprioceptors monitor the position of joints and the receptors in joint capsules are richly innervated by free nerve endings that detect pressure, tension and movement at the joint. The sense of body position results from the integration of information from the receptors eg. muscle spindles, golgi tendon organs, joint mechanoreceptors and the receptors of the inner ear (Martini, 2001).

Nociceptors are sensory receptors of the peripheral nervous system that sends signals that cause the perception of pain in response to damaging stimuli. They are located at the end of nerve cells that originate in the dorsal root ganglion (Marieb, 2003).

Nociceptors in the facet joints are responsible for sending signals to the spinal cord and the brain when damaging stimuli is detected in the facet joint (Marieb, 2003).

2.3.2 Intervertebral discs

The IVD is designed for weight bearing and strength. It provides strong attachment between the vertebral bodies. The discs act as shock absorbers, and their varying shapes produce the secondary curvatures of the vertebral column. The arrangement of fibers of the annulus fibrosis, although allows some movement between adjacent vertebrae, it also provides a strong bond between them. The nucleus pulposus acts like a shock absorber for axial forces and like a semi fluid ball bearing during flexion, extension, rotation and lateral flexion of the vertebral column (Plaugher, 1993).

Nociceptors in the intervertebral discs are responsible for sending signals to the spinal cord and the brain when damaging stimuli is detected in the intervertebral discs (Marieb, 2003).
2.3.3 Muscles

Muscles maintain posture and body position. Tension in skeletal muscles maintains body posture such as holding your head in position when you read a book (Martini, 2001).

The multifidi muscles, acting bilaterally extend the cervical vertebrae and unilaterally they rotate the cervical vertebrae to the opposite side. They are designed for control, and are said to control positional adjustments between vertebrae (Travell and Simons, 1999).

Proprioceptors monitor tension in tendons and the state of muscular contraction. Muscle spindles monitor skeletal muscle length and trigger stretch reflexes. Golgi tendon organs are located at the junction between a skeletal muscle and its tendon. These receptors are stimulated by tension in the tendon, they thus monitor the external tension developed during muscle contraction (Martini, 2001).

Nociceptors in the muscles are responsible for sending signals to the spinal cord and the brain when damaging stimuli is detected in the muscles (Marieb, 2003).

2.3.4 Ligaments

The ligaments that provide added stability to the upper cervical spine include the transverse ligament of the atlas, alar ligaments, posterior longitudinal ligament, posterior atlantooccipital membrane, anterior atlantooccipital membrane, ligamentum nuchae and apical ligament. The ligaments found in the lower cervical spine are the anterior and posterior longitudinal ligaments, the ligamentum nuchae, interspinous ligaments, intertransverse ligament and the ligamentum flava (Peterson and Bergmann, 2002).

Spinal ligaments are uniaxial structures and are most effective in resisting loads in the direction in which the collagen fibers run. The receptors found in the ligaments are stimulated by tension in the ligaments. During physiological ranges of motion, very little force is required to move the motion segment because of the relatively low resistance provided by the various ligaments (Plaugher, 1993).

The function of the ligaments is to allow and guide smooth motion in the physiological range with a minimum of resistance and expenditure of energy from the organism; and to absorb large
quantities of energy near the trauma range thereby protecting the spinal cord during potentially traumatic situations (Plaugher, 1993).

Nociceptors in the ligaments are responsible for sending signals to the spinal cord and the brain when damaging stimuli is detected in the ligaments (Marieb, 2003).

2.4 Nerve Supply of the Cervical Spine

The nerve supply of the spinal column is derived from the spinal nerve root once it passes out the neural foramina. There are eight cervical nerve roots, and the first cervical nerve exists between the atlas and occiput. The cervical nerve roots C2 to C8 exit from the neural foramina so that the lower cervical nerve root exits after crossing the intervertebral disc numbered one higher, ie. C5 crosses the C4-C5 disc (Borenstein, Wiesel and Boden, 1996).

![Figure 2.6: Cross section of nerve supply to anterior and posterior portion of cervical spine](image)

(Boreinstein, Wiesel and Boden, 1996)

The spinal nerve, after it passes out of the neural foramina, divides into a dorsal and ventral ramus. The dorsal ramus, also known as the posterior primary division, is usually smaller than the ventral
ramus, also known as the anterior primary division. The dorsal ramus supplies the muscles and skin of the vertebral column. It divides into medial and lateral branches. The medial branch supplies the transversospinal muscle group, the facet joints and the interspinous ligaments. The lateral branch supplies the erector spinae muscle groups, the splenius capitis and the splenius cervicis muscles. The lateral branch also provides sensory innervation to the skin of the neck (Borenstein et al, 1996).

It is to be noted that only C2 to C5 follow this function. The dorsal rami of C6 to C8 have no cutaneous branches and the dorsal ramus of C1 is the exception. C1 dorsal ramus does not divide into a medial and lateral branch (Borenstein et al, 1996).

The ventral ramus innervates the sympathetic chain and the autonomic nervous system associated with the vertebral nerve and it also forms the cervical plexus and the brachial plexus that innervate the anterior neck and the upper limbs (Borenstein et al, 1996).

2.4.1 Innervation of the facet joints

The facet joint capsule receives a rich supply of sensory innervation. The sensory supply is derived from the medial branch of the dorsal ramus at the level of the joint, and each joint also receives a branch from the posterior primary division of the level above (Moore and Dalley, 1999).

All proprioceptive input originates from diverse nerve endings, which are responsive to mechanical pressures or distortions, collectively termed mechanoreceptors. The proprioceptors in the cervical spine identified as having the greatest influence on the motor responses are the zygapophyseal joint receptors, particularly C0-C1, C1-C2 and C2-C3 and the deep intrinsic neck musculature receptors (Janda and Va’vrova’, 1996).

Articular receptors are best examined as a single system, in which the individual receptor types provide specific information, to complete a joints sensory picture. There are two types of receptors making up the system. The first are the various corpuscular receptors (type I, II, and III articular receptor) which provide information regarding increases in tension in the fibrous capsule and ligaments in which they are embedded. The second are the free nerve endings (type IV articular receptors) which provide nociceptive information regarding the joint (McLain, 1994).

The three types of corpuscular receptors each provide specific information relating to the
movement in a joint. Type I receptors are found in the outer layers of the joint capsules and they respond to changes in tension within the fibrous capsule. They also provide information regarding direction, amplitude and velocity of joint movements to allow reflex modulation of posture and movement, tonic regulation of neck muscles and inhibition of pain transmission. They adapt slowly and result in long term effects. Type II receptors are found in the deep capsular layers and they only respond to changes in fibrous capsule tension and only while the change in tension is occurring. Type III receptors, not confirmed in spinal synovial joints and are only active when high tensions are present in the joint ligaments. They are implicated in a protective function to recognize potentially harmful movements and thus prevent over displacement of the joint. Type IV receptors are composed of a network of free nerve endings, as well as unmyelinated fibers. They are associated with pain perception and include many different varieties with large ranges of sensations, including itch and tickle. They are located throughout the fibrous portions of the joint capsule and ligaments. They are absent from articular cartilage and synovial linings, although they have been found in synovial folds. They are very high-threshold receptors and are completely inactive in the physiologic joint. Joint capsule pressure, narrowing of the intervertebral disc, fracture of the vertebral body, dislocation of the facet joints, chemical irritation and edema associated with acute or chronic inflammation may all activate the nociceptive system (Bergmann, Peterson and Lawrence, 1993).

A relationship exists between mechanoreceptors and nociceptors such that when the mechanoreceptors function correctly, an inhibition of nociceptor activity occurs. When the mechanoreceptors fail to function correctly, inhibition of nociceptors will occur less, and pain will be perceived (Peterson and Bergmann, 2002).

In cervical facet syndrome, damage to the synovial membrane sensitizes the joint nociceptors causing pain and the hypomobile joints alters the afferent impulses and reducing mechanoreceptor activity therefore reducing proprioception (White, Hudgins and Alleva, 2009).

2.4.2 Innervation of the intervertebral disc

The outer third of the annulus fibrosus of the IVD has been found to receive both sensory and vasomotor innervation. The sensory fibers are both nociceptive (pain sensitive) and proprioceptive in nature. The posterior aspect of the disc receives its innervation from the recurrent meningeal
nerve. The postero-lateral aspect of the annulus receives both direct branches from the anterior primary division and also branches from the sympathetic chain. The lateral and anterior aspects of the disc primarily receive their innervation from branches of the sympathetic chain (Gatterman, 1995).

2.4.3 Innervation of the deeper cervical muscles

The deeper posterior cervical muscles are supplied by branches of the dorsal ramus of the cervical spinal nerves (Gatterman, 1995).

Skeletal muscles utilize a specialized receptor system to report their proprioceptive information. The muscle receptor system also provides the major proportion of proprioceptive inputs to the central nervous system during normal activity. For the purpose of muscle proprioception, two types of muscle fibres exist. The first type are the extrafusal fibres found in the main bulk of skeletal muscle mass. The second type are the intrafusal fibers which are attached to the surrounding layer of the skeletal muscle and exhibit some contractile ability. The intrafusal fibres are surrounded by primary and secondary sensory nerve endings that provide information regarding the length of the muscle and the rate at which the length is changing (Bolton, 1998).

The deep intrinsic, interarticular muscles of the cervical spine have a much higher concentration of muscle spindles when compared with the rest of the muscles of the body (Bolton, 1998).

The tendons attached to skeletal muscle have a receptor system referred to as the golgi tendon organs and are located at the musculotendinous junctions. These receptors provide a constant report of the tension in the tendon caused by contraction of the attached skeletal muscle, which contributes to the maintenance of muscle tone. These receptors also have a protective function that causes a reflex inhibition of its related skeletal muscle when the contraction could be damaging (Bolton, 1998).

Discharges from the articular mechanoreceptors produce coordinated facilitory and inhibitory reflex changes in the spinal musculature. This provides a significant contribution to the reflex control of these muscles. In cervical facet syndrome normal function of the joint is altered and for normal function of the joint structures an integration of proprioception, kinesthetic perception and reflex regulation is essential (Peterson and Bergmann, 2002).
2.5 The anatomy of the spinal cord and its pathways

Stimuli from all sensory organs are conveyed to the spinal cord and further to the brain via large myelinated fast conducting somatic afferent nerves (Tan and Wong, 1990).

Two pathways exist for gathering the peripheral sensory information: the spinothalamic pathway (conveying pain, temperature, light touch and pressure) and the posterior column pathway (conveying sense of position and movement, vibration and discriminative touch). The posterior column pathway and the spinothalamic pathway begins at a peripheral receptor and ends at the primary sensory cortex of the cerebral hemisphere (Martini, 2001).

![Diagram of spinal cord pathways](image)

**Figure 2.7: The posterior column and spinothalamic pathways (Marieb, 2003)**

Most somatic sensory information from the somatic segments arising from body segments enters the spinal cord through the dorsal roots of the spinal nerves. From the point of entrance up to the higher brain centers the information can be relayed along the posterior column pathway or the spinothalamic pathway (Guyton, 1991).
The posterior column pathway is composed of large diameter myelinated nerve fibers that transmit signals much faster. Once information reaches the spinal cord from the dorsal roots of the spinal nerve, the large myelinated fibers from the specialized mechanoreceptors for proprioception pass into the dorsal white columns. Each fiber then divides into a medial and a lateral branch. The medial branch turns upward in the dorsal column and proceeds to the medulla where they synapse in the dorsal column. From here crossover takes place via second order neurons to the opposite side and then upward to the thalamus. From here, the third order nerve fibers project to the primary somatic sensory area in the cerebral cortex (Guyton, 1991).

The spinothalamic pathway transmits sensory signals of pain, and temperature. Pain is a protective mechanism that occurs when tissues are damaged and it serves to cause the individual to react to remove the painful stimulus. There are two different types of pain, slow pain and fast pain. The conductive pathway for each type of pain classification is different. Fast pain is described as acute, sharp or pricking and slow pain is described as chronic, dull, burning or aching. Acute pain is transmitted through thin myelinated type A delta fibers and chronic pain is transmitted through type C unmyelinated (Marieb, 2003).

All nociceptors are free nerve endings within nociceptive tissue, but the two types of pain use two different pathways to reach the central nervous system (CNS). The cell bodies of these types of nociceptors are located in the dorsal root ganglion. They enter the dorsal horn that receives large and small diameter pain carrying fibers known as the Tract of Lissauer. They then terminate on neurons in the dorsal horn. From this point, two different pathways to the brain are taken (Guyton, 1991).

Acute pain type A fibers carrying mechanical pain, terminate in the dorsal horn of spinal cord and stimulate second order neurons that give rise to fibers that cross to the opposite side of the spinal cord and pass upward to the brain where the signals are relayed to the primary somatic sensory cortex. Chronic pain type C fibers terminate in the dorsal horn of the spinal cord. Substance P is used as the synaptic transmitter which is slow to build up at the synapse and is slow to be destroyed. Its concentration increase much longer after pain stimulation via type C fibers occurs. From here, fibers will pass to the opposite side of the spinal cord and continue up to the primary somatosensory cortex (Guyton, 1991).
2.6 Position sense

The body gathers information about its surroundings from three sources: (i) the visual system which provides information about the orientation of objects in the environment; (ii) the vestibular system which provides information concerning the position of the head in relation to gravitational forces, in addition to linear and angular acceleration of the head and (iii) proprioception via the somatosensory system which provides a diverse range of information regarding the environment and the current level of interaction with it, most specifically from the cervical posterior zygapophyseal joints and intrinsic cervical musculature (Jada and Va’vrova’, 1996).

2.6.1 The visual and vestibular system

The vestibular system sends information to the vestibular nuclei in the medulla and lower pons via the vestibular branch of cranial nerve VIII. The cerebellum, receiving input from the proprioception input, also sends information to the vestibular nuclei. The midline cerebellar structures have a strong inhibitory effect on the vestibular nuclei. In turn, the vestibular nuclei project to the cerebellum, to all spinal levels through the vestibulospinal tract, and to the medial longitudinal fasciculus and the pontine reticular formation. Fibers in the medial longitudinal fasciculus project to the nuclei of the third, fourth and sixth cranial nerves stimulating reflex conjugate eye movement in reaction to head position change. The cerebral cortex, although not part of the vestibular system, controls motor activity and coordination as a result of information supplied from various sensory inputs (Souza, 2001).

2.6.2 Proprioception

Kinesthesia generally refers to the perception of changes in the angles of joints, a function dependent upon mechanoreceptor input; it is a critical component in the proprioceptive system (Rogers, 1997).

Proprioceptive information from the upper cervical musculature and joints, play a major role in a patient’s perception of balance. The high density of receptors in the upper cervical region participates in several reflexes. The facet joints contain mainly nociceptors with type I or type II proprioceptors. The majority of proprioceptors are located in other tissue, in particular the deep cervical muscles such as the multifidi (Souza, 2001).
The main type of sensation from a joint is proprioception which provides information concerning the movement and position of the parts of the body. Impulses pass from nerve endings in the articular capsule to the spinal cord and brain and act in reflexes concerned with the control of the muscles acting on the joints (Moore, 1992).

In paraspinal neck muscles, inflammation initiates both local and remote reflex effects. Chemical stimulation of group III and IV afferents from inflammation activates gamma-motorneurons which innervate the intrafusal fibers of the muscle spindle. The reflex increase in gamma-motorneuron discharge, increase the stretch sensitivity of muscle spindles and thereby contribute to joint protection and to physiologic control of postural stability and coordination of joint movement (Leach, 2004).

2.7 The Joints and Biomechanics of the Cervical Spine

2.7.1 Characteristics of normal motion

The fundamental unit of spinal movement referred to as the motion segment is a three-joint complex. This unit consists of an intervertebral disc surrounded by two adjacent vertebrae, the two facet joints, and the surrounding contiguous ligaments including capsules. The three-joint complex is the functional unit of spinal motion (Gattermann, 2005).

2.7.2 Normal intersegmental motion in the cervical spine

Regardless of the spinal location, the quantity and quality of motion are determined by normal variations in sagittal curvature and segmental orientation, muscular control, facet orientation, and degenerative changes of the motion segments (Gatterman, 2005).

a. The atlantooccipital joints

The atlantooccipital joint, i.e. C0 and C1, is formed by the articulation of the convex occipital condyle with the concave facet of the atlas. This is a symmetrical and mechanically linked joint (Gatterman, 2005).
Pure rotation does not occur at the atlantooccipital joints. Rotation between C0 and C1 is approximately 3 degrees (Gatterman, 2005).

When the occiput rotates on the atlas, the movement occurs secondarily to rotation of the atlas on the axis. Rotation is associated with an anterior displacement of the occipital condyle on the lateral mass of the atlas on the opposite side and a lateral flexion of the occiput to the opposite side of rotation. The alar ligament wraps itself around the dens and is stretched, pulling the contra-lateral occipital condyle to the same side as rotation. Therefore rotation is associated with translation and flexion at the atlanto-occipital joint (Kapandji, 2008).

**b. The atlantoaxial joint**

The mechanically linked four-joint complex between C1 and C2 lacks the disc of the typical vertebral motion segment. Thus the pattern of motion is controlled by the osseous and ligamentous articulations. There are two atlantoaxial joints: median and lateral. The median atlantoaxial joint is a
double joint. One joint is between the posterior surface of the anterior arch of atlas and the anterior surface of the odontoid process. The other joint is between the anterior surface of the transverse ligament and the posterior surface of the odontoid process. The lateral atlantoaxial joint is the two paired joints between the inferior process of atlas and the superior process of axis. There are approximately 47 degrees of rotational movement accounting for 40% to 50% of the total axial rotation available in the cervical spine and making the atlantoaxial joints the most mobile segment of the cervical spine (Kapandji, 2008).

During rotation, the odontoid process remains stationery while the atlas and the transverse ligament turn anti-clockwise, relaxing the articular capsule on the same side of rotation. The lateral mass of the atlas moves anteriorly on the side away from rotation, and posteriorly on the same side of rotation. The movement also occurs in the atlanto-axial joints due to their mechanical link (Kapandji, 2008).

c. The lower cervical joints

The vertebral bodies from C3-C7 are connected by an intervertebral disc. They are also connected by their articular processes whose articular surfaces are arranged obliquely inferiorly and posteriorly. At this level of the cervical vertebrae, the facets are slightly concave anteriorly in the parasagittal plane and their center of curvature lies a long way inferiorly and anteriorly (Kapandji, 2008).

Rotational movements in the lower cervical spine demonstrate the same coupling as described for lateral flexion. Left/right axial rotation is coupled with lateral flexion to the same side. On the side of cervical rotation, the inferior facet of the superior vertebra glides posteriorly and inferiorly as the contralateral glides anteriorly and superiorly (Peterson and Bergman, 2002).

2.8 Cervical Facet Syndrome

2.8.1 Definition of cervical facet syndrome

Cervical facet syndrome is a dysfunction of the posterior joints of the neck with ligament shortening occurring from muscle hypertonicity, in which the contiguous parts of adjacent vertebrae are pulled together (Gatterman, 1990). There is irritation or damage of the facets that may cause cranial,
cervical or upper shoulder and back pain referral (Carnes and Vizniak, 2010).

The facet joints can become restricted. This process results in the axis of motion shifting towards the side of the restriction, resulting in asymmetrical motion of the spinal motor unit. Altered mechanics or biomechanical dysfunction leads to changes in the normal axis of motion which sets up neural receptor irritation and altered muscle function (Esposito, 2005). Several studies have found evidence that suggests spinal restriction may lead to altered afferent input to the central nervous system (CNS) (Tylor and Murphy, 2008).

2.8.2 Pathogenesis of cervical facet syndrome

Changes seen in facet syndrome begin with synovitis, which is damage to the synovial membrane causing inflammation. Posterior segmental muscles protect the joint by sustained hypertonic contraction. Muscles become ischaemic and cause more pain. Accumulation of metabolites in muscle further aggravates the pain and sustains the hypertonic state of contraction. The posterior joint becomes splinted and the minor subluxation is maintained defined as motion segment in which alignment, movement and function are altered (Peterson and Bergmann, 2002).

There is tenderness to pressure usually at the facet joint and multifidi muscles. The hypertonic state of the muscles around causes abnormal muscle activity and all movements are restricted (Peterson and Bergmann, 2002).

Vasoconstriction and sustained muscle contraction with accumulation of metabolites, leads to muscle fatigue. This leads to changes in recruitment of motor units in an individual muscle and in muscle groups used for a particular movement. The result is an altered pattern of muscle contraction. Multifidi, which are largely postural are commonly affected. Uncontrolled contractions produce tortional injury to facet joints and disc (Peterson and Bergmann, 2002).

2.8.3 Signs and symptoms of cervical facet syndrome

In vivo studies have confirmed the facet joint as a potential source of pain with particular patterns of pain distribution based on the level of injury (White, Hudgins and Alleva, 2009). Potential causes are secondary to cervical injury; cervical disc injuries (disc pain at the same spinal level is associated with facet pain in approximately 40% of cases); whiplash; sprain or strain;
osteoarthrosis or rheumatoid arthritis; repetitive stress and poor posture (occupational) (Vizniac and Carnes, 2010).

The case history of patients with cervical facet syndrome is a dull pain although may be sharp during acute episodes, headaches and limited range of motion (ROM), pain is localized and the patient can often pinpoint the pain, neck muscle spasm or torticollis. Sometimes pain radiates to the shoulder or mid back regions, although it does not often radiate beyond the elbow or upper thoracic spine. Patients may report a history of whiplash injury (Vizniac and Carnes, 2010).

Figure 2.9: Referred pain patterns suggested with pathology of the facet joints (Magee, 2008)

Physical examination of patients with cervical facet syndrome often reveals increased pain on extension and rotation movements of the cervical spine due to facet joint approximation. Antalgia is due to facet joint approximation. Antalgia is typically away from facet in acute patients, resulting in a slight flexion and lateral flexion position (antalgic posture – torticollis-like posture) (Vizniac and Carnes, 2010).

Clinical evidence of joint dysfunction includes tenderness to palpation of the relevant joints,
restricted intersegmental ROM, palpable asymmetric intervertebral muscle tension, abnormal or blocked joint play and end-feel of a joint (Tylor and Murphy, 2008).

### 2.8.4 The effects of cervical facet syndrome on proprioception

Receptors can be adversely affected by facet capsular strain, spinal dysfunction and neck muscle fatigue. Inflammation of the facet joint can sensitize nociceptive neurons and lower the firing threshold, causing pain during “normal” motion, or peripheral sensitization. Similarly, disruption of mechanoreceptors can cause subtle proprioceptive disturbances and result in spinal instability or uncoordinated, painful cervical muscle contraction and guarding (White, Hudgins and Alleva, 2009).

Hypomobile joints found in cervical facets syndrome can act as a source of altered afferent impulses that reduce mechanoreceptor activity, because the adequate stimulus required for proper mechanoreceptor function, is movement. Hypomobile joints will produce altered afferent input, inducing a persistent nociceptive input, as well as an altered and reduced proprioception (Young, 2008).

In cervical facet syndrome, the joint dysfunction induced nociceptive input results in a reduction in proprioceptive input, in a process referred to as dysafferentation. It is considered to describe the disruption of afferent nerve fibers in an injured joint. Joint dysfunction in terms of tissue texture change, vertebral motion restriction and facet joint tenderness results in reduced standing balance. This is particularly true of dysfunction at CO-C1 (Rogers, 1997).

Trigger points, which are areas of prolonged hyperactivity in a muscle, are characterized by areas of reduced blood flow that may cause damage to the muscle spindles, resulting in abnormal proprioceptive output (Guyton, 1996).

In muscle tension, the increased nociceptive output can activate motor neuron activity at the same spinal segmental level. The resulting hypertonic muscle produces excess potassium, lactic acid and arachidonic acid that may sensitize proprioceptors and generate aberrant sensory information (Murphy, 2000).

Dysfunctional muscle may result in aberrant proprioceptive output as a result of disturbance to the
muscle spindle output. Numerous conditions that have been hypothesized to have an effect on muscle spindles are pain and inflammation, muscle tension, muscle atrophy and trigger points. The evidence suggests that muscles in the superior part of the cervical spine play a greater role in proprioceptive output than at lower levels. Pain and muscle inflammation may affect the gamma reflex loop by preventing the adaptation of the muscle spindles once the muscle is in a hypertonic state, resulting in aberrant proprioceptive information (Guyton, 1996).

2.9 Chiropractic Adjustment and Joint Mobilization

2.9.1 Chiropractic adjustment

Chiropractic adjustments involve the use of short lever, low-amplitude, high-velocity, controlled forceful thrusts by hand that are directed at specific articulations (Leach, 1994).

The joint is carried beyond the usual physiological limit of movement (beyond the elastic barrier of resistance into the paraphysiological range of motion) without exceeding the boundaries of anatomical integrity (Haldeman, 1992).

The physical properties of an adjustment occur within the joint’s normal range of motion. Joint range of motion can be split into three zones (active range of motion, passive range of motion and the paraphysiological space) and two barriers (the elastic barrier of resistance and the limit of anatomical integrity) (Esposito and Phillipson, 2005).

The elastic barrier of resistance is the important area in a chiropractic adjustment because it is the area where joint play is examined. Joint play is found at the end of passive range of motion (Esposito and Phillipson, 2005).

During the chiropractic adjustment, three events occur whilst passing through the elastic barrier and entering the paraphysiological space: a sudden separation of the joint surfaces, an audible cracking sound, and the appearance of the radiolucent space in the joints (Esposito and Phillipson, 2005).
The physiological basis of the adjustment involves the separation of the joint surfaces to a point where cavitation occurs which nullifies the negative pressure that normally assists in approximating the joint surfaces. This leads to an increase in the range of motion of the joint (Haldeman, 1992).

The temporary increase in range of motion for the joint results in the number of important related effects. Mechanoreceptors in the adjusted joints, capsule and ligaments are stimulated, in conjunction with the surrounding muscle and tendon proprioceptors. This leads to a reflex relaxation of the paraspinal musculature by a reduction of the excitability of these muscles, removing a component of the joint subluxation complex and blocking pain signals (Bergmann, Peterson and Lawrence, 1993).
Figure 2.11: Mechanism by which a high-velocity chiropractic adjustment inhibits the central transmission of pain through activation of mechanoreceptors and nociceptors (Bergmann et al., 2002)

The mechanisms associated with the beneficial effects of adjustment for neck pain are mechanical, neurophysiological and reflexogenic. The mechanical mechanism is believed to cause a realignment of previously misaligned vertebral motion segment. The neurophysiological mechanism is believed to trigger the release of endorphins or substance P. The reflexogenic mechanism is believed to cause a relief of pain and loss of hypertonicity in muscles directly in the target area where the spinal adjustment is applied (Hertzog, Scheele and Conway, 1999).

Adjustment has the potential to remove the source of mechanical pain and inflammation and induce stimulus-produced analgesia. The adjustment induces sufficient force to activate both superficial and deep somatic mechanoreceptors, proprioceptors and nociceptors. The effect of this stimulation is a strong afferent segmental barrage of spinal cord sensory neurons, capable of inhibiting the central transmission pain (Peterson and Bergmann, 2002).

Adjustments that induce joint cavitation and capsular distraction may be a source of nociceptive stimulation capable of initiating long lasting pain inhibition. The short term bursts of proprioceptive and nociceptive input associated with adjustments increase the levels of neurochemical inhibition (Peterson and Bergmann, 2002).
The mechanism by which adjustment relieve muscle spasm is one through direct action on muscle and also by stretching the joint capsule and stimulation of mechanoreceptors. The concept is that, adjustment induces a strong stretch on the muscle tendon complex activating the golgi tendon organ and induces reflex muscle relaxation. Joint and soft tissue mechanoreceptors and nociceptors play a role in the inhibition of muscle spasm and the interruption of painful myofacial cycles and joint locking (Peterson and Bergmann, 2002).

The benefit from the adjustment is restoration of normal alignment, increase in joint range of motion and modulation of sensory input (proprioception) to the nervous system, the motor control system and the pain processing system (Ma and Kim, 2010).

2.9.2 Joint mobilization

Joint mobilization is a form of non-thrust joint manipulation typically applied within the physiologic range of motion and not exceeding the anatomic end range of joint movement. It is not commonly applied beyond a joint’s elastic barrier. In contrast to adjustment, mobilization does not employ a thrust component and is usually not associated with joint cavitation. Joint mobilization is a passive rhythmic graded movement of controlled depth and rate without a sudden increase in velocity. They may be applied with fast or slow repetitions and various depths (Bergmann et al, 1993).

An adjustment is much more frequently associated with joint cavitation than mobilization. However, deep mobilization may also be associated with joint cavitation (Bergmann et al, 1993).

The graded oscillatory movement is a form of mobilization whereby alternate pressure (on and off) is delivered at different segments. The size of the oscillation may also vary according to the purpose of the treatment. Mobilization can be performed at general regions or at specific joint levels. The difference between these procedures rests in the localization of forces. To produce a specific mobilization, a particular segment must be placed in its most favorable position for movement, and contacts must be placed on or close to the segment being mobilized. The arc of movement for a regional mobilization will be greater than the arc of motion used for the specific or segmental mobilization. Mobilization can be performed in a physiologic direction (rotation, flexion, extension, or lateral flexion) or in a non-physiologic direction (longitudinal traction or posterior-to-anterior gliding) (Bergmann et al, 1993).
Spinal mobilization can increase the range of motion of spinal joint, and affect modulation of sensory input to the nervous system, the motor control system and the pain processing system. It has been shown to produce hypoalgesia and a sympathoexcitatory effect. This suggests that a central mechanism is responsible for the effects of mobilization (Ma and Kim, 2010).

Reduction of pain due to cervical function dysfunction, by mobilization, occurs by removing the potential source of mechanical pain and inflammation and alteration in the receptor balance within joints (Esposito and Phillipson, 2005).

The primary goal of mobilization is to restore optimal pain-free range of motion and quality of movement to the joint. Indirect benefit is thought to be received because of improved function within each part of the kinetic chain in need of treatment. Compensatory mechanical stress on adjacent structures may be reduced when a previously painful or restricted part of the chain is returned to normal function. The return to comfortable, maximal range of motion serves as a passive treatment end point. The nature of the graded oscillations is thought to activate sensory mechanoreceptors that may help reduce pain and improve proprioceptive function (Bergmann, 1993).

Restriction of cervical spinal motion and changes in the quality of proprioceptive information from the cervical spine region, may affect postural and oculomotor control. Removal of the abnormal afferent input will thus result in an improved proprioception and motor response. Chiropractic adjustment is considered to be the most powerful treatment for improving cervical joint position sense and reducing dizziness (Heikkila, Johansson and Wenngren, 2000).

There is a strong evidence that suggests that cervical mobilization have been shown to decrease pain, increase range of motion and improve proprioceptive function. Therefore, both mobilization and adjustment has effects on the joint and adjacent tissues (Madson et al, 2010).
CHAPTER THREE - METHODOLOGY

3.1 Introduction

This chapter serves to explain how the research study was designed and performed. It also includes the treatment approach to participants, the different measurements that were used and the way in which data was analyzed.

3.2 Study Design

It is a clinical comparative study.

3.2.1 Participant recruitment

Participants for the research study were recruited by means of advertisements (Appendix A) placed in and around the University of Johannesburg, Doornfontein campus and Chiropractic Day Clinic, where the research study took place. Participants were also recruited by word of mouth.

3.2.2 Sample selection and size

Participants were accepted on the basis of the inclusion and exclusion criteria. The research study was fully explained to the participants and they were required to sign the information and consent form specific to this study (Appendix B). Thirty participants were required to participate in the study. Group 1 consisted of 15 participants; each received adjustments to the cervical spine for the treatment of cervical facet syndrome. Group 2 also consisted of 15 participants; each received mobilizations to the cervical spine for the treatment of cervical facet syndrome.

3.2.3 Inclusion criteria

- Participants were male or female.

- Participants were between or including the ages of 18 and 45 years old.

- Participants presented with unilateral or bilateral chronic neck pain which is defined as pain duration of more than three months (Palmgren, 2006).

- The neck pain was due to cervical facet syndrome defined as the presence of hypomobile
cervical spine joints and decreased intersegmental ROM and tenderness to palpation of the facet joint of at least one cervical spine segment (Taylor and Murphy, 2008).

3.2.4 Exclusion criteria

- Contra-indications to cervical spine mobilization and cervical spine adjustment (Appendix C).
- Conditions that may mimic cervical facet syndrome (Strunk and Hawk, 2009).
- Participants taking any analgesic, anti-inflammatory or muscle relaxant medication or receiving any treatment (including chiropractic treatment) for the duration of the study (Strunk and Hawk, 2009).
- Presence of any pathology such as cerebellar abnormality, ear abnormality, presence of loss of balance due to inner ear pathology or any neurological pathology, etc. Physical examination must have excluded any pathologies (Strunk and Hawk, 2009)
- Visual loss (Strunk and Hawk, 2009). This is because the perception of the orientation of the head in spaces requires vestibular and visual input. Also to provide similarities to participation (Strimpakos, 2011).

3.2.5 Group allocation

The participants were assigned systematically to group 1 or group 2. The first participant who qualified for the study was placed in the adjustment group (group 1), the second participant who qualified was placed in the mobilization group (group 2), the third participant who qualified, in the adjustment group and so forth.

3.3 Treatment Approach

3.3.1 First visit

Participants were required to read and sign the information and consent form (Appendix B). They were then screened and assessed through a case history (Appendix G), physical examination (Appendix H) and a cervical spine regional examination (Appendix I) to determine if they could participate in the study. Inclusion and exclusion criteria were taken into account.
Subjective tests were then completed by the participants thereafter objective tests were completed by the researcher.

The subjective tests that were used, were the Vernon and Mior Neck Pain and Disability Index Questionnaire (Appendix D) which measures disability in patients with neck pain and the Visual Analogue Scale (VAS) (Appendix E) which was used to measure the intensity of pain.

The objective test that was used was CROM goniometer which was used to assess the rotation range of motion of the cervical spine (Tousignant, de Bellefeule, O'Donough and Grahovac, 2000). The other objective test that was used was the kinesthetic sensibility test. The test was used to assess the ability of the participant to perceive position of the head relative to the trunk during rotation movement (Palmgren, Sandstrom, Lundqvist and Heikkila, 2006).

After taking measurements, all participants in both groups were required to lie in a supine position. Motion palpation of the cervical spine was conducted by the researcher by passively moving the cervical spine through the desired range of motion to identify restricted articulations (Plaugher and Lopez, 1993).

Group 1 then received adjustments to the cervical spine depending on the restrictions present and group 2 received mobilizations to the cervical spine depending on the restrictions present. Treatment was then complete.

3.3.2 Follow up visits

Five more treatments were given depending on their group allocation. Participants in both group 1 and group 2 consulted 7 times over a period of 3 weeks. Subjective and objective measurements were taken again before the relevant treatment in each group, at visit 4 and at visit 7. No treatment was given at visit 7 for group 1 and group 2, only measurements were taken.

3.4 Subjective Measurements

Subjective measurements were collected using the Vernon and Mior Neck Pain and Disability Index Questionnaire and the Visual Analogue Scale (VAS).
3.4.1 Vernon and Mior Neck Pain and Disability Index

The Vernon and Mior Neck Pain and Disability Index Questionnaire is a 10 item questionnaire which measures disability in patients with neck pain. The questionnaire asks patients about their symptoms and the effect of the neck pain on a range of functional activities. It consists of 10 questions each with 6 answers (scoring 0-5). The participant chooses one answer per question. The sum of the scores obtained is doubled to give a percentage score out of 100 (0-20 \% normal, 21-40\% mild disability, 41-60\% moderate, 61-80\% severe and 80+\% complete/exaggerated disability). The higher score is indicative of greater disability associated with the neck disorder (McCarthy, Grevitt, Silcocks and Hobbs, 2007).

It has been used in many manual therapy studies. It is the most widely used and most strongly validated tool for assessing self related disability in patients with neck pain. It continues to be the most clinically useful self-report measure for neck pain (Madson, Cieslak and Gay, 2010).

The Vernon and Mior questionnaire has been shown to be a valid and reliable subjective tool in the study of patients with mechanical neck disorders (Young, Walker, Boyles, Whitman and Childs, 2009).

A randomized study with ninety-one subjects with a primary complaint of neck pain was used to test-retest reliability and construct validity for the Vernon and Mior Neck Pain and Disability Index Questionnaire. All subjects completed the Vernon and Mior Neck Pain and Disability Index at a three week follow up. Subjects also completed the Global Rating of Change (GRC) scale, which was used to separate patients into improved or stable groups (Young et al, 2009).

In conclusion, the Vernon and Mior Neck Pain and Disability Index questionnaire was found to be valid and reliable and demonstrates good responsiveness when used in a sample with high percentage of patients with neck pain. Changes showed good validity and reliability (Young et al, 2009).

3.4.2 Visual Analogue Scale

The VAS evaluates pain intensity typically on a 100mm long horizontal line which is anchored at each end with a statement presenting the extremes of the dimension being measured, such as “no
“pain” and “excruciating pain/worst pain imaginable”. The participant indicates by a mark on the line the perceived pain level at that point in time; this can be compared with subsequent treatments (Khorsan et al, 2008).

The VAS has been shown to be reliable and valid in the study of comparison of verbal and visual analogue scales for measuring the intensity and unpleasantness of experimental pain. A study compared the two currently available methods, the Verbal Descriptor and Visual Analogue Scales. Eight subjects rated painful and near-painful heat stimuli by using VAS for intensity or unpleasantness and by choosing the most appropriate phrases from lists of intensity or unpleasantness descriptors. In the intensity dimension, the relationship between perception and stimulus temperature was identical whether calculated from the VAS or Verbal Description Scales (Duncan, Bushnell and Lavigne, 1989).

These results confirm that both VAS and Verbal Descriptor techniques are valid and very reliable, and that they successfully quantify sensory intensity and active aspects of pain (Duncan et al, 1989).

3.5 Objective Measurements

3.5.1 Cervical spine range of motion

A CROM goniometer was used to assess the ranges of motion of the cervical spine. It measures the cervical spine range of motion for flexion, extension, lateral flexion, and rotation using separate inclinometers. One inclinometer in the sagittal plane for flexion-extension, a second in the frontal plane for lateral flexion, and a third in the horizontal plane for rotation. The sagittal and frontal inclinometers are gravity dependent. For this study, only the inclinometer in the horizontal plane was used for evaluation of cervical spine rotation. The inclinometer in the horizontal plane is magnetic. A magnetic neck brace was worn by the participant (Tousignant et al, 2000).

These inclinometers are attached to a frame similar to that for eye glasses. The cervical spine range of motion assessment was done in conjunction with a kinesthetic sensibility test. The changes detected on the CROM were recorded in degrees on the recording sheet (Appendix F) and the changes detected with the kinesthetic sensibility test were also recorded in millimeters on the recording sheet (Appendix F) (Tousignant et al, 2000).
A considerable number of reliability and concurrent validity studies have been published for CROM and it has undergone most evaluation and has been shown to be valid and reliable (Tousignant et al, 2000).

Since the release of the CROM on the market, several researchers have studied the instrument. These studies investigated the CROM’s intrarater and interrater reliabilities. These studies indicate that the CROM offers good reliability and high validity (Tousignat et al, 2000).

A systemic review of reliability and validity studies of methods for measuring cervical spine range of motion was done. The purpose of the study was to evaluate the reliability and validity of the method for measuring CROM. Electronic databases were searched and articles were selected. Data was extracted regarding publication details, type of study, movements and device evaluated, subject and observer characteristics and measurement protocol including blinding and statistical analysis methods. Quality assessment was undertaken using developed criteria to assess internal validity, external validity and statistical methods. An estimate of the level of reliability and validity was calculated and used to categorize studies as good, moderate or poor (Williams, McCarthy, Chorti, Cooke and Simon, 2010).

Devices that had “good” reliability and validity were CROM device, the Spin-T goniometer and the single inclinometer (Williams et al, 2010).

3.5.2 Kinesthetic sensibility test

The kinesthetic sensibility test was used to assess the ability to perceive both the movement and the position of the head relative to the trunk (Palmgren et al, 2006).

To perform the sensibility test, a CROM mounted with a laser pointer device was strapped around the head of the participant. A target sheet was placed on the wall in front of the participant. For every test, the level of the target sheet on the wall was placed in line with the head of the participant. The participant was seated in a comfortable position with the eyes closed facing straight ahead in a position that felt neutral to them. The participant was asked to memorize that position as a starting point, zero (neutral position). The laser beam from the laser pointer device was projected on to the target sheet on the wall. The examiner marked that point with a permanent marker on the target sheet (Revel, Andre-Deshays and Minguet, 1991).
The participant was then instructed to fully rotate the head to the right and hold that position for 5 seconds and then researcher took the measurements. The participant was then instructed to rotate the head back to neutral (point zero) still with the eyes closed. If the participant overshot the starting point, a ruler was used to measure from the starting point to the next point in millimeters. Measurements were recorded on the recording sheet. The procedure was repeated for rotation of the head to the left. Changes detected on the CROM were recorded in degrees on the recording sheet. The test was repeated three times for rotation to the right and three times for rotation to the left and an average was taken (Revel et al, 1991).

Current research suggests that the kinesthetic sensibility test is appropriate for use in clinical practice and was shown to be valid and reliable in the test-retest reliability of cervicocephalic kinesthetic sensibility in three cardinal planes. The test-retest reliability of both the head-to-neutral head position and head-to-target repositioning test in three cardinal planes was examined in a study. Twenty young adults underwent both head repositioning tests and retests with 10 minute rest intervals (Lee, Teng, Chai and Wang, 2006).

The results showed excellent reliability and validity during head-to-neutral head position and head-to-target tests (Lee et al, 2006).

3.6 Data Analysis

Friedman’s test was used to assess if there were any differences within each group over time. If there were any differences within each group over time, Wilcoxon Signed Ranks test was used to assess the comparability of the results within each group separately. Statistical analysis was performed using the Mann-Whitney U test which was used to compare if there were any differences between both groups, comparing the accumulated data between both groups.

3.7 Ethical Consideration

All participants that took part in this particular study were required to read and sign the information and consent form specific to this study. The information and consent form outlined the names of the researcher, purpose of the study and benefits of partaking in the study, participant assessment and treatment procedure. Any risks, benefits and discomforts pertaining to the treatments involved were also explained and the participant’s safety was ensured (prevented from harm). The
information and consent form also explained that the participant’s privacy was protected as only the
doctor, participant and clinician were in the treatment room and anonymity was ensured as the
participant information was converted into data and therefore was not traced back to the individual.
The form also stated that standard doctor/patient confidentiality would be adhered to at all times
when the research dissertation was compiled. The participants were informed that their
participation was on a voluntary basis and they were free to withdraw from the study at any stage.
If the participant had any further questions, these were explained by the researcher; whose contact
details were made available. The participants were then required to sign the information and
consent form that signified that they understood all that was required of them for that particular
study. Results of the study were made available on request.

With regards to this particular study, the following risks, benefits and discomforts were considered:
The chiropractic adjustment and mobilization treatments of the cervical spine are both safe and
non-invasive procedures when safe techniques are used, however post adjustment discomfort,
pain and headaches may have occurred which should have settled within a few days. The benefit
of the study was to decrease neck pain, increase range of motion of the cervical spine and
increase position sense.

Participants were referred when necessary.
CHAPTER FOUR – 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 representative of the group that received chiropractic adjustments to the cervical spine, the other 15 participants were representative of the group that received mobilizations to the cervical spine. The p-value for all tests was set at 0.05 and represents the level of significance of the results.

The analyses included demographic data analyses consisting of age and gender. Subjective measurements consisted of the Vernon-Mior Neck Pain and Disability Index and the Visual Analogue Scale. Objective measurements from the CROM instrument and Laser beam device were used.

The Shapiro-Wilks test was performed to determine if data was normally distributed across the entire group.

Intragroup analysis was performed using the Friedman test. If statistically significant values were revealed, further intragroup analysis was performed using the Wilcoxon Signed Ranks Test.

Intergroup analysis was performed using the Mann-Whitney U test.

Group 1 represents chiropractic adjustments to cervical spine, whilst group 2 represents mobilization to cervical spine.

4.2 Demographic Data Analysis

<table>
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<tr>
<th>Table 4.1: Demographic data provided for age and gender</th>
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<td>GROUP 1</td>
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<td>GROUP 1</td>
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<td>GROUP 2</td>
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The participants recruited for this study were aged between 18 and 45 years of age. Group 1 participants had a mean age of 29.13 years and group 2 participants had a mean age of 28.13 years.

A total of 30 participants were recruited for this study. Group 1 consisted of 8 female and 7 male participants, whilst group 2 consisted of 7 female and 8 male participants.

4.3 Subjective Data Analysis

4.3.1 Visual Analogue Scale

![Bar graph comparing mean Visual Analogue Scale values over time](Image)

**Figure 4.1: Bar graph comparing mean Visual Analogue Scale values over time**

**a. Clinical interpretation**

Figure 4.1 shows a bar graph comparing the mean Visual Analogue Scale (VAS) values of group 1 and group 2 measured at the first, fourth and seventh visits. From the bar graph it may be seen that the mean VAS value for group 1 was 56.53 at the first visit, 29.6 at the fourth visit and 4.33 at the seventh visit. In group 1 an improvement of the VAS totaling 92%, was noted at the seventh visit compared to that of the first. The mean Visual Analogue Scale value for group 2 was 51.66 at the first visit, 39.53 at the fourth visit and 23.8 at the seventh visit. In group 2 an improvement of the
VAS totaling 53.9%, was noted at the seventh visit compared to that of the first.

b. Intragroup analysis

The Friedman test did reveal a statistically significant difference over time in group 1 ($p = 0.000$), and in group 2 ($p = 0.000$).

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the fourth visit with those recorded at the first visit. A statistically significant difference was found in group 1 ($p = 0.000$) and group 2 ($p = 0.001$). Comparison was made of the values recorded at the seventh visit with those recorded at the first visit. A statistically significant difference was found in group 1 ($p = 0.000$) and group 2 ($p = 0.000$).

c. Intergroup analysis

The Mann-Whitney U test was used to compare group 1 and group 2 over time. The Mann-Whitney U test revealed that the groups were not statistically different at visit 1 ($p = 0.492$), but were statistically significant at visit 4 ($p = 0.046$) and at visit 7 ($p = 0.000$).

4.3.2 Vernon-Mior Neck Pain and Disability Index

![Figure 4.2: Bar graph comparing mean Neck Pain and Disability Index values over time](image)

Figure 4.2: Bar graph comparing mean Neck Pain and Disability Index values over time
a. Clinical interpretation

Figure 4.2 shows a bar graph comparing mean Neck Pain and Disability Index (NDI) values of group 1 and group 2 measured at the first, fourth and seventh visits. From the bar graph it may be seen that the mean Neck Pain and Disability Index value for group 1 was 29.60% at the first visit, 19.86% at the fourth visit and 10.13% at the seventh visit. In group 1 an improvement of the NDI totaling 65.7%, was noted at the seventh visit compared to that of the first. The mean Neck Pain and Disability Index value for group 2 was 26.26% at the first visit, 21.73% at the fourth visit and 20.0% at the seventh visit. In group 2 an improvement of the NDI totaling 23.8%, was noted at the seventh visit compared to that of the first.

b. Intragroup analysis

The Friedman test did reveal a statistically significant difference over time in group 1 ($p = 0.000$) and in group 2 ($p = 0.000$).

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the fourth visit with those recorded at the first visit. A statistically significant difference was found in group 1 ($p = 0.000$) and group 2 ($p = 0.003$). Comparison was made of the values recorded at the seventh visit with those recorded at the first visit and a statistically significant difference was found in group 1 ($p = 0.000$) and group 2 ($p = 0.002$).

c. Intergroup analysis

The Mann-Whitney U test was used to compare group 1 and group 2 over time. The Mann-Whitney U test revealed that the groups were not statistically different at visit 1 ($p = 0.588$) and visit 4 ($p = 0.307$), but were statistically significant at visit 7 ($p = 0.006$).
4.4 Objective Data Analysis

4.4.1 Cervical spine right rotation

Figure 4.3: Bar graph comparing mean cervical spine right rotation values over time

![Bar graph comparing mean cervical spine right rotation values over time.](image)

**Figure 4.3: Bar graph comparing mean cervical spine right rotation values over time**

a. Clinical interpretation

Figure 4.3 shows a bar graph comparing mean cervical spine right rotation values of group 1 and group 2 measured at the first, fourth and seventh visits. From the bar graph it may be seen that the mean cervical spine right rotation value for group 1 was 54.73º at the first visit, 63.0º at the fourth visit and 70.13º at the seventh visit. In group 1 an improvement of the cervical spine right rotation totaling 21.9%, was noted at the seventh visit compared to that of the first. The mean cervical spine right rotation value for group 2 was 61.0º at the first visit, 62.93º at the fourth visit and 67.73º at the seventh visit. In group 2 an improvement of the cervical spine right rotation totaling 9.93%, was noted at the seventh visit compared to that of the first.

b. Intragroup analysis

The Friedman test did reveal a statistically significant difference over time in group 1 ($p = 0.000$) and in group 2 ($p = 0.008$).

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the fourth visit
with those recorded at the first visit. A statistically significant difference was found in group 1 ($p = 0.002$) and no statistical significance in group 2 ($p = 0.500$). Comparison was made of the values recorded at the seventh visit with those recorded at the first visit and a statistically significant difference was found in group 1 ($p = 0.002$) and group 2 ($p = 0.040$).

c. Intergroup analysis

The Mann-Whitney U test was used to compare group 1 and group 2 over time. The Mann-Whitney U test revealed that the groups were not statistically different at visit 1 ($p = 0.950$), visit 4 ($p = 0.517$) and visit 7 ($p = 0.546$).

4.4.2 Cervical spine left rotation

![Bar graph comparing mean cervical spine left rotation values over time](image)

**Figure 4.4: Bar graph comparing mean cervical spine left rotation values over time**

a. Clinical interpretation

Figure 4.4 shows a bar graph comparing mean cervical spine left rotation values of group 1 and group 2 measured at the first, fourth and seventh visits. From the bar graph it may be seen that the mean cervical spine left rotation value for group 1 was **54.46** at the first visit, **60.73** at the fourth
visit and 69.0 at the seventh visit. In group 1 an improvement of the cervical spine left rotation totaling 21.07%, was noted at the seventh visit compared to that of the first. The mean cervical spine left rotation value for group 2 was 58.53 at the first visit, 59.87 at the fourth visit and 67.06 at the seventh visit. In group 2 an improvement of the cervical spine left rotation totaling 12.72%, was noted at the seventh visit compared to that of the first.

b. Intragroup analysis

The Friedman test did reveal a statistically significant difference over time in group 1 ($p = 0.000$) and in group 2 ($p = 0.014$).

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the fourth visit with those recorded at the first visit. A statistically significant difference was found in group 1 ($p = 0.000$) and no statistical significance in group 2 ($p = 0.288$). Comparison was made of the values recorded at the seventh visit with those recorded at the first visit. A statistically significant difference was found in group 1 ($p = 0.000$) and in group 2 ($p = 0.007$).

c. Intergroup analysis

The Mann-Whitney U test was used to compare group 1 and group 2 over time. The Mann-Whitney U test revealed that the groups were not statistically different at visit 1 ($p = 0.175$), visit 4 ($p = 0.834$) and visit 7 ($p = 0.428$).
4.4.3 Laser pointer device right rotation

**Figure 4.5: Bar graph comparing mean laser pointer device right rotation values over time**

**a. Clinical interpretation**

Figure 4.5 shows a bar graph comparing mean laser pointer device right rotation values of group 1 and group 2 measured at the first, fourth and seventh visits. From the bar graph it may be seen that the mean laser pointer device right rotation value for group 1 was **98.3** at the first visit, **52.26** at the fourth visit and **23.06** at the seventh visit. In group 1 an improvement of the laser pointer device right rotation totaling **76.54%**, was noted at the seventh visit compared to that of the first. The mean laser pointer device right rotation value for group 2 was **99.26** at the first visit, **78.6** at the fourth visit and **61.53** at the seventh visit. In group 2 an improvement of the laser pointer device right rotation totaling **38.01%**, was noted at the seventh visit compared to that of the first.

**b. Intragroup analysis**

The Friedman test did reveal a statistically significant difference over time in group 1 (**p = 0.000**) and in group 2 (**p = 0.038**).

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the fourth visit
with those recorded at the first visit. A statistically significant difference was found in group 1 \((p = 0.000)\) and no statistical significance in group 2 \((p = 0.078)\). Comparison was made of the values recorded at the seventh visit with those recorded at the first visit. A statistically significant difference was found in group 1 \((p = 0.000)\) and in group 2 \((p = 0.019)\).

c. Intergroup analysis

The Mann-Whitney U test was used to compare group 1 and group 2 over time. The Mann-Whitney U test revealed that the groups were not statistically different at visit 1 \((p = 0.983)\), visit 4 \((p = 0.119)\) but were statistically significant at visit 7 \((p = 0.000)\).

4.4.4 Laser pointer device left rotation

![Figure 4.6: Bar graph comparing mean laser pointer device left rotation values over time](image)

**Figure 4.6: Bar graph comparing mean laser pointer device left rotation values over time**

a. Clinical interpretation

Figure 4.8 shows a bar graph comparing mean laser pointer device left rotation values of group 1 and group 2 measured at the first, fourth and seventh visits. From the bar graph it may be seen that the mean laser pointer device left rotation value for group 1 was 87.33 at the first visit, 50.66 at the fourth visit and 24.4 at the seventh visit. In group 1 an improvement of the laser pointer device left rotation totaling 72.06%, was noted on the seventh visit compared to that of the first. The mean
laser pointer device left rotation value for group 2 was 101.8 at the first visit, 102.6 at the fourth visit and 87.73 at the seventh visit. In group 2 an improvement of the laser pointer device left rotation totaling 13.03%, was noted on the seventh visit compared to that of the first.

b. Intragroup analysis

The Friedman test did reveal a statistically significant difference over time in group 1 (p = 0.000) but not in group 2 (p = 0.429).

The Wilcoxon Signed Ranks test showed a comparison of the values recorded at the fourth visit with those recorded at the first visit. A statistically significant difference was found in group 1 (p = 0.021) and no statistical significance in group 2 (p = 1.000). Comparison was made of the values recorded at the seventh visit with those recorded at the first visit. A statistically significant difference was found in group 1 (p = 0.002) and no statistical significance in group 2 (p = 0.167).

c. Intergroup analysis

The Mann-Whitney U test was used to compare group 1 and group 2 over time. The Mann-Whitney U test revealed that the groups were not statistically different at visit 1 (p = 0.237), but were statistically significant for visit 4 (p = 0.000) and visit 7 (p = 0.000).
CHAPTER FIVE - DISCUSSION

5.1 Introduction

This chapter serves to discuss the results described in chapter four. The results were obtained through clinical and statistical analysis of the Visual Analogue Scale and the Neck Pain and Disability Index Questionnaire measurements and the range of motion and kinaesthetic sensibility readings. The results will be discussed with reference to the literature review.

5.2 Demographic Data

From table 4.1 in chapter four, the average age of participants in group 1 was 29.13 years and group 2 had a mean age of 28.13 years. There were an equal number of male and female participants who took part in the study. The total number of female participants was 15 in the study and the male participant was also 15.

These results can be associated with the fact that both male and female adults are affected by cervical facet syndrome (Madson, Cieslak and Gay, 2010).

5.3 Analysis of Subjective Data

5.3.1 Visual Analogue Scale and Vernon-Mior Neck Pain and Disability Index

a. Clinical interpretation

In Visual Analogue Scale both group 1 and group 2 revealed that there was a clinically significant improvement in pain perception from visit 1 to visit 7; group 1 had better improvement over time.

Group 1 and group 2 in Vernon-Mior Neck pain and Disability Index also revealed that there was a clinically significant improvement in neck pain and disability from visit 1 to visit 7; group 1 had a better improvement over time.

b. Intragroup analysis

Intragroup analysis of Visual Analogue Scale revealed statistically significant differences in both groups over time. These results show that both interventions were effective in decreasing pain intensity.
A comparison of the values within each group was recorded at the fourth visit with those recorded at the first visit, and a statistically significant difference was found in both groups. A comparison of the values recorded at the seventh visit with those recorded at the first visit also revealed a statistically significant difference in both groups.

Intragroup analysis of Vernon-Mior Neck Pain and Disability Index revealed statistically significant differences in both groups over time. These results show that both interventions were effective in increasing the participant’s abilities in terms of their daily activities.

A comparison of the values within each group was recorded at the fourth visit with those recorded at the first visit, and a statistically significant difference was found in both groups. A comparison of the values recorded at the seventh visit with those recorded at the first visit also revealed a statistically significant difference in both groups.

c. Intergroup analysis

Intergroup analysis of Visual Analogue Scale did not reveal any statistical significance between the two groups at visit 1 only. There was a statistically significant difference between the two groups at visit 4 and visit 7. This shows that the two groups were similar to begin with.

Intergroup analysis of Vernon-Mior Neck Pain and Disability Index did not reveal any statistically significant difference between the two groups at visit 1 and visit 4. There was a statistically significant difference between the two groups at visit 7. This shows that the two groups were similar to begin with.

5.3.2 Discussion for subjective data

There is a relief of pain and loss of hypertonicity in muscles where the spinal adjustment is applied (Herdzog, Scheele and Conway, 1999).

The adjustment removes the source of mechanical pain and inflammation from the facet joints; and induces analgesia that inhibits the central transmission of pain. The joint cavitation and capsular distraction initiates long lasting pain inhibition (Peterson and Bergmann, 2002).

Reduction of pain by mobilization occurs by removing the source of mechanical pain and inflammation and alteration in the receptor balance within joints (Esposito and Phillipson, 2005).
The oscillations during the mobilization, activates the sensory mechanoreceptors that help reduce pain (Bergmann, Peterson and Lawrence, 1993).

Group 1 had a better improvement over time in both VAS for pain intensity and NDI for disability from neck pain. This is due to the fact that, unlike mobilization, the adjustment induces a force that is sufficient enough to activate both superficial and deep somatic mechanoreceptors which affect a strong afferent barrage of spinal cord sensory neurons that inhibit the central transmission of pain (Peterson and Bergmann, 2002).

Then short term bursts of proprioceptive input caused by spinal adjustment increases the levels of neurochemical pain inhibitors, enkephalins and endorphins which lead to pain reduction (Peterson and Bergmann, 2002).

Spinal mobilization affects modulation of the pain processing system. It has been shown to produce hypoalgesia and a sympathoexcitatory effect, meaning that a central mechanism is responsible for the effects of mobilization (Ma and Kim, 2010).

These results indicate that both groups were effective in neck pain and disability reduction. The above results are supported by a study done by Murphy et al (2010) that investigated the effect of spinal adjustment on the efficacy of a rehabilitation protocol for patients with chronic neck pain. The study concluded that chiropractic adjustment is effective at reducing functional disability and pain in chronic neck pain patients (Murphy et al, 2010).

The above results are also supported by a study done by Pikula (1999) that investigated the effects of spinal manipulative therapy on pain reduction and range of motion in patients with acute unilateral neck pain. The study concluded that after a single adjustment to the cervical spine in patients with neck pain from facet syndrome, there is less pain intensity and an increase in cervical spine range of motion.

This is supported by Hertzog, Scheele and Conway (1999) that the neurophysiological mechanism is believed to trigger the release of endorphins or substance P. The reflexogenic mechanism is believed to cause a relief of pain and loss of hypertonicity in muscles directly in the target area where the spinal adjustment is applied (Hertzog et al, 1999).
5.4 Analysis of Objective Data

5.4.1 Right and left cervical spine rotation

a. Clinical interpretation

In right cervical spine rotation both group 1 and group 2 revealed that there was a clinically significant improvement in range of motion from visit 1 to visit 7; group 1 had better improvement over time.

Group 1 and group 2 in left rotation cervical range of motion also revealed that there was a clinically significant improvement in range of motion from visit 1 to visit 7; group 1 had a better improvement over time.

b. Intragroup analysis

Intragroup analysis of right cervical spine rotation revealed a statistically significant difference in group 1 and in group 2 over time. These results show that both the interventions were effective in increasing the cervical spine right rotation range of motion.

A comparison of the values within each group was recorded at the fourth visit with those recorded at the first visit, and a statistically significant difference was found in group 1 and not in group 2. A comparison of the values recorded at the seventh visit with those recorded at the first visit revealed a statistically significant difference in both groups.

Intragroup analysis of left cervical spine rotation revealed a statistically significant difference in group 1 and in group 2 over time. These results show that both the interventions were effective in increasing the cervical spine left rotation range of motion.

A comparison of the values within each group was recorded at the fourth visit with those recorded at the first visit, and a statistically significant difference was found in group 1 and not in group 2. A comparison of the values recorded at the seventh visit with those recorded at the first visit revealed a statistically significant difference in both groups.
c. Intergroup analysis

Intergroup analysis of right cervical spine rotation did not reveal a statistically significant difference between the two groups in visit 1, visit 4 and visit 7. This shows that both groups were comparable to begin with and throughout all visits.

Intergroup analysis of left cervical spine rotation did not reveal a statistically significant difference between the groups in visit 1, visit 4 and visit 7. This shows that both groups were comparable to begin with and throughout all visits.

5.4.2 Discussion for objective data

The adjustment is associated with a “cracking” sound that occurs at the end range of passive joint motion when a quick thrust overcomes the remaining joint fluid tension. The quick separation of the joint produces a cavity within the joint and induces joint cavitation which is the formation of gas bubbles within fluid. The cavitation increases the range of motion and the joint space. Increased joint space persists from the excess synovial fluid that rushes to the decompressed center of the joint. The cavitation represents a physical event that signifies joint separation, stretching of periarticular tissue, and stimulation of mechanoreceptors. These events are responsible for reducing cervical spine joint hypomobility. The adjustment of the cervical spine in rotation increases the cervical spine rotation range of motion (Peterson and Bergmann, 2002).

Joint mobilization is applied within the physiologic range of motion and does not exceed the anatomic end range of joint movement. Mobilization does not employ a thrust component and is not associated with joint cavitation therefore a smaller increase in cervical spine joint range of motion and space (Bergmann, 1993).

The results are supported by Mireau (1998) that studied the post adjustment joint mobility of subjects who recorded an audible release and those who did not. In the audible cavitation group, an increase in joint space of 0.88 mm was noted and an increase in joint space of 0.45 mm was noted for the group without an audible cavitation. Also a more increase in joint range of motion was noted for the group with an audible cavitation. The findings suggest that there is a different physical effect between the adjustment group and the mobilization group (Mireau, 1998).
The adjustment increases the range of motion by separating the joint surfaces to a point where cavitation occurs removing the negative pressure that normally approximates the joint surfaces (Haldeman, 1992).

The results are also supported by Hertzog, Scheele and Conway (1999) in that the mechanical mechanisms associated with the beneficial effects of adjustment cause realignment of previously misaligned vertebral motion segment. Also, the reflexogenic mechanism causes a loss of hypertonicity in muscles in the target area where the spinal adjustment is applied (Hertzog et al, 1999).

The results are also supported by a study done by Ma and Kim (2010) that investigated the effects of proprioception rehabilitation on postural control. The study concluded that spinal mobilization can increase the range of motion of spinal joint and affect modulation of sensory input to the nervous system, the motor control system and the pain processing system (Ma and Kim, 2010).

The bigger increase in range of motion for the joint after an adjustment, seen in group 1, results in the number of important related effects. Mechanoreceptors in the adjusted joints, capsule and ligaments are stimulated, in conjunction with the surrounding muscle and tendon proprioceptors. This leads to a reflex relaxation of the paraspinal musculature by a reduction of the excitability of these muscles, removing a component of the joint subluxation complex and increasing range of motion (Bergmann, Peterson and Lawrence, 1993).

The increase in cervical spine range of motion in group 1 comparing to group 2 could be due to the fact that joint mobilization, in contrast to adjustment, does not employ a thrust component and is usually not associated with joint cavitation. It is applied to induce movement of controlled depth and rate without a sudden increase in velocity (Bergmann et al, 1993).

### 5.4.3 Right and left laser pointer device

#### a. Clinical interpretation

In laser pointer device right rotation both group 1 and group 2 revealed that there was a clinically significant improvement in head repositioning accuracy from visit 1 to visit 7; group 1 had better improvement over time.
Group 1 and group 2 in laser pointer device left rotation also revealed that there was a clinically significant improvement in range of motion from visit 1 to visit 7; group 1 had a better improvement over time.

b. Intragroup analysis

Intragroup analysis of laser pointer device right rotation revealed a statistically significant difference in group 1 and in group 2 over time. These results show that both the interventions were effective in increasing the head reposition accuracy.

A comparison of the values within each group was recorded at the fourth visit with those recorded at the first visit, and a statistically significant difference was found in group 1 and not in group 2. A comparison of the values recorded at the seventh visit with those recorded at the first visit revealed a statistically significant difference in both groups.

Intragroup analysis of laser pointer device left rotation revealed a statistically significant difference in group 1 and not in group 2 over time. These results show that the adjustment was more effective in increasing head reposition accuracy compared to the mobilisation delivered in group 2.

A comparison of the values within each group was recorded at the fourth visit with those recorded at the first visit, and a statistically significant difference was found in group 1 and no statistically significant difference was found in group 2. A comparison of the values recorded at the seventh visit with those recorded at the first visit revealed a statistically significant difference in group 1 and no statistically significant difference in group 2.

c. Intergroup analysis

Intergroup analysis of laser pointer device right rotation did not reveal a statistically significant difference between both groups in visit 1 and visit 4, but was statistically significant at visit 7. The comparison of the laser pointer device right rotation between the two groups at the initial consultation and fourth consultation displayed no statistically significant difference showing that the two groups were similar to begin with.

Intergroup analysis of laser pointer device left rotation did not reveal a statistically significant difference between both groups in visit 1 only, but revealed statistically significant differences in
The comparison of the laser pointer device left rotation between the two groups at the initial consultation displayed no statistically significant difference showing that the two groups were similar to begin with.

5.4.4 Discussion for objective data

The adjustment provides a rich sensory stimulus capable of triggering a circulation and a neurological change. Mechanoreceptive endings including proprioceptors (ie. muscle spindles and golgi tendon organs) in the superficial and deep paraspinal tissues are activated since mechanical forces applied during the adjustment are adequate to reach their mechanical thresholds. Muscle spindles along with golgi tendon organs make up a proprioceptive feedback system that contributes to the sense of movement and position (Leach, 2004).

The adjustment induces sufficient force to activate proprioceptors. During the adjustment mechanoreceptors in the adjusted joints, capsule, ligaments and in the muscles are stimulated, in conjunction with the surrounding muscle and tendon proprioceptors increasing position sense (Bergmann, 1993).

The gamma motoneuron discharge that is stimulated by an adjustment increases the stretch sensitivity of muscle spindles and contributes to joint protection and to the physiologic control of postural stability and coordination of joint movement (Leach, 2004).

The graded oscillations during mobilization are thought to activate sensory mechanoreceptors and alteration in the receptor balance within joints that may help improve proprioceptive function (Esposito and Phillipson, 2005).

The results are supported by a study done by Rogers (1997) to assess the effects of spinal manipulation on cervical kinaesthesia in patients with chronic neck pain. The purpose of the study was to determine whether an adjustment as an isolated intervention has any effect on proprioception in subjects with chronic neck pain compared with effects achieved through stretching exercises. The study concluded that subjects receiving cervical spine adjustment demonstrated a 41% improvement in mean scores for the head repositioning skill compared to the 12% improvement observed for the stretching group. In conclusion, the results suggest a possible effect of adjustment on proprioception in subjects with chronic neck pain.
The results are also supported by the study done by Palmgren et al. (2006) to examine alteration in head repositioning accuracy (HRA) in patients with chronic cervical pain syndrome after chiropractic care. Forty-one participants with chronic cervical pain were assigned to either a control group or a cervical spine adjustment group. The cervical adjustment group showed significant reductions in pain and improvement in HRA whereas the control subjects did not show any reduction in pain and improvement in HRA. The results of this study suggested that cervical spine adjustment can be effective in influencing the complex process of proprioceptive sensibility and pain of cervical origin.
CHAPTER 6 – CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The aim of this study was to compare the effects of mobilization to the cervical spine versus the chiropractic adjustment to the cervical spine in participants suffering from chronic cervical facet syndrome with regards to neck pain, cervical spine range of motion and position sense.

Group 1 received chiropractic adjustment as treatment to the restricted segments of the cervical spine and group 2 received mobilization to the restricted segments of the cervical spine as treatment.

Both groups displayed clinically significant improvements for both Vernon and Mior Neck Pain and Disability Index and Visual Analogue Scale. Group 1 displayed more improvement than group 2 in Vernon and Mior Neck Pain and Disability Index and also in the Visual Analogue Scale.

Intragroup analysis showed a statistically significant difference in both group 1 and group 2 for the Visual Analogue Scale and the Vernon and Mior Neck Pain and Disability Index over time.

Intergroup analysis identified a statistically significant difference in Visual Analogue Scale and in Vernon-Mior Neck Pain and Disability Index in visit 4 only. There was no statistical difference in the first and second visits for both groups.

Both groups had clinically statistically improvement in objective measurements i.e. CROM and Laser Pointer Device. In CROM goniometer, group 1 improved more than group 2 in both cervical right rotation and left rotation. In Laser Pointer Device, group 1 improved more than group 2 in both right rotation and left rotation.

Intragroup analysis of both groups displayed statistically significant improvement in CROM goniometer right rotation cervical range over time in group 1 and no statistical significance in group 2 over time. In CROM goniometer left rotation cervical range, group 1 displayed a statistically significant difference over time and no statistical difference over time in group 2. Intragroup analysis of both groups in Laser Pointer Device right rotation displayed a statistically significant difference in group 1 and no statistical significant difference in group 2. Laser Pointer Device left
rotation also displayed a statistically significant difference in group 1 and no statistical significant difference in group 2.

Intergroup analysis identified a statistical significant difference at final visit in Laser Pointer Device left and right rotation in both groups. There was no statistical significant difference in CROM goniometer left and right rotation in all visits.

It can be concluded that, based on the results, chiropractic adjustments was more effective than mobilization in the treatment of cervical facet syndrome and improvement in position sense. This is based on the results that chiropractic adjustment was more effective in all the objective and subjective measurements. However, this does not rule out mobilization as a treatment for cervical facet syndrome, it can be used as an additional treatment protocol especially in osteoporotic patients and patients with severe arthritis.

6.2 Recommendations

The following recommendations were made, that could improve future related research:

- An age specific study would decrease the amount of variables, as people of different ages react differently to any treatment protocol.

- A gender specific study could result in fewer variables as women tend to present frequent and persistent symptoms of neck pain could result in fewer variables since women tend to present frequent and persistent symptoms of neck pain in the general population.

- Using the same type of chair to avoid sitting with different postures for different visits which might alter the cervical spine ranges of motion results.

- Keeping the same distance between the recording sheet against the wall and the seated participant while performing the kinesthetic sensibility test to make the test consistent.
REFERENCES


• Ma, S. and Kim H. (2010). The efficacy of spinal decompression via DRX 3000 combined with a spinal mobilization and a lumbar stabilization exercise program for patients with discogenic


APPENDIX A

DO YOU SUFFER FROM NECK PAIN?

FREE CHIROPRACTIC TREATMENT!

Take part in a research study that is aimed to improve your neck pain. Participants must be males and females between the ages of 18 to 45 years of age.

Treatment is conducted at the University of Johannesburg Chiropractic Day Clinic at SHERWELL ROAD, DOORNFONTEIN, GATE 7.

Kindly contact DIMPHO MAJENG at the under mentioned contact number if you are interested.

Dimpho Majeng: 0781108193
DEPARTMENT OF CHIROPRACTIC

INFORMATION AND CONSENT FORM

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

The aim of this study is to compare the effects of mobilization of cervical spine versus chiropractic adjustments to the cervical spine in participants suffering from chronic cervical facet syndrome with regards to pain, cervical spine range of motion and position sense.

First time visits for all the participants will include completion of a case history, physical examination, and cervical spine regional examination. Subjective tests will then be completed by the participant and objective tests by the researcher. The subjective tests will be in a form of a questionnaire called the Vernon and Mior Neck Pain Disability Index which you will complete. It measures pain and disability caused by neck pain. You also need to complete the Visual Analogue Scale which evaluates intensity if your pain.

The objective test will be the kinesthetic sensibility test and it will be used to assess cervical spine range of motion balance of head. CROM goniometer will also be used to detect any changes in ranges of motion of the cervical spine.

After the tests, motion palpation of your cervical spine will be performed by the researcher to detect any restricted joints. This will be performed for both group 1 and group 2 participants. Group 1 will then receive adjustments to cervical spine and group 2 will receive mobilizations to cervical spine.

Follow-up visits for all the participants will only include re-examination of the cervical spine and
treatment for both groups, adjustment to the cervical spine for group 1 and mobilization for group 2. There will be no treatment given on visit seven. subjective

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 and mobilization of the cervical spine are non-invasive treatment techniques. All participants in both groups will consult 7 times and receive 6 treatments over a period of 3 weeks.

The research study will take place at the University of Johannesburg Chiropractic Day Clinic. 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.

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. The potential risks of the study are aggravation of pain and discomfort after the treatment may last only a few days and the benefits of the study are long term relieve of neck pain, increased range of motion and improved position sense.

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

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

Researcher: Dimpho Majeng  Telephone number: 078 110 8193
Supervisor: Dr. C. Pyper  Telephone number: 011 559 6716
CONTRAINDICATIONS TO ADJUSTMENT AND MOBILIZATION OF THE CERVICAL SPINE
(Esposito and Phillipson, 2005)

- Trauma to the cervical spine such as fractures, complete dislocations of the cervical spine.
- Neck pain associated with inflammation and infection e.g. Rheumatoid arthritis as it may aggravate the symptoms and Pott’s disease (TB of the spine) due to osseous distraction of the vertebral bodies that may fracture and collapse on adjustment or mobilization.
- Tumors, as it may lead to fractures, dislocation or compression of the spinal cord. Also metastatic dispersion may also be encouraged.
- Spondylolisthesis of the cervical spine as it may aggravate the neurological symptoms.
- Hypertension and cardiovascular disease
- Participants who presents with signs and symptoms of stroke e.g. dizziness or vertigo, loss of consciousness, nausea and vomiting, numbness on one side of the body, tinnitus, nystagmus and visual disturbance (loss of vision).
- Also incoordination of extremities and walking difficulties.
This questionnaire has been designed to give the doctor information as to how neck pain has affected your ability to manage in everyday life. Please answer every section and mark in each section only the ONE box that applies to you. We realize that you may consider that two of the statements in any section relate to you, but just mark the box which most closely describes your problem.

<table>
<thead>
<tr>
<th>Section 1 - Pain Intensity</th>
<th>Section 3- Lifting</th>
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</thead>
<tbody>
<tr>
<td>□ I have no pain at the moment.</td>
<td>□ I can lift heavy weights without extra pain.</td>
</tr>
<tr>
<td>□ The pain is very mild at the moment.</td>
<td>□ I can lift heavy weights but it gives extra pain.</td>
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<tr>
<td>□ The pain is moderate at the moment.</td>
<td>□ Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, for example on a table.</td>
</tr>
<tr>
<td>□ The pain is fairly moderate at the moment.</td>
<td>□ Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned.</td>
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<tr>
<td>□ The pain is very severe at the moment.</td>
<td>□ I can lift very lightweights.</td>
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</table>

Section 2 – Personal Care (Washing, Dressing, etc)

| □ I can look after myself normally without causing any pain. |
| □ I can look after myself normally but it causes extra pain. |
| □ It is painful to look after myself and I am slow and careful. |
| □ I need some help but manage most of personal care. |
| □ I need help everyday in most aspects of self-care. |
| □ I do not get dressed, I wash with difficulty and stay in bed. |
| □ The pain is the worst imaginable at the moment |

Section 4 - Reading

| □ I can read as much as I want with no pain in my neck |
| □ I can read as much as I want with slight pain in my neck |
| □ I can read as much as I want with moderate pain in my neck |
| □ I can not read as much as I want because of moderate pain in my neck. |
| □ I can hardly read at all because of severe pain in my neck. |
| □ I cannot read at all. |
Section 5 - Headaches

☐ I have no headaches at all.
☐ I have slight headaches which come infrequently.
☐ I have moderate headaches which come infrequently.
☐ I have moderate headaches which come frequently.
☐ I have severe headaches which come frequently.
☐ I have headaches almost all the time.

Section 6 - Concentration

☐ I can concentrate fully when I want with no difficulty.
☐ I can concentrate fully when I want with slight difficulty.
☐ I have a fair degree of difficulty in concentrating when I want.
☐ I have a lot of difficulty in concentration when I want.
☐ I have a great difficulty in concentration when I want.
☐ I cannot concentrate at all.

Section 7 - Work

☐ I can do as much work as I want.
☐ I can only do my usual work but no more.
☐ I can do most of my usual work but no more.
☐ I cannot do my usual work.
☐ I can hardly do any work at all.

Section 8 - Driving

☐ I can drive my car without any neck pain.
☐ I can drive my car as long as I want with slight pain in my neck.
☐ I can drive my car as long as I want with moderate pain in my neck.
☐ I cannot drive my car as much as I want because of moderate pain in my neck.
☐ I can hardly drive my car because of severe pain in my neck.
☐ I cannot drive my car at all.

Section 9 - Sleeping

☐ I have no trouble sleeping.
☐ My sleep is slightly disturbed (less than 1 hr sleepless).
☐ My sleep is mildly disturbed (1-2 hrs sleepless).
☐ My sleep is moderately disturbed (2-3 hrs sleepless).
☐ My sleep is greatly disturbed (3-5 hrs sleepless).
☐ My sleep is completely disturbed (5-7 hrs sleepless).

Section 10 - Recreation

☐ I am able to engage in all my recreation activities with no neck pain at all.
☐ I am able to engage in all my recreation activities with some pain in my neck.
☐ I am able to engage in most, but not all of my usual recreation activities because of pain in my neck.
☐ I am able to engage in a few of my usual recreation activities because of pain in my neck.
☐ I can hardly do any recreation activities because of pain in my neck.
☐ I cannot do any recreation activities at all.
APPENDIX E

NAME: ____________________________          DATE: ____________________________

Visual Analogue Scale: Rate the severity of your pain by indicating with a mark on the line (Wewers and Lowe, 1990).

No Pain.  ___________________________________________________________ Excrutiating Pain.
# APPENDIX F

## RECORDING SHEET

<table>
<thead>
<tr>
<th>LASER POINTER DEVICE (mm)</th>
<th>Left rotation</th>
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<table>
<thead>
<tr>
<th>CROM (degrees)</th>
<th>Left rotation</th>
<th>Right rotation</th>
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<th>3.</th>
<th>Mean:</th>
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<th>Mean:</th>
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<tbody>
<tr>
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<td>VISIT 4</td>
<td>VISIT 7</td>
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