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THE EFFECT OF MANUAL CERVICAL TRACTION VERSUS MECHANICAL CERVICAL TRACTION IN THE TREATMENT OF CHRONIC NECK PAIN

A dissertation submitted to the Faculty of Health Sciences, University of Johannesburg, as a partial fulfilment of the requirements for the Masters degree in Technology, Chiropractic by:

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DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the Masters Degree in Technology in the program Chiropractic at the University of Johannesburg. It has not been submitted before for any degree of examination in any other Tertiary Institute.

________________________
Marike Rinke

On this_____ day of _______ 2013
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This affidavit conforms with the requirements of the JUSTICES OF THE PEASE AND COMMISSIONERS 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 2 February 2001 as amended.
DEDICATION

To my father and mother, thank you for giving me this great opportunity to study for this degree, and for always supporting me and encouraging me to keep going. I am so privileged to have great parents like you. Thank you. (How do you eat an elephant? Bit by bit).

To my husband, Derrick van der Merwe, thank you for always being there for me through tough times, always supporting me, always encouraging me and loving me. Thank you for your understanding during this time. I could not have done this without you.

To Vanessa Moorcroft, my best friend, and roommate for five years, thank you for all your help, support and great friendship over the past few years.
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To all my chiropractic friends and class-mates, thank you for joining me on this long and interesting journey together.

To all the participants who partook in this research study, thank you for your time and patience. Without you it would not have been possible.
ABSTRACT

Introduction: The most common chronic pain condition in modern society is neck pain (Jensen and Harms-Ringdahl, 2007). Chronic neck pain is a common complaint for many, from young patients to older patients with stressful work situations. According to Graham, Gross and Goldsmith (2006) neck disorders are common, disabling to various degrees and costly. Various structures in the cervical spine capable of transmitting pain include facet joints, intervertebral discs, nerve root dura, ligaments, and muscles (Manchikanti, Singh, Rivera and Pampati, 2002).

According to Rochester (2009) chiropractors treat patients with chronic neck pain by using spinal manipulative therapy (SMT) to address a segmental joint hypomobility within the cervical spine as determined by joint motion palpation and endplay assessment.

Traction is commonly used for the treatment of the spine by various physical therapists. It may be included as part of a chiropractic treatment protocol. According to Hooper (1996) traction involves the application of both manual and mechanical forces to draw adjacent body parts away from each other resulting in decompressed irritated tissues, realign parts, and relaxing tight structures. There are several types of cervical traction. The short and medium term improvement for chronic neck pain as well as the comparative effect of manual cervical traction versus mechanical cervical traction in combination with spinal manipulative therapy has not yet been established.

Aim: This particular research study aimed to compare the short to medium term efficacy of manual cervical traction with mechanical cervical traction combined with spinal manipulative therapy with regards to decreased pain and improvement of cervical spine ranges of motion in patients with chronic neck pain.
**Methodology:** Participants who met the inclusion and exclusion criteria were eligible to participate in this study. Advertisements were placed on notice boards around the campus of the University of Johannesburg and participants were recruited from the use of advertisements as well as word of mouth to partake in this research study.

Thirty participants who suffered from chronic neck pain, volunteered for this comparative research study. This study was a randomized comparative study, where participants were randomly selected to be either in Group 1 or in Group 2. Group 1 received manual cervical traction whereas Group 2 received mechanical cervical traction. Both groups received spinal manipulative therapy to the restricted motion segments found in the cervical spine. Participants received seven trial sessions, with six treatments, over a period of two weeks. At the final 7th visit, one month after the sixth visit, no treatment was performed. Subjective and objective measurements were recorded at each visit.

The subjective measurements of this particular study consisted of the Numerical Pain Rating Scale (NPRS) and the Vernon-Mior Neck Disability Index to evaluate the participants' sensitivity to pain and disability. The objective measurements of this study included the Cervical Spine Range of Motion instrument to assess the participants' cervical spine movement.

**Results:** Both groups demonstrated a statistically significant improvement over time with regards to pain and disability, as well as increased range of motion to the cervical spine. The greatest percentage improvement with regards to range of motion was in lateral flexion and rotation of the cervical spine.

**Conclusion:** According to the results of this study, it could be concluded that either manual cervical traction or mechanical cervical traction in combination with spinal manipulative therapy can be used effectively in the treatment of chronic neck pain as part of a chiropractic treatment protocol. Both groups proved to have a statistically significant improvement with regards to pain and disability as well as increased cervical spine range of motion. Therefore it
could not be concluded whether manual cervical traction to be greater than mechanical cervical traction or vice versa.
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CHAPTER ONE - INTRODUCTION

1.1 General Introduction

In modern society, neck pain is considered to be the most common chronic pain condition (Jensen and Harms-Ringdahl, 2007). Chronic neck pain is a common complaint for many, from young patients to older patients with stressful work situations. According to Graham, Gross and Goldsmith (2006) neck disorders are common, disabling to various degrees and costly. Various structures in the cervical spine are capable of transmitting pain and include facet joints, intervertebral discs, nerve root dura, ligaments, and muscles (Manchikanti, Singh, Rivera and Pampati, 2002). According to a population based study in northern Sweden, the prevalence of chronic neck pain was 43%, where woman (48%) reported more neck pain than men (38%) (Guez, Hildingsson, Nilsson and Toolanen, 2002).

According to Rochester (2009) chiropractors treat patients with chronic neck pain by using spinal manipulative therapy (SMT) to address a segmental joint hypomobility within the cervical spine as determined by joint motion palpation and endplay assessment. Peterson and Bergmann (2002) showed that chiropractic adjustment to the cervical spine is effective in the treatment of chronic neck pain. SMT is also effective in reducing neck pain as well as increasing cervical spine range of motion (Bale and Newell, 2005).

Traction is commonly used for the treatment of the spine by various physical therapists. It may be included as part of a chiropractic treatment protocol. According to Hooper (1996) traction involves the application of both manual and mechanical forces to draw adjacent body parts away from each other resulting in decompressed irritated tissues, realign parts, and relax tight structures. Graham et al., (2006) used traction in their study as part of a comprehensive rehabilitation program for patients suffering from neck pain. However, the short and medium term improvement for chronic neck pain as well as the comparative effect of manual cervical
traction versus mechanical cervical traction combined with spinal manipulative therapy is not yet established.

1.2 Aim of the Study

The aim of this study was to compare the short to medium term efficacy of manual cervical traction with mechanical cervical traction in combination with spinal manipulative therapy with regards to decreased pain and improvement of cervical spine ranges of motion in patients with chronic neck pain. The Saunders HomeTrac® traction unit was used in mechanical cervical traction.

1.3 Benefits of the Study

The results of this study determined which of the two treatment protocols were more effective in reducing pain and increasing cervical spine range of motion. This study helps future chiropractors decide as to which type of traction is most beneficial to include as part of their treatment protocol of chronic neck pain. This study also adds further knowledge to the use of cervical traction treatment both in the Chiropractic profession and to other professions which utilize the use of cervical traction.

This study demonstrated that either manual cervical traction or mechanical cervical traction can be used as part of a chiropractic treatment protocol in the treatment of chronic neck pain. Both cervical traction techniques in combination with spinal manipulative therapy showed increased improvement with regards to cervical spine range of motion and decreased pain and disability.

With respect to the above mentioned introduction, Chapter Two will review the literature done on the anatomy and biomechanics of the cervical spine, cervical facet syndrome, chiropractic spinal manipulative therapy and cervical traction, followed by Chapter Three
which will focus on the methodology applicable to this study. Chapter Four reports the results with Chapter Five discussing these results. Chapter Six will provide possible conclusions and recommendations for future studies on this topic.
CHAPTER TWO – LITERATURE REVIEW

2.1 Anatomy of the Cervical Spine

2.1.1 Introduction

The cervical spine consists of seven vertebrae which are stacked on top of each other to support the weight of the head and are separated by flexible intervertebral discs for movement of the head and neck. The cervical spine can be divided into the upper cervical spine and the lower cervical spine. The upper cervical spine includes the occiput, atlas (C1), and axis (C2). According to Magee (2008), the primary motion of the atlanto-occipital joint (C0-C1) is flexion-extension (15° to 20°) while lateral flexion is about 10° and rotation is negligible. The atlanto-axial joint’s (C1-C2) primary motion is rotation, which is approximately 50°. The lower cervical spine consists of the third to the seventh cervical vertebrae (C3-C7). Magee (2008) also states that the lower cervical spine is called the “cervico-brachial area” because pain in this region leads to neck pain, arm pain or both and other symptoms include headaches, decreased range of motion, paraesthesia and muscle weakness.

2.1.2 Typical Cervical Vertebrae

There are four typical cervical vertebrae namely C3-C6. These vertebrae all share the same characteristics. They all have a vertebral body made out of cortical bone on the outside and spongy bone on the inside. Hyaline cartilage, also called vertebral end plates covers the superior and inferior surface of the vertebral body. The vertebral body is concave on its superior surface and convex on its inferior surface. The uncinate process is found on the superolateral margin of the vertebral body. Posterior to the vertebral body is a large triangular vertebral foramen for the spinal cord to pass through. The vertebral foramen is made out of two pedicles and two laminae which collectively forms the vertebral arch. The vertebral arch extends further posteriorly into a short and bifid spinous process.
The intervertebral foramen on the lateral side of each vertebra and posterior to the vertebral body is formed by the inferior vertebral notch of the vertebra above and the superior vertebral notch of the vertebra below. Nerves are named according to the vertebra below, for example C4 nerve root exits between C3 and C4. The transverse processes of all the cervical vertebrae possess oval transverse foramina for the passage of the vertebral artery except for C7. Each transverse process has an anterior and a posterior tubercle which provide attachment for muscles. Between the anterior and posterior tubercles lies a groove for the spinal nerve. Each vertebra has four processes for articulation with vertebrae above and below. According to Moore and Dalley (2006) the superior facets of the articular processes face superoposteriorly, and the inferior facets of the articular processes face interposteriorly.

Figure 2.1: Typical cervical vertebra (Netter, 2006)
2.1.3 Atypical Cervical Vertebrae

There are three atypical cervical vertebrae namely the atlas (C1), the axis (C2) and the seventh cervical vertebra (C7). Atypical cervical vertebrae are different in their structure towards typical cervical vertebrae.

The atlas is different in that it doesn't have a vertebral body, but is made out of an anterior arch and a posterior arch which forms a ring-like bone. Each arch has a centrally placed tubercle on the external aspect. On the superior surface of the posterior arch is a groove for the passage of the vertebral artery. The atlas also doesn't possess a spinous process. The atlas articulates with the occipital condyles superiorly (also known as the atlanto-occipital joint) and with the axis inferiorly (also known as the atlanto-axial joint) by means of a lateral mass on each side. These lateral masses bear the weight of the heavy cranium and therefore the transverse processes are more laterally placed than the vertebrae below. The transverse processes on each side also have a transverse foramen for the passage of the vertebral artery. A very important transverse ligament extends from the one lateral mass to the other, in order to keep the odontoid process (dens) of the axis in place, preventing anterior displacement of C1 on C2, and forming a pivot of rotation. The transverse ligament has thin layer of articular cartilage on its anterior surface for articulation with the dens, and longitudinal fibers extend superiorly to attach to the occipital bone, and inferior fibers descend to the posterior portion of the axis (Levangie and Norkin, 2005).

The axis is different in that it has a unique peg-like odontoid process that projects from the superior surface of the body (Moore and Dalley, 2006). The axis has two superior articular facets which is big and flat to articulate with the atlas. This particular arrangement causes rotation of the atlas on the axis. The two inferior articular facets articulate with the third cervical vertebra below. The axis also has a bifid spinous process which is large. At the posterior aspect of the dens, there is a posterior articular facet for the transverse ligament of the atlas. According to Moore and Dalley (2006), the dens is held in position against the
posterior aspect of the anterior arch of the atlas by the transverse ligament which prevents posterior displacement of the dens and anterior displacement of the atlas.

The seventh cervical vertebra (C7) is unique for its very long spinous process which can easily be felt in the neck when the neck is in a flexed position. C7 is also known as vertebra prominence. The spinous process is not bifid like the rest of the cervical vertebrae. The transverse processes of C7 are large, but its transverse foramina are very small (Moore and Dalley, 2006).

2.1.4 The Intervertebral Disc (IVD)

According to Snell (2004), the IVD are responsible for one fourth of the length of the vertebral column, and they are thickest in the cervical and lumbar regions, where the most movement occur of the vertebral column. They are found between each vertebra except between C1 and
C2, and serve as shock absorbers. They may be regarded as semielastic discs which allow the rigid vertebrae to move one on each other (Snell, 2004). According to Moore and Dalley (2006), each IVD consists of an outer annulus fibrosus, composed of concentric lamellae of fibrocartilage, an inner gelatinous mass called the nucleus pulposus, and the vertebral end plate.

The annulus fibrosus, which is the peripheral part of the IVD, is composed of fibrocartilage, in which the collagen fibres are arranged in concentric layers. The fibers forming each lamella run obliquely from one vertebra to another; the fibers of one lamella typically run at right angles to those of the adjacent ones (Moore and Dalley, 2006). This arrangement permits some movement between two vertebrae as well as keeping a strong connection. The more peripheral fibers are strongly attached to the anterior and posterior longitudinal ligaments of the vertebral column (Snell, 2004).

The nucleus pulposus is the central part of the IVD and composed of gelatinous material containing a great amount of water, some collagen fibers, and a small number of cartilage cells. The nucleus pulposus is found more posterior than anterior to the margin of the disc and is usually under pressure. The nucleus pulposus is avascular; it receives its nourishment by diffusion from blood vessels at the periphery of the annulus fibrosus and vertebral body (Moore and Dalley, 2006). According to Snell (2004), the semifluid nature of the nucleus pulposus allows it to change shape and permits one vertebra to rock forward or backward on another, as in flexion and extension of the vertebral column. An increase in compression forces on the vertebral column causes the semifluid nucleus pulposus to become broader and loosens water, while traction forces causes the nucleus pulposus to become thinner. With severe compression forces, the outward thrust of the nucleus pulposus is accommodated by the resilience of the surrounding annulus fibrosus which then ruptures, allowing the nucleus pulposus to herniate and protrude into the vertebral canal, where it may press on the spinal nerve roots, the spinal nerve, or even the spinal cord (Snell, 2004). With increasing age, the water content of the nucleus pulposus diminishes and the collagen fibers of the anulus
fibrosus degenerate and as a result, the anulus cannot always contain the nucleus pulposus under stress (Snell, 2004).

The vertebral end plate is made out of layers of hyaline cartilage and fibrocartilage covering the superior and inferior surfaces of the vertebral body. According to Levangie and Norkin (2005), the vertebral end plate is strongly attached to the anulus fibrosus and only weakly attached to the vertebral body, which is why it is considered to be a component of the disc rather than the vertebral body. The vertebral end plate consists of water, proteoglycans and collagen. Fibrocartilage is found more at the nucleus pulposus, where as hyaline cartilage is found more at the vertebral body.

![Intervertebral disc](image)

**Figure 2.3: Intervertebral disc (Peterson and Bergman, 2002)**

### 2.1.5 Unco-vertebral Joints

These joints are also known as the unco-vertebral joints of Luschka. They are found at the lateral and posterolateral margins of the IVD between the third and sixth cervical vertebrae (C3-C6). They are classified as synovial joints and the articulating surfaces are covered with cartilage. The unco-vertebral joints are frequent sites of spur formation, which may cause neck pain (Moore and Dalley, 2006).
2.1.6 Zygaphophysial Joints

The cervical vertebra above and the cervical vertebra below articulate with each other by means of a superior and inferior facet joint, which is also called a zygapophysial joint. These articulations are plane synovial joints and contain a thin, loose capsule which provides a broad range of gliding movements. According to Moore and Dalley (2006), the capsule is attached to the margins of the articular surfaces of the articular processes of adjacent vertebrae and accessory ligaments unite the laminae, transverse processes and spinous processes as well as help stabilize the joints. According to Levangie and Norkin (2005) the zygapophysial joint capsules and the ligaments, in addition to the shape of the joints, dictate motions at all of the cervical segments.

The zygapophysial joints are innervated by articular branches that arise from the medial branches of the posterior rami of spinal nerves, which indicate that each articular branch supplies two adjacent joints and therefore each joint is supplied by two nerves (Moore and Dalley, 2006). These joints lie very close to the intervertebral foramen and when injured the associated spinal nerves are also affected causing pain.

2.1.7 Ligaments of the Cervical Spine

A ligament is classified as a connective tissue fiber composed of collagen and some elastic fibers which are long, straight, unbranched and flexible yet still very strong (Martini, 2006). Ligaments attach one bone to another bone and provide stability. There are six main ligaments which are associated with the zygapophysial and intervertebral joints, namely the anterior and posterior longitudinal ligaments, the ligamentum flavum, and the interspinous, supraspinous and intertransverse ligaments. The alar ligament and apical ligaments are specific for the cervical spine.
a) Anterior longitudinal ligament (ALL)

The ALL is a strong, broad fibrous band that runs along the anterior and lateral surfaces of the vertebral bodies from the sacrum to the second cervical vertebra (C2) and extensions of the ligament from C2 to the occiput are called the anterior atlanto-occipital and anterior atlantoaxial ligaments (Levangie and Norkin, 2005). It consists of two thick layers of collagen fibers of which the superficial layer is elongated and connects several vertebrae where as the deep layer is short and connects single pairs of vertebra. According to Snell (2004), the anterior atlanto-occipital membrane is a continuation of the anterior longitudinal ligament and connects the anterior arch of the atlas to the anterior margin of the foramen magnum. The main function of the ALL is to limit hyperextension of the vertebral column and is the only ligament that prevents extension; all other intervertebral ligaments limit forms of flexion (Moore and Dalley, 2006). Levangie and Norkin (2005) state that the ALL is compressed in flexion and stretched in extension, and twice as strong as the posterior longitudinal ligament.

b) Posterior longitudinal ligament (PLL)

Like the ALL, the PLL also contains two layers of collagen fiber, a superficial layer which spans several vertebrae and a deep layer which only connects to adjacent vertebra. This narrow ligament runs along the posterior aspect of the vertebral bodies within the vertebral canal. It is attached mainly to the intervertebral discs and less so to the posterior aspects of the vertebral bodies from C2 to the sacrum (Moore and Dalley, 2006). The main function of the PLL is to limit hyperflexion of the cervical vertebrae and helps to avoid posterior protrusion of the nucleus pulposus. In the same manner as the ALL, the PLL is now stretched in flexion and compressed in extension. The tectorial membrane is a continuation of the PLL and is a broad, strong membrane that originates from the posterior vertebral body of the axis, covers the dens and its cruciate ligament, and inserts at the anterior rim of the foramen magnum (Levangie and Norkin, 2005).
c) **Ligamentum flavum**

The ligamentum flavum is a thick, elastic ligament that connects lamina to lamina from C2 to the sacrum and some fibers extend laterally to cover the articular capsules of the zygapophysial joints (Levangie and Norkin, 2005). The main function of this ligament is to prevent separation of the vertebral lamina by resisting sudden flexion of the cervical spine, therefore being stretched during flexion. According to Levangie and Norkin (2005), the ligamentum flavum is always under tension, even when the spine is in a neutral position, because of its elastic nature. From C2 to the occiput, the ligamentum flavum continues as the posterior atlanto-occipital and atlantoaxial membranes. These membranes vary in their structure to the ligamentum flavum in that they are less elastic and therefore permit a greater range of motion, especially in rotation (Levangie and Norkin, 2005).

d) **Interspinous ligament**

The interspinous ligament attaches from one spinous process to the adjacent spinous process and is composed of type I collagen and elastin fibers. The main function of this ligament is to prevent sudden flexion of the cervical spine. This ligament is the first ligament to get damaged during extreme flexion. According to Levangie and Norkin (2005), the interspinous ligament is innervated by medial branches of the doral rami and thought to be a possible source of pain.

e) **Supraspinous ligament**

The supraspinous ligament is a rope-like structure that attaches from the tips of the spinous processes of the seventh cervical vertebra (C7) to the third lumbar vertebra (L3). This ligament, like the interspinous ligament, is stretched in flexion, and its fibers resist separation of the spinous processes during forward flexion (Levangie and Norkin, 2005). The supraspinous ligament merges superiorly with the nuchal ligament which is found at the posterior aspect of the neck and is a sturdy, broad, median band. The nuchal ligament is composed of thickened fibroelastic tissue, extending from the external occipital protuberance
and posterior border of the foramen magnum to the spinous processes of the cervical vertebrae (Moore and Dalley, 2006). The nuchal ligament offers sites for muscle attachment.

f) **Intertransverse ligament**

The intertransverse ligaments just like their name suggest, attach between adjacent transverse processes, and consist of a few scattered fibers in the cervical region. The ligaments on the right side are stretched and offer resistance to lateral bending to the left, whereas the ligaments on the left side are slack and compressed during this motion (Levangie and Norkin, 2005).

g) **Alar and apical ligament**

The two paired alar ligaments originate from the axis on either side of the dens and extend laterally and superiorly to attach to roughened areas on the medial sides of the occipital condyles and to the lateral masses of the atlas (Levangie and Norkin, 2005). The main function of these ligaments is to prevent excessive rotation. The apical ligament is fan-shaped and attaches from the apex of the odontoid process to the anterior margin of the foramen magnum.
2.1.8 Movement of the Upper Cervical Spine

During flexion of the atlanto-occipital joint (C0-C1), the occipital condyles recede on the lateral masses of the atlas while the occipital bone is separated from the posterior arch of the atlas. At the same time, the posterior arches of the atlas and axis move apart. Flexion is restricted by tension developed in the articular capsules, posterior atlanto-occipital membrane and the posterior cervical ligament (Kapandji, 1974).

During extension of the C0-C1 joint, the occipital condyles slide anteriorly on the lateral masses of the atlas. The occipital bone moves into close proximity to the posterior arch of the atlas and while the atlanto-axial joint is also moving into extension, the posterior arches of the atlas and axis also come into close proximity of each other. Extension is restricted by the collision of these bony arches, and during forced extension the posterior arch of the atlas can be caught as in a nutcracker and fractured (Kapandji, 1974).
During lateral flexion of the atlanto-occipital joint, the occipital condyles slip to the right during lateral flexion to the left and vice versa in lateral flexion to the right. During lateral flexion to the left, the odontoid and the left occipital condyle come into close proximity of each other without coming into contact. Lateral flexion is restricted by tension developed in the capsular ligament of the atlanto-occipital joint and odonto-occipital ligament (Kapandji, 1974).

During rotation of the atlanto-occipital joint to left, the right occipital condyle is displaced anteriorly on the right lateral mass of the atlas. During this movement, the lateral atlanto-occipital ligament wraps itself around the odontoid and tension is developed which pulls the right occipital condyle to the left. Rotation of the occiput to the left is associated with a linear displacement to the left and lateral flexion to the right (Kapandji, 1974).

During flexion of the atlanto-axial joint (C1-C2), the lateral masses of the atlas rolls anteriorly on the superior surface of the axis while the interspace of the atlanto-odontoid joint opens out superiorly. In the same way, during extension, the lateral masses of the atlas rolls posteriorly and the interspace of the atlanto-odontoid joint opens out inferiorly. According to Kapandji (1974), with rotation to the left, the odontoid stays put while the osteoligamentous ring formed by the axis and the transverse ligament turns anticlockwise, relaxing the articular capsule on the left and stretching it on the right. During rotation from right to left, the right lateral mass of the atlas moves anteriorly while the left lateral mass recedes and vice versa.

2.1.9 Movement of the Lower Cervical Spine

During extension of the cervical spine, the vertebral body above tilts and slides posteriorly. The intervertebral space is compacted posteriorly, the nucleus pulposus is driven slightly anteriorly and the anterior fibers of the annulus fibrosus are taut. The interspace between the articular facets of the articular processes is widened anteriorly. The superior articular facet tilts and slides inferiorly and posteriorly on the inferior articular facet. Extension is restricted by the tension developed in the anterior longitudinal ligament and by the impact of the superior
articular process of the lower vertebra on the transverse process of the upper vertebra and by the impact of the posterior arches through the ligaments (Kapandji, 1974).

During flexion of the cervical spine, the vertebral body above tilts and slides anteriorly, compressing the intervertebral space anteriorly and driving the nucleus pulposus posteriorly and stretching the posterior fibers of the annulus fibrosus. The tilting of the vertebra above is assisted by the anterior ledge on the superior plateau of the vertebra below which allows the beak-like projection of the lower plateau of the vertebra above to move past. The inferior facet of the vertebra above moves superiorly and anteriorly and the interspace is widened out posteriorly. Flexion is restricted by tension developed in the posterior longitudinal ligament, the capsular ligament of the joint between the articular process, the ligamentum flava, the ligamentum nuchae and the posterior cervical ligament (Kapandji, 1974).

2.1.10 Movement of the Unco-vertebral Joint

The unco-vertebral joints or joints of Luschka have their cartilage-lined articular surfaces aiming medially and superiorly and matching to the cartilage-lined semilunar facets of the inferior plateau of the vertebra above with their facets aiming inferiorly and laterally. During flexion and extension of the cervical spine, while the body of the vertebra above slides anteriorly or posteriorly, the articular facets of the unco-vertebral joints also slide relative to each other, thereby guiding the vertebral body into this anteroposterior movement (Kapandji, 1974).

During lateral flexion of the cervical spine, the interspaces of the unco-vertebral joints widen out with lateral displacement of the nucleus pulposus and stretching of the capsule of the unco-vertebral joint. According to Kapandji (1974), pure lateral flexion does not occur but is always associated with rotation and extension.
2.1.11. Range of Motion of the Cervical Spine

According to Kapandji (1974) the range of motion of the cervical spine in flexion and extension for the whole cervical column is 130˚. Flexion and extension in the suboccipital column is 20˚-30˚. Flexion and extension in the lower cervical spine is 100˚-110˚. The total range of motion in lateral flexion is about 45˚ on either side, while rotation varies from 80˚-90˚ on either side.

2.1.12 Biomechanics of the IVD

The IVD is found between adjacent vertebrae which increase the range of motion between vertebrae. If there was no IVD, the two adjacent vertebrae will simply translate on each other, instead they are permitted to rock or tilt on each other due to the soft, deformable disc between them. The fibers of the annulus fibrosus behave as a ligamentous structure and act as restraints to motion, whereas the nucleus pulposus acts like a pivot, but unlike a ball, is able to undergo greater distortion because it behaves as a fluid (Levangie and Norkin, 2005).

2.2 Chronic Neck Pain

Chronic neck pain is one of the most common sources of musculoskeletal disability. According to Bovim, Schrader and Sand (1994), 34% of the general population experience neck pain at some time in their life, of which 14% have symptoms lasting longer than six months. Chronic neck pain is defined as pain and/or disability for more than 12 weeks (Nachemson and Jonsson, 2000). Neck pain may start as a result of injury or whiplash, and later, if no treatment is received, may become chronic. Pain that lasts longer than a few weeks is usually due to deeper problems such as injury to the disc or facet joint, or both. Jensen and Harms-Ringdahl (2007) state that many of the patients with recurrent pain episodes, can also be classified as having a chronic condition. Neck pain can come from many disorders and include cervical facet syndrome, neck sprain, neck strain, mechanical neck disorders, degenerative disc disease, whiplash injury and neck-and-shoulder pain (Jensen and Harms-Ringdahl, 2007).
2.2.1 Cervical Facet Syndrome

Cervical facet syndrome is defined as cervical facet or zygapophysial joint irritation or damage that may cause cranial, cervical or upper shoulder and back pain referral, and is often difficult to differentiate from other causes of neck pain (Carnes and Vizniak, 2010). According to Wyatt (2004), the so called “facet syndrome” originally described in 1933, has only recently been investigated as a source of neck pain. Research showed that this condition is more frequent than previously thought and a valid cause of chronic neck pain. Cervical facet syndrome implies the existence of axial pain in the neck, frequently with referred pain that is due to a secondary involvement of the facet joints of the cervical spine (Wyatt, 2004). Degenerative changes in the cervical spine as well as poor posture can lead to abnormal stress and strain, which increase the load on the facet joints and result in pain and inflammation. According to Wyatt, (2004) clinical features of cervical facet pain include tenderness to palpation over the facet joints or paraspinal muscles, pain with cervical extension or rotation, pain referring into the shoulders and arms, and lacking any neurological abnormalities.

2.2.2 Causes of Cervical Facet Syndrome

According to Carnes and Vizniak (2010), possible causes of cervical facet syndrome include:

1. Secondary to cervical injury
2. Cervical disc injuries
3. Whiplash
4. Cervical sprain or strain
5. Osteoarthritis
6. Rheumatoid arthritis
7. Repetitive stress
8. Poor posture
2.2.3 Signs and Symptoms of Cervical Facet Syndrome

A patient suffering from cervical facet syndrome complains of a dull aching pain in their neck with occasional headaches and decreased painful range of motion. The patient can pinpoint the precise location of pain as the pain is localized to a specific area. Patients may also suffer from torticollis or muscle spasm in the neck. The pain is increased when the neck is extended and rotated due to the approximation of the facet joints. The neck pain may sometimes radiate to the shoulder or mid back regions, although does not often radiate beyond the elbow or upper thoracic spine (Carnes and Vizniak, 2010).

![Cervical facet pain referral pattern](image)

**Figure 2.5: Cervical facet pain referral pattern (Carnes and Vizniak, 2010)**

2.2.4 Orthopaedic Tests for Cervical Facet Syndrome

Most of these special tests are made to produce or reproduce the patient's pain. Since the zygapophysial joint is under most stress while the head is extended and rotated, any of these movements will produce pain to the patient.
Maximum cervical compression test and Jackson's test are positive for local pain on the same side being tested (Magee, 2008). For maximum cervical compression test the examiner applies pressure straight down on the patient's head. Maximum cervical compression test is positive when the patient complains of local pain on one side of the neck. Jackson's test are performed with the patient's head laterally flexed to one side and the examiner then applying pressure straight down on the patient's head. This test is also positive when the patient complains of local pain on the same side being tested. According to Magee (2008), pain on the concave side indicates nerve root or facet joint pathology, whereas pain on the convex side indicates muscle strain.

2.3 Chiropractic Therapy

2.3.1 The Chiropractic Subluxation

The founder of chiropractic in 1895, D.D. Palmer hypothesized that a bone out of place in the spine (vertebral subluxation) resulted in nerve impingement, increased or decreased body tonus, and thereby disease (Leach, 1994). A chiropractic subluxation is defined as an alteration of alignment and movement of a motion segment, even though contact between the surfaces remains intact (Gatterman, 2004). The vertebral subluxation causes irritation to the spinal nerve root and also causes interference with normal nerve root function which results in pain, muscle spasm, loss of normal motion and other clinical symptoms and pathology (Haldeman, 2000).

According to the British Medical Association Illustrated Medical Dictionary (2008), a subluxation is defined as an incomplete dislocation of a joint, in which the surfaces of the bones remain in partial contact. To avoid confusion, chiropractors use the term dysfunction or segmental dysfunction. According to Plaugher (2003), segmental dysfunction implies that there are abnormal motion characteristics at the spinal motion segments.
2.3.2 The Vertebral Subluxation Complex (VSC)

According to Leach (1994), the VSC is a theoretical model of motion segment dysfunction that incorporates the complex interaction of pathological changes in nerve, muscle, ligamentous, vascular and connective tissue. Later the VSC model included the role of inflammation to a motion segment. The VSC was originally developed by Faye and Lantz and included the three phase model of spinal degeneration and dysfunction. The three phase model includes segmental dysfunction (phase 1), instability (phase 2) and stabilization (phase 3). Leach (1994) proposed that segmental dysfunction, for example, as a result of chronic poor posture at work (muscle fatigue-induced inflammation), might lead directly to stabilization (e.g. degenerative joint disease) without any known history of trauma-induced instability.

The VSC model consists of the interaction between kinesiopathology, neuropathology, myopathology, histopathology, connective tissue, vascular, inflammatory and biochemical changes within the VSC. All of these components of the VSC function together to restore proper motion at a spinal motion segment.

A spinal motion segment is a functional unit which includes the articular surfaces of two adjacent vertebrae and the connecting tissues which bind them together (Gatterman, 2005). According to Leach (1994), the two adjacent vertebrae are joined by an IVD, two posterior articulations, a number of ligaments and a joint capsule.

a) Kinesiopathology

The spine is an integral unit, where restriction of movement at one level may lead to compensatory changes in other areas and levels of the spine. As a result, no single component of a motion segment can exists without affecting the function of other levels of the spine. A motion segment is the basic functional unit of a spinal segment and is a three-joint complex. This three-joint complex consists of the IVD and two posterior articulations with their
capsules and ligaments. According to Leach (1994), joint movement is therefore complicated and the role of ligamentous, capsular and muscular systems should be noted. Gatterman (2005) suggests that gross range of motion must also be considered and not just intersegmental movement.

Restricted movement of a motion segment is called a hypomobile joint and is used by all chiropractors in their terminology to describe a restricted joint. All conditions that lead to decreased movement and immobilisation of a joint eventually cause degenerative changes which result in pain and stiffness, followed by more degeneration of the joint and ultimately fusion by ankylosis (Gatterman, 2005).

b) Neuropathology

The cornerstone of Chiropractic theory is the neurological component of the VSC. It was D.D. Palmer's most important hypothesis: a bone out of place in the spine could press on a spinal nerve and thereby increase or decrease its flow of nerve energy (Leach, 1994). The most important feature for patients who seek chiropractic care is pain.

The integral component of each vertebral joint is the segmental nerve. According to Gillete, Kramis and Roberts (1991), subluxations or segmental dysfunctions are speculated to structurally alter the size of the intervertebral foramen (IVF) thus compressing the neurovascular structures within the IVF, and so impair the function of the nerve root. The spinal nerves are also affected by degenerative changes of the spinal articulations. According to Leach (1994), herniated discs, hypertrophy of the zygapophysial joints, spurs and osteophytes around the joints of Luschka may impinge on segmental nerve roots, leading to pain. Primary indicators of neurological function are muscle strength, reflexes, altered sensations and pain responses (Lantz, 1995).
c) Myopathology

Chiropractors mainly treat neuro-musculoskeletal conditions. Muscles are therefore required to move bones and keep the spinal column and other joints in full range of motion. When the joints are unable to move, the muscles associated with the joints undergo degenerative changes which results in muscle atrophy. The development of osteoarthritis may start with muscle spasm which leads to excessive degeneration of cartilage by compressing the joint surfaces together. It is therefore important to keep the joints in full range of motion, as immobilizing the joints can become a vicious cycle of muscle spasm which results in joint contracture, which further leads to muscle spasm.

Other changes in muscle affected by immobilization include shortening, thickening and degeneration of primary muscle spindles endings. An increased sensitivity to stretch and elevation of the resting rate of discharge is some of the physiological changes that occur. Muscle spasm and tender, painful trigger points are the result of over-stimulation of the muscle groups. According to Leach (1994), the changes in muscle function are occasionally completely reversible, but the time required for complete restoration is dependent on the period of immobilization.

d) Connective tissue pathology

When the joint is immobilized all the connective tissue elements are affected and can also be termed as histopathological changes. According to Gatterman (2005), these minuscule changes occur when spinal muscles, zygapophysial joints and intervertebral discs undergo tissue degeneration.

Connective tissues are internal tissues with many important functions which include: establishing a structural framework, transporting fluids and dissolved materials, protecting delicate organs, supporting, surrounding and defending the body from microorganisms.
(Martini, 2006). All connective tissues contain specialized cells and a matrix, composed of extracellular protein fibers and a ground substance (Martini, 2006). When the joint is immobilized, the articular cartilage shrinks due to the loss of proteoglycans and cell re-organization causes the cartilage to form adhesions. The synovial tissue undergoes fibrous fatty consolidation which results in the formation of a fibrous tissue matrix for the deposition of bone salts (Gatterman, 2005). According to Leach (1994), within four weeks of spinal immobilization, the zygapophysial joints underwent histopathological changes which included osteophyte formation and degenerative changes on the articular surfaces.

e) Vascular pathology

Just like a spinal nerve root is susceptible to degenerative changes and joint dysfunction, so is a segmental artery which passes through the intervertebral canal and into the spinal canal. Here the segmental artery divides into two radicular arteries, the dorsal and ventral arteries (Lantz, 1995). Leach (1994) suggests that compression of the segmental arteries within the IVF will affect the vascular component before it directly affects the neurological structures. According to Peterson and Bergmann (2002), due to joint immobilisation, these arteries become occluded and the lack of venous drainage is thought to lead to increased capillary pressure, decreased arterial blood flow and the production of local ischaemia, inflammation and potential associated joint stiffness.

Venous drainage is depended on movement and the forces of gravity. With immobilisation there is no removal of toxins which causes inflammation and eventually leads to degenerative processes.

f) Inflammatory response

The most clinical presentation of inflammation is pain. Inflammation is linked with the immune system as well as the vascular system and is composed of cellular and biochemical
processes. Inflammation is also linked to wound healing after acute injury or trauma. Chronic inflammation can occur from the outset; as in arthritic problems and injuries to the avascular skeletal structures, such as the IVD, and in problems related to immobilisation (Leach, 1994). The inflammatory response is initiated by local cell events within the tissue themselves. Immobilisation of the zygapophysial joints result in an inflammatory response in which the end stage is ossification of the joints. The restoration of motion leads to a decrease in the degenerative process (Lantz, 1995).

According to Bergmann and Peterson (2002), pain that accompanies inflammation may initiate a local reflex muscle contraction, which over time, may lead to ischaemia and therefore more pain. According to Lantz (1995), inflammation is usually well regulated, but if there is marked oedema with an accumulation of primary neutrophils and leukocytes, it may lead to scar formation.

Nerves that are inflamed become hyper-excitible and reveal different behaviour from normal nerves. The dorsal root ganglion of normal nerves reacts to mechanical stimulation by the release of an action potential. The action potential ceases when the mechanical stimulus is terminated. However, when the dorsal root ganglion is inflamed, the action potential keeps firing even after the mechanical stimulus has been removed. According to Lantz (1995), this constant firing of action potentials may result in an increase in muscle tone, as the nerves remain exposed to inflammatory by-products and remain in a hyper-excited state.

2.3.3 Chiropractic Spinal Manipulative Therapy (SMT)

Chiropractors all over the world use spinal manipulative therapy (SMT) to treat patients who suffer from neck pain and/or lower back pain. According to Peterson and Bergmann (2007) SMT is perceived as the foundation of chiropractic practice and the most specialized and significant therapy used by chiropractors. The chiropractic profession has remained dedicated to the use of manipulative therapy, specifically spinal adjustment, throughout its development over the past 100 years or more, and it has been estimated that currently there are
somewhere in the region of 300 discrete chiropractic techniques employed by the profession worldwide (Byfield, 2005). SMT is used to restore normal articular alignment and function of the zygapophysial joints.

According to Leach (1994), SMT forces the joint surfaces beyond the initial barrier of resistance until it reaches the safe anatomical space of joint play. Joint play is described as the passive motion, elasticity or give in a joint, found at the end range of the passive range of motion (Kirk, Lawrence and Valvo, 1991). Chiropractors localise a dysfunctional segment by the alteration in joint play. The three-joint complex passes through the normal physiological range of movement into the paraphysiological space without exceeding the normal limit of anatomical integrity, thereby removing impingements and restoring the joint to normal function (Gatterman, 2005). SMT is commonly associated with an audible articular crack (cavitation).

According to Kirk, Lawrence and Valvo (1991), cavitation is defined as a process whereby the elastic barrier is passed resulting in a sudden increase in joint separation, a radiolucent cavity in the joint space, and a cracking sound.

According to Hertzog (2000) SMT techniques include controlled forceful thrusts and are applied by hand, and various patient positions and hand placements maximise leverage and the direction of force. The chiropractor motion palpates a facet joint which is hypo-mobile or restricted and then uses SMT to adjust the spinal segment to improve function. According to Rochester (2009) manipulation of the cervical spine involves a specific spinal segmental contact, passive lateral flexion and rotation of the head and neck to the point of increased joint tension followed by a high velocity, low amplitude thrust.

Rochester (2009) also found that recent systematic reviews have shown that there is moderate to high quality evidence that high velocity, low amplitude thrust is better than placebo (no treatment) for chronic neck pain, better for general medical care and about the same for rehabilitation. According to Esposito and Philipson (2005), chiropractors use SMT to decrease pain and increase cervical spine range of motion.
2.3.4 The Effects of Spinal Manipulative Therapy

According to Gatterman (2005), the aim of chiropractic adjustments is to remove the subluxation or fixation in a joint and to restore it to normal function with full range of motion. The adjustment opens a joint to increase space or stretch the tissue that causes a decrease in range of movement, therefore providing a local mechanical, neurological and vascular effect (Esposito and Philipson, 2005).

a) Mechanical effects

Chiropractic adjustments cause changes in the zygapophysial joint alignment and dysfunctional joint movement (Gatterman, 2005). The mechanical force of an adjustment is delivered to dysfunctional joints to change the biomechanics of that specific joint. According to Kirkaldy-Willis (1992), the mechanical force applied causes the breakdown of contractile and collagen adhesions in the soft tissues which result in an increased available active and passive range of motion. Each motion segment can buckle, that is when the motion segment concerned, is structurally completely normal, but the motion itself will alter the behaviour of other motion segments within the spine during spinal loading (Gatterman, 2005). This buckling will result in large vertebral motions which achieve a new position of stable equilibrium (Pickar, 2002). According to Gatterman (2005), the system of joints undergo undesirable deformation and can irritate the adjacent tissues and lead to motion changes. An inflammatory response is triggered in spite of the mechanism of injury (Howe, 1970).

Chiropractic adjustments are aimed at restoring a buckled segment and minimizing the extent of associated inflammatory exudates, and decreasing the mechanical stress or strain on soft and hard paraspinal tissues (Fitz-Ritson, 1990). According to Plaugher (1993), chiropractic adjustments cannot reverse the damage sustained to the zygapophysial joint, but it has a long-lasting effect against pain and joint dysfunction.
Chiropractic adjustments cause biomechanical change which may be caused by the effects on the inflow of sensory information to the central nervous system. Pickar (2002) suggests that as a chiropractic adjustment releases trapped meniscoids or discal material and normalizing a buckled joint segment, the mechanical input may decrease the nociceptive input from the nerve endings in the innervated paraspinal tissues or joint capsules.

b) Soft tissue effects

During a chiropractic adjustment, the sensory receptors in muscle, ligaments, facet joints, paraspinal skin, the meninges and outer fibers of the IVD which are richly innervated are all responsive to direct mechanical forces. Stimulation of these receptors triggers central reflex pathways and somato-somatic reflexes resulting in muscle relaxation and increased range of motion. Haldeman (2000) believes that chiropractic adjustments have a direct effect on the structures which surround the spine.

According to Pickar (2002) joint dysfunction may alter the signaling properties of mechanically or chemically sensitive neurons which may result in pain, muscle spasm and alteration of visceromotor activities. Chiropractic adjustments may increase movement in dehydrated tissues and promote the imbibition of fluid (Gatterman, 2005).

Gatterman (2005) believes that chiropractic adjustments decrease the hypertonicity of muscles by changing the tone and strength, causing spindle reflexes and stretching of the segmental muscles. According to Plaugher (1993) SMT breaks up adhesions which could account for the instantaneous changes that occur in intersegmental motion once a chiropractic adjustment is delivered.
c) Neurological effects

Chiropractic adjustments stimulate the mechanoreceptors associated with synovial joints and repair their normal function. The mechanical force used during an adjustment is below the mechanical threshold of the mechanoreceptors which suggests that the receptor nerve endings are affected by chiropractic adjustments (Gatterman, 2005). The perception of pain is the result of type IV nociceptors becoming active and types I, II and III mechanoreceptors becoming inactive due to joint dysfunction. According to Gatterman (2005) a chiropractic adjustment will restore joint motion and will result in normal functioning of the type I, II and III mechanoreceptors, while the type IV nociceptors will be inhibited.

Leach (1994) believes that the biomechanical changes caused as a result of a chiropractic adjustment affects the nervous system's neural activity by removing the aberrant sensory input or providing new input through the adjustment. This results in a reflex inhibition of pain and reflex muscle relaxation, thus leading to increased mobility (Cassidy, Lopes & Yong-Hing, 1992). According to Haldeman (2000), this is the leading theory with regards to the effect that chiropractic adjustments have on altered joint function.

The amplitude of cortical somatosensory responses in the cerebrum can be decreased following a high velocity thrust to dysfunctional joints. After a chiropractic adjustment, the somatosensory changes in the CNS can persist for twenty to thirty minutes. The precise mechanism remains unclear with regards to these changes. In the cortical loop, which links the basal ganglia, thalamus, pre-motor areas and the primary motor complex, the greatest amplitude change was noted. Chiropractic adjustments therefore change the transmission of neural signals at a spinal level as well as at a cortical level. According to Haavik-Taylor and Murphy (2007), the decrease in the amplitude of the cortical somatosensory responses following a chiropractic adjustment, reflects a normalization of afferent input and may be a mechanism for the improvement of functional ability.
According to Peterson and Bergmann (2002), chiropractic adjustment delivered to mechanically dysfunctional joints may normalize articular afferent input to the nervous system, re-establish a normal kinaesthetic reflex and normalize nociceptive thresholds, as well as decrease pain.

d) Clinical effects

According to Kirk, Lawrence and Valvo (1991), the following clinical effects of a spinal adjustment occur:

1. Increase in the active and passive range of motion via restoration of the normal axis of rotation
2. Reduction of pain
3. Increase in skin pain tolerance level
4. Increase in paraspinal muscle pressure pain tolerance
5. Reduce muscle electrical activity and tension
6. Consistent, reliable reflex responses in muscles in the spine and limbs
7. Release of entrapped meniscoid, hyperplastic synovial tissue or synovial folds
8. Breaking of contractile adhesions and collagen adhesions in the local soft tissue and supporting structures
9. Effects upon the IVD either in the form of intradiscal block or generalised effects on the process of disc protrusion
10. Various autonomic responses including vasomotor changes, sudomotor activity, and changes in visceral regulation control
2.4 Cervical Traction

2.4.1 Introduction

Gatterman (1990) defines cervical traction as the application of a drawing or a pulling force along the long axis of the spine in order to stretch the soft tissues, separate joint surfaces, and to separate bony fragments. Traction is one of the oldest methods of therapy known and has been employed in a variety of forms to relieve pain and discomfort since ancient times (Hooper, 1996). Traction has remained a form of therapy and today many chiropractors are still using traction in their treatment protocol. Aker, Gross, Goldsmith and Pekoso (1996) believe that cervical traction is accepted as standard forms of practice in the treatment of neck pain.

Cervical traction causes stretching of the neck muscles which promotes relaxation, increases the intervertebral foraminal diameters and separates the zygapophysial facet joints. Traction relieves any nerve root compression which may cause symptoms such as pain and paraesthesia down the one side of the arm (Jellad, Salah, Boudokhane, Migaou and Rejebl, 2006). Sari, Akarirmak, Karacan and Akman (2003) performed a study on the effects of cervical traction on spinal structures by Computerized Tomography and found regression of herniated disc area, increase in spinal canal area (11.21mm²), spinal column elongation between C2-C7 (1.39mm), and intervertebral discal space widening. Moeti and Marchetti (2001) did a case series on the clinical outcome from intermittent cervical traction for the treatment of cervical radiculopathy, and found more than half the cases demonstrated complete pain resolution.

Many studies have shown that cervical traction prove to decrease pain and increase function in the treatment of chronic neck pain, however the type of cervical traction used as part of a chiropractic treatment protocol is not yet established and therefore the need for this particular study.
2.4.2 Types of Cervical Traction

There are several types of cervical traction. Continuous traction is generally used to align and stabilize adjacent body parts when there are fractures and/or dislocations and not typically used by chiropractors, whereas sustained (static) traction is used for a much shorter period of time, from only a few minutes to 30 minutes. According to Hooper (1996), sustained traction is most helpful in the early phases of treatment when there is significant guarding and muscle spasm present and as the patient’s condition improves, intermittent traction may prove to be more helpful.

The most common type of traction used is intermittent traction where a traction force is applied for a few seconds and then released. It is most often used for joint dysfunction and degenerative disc disease, and can also be used for disc protrusions (Hooper, 1996).

2.4.3 Techniques for Cervical Traction

In this particular study, manual traction and mechanical traction are used. As the name implies, manual traction involves the therapist to manually apply cervical traction force with his/her hands to the patient’s neck. The therapist leans backwards to provide a sufficient traction force. This manual type of cervical traction is done for 8-10 seconds, and is repeated 3-4 times in a treatment session. The therapist may also use a towel to cup under the patient’s occiput and provide the traction force in that manner.

Another type of cervical traction is mechanical traction. Hereby, a traction device is used to apply traction to the neck instead of the therapist’s hands. A Saunders Cervical HomeTrac® traction unit is used in this particular study. Bregmann and Davis (1998) mentioned two of the cervical traction devices available that use a pneumatic traction mechanism to create the desired traction. These are the Pneu-Trac and the Pronex. The Pneu-Trac unit can be worn by patients while ambulatory. The Pneu-Trac consists of a stiff collar that is fastened with
Velcro closures, and uses a hand bulb to inflate the device. As the bladder is inflated, the collar is raised to the chin and base of the occiput creating the desired traction.

2.4.4 Effective Position for Cervical Traction

Other traction techniques used include inverted traction, supine or seated traction. Guvenol, Tuzun, Peker and Goktay (2000) compared inverted spinal traction and conventional traction in the treatment of lumbar disc herniations and found both methods of traction to be clinically effective although Computed Tomography findings of the conventional traction group showed more improved parameters. Fater and Kernozek (2008) did a study to compare vertebral separation in the supine and seated positions using home traction units, and found supine vertebral traction to be more effective for increasing posterior vertebral separation. Therefore, in this study conventional traction was used in the supine position.

2.4.5 Proper Force Used for Cervical Traction

It is important to note the correct amount of force while applying traction to the cervical spine as too much traction force will cause disruption of the intervertebral disc, zygapophysial joints, and surrounding structures. Akinbo, Noronha, Okanlawon and Danesi (2006) studied the effects of different cervical traction weights on neck pain and mobility and found that 10% of total body weight cervical traction to be the ideal weight with minimal side effects and with highest therapeutic efficacy.

According to Hooper (1996), for the safe and effective application of traction to the cervical spine, it is suggested that the therapist begin with a traction force of between 10 and 15 pounds (4.5kg – 6.8kg) and if the patient improves, continue at the same poundage or increase poundage by 5 pound increments to a maximum of 45 pounds (20.4kg). Saunders (1983) performed a study on the use of spinal traction in the treatment of neck conditions and found that weights of 11kg - 20kg were necessary to demonstrate a measurable change in the posterior cervical spine structures.
2.4.6 Angle for Cervical Traction

Cervical traction is applied with the patient in a supine position. The position of the cervical spine will have a direct effect on the location of the traction effect, that is to say if the head is maintained in a flexed, forward-bent position, the traction will exert its maximal effect on the posterior structures of the cervical spine, such as the zygapophysial facet articulations and the intervertebral foramen (Hooper, 1996). It is recommended that an angle of 0 to 15 degrees be used for the upper cervical spine and the angle should be increased by 5 degree increments for each progressively lower cervical segment (Hooper, 1996).

2.4.7 Indications for Cervical Traction

According to Hooper (1996), indications for cervical traction include:

1. Herniated nucleus pulposus with disc protrusion
2. Degenerative disc or joint disease
3. Cervical facet joint dysfunction
4. Muscle stiffness or hypomobility

2.4.8 Contraindications and Precautions for Cervical Traction

Cervical traction is usually not the only therapy used. The examiner should note any changes in the patient's condition and therefore it is important to keep in mind that if the patient's symptoms increase, therapy should be suspended. To minimize any potential injury resulting from inappropriate use of cervical traction (e.g. improper patient position), traction should be initiated gently, with progressively increasing force and time as the patient condition warrants (Hooper, 1996). After the application of cervical traction, the patient must remain supine for a short while before resuming daily activities to sustain the pain relief effect received from cervical traction.
Contra-indications to cervical spine traction: (Wyatt, 2005)

- Spinal cord injuries or compression
- Cervical spine fractures
- Any Malignancies
- Acute inflammation in the cervical spine
- Ruptured ligaments
- Severe Rheumatoid arthritis
- Hypermobility
- Osteoporosis, osteomyelitis
- TMJ pathologies, as manual cervical traction require pressing against the chin
- Abnormal dental occlusions

2.4.9 Effects of Cervical Traction

According to Saunders (1989) cervical traction causes the following effects:

1. Distraction or separation of the vertebral bodies
2. A combination of distraction and gliding of the facet joints
3. Tensing of the ligamentous structures of the spinal segment
4. Widening of the intervertebral foramen
5. Straightening of spinal curves
6. Stretching of the spinal musculature

2.4.10 Advantages and Disadvantages of Cervical Traction

a) Manual cervical traction

There are many advantages to manual cervical traction. Firstly, manual cervical traction requires a short period of time which is beneficial to the patient who comes for treatment and might want to get back to work or home as soon as possible as well as beneficial to the
chiropractor who needs to treat the next patient. Secondly, manual cervical traction is also very comfortable for the patient as there is no tight strapping around the head, which may cause the patient to feel claustrophobic. On the other hand, a disadvantage to manual cervical traction is that it may cause pain to the chiropractor’s hand performing the manual type of cervical traction. Another disadvantage include that the patient may experience some pain or discomfort to the chin while the chiropractor grab onto the patient’s chin to perform the traction technique. The angle and force used is also just an estimate and cannot be carefully monitored.

b) Mechanical cervical traction

The advantage of mechanical cervical traction is that the traction is not performed by the chiropractor, so therefore in a busy clinical setting, while the patient is receiving mechanical cervical traction, the chiropractor can treat the next patient in the meantime. Furthermore, the angle of traction always stays constant and the force of traction can be carefully controlled and even recorded. On the other hand, disadvantages include that mechanical cervical traction requires a lot more time and causes treatment sessions to be long. Also, the patient may experience discomfort as a strap is fastened around the forehead. This may also cause the patient to feel claustrophobic.

2.5 Conclusion

Chronic neck pain affects a patient’s daily activities as well as work ability. Chronic neck pain also causes decrease range of motion. Many patients seek chiropractic treatment for this ongoing pain every day. Chiropractic SMT may increase range of motion and decrease chronic neck pain. Cervical traction is part of a chiropractor’s treatment protocol where adjusting together with cervical traction may improve chronic neck pain in the long run thereby improving the patient’s overall heath being. It is also in the chiropractor’s interest to note whether manual cervical traction or mechanical cervical traction may prove to be the best traction technique used to include in the chiropractic treatment protocol.
The next chapter will discuss and describe the methodology used in this study.
CHAPTER THREE - METHODOLOGY

3.1 Introduction

This chapter serves to describe the details of the study and the procedures involved.

3.2 Study Design

This was a randomized comparative study. In this study two groups were compared to each other. The participants were randomly selected to partake in either one of the groups.

3.3 Participant Recruitment

Advertisements (Appendix A) were placed in local newspapers, as well as placed on notice boards around the University of Johannesburg, Doornfontein campus and the Chiropractic Day Clinic. Anyone who suffered from chronic neck pain and were between the ages of 18 and 45 were considered eligible for this study. Participants were also recruited via word of mouth.

3.4 Sample Selection and Size

The first thirty participants that reported to the Chiropractic clinic and who were eligible for this study were randomly assigned to the two groups. Both groups received cervical spinal manipulation to the restricted segments before traction was performed. Group 1 received manual cervical traction, while Group 2 received mechanical cervical traction after the cervical manipulation.
3.4.1 Inclusion Criteria

- Participants could have been between the ages of 18 and 45 years of age
- Participants could have been male or female
- Participants must have suffered from chronic neck pain. Chronic neck pain is defined as having pain and/or disability of more than 12 weeks duration (Nachemson & Jonsson, 2000)

3.4.2 Exclusion Criteria

- Participants who presented with any contra-indications to cervical spine traction (Appendix B), (Wyatt, 2005)
- Participants who presented with any contra-indications to spinal manipulative therapy (Appendix C), (Esposito & Philipson, 2005)
- Participants who had been involved in other studies which could have interfered with the results of this study
- Participants who had been on muscle relaxants, pain medication or anti-inflammatory medication during the course of the study
- Participants who had neck pain of non musculoskeletal origin

3.5 Group Randomisation

Participants who qualified for this study were randomly divided into two groups of fifteen participants each. There were fifteen envelopes with a note that said “Group 1” and another fifteen envelopes with a note that said “Group 2”. The envelopes were shuffled and then placed in a box. Each participant picked one envelope to see which group they were assigned to. Group 1 received manual cervical traction and Group 2 received mechanical cervical traction.
3.6 Treatment Approach

Participants were required to partake in seven trial sessions consisting of six treatment sessions and one final measurement session, over a period of two weeks.

3.6.1 First Visit

- The researcher completed a full case history (Appendix I), physical examination (Appendix J) and cervical spine regional examination (Appendix K)
- Participants who were eligible for this study were asked to complete and sign the information and consent form (Appendix D), as well as to select an envelope. Participants were asked to complete the Vernon-Mior Neck Disability Index (Appendix E) and the Numerical Pain rating Scale (NPRS) (Appendix F)
- The researcher took measurements (Appendix G) using the Cervical Range of Motion (CROM) instrument before treatment
- Both groups received spinal manipulative therapy by the researcher to any restrictions found using motion palpation to the cervical spine
- Group 1 received manual cervical traction and Group 2 received mechanical cervical traction

3.6.2 Follow-up Visits

- Participants were reassessed and asked to complete the Vernon-Mior Neck Disability Index and NPRS. The researcher completed CROM measurements prior to treatment on the 4th consultation. These measurements were repeated at the one month follow-up where no treatment took place. Measurements were therefore recorded on the 1st, 4th and 7th visit
- Each group received spinal manipulative therapy to all restrictions found in the cervical spine
• Group 1 received manual cervical traction and Group 2 received mechanical cervical traction as described in the first visit

3.6.3 Cervical Spine Assessment

Cervical distraction test is positive when pain is relieved. To perform this test, the examiner places one hand under the patient’s chin and the other hand around the occiput, and then slowly lifts the patient’s head, applying traction to the cervical spine (Magee, 2008). A positive test indicates that pressure on the nerve roots and facet joints have been relieved.

For this particular study, a positive Kemp’s test needs to be elicited. Kemp’s test is used to produce local pain on the side being affected. The examiner stands behind the seated patient and places their left hand on top of the patient’s head to control the movement of the head, while the examiner’s right thumb is placed on the patient’s left cervical facet joint. The examiner then moves the patient’s head into left lateral flexion, rotation and extension while palpating each joint. Kemp’s test is positive when the patient complains of local pain on the same side of lateral flexion, rotation and extension. The intervertebral foramina are also maximally compressed during this test. During the examination, no neurological deficits should be present during myotome, dermatome and reflex testing (Carnes and Vizniak, 2010).

a) Motion palpation of the cervical spine

According to Esposito and Philipson (2005) assessment of the cervical spine is done by motion palpation and remains the cornerstone of chiropractic. Motion palpation was used to locate joint dysfunction at a specific segment in the cervical spine. The researcher used his/her hands to feel joint play in the participant’s cervical spine. Joint play is described as the passive motion, elasticity or give in a joint, found at the end of the passive range of motion (Kirk, Lawrence & Valvo, 1991). A subluxated joint or dysfunctional joint has lost the elasticity or give and appear stiff or hard. According to Esposito and Philipson (2005), motion palpation
is a reliable tool used by chiropractors when evaluating individual motion segments. The researcher used motion palpation to find any restriction in movement of the cervical spine that may have occurred to the participants during this study.

Motion palpation was performed with the participant lying in a supine position on the chiropractic bed. The researcher was standing at the head of the table facing caudad. Motion palpation was concentrated on C0 – C7 in the cervical spine. The contact was an index finger contact to the articular processes of the level to be examined. The indifferent hand was used to passively move the participant's neck in a specific range of motion. Any restrictions found, was recorded on the cervical spine regional examination sheet.

b) Spinal manipulative therapy of the cervical spine

To date, there is substantial clinical evidence from a number of quality clinical studies that supports chiropractic cervical manipulation as safe and effective and suggests that it is an appropriate intervention for a variety of neck pain (Byfield, 2005). Each participant in Group 1 and in Group 2 received spinal manipulative therapy or a chiropractic adjustment to the restricted motion segment. Participants were adjusted in a supine position with an index contact delivered as a high velocity, low amplitude thrust.

A rotary cervical index technique was used to adjust restrictions in the cervical spine. An indication for this technique is rotation restrictions of C1-C7 as determined by motion palpation of the joints.

The participant was lying supine on the chiropractic bed with their head on a pillow for maximum comfort. The researcher was in a squatting position at the side of the involved restriction. An index contact was placed on the articular process after skin slack was removed. The researcher's contact was firm, hand relaxed and wrist was straight. The thumb of the contact hand was placed on the participant's chin for stability. The indifferent hand of the researcher took a split sternocleidomastoid muscle contact with the rest of the fingers hooking
around the rim of the occiput. The participant’s head was rotated and then laterally flexed over the index contact until tension was felt. A high velocity, low amplitude thrust was given in a rotary fashion.

3.6.4 Treatments

- All participants received spinal manipulative therapy as well as cervical traction, depending on which group they were in, three times a week over a two week period
- Participants in Group 1 received manual cervical traction
- Participants in Group 2 received mechanical cervical traction

3.6.5 Manual Cervical Traction Technique

After assessment of the cervical spine and upon completion of the questionnaires, each participant received spinal manipulative therapy to the restricted segments followed by manual cervical traction. The participant lied supine on the chiropractic bed. The researcher stood at the head of the table facing caudal, and cupped the participant’s occiput with one hand, while the other hand was placed under the participant’s chin. A manual traction force was applied to the participant’s neck by leaning backwards for 10 seconds. The traction force was released and then applied again by leaning backwards. This was repeated 4 times.

3.6.6 Mechanical Cervical Traction Technique

A Saunders Cervical HomeTrac® traction unit was used on the cervical spine. The participant lied supine on the chiropractic bed. The participant’s head was placed on the unit and a strap was placed over the head to fit comfortably. All the controls were set to zero and the pump was in the release position. Pumping the handle in and out provided increased pressure which resulted in increased stretch of the neck area. The pressure was increased until the patient indicated that they felt a stretch but was still comfortable, this was at about 10% of the patients’ body weight (Chiu, Kim-Fai Ng, Walther-Zhang, Lin, Ortelli and Chua 2011). The
traction was held in the hold position for 10 minutes. After 10 minutes, the handle was rotated to the release position.

3.7 Subjective Data

3.7.1 Vernon-Mior Neck Disability Index

According to Magee (2008), Vernon and Mior have developed a numerical scoring functional test called the neck disability index, which is a modification of the Oswestry low back pain index. The Neck Disability Index indicated to the researcher how severely the patient's daily activities were affected. There were ten questions which were rated on a score from 0-5. A total score of 50 could be obtained, while multiplying by two would give a percentage of how severe the patient's neck pain was affecting their daily activities. According to MacDermid, Walton, Avery, Blanchard, Etruw and McAlpine (2009) many studies have been done which confirm the high level of reliability and validity supporting the Vernon-Mior Neck Disability Index. The Neck Disability Index had become a standard instrument used by researchers for measuring self rated disability due to chronic neck pain.

3.7.2 Numerical Pain Rating Scale (NPRS)

The NPRS was a scale between 0 and 10. Participants were asked to rate their current pain on this scale. A score of zero indicated no pain, whereas a score of 10 indicated the worst pain they have ever experienced. This scale gave the researcher an indication of how severe the patient's pain was at that current moment. This questionnaire was completed before treatment on the first, fourth and seventh visits. Participants were not told about their scores from previously completed questionnaires. These pain scale scores were compared to the previous measurements. Jensen, Turner, Romano and Fisher (1999) stated that individual 0-10 pain intensity ratings have sufficient psychometric strengths used in chronic pain research.
3.8 Objective Data

3.8.1 Cervical Range of Motion Instrument (CROM)

The objective data of this study measured the cervical spine range of motion using a Cervical Range of Motion (CROM) instrument. The CROM instrument was shown to be accurate and easily used when two studies compared its validity and reliability compared to standard inclinometer measurements on cervical range of motion (Tousignant, de Bellefeuille, O'Donoughue and Grahovac, 2000; Tousignant, Duclos, Lafleche, Mayer, Tousignant-Lafamme, Brosseau and O'Sullivan, 2002). According to Allison, Lepley, Ellingham and Pohtilla (1988), the CROM instrument was a device that was fitted to the head of the patient and allowed the researcher to accurately and quantitatively determine the degree of range of motion of the cervical spine with movements in flexion, extension, left and right lateral flexion and left and right rotation. The range of motion measured in degrees, was recorded in a table and compared over the duration of the study.

Participants sat straight up on the chiropractic bed with their head in neutral position. The CROM instrument was fitted onto their head and the dial was checked to be set on zero degrees. Movements of flexion and extension of the head was in the sagittal plane. Participants were asked to move their head forward toward their chest as far as they can and the degree was recorded. Participants were then asked to move their head backwards from the neutral position to look up towards the ceiling as far as they can and the degree was recorded. Movements of left and right rotation of the head were in the transverse plane. Participants were asked to look left and then to look right starting from neutral position while the degree of rotation was recorded. Movements of left and right lateral flexion of the head were in the coronal plane. Participants were asked to tilt their head towards the left and then towards the right starting from neutral position while the degree of lateral flexion was recorded. Measurements were taken at the end range of movement and recorded. None of the participants were ever shown their results from previous measurements.
3.9 Data Analysis

The subjective measurements and the objective measurements were collected (Appendix H) over the duration of the study by the researcher. The data was analyzed by STATCON, a University Department assisting with data analysis.

An exploratory data analysis was conducted to determine equal variances between the two groups. When the two groups showed equal variances, an inter-group (between groups) analysis was conducted using a Man-Whitney U-Test.

An intra-group (within groups) analysis was also conducted where a Friedman Test was used. The Friedman Test was done to determine any changes within the two groups over the time period of the study. Changes were detected and the non-parametric Wilcoxon signed ranks Test determined where the changes occurred over time.

3.10 Ethical Considerations

All participants that wished to partake in this particular study were requested to read and sign the information and consent form (Appendix D) 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 be explained and that the participants safety was ensured (prevention of harm). The information and consent form explained that the participant's privacy was protected by ensuring their anonymity and confidentiality when compiling the research dissertation. The participants were informed that their participation was on a voluntary basis and that they were free to withdraw from the study at any stage without prejudice. Should the participant have had any further questions, these would have been explained by the researcher; contact details were made available. The participants were then required to sign the information and consent form, signifying that they
understand all that was required of them for this particular study. Results of the study would be made available on request to participants.

With regards to this particular study, risks included post-manipulation pain, aggravation of symptoms due to the traction of posterior neck musculature, with pain and increased stiffness. There was also a risk of over distraction. However, only 10% of total body weight cervical traction was used, thereby limiting the risks. Benefits of this study included pain relief, increased range of motion of the cervical spine and improvement of function. Pressure in the neck region where the researcher grasped the neck for manual cervical traction or where the mechanical cervical traction unit was placed may have later resulted in discomfort.

Participants would have been referred if necessary, however the need did not arise.
CHAPTER FOUR - RESULTS

4.1 Introduction

The findings obtained from the study are presented in this chapter. The sample group consisted of thirty participants divided into Group 1 and Group 2. Group 1 consisted of fifteen participants treated with Manual cervical traction and Group 2 consisted of fifteen participants treated with Mechanical cervical traction. Due to the small sample size of this study, no assumptions can be made with respect to the population as a whole.

The p-value for the tests was set at 0.05 and represented the level of significance of the results. If the p-value was less than or equal to 0.05 ($p \leq 0.05$), there was a statistically significant finding. If the p-value was greater than 0.05 ($p > 0.05$), there was no statistically significant finding. If results were statistically significant, it was unlikely that the findings occurred by chance.

The analyses included:

1. Demographic data analysis consisting of the gender and age of the participants.
2. Subjective measurements consisting of the Numerical Pain Rating Scale and the Neck Disability Index.
3. Objective measurements consisting of the Cervical Range of Motion instrument (CROM) including measurements in flexion, extension, left and right lateral flexion and left and right rotation.

4.2 Demographic Data Analysis

The population consisted of sixteen male and fourteen female participants (n=30). Group 1 consisted of fifteen participants (n=15); 8 males and 7 females. Group 2 also consisted of fifteen participants (n=15); 8 males and 7 females. The mean age of Group 1 was 24.67 years and of Group 2 was 24.67 years, making the total population mean of 24.67 years.
Table 4.1: Comparison of age and gender variables between groups

<table>
<thead>
<tr>
<th>Data</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Combined total</th>
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<tr>
<td>Age distribution (years)</td>
<td>22-30</td>
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<td>22-30</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>24.67</td>
<td>24.67</td>
<td>24.67</td>
</tr>
<tr>
<td>Gender distribution</td>
<td>8 Males, 7 Females</td>
<td>8 Males, 7 Females</td>
<td>16 Males, 14 Females</td>
</tr>
</tbody>
</table>

4.3 Evaluation of Restricted Motion Segments in the Cervical Spine

In this particular study both groups received spinal manipulative therapy before cervical traction treatment. Participants were assessed as to which side their cervical motion segment restriction was and the findings were recorded on the cervical regional examination form (Appendix K). These findings weren't part of the analysis but interesting to note. Group 1 received manual cervical traction and consisted of 15 participants. Out of the 15 participants who each received six treatments, there were 47 right sided restrictions and 43 left sided restrictions. More participants presented with right sided restrictions in Group 1. Group 2 received mechanical cervical traction and also consisted of 15 participants. Out of the 15 participants who also received six treatments each, there were 48 left sided restrictions and 42 right sided restrictions. Therefore, more participants presented with left sided restrictions in Group 2.

Table 4.2: Total Restricted motion segments throughout the study in the cervical spine

<table>
<thead>
<tr>
<th></th>
<th>Manual cervical traction</th>
<th>Mechanical cervical traction</th>
</tr>
</thead>
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<tr>
<td>Right sided restrictions</td>
<td>47</td>
<td>42</td>
</tr>
<tr>
<td>Left sided restriction</td>
<td>43</td>
<td>48</td>
</tr>
</tbody>
</table>
4.4 Subjective Data Analysis

4.4.1 Evaluation of Numerical Pain Rating Scale (NPRS) Readings

The NPRS results on the 1st visit, Group 1 and Group 2 had mean values of 5.80 and 5.0 for numerical pain rating scale measurements respectively. On the 4th visit Group 1 and Group 2 had mean values of 3.0 and 2.87 respectively. On the 7th visit Group 1 and Group 2 had mean values of 1.33 and 1.13 respectively.

Clinical Interpretation of Mean NPRS Values

![Graph showing NPRS mean values on the 1st, 4th and 7th visits](image)

Figure 4.1: NPRS mean values on the 1st, 4th and 7th visits

At the end of the study Group 1 had a mean difference of 4.47 and a mean percentage improvement of 77% on their NPRS. Group 2 had a mean difference of 3.87 and a mean percentage improvement of 77%. This is calculated by dividing the mean difference by the 1st visit mean value and multiplied by 100 to get the percentage difference.
Table 4.3: NPRS mean values. Mean difference and percentage difference between the 1\textsuperscript{st} and 4\textsuperscript{th} visits and 1\textsuperscript{st} and 7\textsuperscript{th} visits.

<table>
<thead>
<tr>
<th>Group</th>
<th>Visit</th>
<th>Mean value</th>
<th>Mean difference</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>5.8</td>
<td>2.8</td>
<td>48%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>4th</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>5</td>
<td>2.13</td>
<td>43%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>4th</td>
<td>2.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>5.8</td>
<td>4.47</td>
<td>77%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>7th</td>
<td>1.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>5</td>
<td>3.87</td>
<td>77%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>7th</td>
<td>1.13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 1 NPRS Readings

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1\textsuperscript{st} and 4\textsuperscript{th} and 4\textsuperscript{th} and 7\textsuperscript{th} treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1\textsuperscript{st} treatment to the 4\textsuperscript{th} treatment ($p=0.001$) and for the 4\textsuperscript{th} treatment to the 7\textsuperscript{th} treatment ($p=0.010$).

The Wilcoxon Signed Rank test was used to compare Group 1’s 1\textsuperscript{st} treatment to the 7\textsuperscript{th} treatment. The results indicated that Group 1 demonstrated a statistically significant improvement over time ($p=0.001$).
Table 4.4: Test of Within-Subjects Contrasts Group 1

<table>
<thead>
<tr>
<th>Visit (Group 1)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.010</td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 2 NPRS Readings

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment (p=0.001) and for the 4th treatment to the 7th treatment (p=0.002).

The Wilcoxon Signed Rank test was used to compare Group 2’s 1st treatment to the 7th treatment. The results indicated that Group 2 demonstrated a statistically significant improvement over time (p=0.001).

Table 4.5: Test of Within-Subjects Contrasts Group 2

<table>
<thead>
<tr>
<th>Visit (Group 2)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Intergroup Analysis

Tests for normality were inconclusive; therefore the Mann-Whitney U tests were used to determine if there is a statistical significance between Group 1 and 2 on the NPRS.
The Between-Subject Effects test revealed that there was no statistical significance between Group 1 and Group 2 at the 1st visit \((p=0.191)\), the 4th visit \((p=0.949)\) and the 7th visit \((p=0.528)\).

Table 4.6: Tests of Between-Subject Effects of NPRS

<table>
<thead>
<tr>
<th>P-values</th>
<th>1st Visit</th>
<th>4th Visit</th>
<th>7th Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.191</td>
<td>0.949</td>
<td>0.528</td>
<td></td>
</tr>
</tbody>
</table>

4.4.2 Evaluation of the Neck Disability Index (NDI) Readings

The NDI results on the 1st visit, Group 1 and Group 2 had mean values of 12.6 and 9.27 measurements respectively. On the 4th visit Group 1 and Group 2 had mean values of 5.07 and 4.93 respectively. On the 7th visit Group 1 and Group 2 had mean values of 2.93 and 2.20 respectively.

Clinical Interpretation of Mean NDI Values

Figure 4.2: NDI mean values on the 1st, 4th and 7th visits
At the end of the study Group 1 had a mean difference of 9.67 and a mean percentage improvement of 77% on their NDI. Group 2 had a mean difference of 7.07 and a mean percentage improvement of 76%.

Table 4.7: NDI mean values. Mean difference and percentage difference between the 1st and 4th visits and 1st and 7th visits.

<table>
<thead>
<tr>
<th>Group</th>
<th>Visit</th>
<th>Mean value</th>
<th>Mean difference</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 Manual</td>
<td>1st</td>
<td>12.6</td>
<td>7.53</td>
<td>60%</td>
</tr>
<tr>
<td>traction</td>
<td>4th</td>
<td>5.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2 Mechanical</td>
<td>1st</td>
<td>9.27</td>
<td>4.34</td>
<td>47%</td>
</tr>
<tr>
<td>traction</td>
<td>4th</td>
<td>4.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1 Manual</td>
<td>1st</td>
<td>12.6</td>
<td>9.67</td>
<td>77%</td>
</tr>
<tr>
<td>traction</td>
<td>7th</td>
<td>2.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2 Mechanical</td>
<td>1st</td>
<td>9.27</td>
<td>7.07</td>
<td>76%</td>
</tr>
<tr>
<td>traction</td>
<td>7th</td>
<td>2.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 1 NDI Readings

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment (p=0.001) and for the 4th treatment to the 7th treatment (p=0.013).
The Wilcoxon Signed Rank test was used to compare Group 1's 1st treatment to the 7th treatment. The results indicated that Group 1 demonstrated a statistically significant improvement over time ($p=0.001$).

### Table 4.8: Test of Within-Subjects Contrasts Group 1

<table>
<thead>
<tr>
<th>Visit (Group 1)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.013</td>
</tr>
</tbody>
</table>

**Intragroup Analysis: Group 2 NDI Readings**

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment ($p=0.001$) and for the 4th treatment to the 7th treatment ($p=0.003$).

The Wilcoxon Signed Rank test was used to compare Group 2’s 1st treatment to the 7th treatment. The results indicated that Group 2 demonstrated a statistically significant improvement over time ($p=0.001$).

### Table 4.9: Test of Within-Subjects Contrasts Group 2

<table>
<thead>
<tr>
<th>Visit (Group 2)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.003</td>
</tr>
</tbody>
</table>
Intergroup Analysis

Tests for normality were inconclusive; therefore the Mann-Whitney U tests were used to determine if there is a statistical significance between Group 1 and 2 on the NDI.

The Between-Subject Effects test revealed that there was no statistical significance between Group 1 and Group 2 at the 1st visit (p=0.177), the 4th visit (p=0.706) and the 7th visit (p=0.658).

Table 4.10: Tests of Between-Subject Effects of NDI

<table>
<thead>
<tr>
<th>1st Visit</th>
<th>4th Visit</th>
<th>7th Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-values</td>
<td>0.177</td>
<td>0.706</td>
</tr>
</tbody>
</table>

4.5 Objective Data Analysis

4.5.1 Evaluation of Cervical Spine Range of Motion (CROM) Measurements in Extension

The CROM measurements in extension on the 1st visit, Group 1 and Group 2 had mean values of 58.67˚ and 56.00˚ respectively. On the 4th visit Group 1 and Group 2 had mean values of 61.00˚ and 61.00˚ respectively. On the 7th visit Group 1 and Group 2 had mean values of 63.67˚ and 62.00˚ respectively.
Clinical Interpretation of Mean CROM Measurements in Extension

Figure 4.3: CROM Extension mean values on the 1st, 4th and 7th visits

At the end of the study Group 1 had a mean difference of 5.00° and a mean percentage improvement of 8.52% on their CROM measurements in extension. Group 2 had a mean difference of 6.00° and a mean percentage improvement of 10.71%.
### Table 4.11: CROM Extension mean values. Mean difference and percentage difference between the 1st and 4th visits and 1st and 7th visits.

<table>
<thead>
<tr>
<th>Group</th>
<th>Visit</th>
<th>Mean value</th>
<th>Mean difference</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 Manual traction</td>
<td>1st Visit</td>
<td>58.67°</td>
<td>2.33°</td>
<td>3.97%</td>
</tr>
<tr>
<td></td>
<td>4th Visit</td>
<td>61.00°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2 Mechanical traction</td>
<td>1st Visit</td>
<td>56.00°</td>
<td>5.00°</td>
<td>8.93%</td>
</tr>
<tr>
<td></td>
<td>4th Visit</td>
<td>61.00°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1 Manual traction</td>
<td>1st Visit</td>
<td>58.67°</td>
<td>5.00°</td>
<td>8.52%</td>
</tr>
<tr>
<td></td>
<td>7th Visit</td>
<td>63.67°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2 Mechanical traction</td>
<td>1st Visit</td>
<td>56.00°</td>
<td>6.00°</td>
<td>10.71%</td>
</tr>
<tr>
<td></td>
<td>7th Visit</td>
<td>62.00°</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Intragroup Analysis: Group 1 CROM Measurements in Extension**

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that there was no statistical significance for the 1st treatment to the 4th treatment (p=0.196) but demonstrated a statistically significant improvement for the 4th treatment to the 7th treatment (p=0.033).

The Wilcoxon Signed Rank test was used to compare Group 1’s 1st treatment to the 7th treatment. The results indicated that Group 1 demonstrated a statistically significant improvement over time (p=0.004).
Table 4.12: Test of Within-Subjects Contrasts Group 1

<table>
<thead>
<tr>
<th>Visit (Group 1)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.004</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.196</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.033</td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 2 CROM Measurements in Extension

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment (p=0.008) but demonstrated that there was no statistical significance for the 4th treatment to the 7th treatment (p=0.470).

The Wilcoxon Signed Rank test was used to compare Group 2’s 1st treatment to the 7th treatment. The results indicated that Group 2 demonstrated a statistically significant improvement over time (p=0.015).

Table 4.13: Test of Within-Subjects Contrasts Group 2

<table>
<thead>
<tr>
<th>Visit (Group 2)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.015</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.008</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.470</td>
</tr>
</tbody>
</table>
Intergroup Analysis

Tests for normality were inconclusive; therefore the Mann-Whitney U tests were used to determine if there is a statistical significance between Group 1 and 2 on the CROM measurements in extension.

The Between-Subject Effects test revealed that there was no statistical significance between Group 1 and Group 2 at the 1st visit \((p=0.476)\), the 4th visit \((p=1.000)\) and the 7th visit \((p=0.645)\).

<table>
<thead>
<tr>
<th>Table 4.14: Tests of Between-Subject Effects of CROM Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Visit</td>
</tr>
<tr>
<td>P-values</td>
</tr>
</tbody>
</table>

4.5.2 Evaluation of CROM Measurements in Flexion

The CROM measurements in flexion on the 1st visit, Group 1 and Group 2 had mean values of 60.00˚ and 64.67˚ respectively. On the 4th visit Group 1 and Group 2 had mean values of 63.67˚ and 67.67˚ respectively. On the 7th visit Group 1 and Group 2 had mean values of 67.00˚ and 68.00˚ respectively.
Clinical Interpretation of Mean CROM Measurements in Flexion

**Figure 4.4: CROM Flexion mean values on the 1st, 4th and 7th visits**

At the end of the study, Group 1 had a mean difference of 7.00° and a mean percentage improvement of 11.67% on their CROM measurements in flexion. Group 2 had a mean difference of 3.33° and a mean percentage improvement of 5.15%. 
Table 4.15: CROM Flexion mean values. Mean difference and percentage difference between the 1st and 4th visits and 1st and 7th visits.

<table>
<thead>
<tr>
<th>Group</th>
<th>Visit</th>
<th>Mean value</th>
<th>Mean difference</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>60.00°</td>
<td>3.67°</td>
<td>6.12%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>4th Visit</td>
<td>63.67°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>64.67°</td>
<td>3.00°</td>
<td>4.64%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>4th Visit</td>
<td>67.67°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>60.00°</td>
<td>7.00°</td>
<td>11.67%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>7th Visit</td>
<td>67.00°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>64.67°</td>
<td>3.33°</td>
<td>5.15%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>7th Visit</td>
<td>68.00°</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 1 CROM Measurements in Flexion

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment (p=0.039) and for the 4th treatment to the 7th treatment (p=0.007).

The Wilcoxon Signed Rank test was used to compare Group 1’s 1st treatment to the 7th treatment. The results indicated that Group 1 demonstrated a statistically significant improvement over time (p=0.001).
Table 4.16: Test of Within-Subjects Contrasts Group 1

<table>
<thead>
<tr>
<th>Visit (Group 1)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.039</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 2 CROM Measurements in Flexion

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that there was no statistical significance for the 1st treatment to the 4th treatment (p=0.067) and for the 4th treatment to the 7th treatment (p=0.856).

The Wilcoxon Signed Rank test was used to compare Group 2’s 1st treatment to the 7th treatment. The results indicated that Group 2 demonstrated no statistical significance over time (p=0.228).

Table 4.17: Test of Within-Subjects Contrasts Group 2

<table>
<thead>
<tr>
<th>Visit (Group 2)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.228</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.067</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.856</td>
</tr>
</tbody>
</table>
Intergroup Analysis

Tests for normality were inconclusive; therefore the Mann-Whitney U tests were used to determine if there is a statistical significance between Group 1 and 2 on the CROM measurements in flexion.

The Between-Subject Effects test revealed that there was no statistical significance between Group 1 and Group 2 at the 1st visit (p=0.215), the 4th visit (p=0.300) and the 7th visit (0.703).

Table 4.18: Tests of Between-Subject Effects of CROM Flexion

<table>
<thead>
<tr>
<th></th>
<th>1st Visit</th>
<th>4th Visit</th>
<th>7th Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-values</td>
<td>0.215</td>
<td>0.300</td>
<td>0.703</td>
</tr>
</tbody>
</table>

4.5.3 Evaluation of CROM Measurements in Left Lateral Flexion

The CROM measurements in left lateral flexion on the 1st visit, Group 1 and Group 2 had mean values of 43.00˚ and 47.00˚ respectively. On the 4th visit Group 1 and Group 2 had mean values of 46.67˚ and 51.33˚ respectively. On the 7th visit Group 1 and Group 2 had mean values of 49.33˚ and 54.00˚ respectively.
Clinical Interpretation of Mean CROM Measurements in Left Lateral Flexion

Figure 4.5: CROM Left Lateral Flexion mean values on the 1st, 4th and 7th visits

At the end of the study Group 1 had a mean difference of 6.33° and a mean percentage improvement of 14.72% on their CROM measurements in left lateral flexion. Group 2 had a mean difference of 7.00° and a mean percentage improvement of 14.89%.
Table 4.19: CROM Left Lateral Flexion mean values. Mean difference and percentage difference between the 1st and 4th visits and 1st and 7th visits.

<table>
<thead>
<tr>
<th>Group</th>
<th>Visit</th>
<th>Mean value</th>
<th>Mean difference</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>43.00˚</td>
<td>3.67˚</td>
<td>2.33%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>4th Visit</td>
<td>46.67˚</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>47.00˚</td>
<td>4.33˚</td>
<td>9.21%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>4th Visit</td>
<td>51.33˚</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>43.00˚</td>
<td>6.33˚</td>
<td>14.72%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>7th Visit</td>
<td>49.33˚</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>47.00˚</td>
<td>7.00˚</td>
<td>14.89%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>7th Visit</td>
<td>54.00˚</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 1 CROM Measurements in Left Lateral Flexion

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment \( (p=0.008) \) and for the 4th treatment to the 7th treatment \( (p=0.011) \).

The Wilcoxon Signed Rank test was used to compare Group 1’s 1st treatment to the 7th treatment. The results indicated that Group 1 demonstrated a statistically significant improvement over time \( (p=0.001) \).
Table 4.20: Test of Within-Subjects Contrasts Group 1

<table>
<thead>
<tr>
<th>Visit (Group 1)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.008</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 2 CROM Measurements in Left Lateral Flexion

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment \((p=0.004)\) but no statistical significance for the 4th treatment to the 7th treatment \((p=0.092)\).

The Wilcoxon Signed Rank test was used to compare Group 2’s 1st treatment to the 7th treatment. The results indicated that Group 2 demonstrated a statistically significant improvement over time \((p=0.030)\).

Table 4.21: Test of Within-Subjects Contrasts Group 2

<table>
<thead>
<tr>
<th>Visit (Group 2)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.030</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.004</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.092</td>
</tr>
</tbody>
</table>
Intergroup Analysis

Tests for normality were inconclusive; therefore the Mann-Whitney U tests were used to determine if there is a statistical significance between Group 1 and 2 on the CROM measurements in left lateral flexion.

The Between-Subject Effects test revealed that there was no statistical significance between Group 1 and Group 2 at the 1st visit \( (p=0.339) \), the 4th visit \( (p=0.206) \) and the 7th visit \( (p=0.178) \).

Table 4.22: Tests of Between-Subject Effects of CROM Left Lateral Flexion

<table>
<thead>
<tr>
<th></th>
<th>1st Visit</th>
<th>4th Visit</th>
<th>7th Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-values</td>
<td>0.339</td>
<td>0.206</td>
<td>0.178</td>
</tr>
</tbody>
</table>

4.5.4 Evaluation of CROM Measurements in Right Lateral Flexion

The CROM measurements in right lateral flexion on the 1st visit, Group 1 and Group 2 had mean values of 43.33˚ and 48.00˚ respectively. On the 4th visit Group 1 and Group 2 had mean values of 47.33˚ and 53.00˚ respectively. On the 7th visit Group 1 and Group 2 had mean values of 52.67˚ and 56.33˚ respectively.
Clinical Interpretation of Mean CROM Measurements in Right Lateral Flexion

Figure 4.6: CROM Right Lateral Flexion mean values on the 1st, 4th and 7th visits

At the end of the study Group 1 had a mean difference of 9.34˚ and a mean percentage improvement of 21.56% on their CROM measurements in right lateral flexion. Group 2 had a mean difference of 8.33˚ and a mean percentage improvement of 17.35%.
Table 4.23: CROM Right Lateral Flexion mean values. Mean difference and percentage difference between the 1st and 4th visits and 1st and 7th visits.

<table>
<thead>
<tr>
<th>Group</th>
<th>Visit</th>
<th>Mean value</th>
<th>Mean difference</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>43.33˚</td>
<td>4.00˚</td>
<td>9.23%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>4th Visit</td>
<td>47.33˚</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>48.00˚</td>
<td>5.00˚</td>
<td>10.42%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>4th Visit</td>
<td>53.00˚</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>43.33˚</td>
<td>9.34˚</td>
<td>21.56%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>7th Visit</td>
<td>52.67˚</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>48.00˚</td>
<td>8.33˚</td>
<td>17.35%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>7th Visit</td>
<td>56.33˚</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 1 CROM Measurements in Right Lateral Flexion

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment ($p=0.003$) and for the 4th treatment to the 7th treatment ($p=0.002$).

The Wilcoxon Signed Rank test was used to compare Group 1’s 1st treatment to the 7th treatment. The results indicated that Group 1 demonstrated a statistically significant improvement over time ($p=0.001$).
Table 4.24: Test of Within-Subjects Contrasts Group 1

<table>
<thead>
<tr>
<th>Visit (Group 1)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.003</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 2 CROM Measurements in Right Lateral Flexion

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment (p=0.005) and for the 4th treatment to the 7th treatment (p=0.008).

The Wilcoxon Signed Rank test was used to compare Group 2's 1st treatment to the 7th treatment. The results indicated that Group 2 demonstrated a statistically significant improvement over time (p=0.001).

Table 4.25: Test of Within-Subjects Contrasts Group 2

<table>
<thead>
<tr>
<th>Visit (Group 2)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.005</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.008</td>
</tr>
</tbody>
</table>
Intergroup Analysis

Tests for normality were inconclusive; therefore the Mann-Whitney U tests were used to determine if there is a statistical significance between Group 1 and 2 on the CROM measurements in right lateral flexion.

The Between-Subject Effects test revealed that there was no statistical significance between Group 1 and Group 2 at the 1st visit \((p=0.085)\), and the 7th visit \((p=0.228)\), but there was a statistically significant improvement at the 4th visit \((p=0.027)\).

<table>
<thead>
<tr>
<th></th>
<th>1st Visit</th>
<th>4th Visit</th>
<th>7th Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-values</td>
<td>0.085</td>
<td>0.027</td>
<td>0.228</td>
</tr>
</tbody>
</table>

4.5.5 Evaluation of CROM Measurements in Left Rotation

The CROM measurements in left rotation on the 1st visit, Group 1 and Group 2 had mean values of 64.67˚ and 64.00˚ respectively. On the 4th visit Group 1 and Group 2 had mean values of 71.00˚ and 71.67˚ respectively. On the 7th visit Group 1 and Group 2 had mean values of 73.33˚ and 75.00˚ respectively.
Clinical Interpretation of Mean CROM Measurements in Left Rotation

Figure 4.7: CROM Left Rotation mean values on the 1st, 4th and 7th visits

At the end of the study, Group 1 had a mean difference of 8.66° and a mean percentage improvement of 13.39% on their CROM measurements in left rotation. Group 2 had a mean difference of 11.00° and a mean percentage improvement of 17.19%.
### Table 4.27: CROM Left Rotation mean values. Mean difference and percentage difference between the 1st and 4th visits and 1st and 7th visits.

<table>
<thead>
<tr>
<th>Group</th>
<th>Visit</th>
<th>Mean value</th>
<th>Mean difference</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 Manual traction</td>
<td>1st Visit</td>
<td>64.67°</td>
<td>6.33°</td>
<td>9.79%</td>
</tr>
<tr>
<td></td>
<td>4th Visit</td>
<td>71.00°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2 Mechanical traction</td>
<td>1st Visit</td>
<td>64.00°</td>
<td>7.67°</td>
<td>11.98%</td>
</tr>
<tr>
<td></td>
<td>4th Visit</td>
<td>71.67°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1 Manual traction</td>
<td>1st Visit</td>
<td>64.67°</td>
<td>8.66°</td>
<td>13.39%</td>
</tr>
<tr>
<td></td>
<td>7th Visit</td>
<td>73.33°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2 Mechanical traction</td>
<td>1st Visit</td>
<td>64.00°</td>
<td>11.00°</td>
<td>17.19%</td>
</tr>
<tr>
<td></td>
<td>7th Visit</td>
<td>75.00°</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Intragroup Analysis: Group 1 CROM Measurements in Left Rotation**

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment \((p=0.003)\) and for the 4th treatment to the 7th treatment \((p=0.020)\).

The Wilcoxon Signed Rank test was used to compare Group 1’s 1st treatment to the 7th treatment. The results indicated that Group 1 demonstrated a statistically significant improvement over time \((p=0.001)\).
Table 4.28: Test of Within-Subjects Contrasts Group 1

<table>
<thead>
<tr>
<th>Visit (Group 1)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.003</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.020</td>
</tr>
</tbody>
</table>

Intragroup Analysis: Group 2 CROM Measurements in Left Rotation

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment (p=0.004) and for the 4th treatment to the 7th treatment (p=0.013).

The Wilcoxon Signed Rank test was used to compare Group 2’s 1st treatment to the 7th treatment. The results indicated that Group 2 demonstrated a statistically significant improvement over time (p=0.001).

Table 4.29: Test of Within-Subjects Contrasts Group 2

<table>
<thead>
<tr>
<th>Visit (Group 2)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.004</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.013</td>
</tr>
</tbody>
</table>
Intergroup Analysis

Tests for normality were inconclusive; therefore the Mann-Whitney U tests were used to determine if there is a statistical significance between Group 1 and 2 on the CROM measurements in left rotation.

The Between-Subject Effects test revealed that there was no statistical significance between Group 1 and Group 2 at the 1st visit (p=0.816), the 4th visit (p=0.404) and the 7th visit (p=0.218).

Table 4.30: Tests of Between-Subject Effects of CROM Left Rotation

<table>
<thead>
<tr>
<th></th>
<th>1st Visit</th>
<th>4th Visit</th>
<th>7th Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-values</td>
<td>0.816</td>
<td>0.404</td>
<td>0.218</td>
</tr>
</tbody>
</table>

4.5.6 Evaluation of CROM Measurements in Right Rotation

The CROM measurements in right rotation on the 1st visit, Group 1 and Group 2 had mean values of 64.00˚ and 67.33˚ respectively. On the 4th visit Group 1 and Group 2 had mean values of 69.67˚ and 72.33˚ respectively. On the 7th visit Group 1 and Group 2 had mean values of 74.33˚ and 74.00˚ respectively.
Clinical Interpretation of Mean CROM Measurements in Right Rotation

Figure 4.8: CROM Right Rotation mean values on the 1\textsuperscript{st}, 4\textsuperscript{th} and 7\textsuperscript{th} visits

At the end of the study Group 1 had a mean difference of 10.33˚ and a mean percentage improvement of 16.14% on their CROM measurements in right rotation. Group 2 had a mean difference of 6.67˚ and a mean percentage improvement of 9.91%.
Table 4.31: CROM Right Rotation mean values. Mean difference and percentage difference between the 1st and 4th visits and 1st and 7th visits.

<table>
<thead>
<tr>
<th>Group</th>
<th>Visit</th>
<th>Mean value</th>
<th>Mean difference</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>64.00°</td>
<td>5.67°</td>
<td>8.86%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>4th Visit</td>
<td>69.67°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>67.33°</td>
<td>5.00°</td>
<td>7.43%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>4th Visit</td>
<td>72.33°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>1st Visit</td>
<td>64.00°</td>
<td>10.33°</td>
<td>16.14%</td>
</tr>
<tr>
<td>Manual traction</td>
<td>7th Visit</td>
<td>74.33°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>1st Visit</td>
<td>67.33°</td>
<td>6.67°</td>
<td>9.91%</td>
</tr>
<tr>
<td>Mechanical traction</td>
<td>7th Visit</td>
<td>74.00°</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Intragroup Analysis: Group 1 CROM Measurements in Right Rotation**

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1st and 4th and 4th and 7th treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1st treatment to the 4th treatment (\(p=0.004\)) and for the 4th treatment to the 7th treatment (\(p=0.003\)).

The Wilcoxon Signed Rank test was used to compare Group 1’s 1st treatment to the 7th treatment. The results indicated that Group 1 demonstrated a statistically significant improvement over time (\(p=0.001\)).
### Table 4.32: Test of Within-Subjects Contrasts Group 1

<table>
<thead>
<tr>
<th>Visit (Group 1)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.004</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.003</td>
</tr>
</tbody>
</table>

**Intragroup Analysis: Group 2 CROM Measurements in Right Rotation**

Tests for normality was inconclusive, therefore the Wilcoxon Signed Rank Tests were used to determine intragroup results between the 1<sup>st</sup> and 4<sup>th</sup> and 4<sup>th</sup> and 7<sup>th</sup> treatment.

The Within-Subjects Contrast test revealed that the values demonstrated a statistically significant improvement for the 1<sup>st</sup> treatment to the 4<sup>th</sup> treatment (**p=0.002**) but no statistical significance for the 4<sup>th</sup> treatment to the 7<sup>th</sup> treatment (**p=0.132**).

The Wilcoxon Signed Rank test was used to compare Group 2’s 1<sup>st</sup> treatment to the 7<sup>th</sup> treatment. The results indicated that Group 2 demonstrated a statistically significant improvement over time (**p=0.001**).

### Table 4.33: Test of Within-Subjects Contrasts Group 2

<table>
<thead>
<tr>
<th>Visit (Group 2)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Treatment- 7th treatment</td>
<td>0.001</td>
</tr>
<tr>
<td>1st Treatment- 4th treatment</td>
<td>0.002</td>
</tr>
<tr>
<td>4th Treatment- 7th treatment</td>
<td>0.132</td>
</tr>
</tbody>
</table>
Intergroup Analysis

Tests for normality were inconclusive; therefore the Mann-Whitney U tests were used to determine if there is a statistical significance between Group 1 and 2 on the CROM measurements in right rotation.

The Between-Subject Effects test revealed that there was no statistical significance between Group 1 and Group 2 at the 1st visit ($p=0.088$), the 4th visit ($p=0.206$) and the 7th visit ($p=0.983$).

Table 4.34: Tests of Between-Subject Effects of CROM Right Rotation

<table>
<thead>
<tr>
<th></th>
<th>1st Visit</th>
<th>4th Visit</th>
<th>7th Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-values</td>
<td>0.088</td>
<td>0.206</td>
<td>0.983</td>
</tr>
</tbody>
</table>
CHAPTER FIVE – DISCUSSION

5.1 Introduction

With reference to the tables and figures of the previous results chapter, the results of this study are discussed. This chapter emphasizes any statistical significant results. Possible explanations of these results with regards to the literature review mentioned in chapter two will be included.

5.2 Demographic Data Analysis

5.2.1 Age and Gender Distribution

For participants to partake in this study, they had to be between the ages of 18 and 45 years of age. Table 4.1 demonstrates that the average age was 24.67 years and that the gender allocation was set at 16 males and 14 females. With these values, the gender related variable was kept to the bare minimum.

According to Plaugher (1993) the precise cause of chronic neck pain is frequently unknown, but occurs in all groups of people. Neck pain is primarily seen in females (Guez et, al., 2002) however this does not conform to this particular study as more males presented with chronic neck pain, however this study only signifies a small part of the population.
5.3 Data Analysis

5.3.1 Discussion of SMT

In this particular study manual cervical traction was compared to mechanical cervical traction in combination with spinal manipulative therapy. Both groups received spinal manipulative therapy to the restricted motion segment before cervical traction was applied.

As discussed in the literature review, the VSC is a theoretical model of motion segment dysfunction that incorporates the complex interaction of pathological changes in nerve, muscle, ligamentous, vascular and connective tissue (Leach, 1994). The adjustment opens a joint to increase space or stretch the tissue that causes a decrease in range of movement, therefore providing a local mechanical, neurological and vascular effect (Esposito and Philipson, 2005). According to Byfield (2005), there is substantial clinical evidence from a number of quality clinical studies that supports chiropractic cervical manipulation as safe and effective and suggests that it is an appropriate intervention for a variety of neck pain (Byfield, 2005).

McMorland and Suter (2000) proved in their study on chiropractic management of neck pain that a chiropractic adjustment had a statistically significant decrease in pain-related disability with patients suffering from neck pain. Wyatt (2004) performed a study on different treatment techniques for cervical facet syndrome and found that spinal manipulative therapy of the cervical spine improves function and increase range of motion.

In a study performed by Koes, Bouter and van Mameren (1993), patients suffering from chronic neck complaints and limited cervical range of motion received either spinal manipulative therapy, physiotherapy or general practitioner care and found that only patients treated with spinal manipulative therapy had improved lateral flexion range of motion during all follow up visits.
The clinically significant percentage improvement in range of motion for this particular study may also be due to chiropractic spinal manipulative therapy which involved a high velocity, low amplitude thrust delivered to the restricted segments in the cervical spine. As discussed in chapter two, an adjustment produces a reflex inhibition of hypertonic muscles and a reduction of pain resulting in an increased cervical spine range of motion (Peterson and Bergmann, 2002). According to Esposito and Philipson (2005), chiropractors use SMT to decrease pain and increase cervical spine range of motion.

Spinal manipulative therapy will not be discussed further as both groups received it and is therefore a consistent variable.

5.4 Subjective Data Analysis

5.4.1 Numerical Pain Rating Scale (NPRS)

This particular study was divided into two different analyses which included an intragroup analysis and an intergroup analysis which pertain to the NPRS results. Manual cervical traction versus mechanical cervical traction was then directly compared to each other.

In this particular study, both manual cervical traction and mechanical cervical traction showed a statistically significant improvement with regards to pain sensitivity. Both groups showed an equal mean percentage improvement clinically.

a) Manual cervical traction

Comparing the 1st treatment to the 7th treatment, manual cervical traction demonstrated a statistically significant improvement with regards to pain sensitivity (p=0.001). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.001) and the 4th treatment to the 7th treatment (p=0.010). At the end of this
study, the intragroup analysis proved that manual cervical traction had a mean percentage improvement of 77% with regards to pain sensitivity.

b) **Mechanical cervical traction**

Comparing the 1\textsuperscript{st} treatment to the 7\textsuperscript{th} treatment, mechanical cervical traction demonstrated a statistically significant improvement with regards to pain sensitivity (p=0.001). There was also a statistically significant improvement when comparing the 1\textsuperscript{st} treatment to the 4\textsuperscript{th} treatment (p=0.001) and the 4\textsuperscript{th} treatment to the 7\textsuperscript{th} treatment (p=0.002). At the end of this study, the intragroup analysis proved that mechanical cervical traction also had a mean percentage improvement of 77% with regards to pain sensitivity.

c) **Intergroup analysis**

Measurements were compared between Group 1 and Group 2 on the 1\textsuperscript{st}, 4\textsuperscript{th} and 7\textsuperscript{th} treatment sessions. The intergroup analysis resulted in p-values of 0.191, 0.949 and 0.528 respectively. These values prove that there was no statistical significance between manual cervical traction and mechanical cervical traction with regards to pain sensitivity. According to Aberson (2010) this might be due to the small sample size of the population. On the other hand, the intragroup analysis showed that both manual cervical traction and mechanical cervical traction had a mean percentage improvement of 77% with regards to pain sensitivity.

d) **Discussion of NPRS results**

It has been proven that manual cervical traction is accepted as a standard form of practice in the treatment of neck pain (Aker \textit{et al.}, 1996). Moeti and Marchetti (2001) used NPRS values in their study on manual cervical traction for the treatment of cervical radiculopathy and found that patients had an improvement with regards to pain and disability.
Jellad et al (2009) proved that manual or mechanical cervical traction to be of great value in the treatment of cervical pain and disability. As discussed before, mechanical cervical traction as well as manual cervical traction cause stretching of the spinal musculature, distraction or separation of the vertebral bodies and widening of the intervertebral foramen, which in turn takes pressure off of the spinal nerves and therefore decreases pain and improves function (Hooper, 1996).

5.4.2 Neck Disability Index (NDI)

This particular study was divided into two different analyses which included an intragroup analysis and an intergroup analysis which pertain to the NDI results. Manual cervical traction versus mechanical cervical traction was then directly compared to each other.

In this particular study manual cervical traction and mechanical cervical traction showed a statistically significant improvement with regards to neck disability. Although mechanical cervical traction resulted in 1% less improvement than manual cervical traction, both groups demonstrated a mean percentage improvement with regards to neck disability.

a) Manual cervical traction

Comparing the 1st treatment to the 7th treatment, manual cervical traction demonstrated a statistically significant improvement with regards to neck disability (p=0.001). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.001) and the 4th treatment to the 7th treatment (p=0.013). At the end of this study, the intragroup analysis proved that manual cervical traction had a mean percentage improvement of 77% with regards to neck disability.
b) Mechanical cervical traction

Comparing the 1st treatment to the 7th treatment, mechanical cervical traction demonstrated a statistically significant improvement with regards to neck disability (p=0.001). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.001) and the 4th treatment to the 7th treatment (p=0.003). At the end of this study, the intragroup analysis proved that mechanical cervical traction had a mean percentage improvement of 76% with regards to neck disability.

c) Intergroup analysis

Measurements were compared between Group 1 and Group 2 on the 1st, 4th and 7th treatment sessions. The intergroup analysis resulted in p-values of 0.177, 0.706 and 0.658 respectively. These values prove that there was no statistical significance between manual cervical traction and mechanical cervical traction with regards to neck disability. According to Aberson (2010) this might be due to the small sample size of the population. However, the intragroup analysis showed that manual cervical traction had a 1% higher mean percentage improvement of 77% with regards to neck disability, which may prove that manual cervical traction may be better.

d) Discussion of the NDI results

In a study performed by Kjellman, Skargren and Oberg (1999) chiropractic manipulation treatment was effective for pain, activities of daily living disability, and for restricted range of cervical motion. Cleland, Whitman, Fritz and Palmer (2005) performed a study where chiropractic adjustments were combined with manual cervical traction and strengthening exercises and found significant improvements in terms of pain, disability and function.
Swezey, Swezey and Warner (1997), performed a research study to establish the efficacy of home mechanical cervical traction and found that 85% of the participants showed improvement in terms of pain and neck disability. In a study performed by Olson (1997), the patient made use of mechanical cervical traction to treat chronic whiplash associated headache for duration of one month, and found that there was increased range of cervical motion, increased function, as well as decreased neck pain.

5.5 Objective Data Analysis

This particular study was divided into two different analyses which included an intragroup analysis and an intergroup analysis which pertain to the CROM measurement results. Manual cervical traction versus mechanical cervical traction was then directly compared to each other.

5.5.1 Cervical Spine Range of Motion in Extension

a) Manual cervical traction

Comparing the 1st treatment to the 7th treatment, manual cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in extension (p=0.004). There was no statistical significance when comparing the 1st treatment to the 4th treatment (p=0.196) but a statistically significant improvement when comparing the 4th treatment to the 7th treatment (p=0.033). At the end of this study, the intragroup analysis proved that manual cervical traction had a mean percentage improvement of 8.52% on cervical spine range of motion in extension.

b) Mechanical cervical traction

Comparing the 1st treatment to the 7th treatment, mechanical cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in
extension (p=0.015). There was also a statistically significant improvement when comparing the 1\textsuperscript{st} treatment to the 4\textsuperscript{th} treatment (p=0.008) but no statistical significance when comparing the 4\textsuperscript{th} treatment to the 7\textsuperscript{th} treatment (p=0.470). At the end of this study, the intragroup analysis proved that mechanical cervical traction had a mean percentage improvement of 10.71% on cervical spine range of motion in extension.

c) Intergroup analysis

Measurements were compared between Group 1 and Group 2 on the 1\textsuperscript{st}, 4\textsuperscript{th} and 7\textsuperscript{th} treatment sessions. The intergroup analysis resulted in p-values of 0.476, 1.000 and 0.645 respectively. These values prove that there was no statistical significance between manual cervical traction and mechanical cervical traction with regards to cervical spine range of motion in extension. According to Aberson (2010) this might be due to the small sample size of the population. However, the intragroup analysis showed that mechanical cervical traction had a higher mean percentage improvement of 10.71% versus 8.52% with regards to cervical spine range of motion in extension, and may prove to be better than manual cervical traction.

5.5.2 Cervical Spine Range of Motion in Flexion

a) Manual cervical traction

Comparing the 1\textsuperscript{st} treatment to the 7\textsuperscript{th} treatment, manual cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in flexion (p=0.001). There was also a statistically significant improvement when comparing the 1\textsuperscript{st} treatment to the 4\textsuperscript{th} treatment (p=0.039) and the 4\textsuperscript{th} treatment to the 7\textsuperscript{th} treatment (p=0.007). At the end of this study, the intragroup analysis proved that manual cervical traction had a mean percentage improvement of 11.67% on cervical spine range of motion in flexion.
b) Mechanical cervical traction

Comparing the 1st treatment to the 7th treatment, mechanical cervical traction demonstrated to have no statistical significance with regards to cervical spine range of motion in flexion (p=0.228). There was also no statistical significance when comparing the 1st treatment to the 4th treatment (p=0.067) and the 4th treatment to the 7th treatment (p=0.856). At the end of this study, the intragroup analysis proved that mechanical cervical traction had a mean percentage improvement of 5.15% on cervical spine range of motion in flexion.

c) Intergroup analysis

Measurements were compared between Group 1 and Group 2 on the 1st, 4th and 7th treatment sessions. The intergroup analysis resulted in p-values of 0.215, 0.300 and 0.703 respectively. These values prove that there was no statistical significance between manual cervical traction and mechanical cervical traction with regards to cervical spine range of motion in flexion. According to Aberson (2010) this might be due to the small sample size of the population. However, the intragroup analysis showed that manual cervical traction had a higher mean percentage improvement of 11.67% versus 5.15% with regards to cervical spine range of motion in flexion, and may prove to be better than mechanical cervical traction.

5.5.3 Cervical Spine Range of Motion in Left and Right Lateral Flexion

a) Manual cervical traction

Left lateral flexion

Comparing the 1st treatment to the 7th treatment, manual cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in left lateral flexion (p=0.001). There was also a statistically significant improvement when
comparing the 1st treatment to the 4th treatment (p=0.008) and the 4th treatment to the 7th treatment (p=0.011). At the end of this study, the intragroup analysis proved that manual cervical traction had a mean percentage improvement of 14.72% on cervical spine range of motion in left lateral flexion.

**Right lateral flexion**

Comparing the 1st treatment to the 7th treatment, manual cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in right lateral flexion (p=0.001). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.003) and the 4th treatment to the 7th treatment (p=0.002). At the end of this study, the intragroup analysis proved that manual cervical traction had a mean percentage improvement of 21.56% on cervical spine range of motion in right lateral flexion.

b) **Mechanical cervical traction**

**Left lateral flexion**

Comparing the 1st treatment to the 7th treatment, mechanical cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in left lateral flexion (p=0.030). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.004) but no statistical significance when comparing the 4th treatment to the 7th treatment (p=0.092). At the end of this study, the intragroup analysis proved that mechanical cervical traction had a mean percentage improvement of 14.89% on cervical spine range of motion in left lateral flexion.
Right lateral flexion

Comparing the 1st treatment to the 7th treatment, mechanical cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in right lateral flexion (p=0.001). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.005) and the 4th treatment to the 7th treatment (p=0.008). At the end of this study, the intragroup analysis proved that mechanical cervical traction had a mean percentage improvement of 17.35% on cervical spine range of motion in right lateral flexion.

c) Intergroup analysis

Left lateral flexion

Measurements were compared between Group 1 and Group 2 on the 1st, 4th and 7th treatment sessions. The intergroup analysis resulted in p-values of 0.339, 0.206 and 0.178 respectively. These values prove that there was no statistical significance between manual cervical traction and mechanical cervical traction with regards to cervical spine range of motion in left lateral flexion. According to Aberson (2010) this might be due to the small sample size of the population. However, the intragroup analysis showed that mechanical cervical traction had a higher mean percentage improvement of 14.89% versus 14.72% with regards to cervical spine range of motion in left lateral flexion, and may prove to be better than manual cervical traction although the values are really small.

Right lateral flexion

Measurements were compared between Group 1 and Group 2 on the 1st, 4th and 7th treatment sessions. The intergroup analysis resulted in p-values of the 1st visit 0.085, and the 7th visit 0.228. There was a statistically significant improvement on the 4th visit with a p-value of 0.027. These values prove that there was no statistical significance between
manual cervical traction and mechanical cervical traction with regards to cervical spine range of motion in right lateral flexion. According to Aberson (2010) this might be due to the small sample size of the population. However, the intragroup analysis showed that manual cervical traction had a higher mean percentage improvement of 21.56% versus 17.35% with regards to cervical spine range of motion in right lateral flexion, and may prove to be better than mechanical cervical traction.

5.5.4 Cervical Spine Range of Motion in Left and Right Rotation

a) Manual cervical traction

Left rotation

Comparing the 1st treatment to the 7th treatment, manual cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in left rotation (p=0.001). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.003) and the 4th treatment to the 7th treatment (p=0.020). At the end of this study, the intragroup analysis proved that manual cervical traction had a mean percentage improvement of 13.39% on cervical spine range of motion in left rotation.

Right rotation

Comparing the 1st treatment to the 7th treatment, manual cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in right rotation (p=0.001). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.004) and the 4th treatment to the 7th treatment (p=0.003). At the end of this study, the intragroup analysis proved that manual cervical traction had a mean percentage improvement of 16.14% on cervical spine range of motion in right rotation.
b) Mechanical cervical traction

**Left rotation**

Comparing the 1st treatment to the 7th treatment, mechanical cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in left rotation (p=0.001). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.004) and the 4th treatment to the 7th treatment (p=0.013). At the end of this study, the intragroup analysis proved that mechanical cervical traction had a mean percentage improvement of 17.19% on cervical spine range of motion in left rotation.

**Right rotation**

Comparing the 1st treatment to the 7th treatment, mechanical cervical traction demonstrated a statistically significant improvement with regards to cervical spine range of motion in right rotation (p=0.001). There was also a statistically significant improvement when comparing the 1st treatment to the 4th treatment (p=0.002) but no statistical significance when comparing the 4th treatment to the 7th treatment (p=0.132). At the end of this study, the intragroup analysis proved that mechanical cervical traction had a mean percentage improvement of 9.91% on cervical spine range of motion in right rotation.

c) Intergroup analysis

**Left rotation**

Measurements were compared between Group 1 and Group 2 on the 1st, 4th and 7th treatment sessions. The intergroup analysis resulted in p-values of 0.816, 0.404 and 0.218 respectively. These values prove that there was no statistical significance between manual cervical traction and mechanical cervical traction with regards to cervical spine range of motion.
motion in left rotation. According to Aberson (2010) this might be due to the small sample size of the population. However, the intragroup analysis showed that mechanical cervical traction had a higher mean percentage improvement of 17.19\% versus 13.39\% with regards to cervical spine range of motion in left rotation, and may prove to be better than manual cervical traction.

**Right rotation**

Measurements were compared between Group 1 and Group 2 on the 1\(^{st}\), 4\(^{th}\) and 7\(^{th}\) treatment sessions. The intergroup analysis resulted in p-values of 0.088, 0.206 and 0.983 respectively. These values prove that there was no statistical significance between manual cervical traction and mechanical cervical traction with regards to cervical spine range of motion in right rotation. According to Aberson (2010) this might be due to the small sample size of the population. However, the intragroup analysis showed that manual cervical traction had a higher mean percentage improvement of 16.14\% versus 9.91\% with regards to cervical spine range of motion in right rotation, and may prove to be better than mechanical cervical traction.

5.6 Discussion of the Cervical Spine Range of Motion

According to Carnes and Vizniak (2010), the resting position of the cervical spine is in slight extension, whereas the closed packed position of the cervical spine is in full extension. With the cervical spine in full extension, the zygapophysial joints are approximated and tension develops in the anterior longitudinal ligament. The capsular pattern of the cervical spine is lateral flexion and rotation with extension (Carnes and Vizniak, 2010). Each joint has its own pattern of limitation. Capsular pattern is the effect of a total joint reaction, with muscle spasm, capsular contraction and generalised osteophyte formation may be possible causes (Gatterman, 2004). With the cervical spine, any damage to the joint would result in motion first lost in lateral flexion, rotation, then extension and finally flexion. Patients who complain of
neck pain and presents with cervical facet syndrome may have decreased range of motion in lateral flexion, rotation, extension and finally flexion.

In this particular study, the most percentage improvement was in right lateral flexion with a percentage of 21.56% for the manual cervical traction group, whereas the least percentage improvement was in flexion with a percentage of 5.15% for the mechanical cervical traction group. This also demonstrates that when restoring a joint to its normal function, the range of motion will also be increased according to the capsular pattern as mentioned above. Range of motion is first lost in lateral flexion, rotation, extension and finally flexion.

For manual cervical traction, the range of motion changes were to be expected as it is demonstrated that manual cervical traction is the most common type of cervical traction used by chiropractors and is used for joint dysfunction and degenerative disc disease to decrease pain and in turn increase range of motion (Hooper, 1996). Graham, Gross and Goldsmith (2006) found in their study of mechanical traction for mechanical neck disorders that manual cervical traction to be favoured, and showed evidence for pain reduction. Once a patient showed decreased values on their NPRS and NDI, their range of motion also increased, and they could move their neck more easily in all ranges of motion. Manual cervical traction also showed that there was a statistically significant improvement between the 1st treatment and the 7th treatment in all the ranges of motion, which indicates that manual cervical traction treatment showed positive effects in the short and medium term.

Likewise, for mechanical cervical traction, the range of motion changes were also to be expected as it also has a positive effect on increasing the range of motion, although as the patient’s condition improves, intermittent manual traction prove to be more helpful (Hooper, 1996). Mechanical cervical traction showed no significant difference in a study performed by Graham et al., (2006).

When looking at the overall results, and comparing manual cervical traction with mechanical cervical traction, the changes between visits weren't consistent. Mechanical cervical traction
showed that between the 4th visit and the 7th visit for extension, flexion, lateral flexion and right rotation, there were no statistical significance, which indicates that manual cervical traction may be better in those specific ranges of motion although both groups showed increased improvement with regards to range of motion in all directions. Both groups demonstrated a mean percentage improvement, and therefore one group could not be favoured above the other group.

According to Middleditch and Olivier (2005) range of motion in flexion and extension, have the most degrees of movement (100°-130°) followed by rotation (80°-90°) and then finally lateral flexion (45°-60°). The capsular pattern of the cervical spine is range of motion lost first in lateral flexion, rotation, then extension and lastly flexion, which is contradictory of the prior statement (Carnes and Vizniak, 2010).

With regards to manual cervical traction, range of motion in right lateral flexion (21.56%) and right rotation (16.14%) showed the greatest percentage improvement when compared to mechanical traction. On the other hand, mechanical cervical traction showed the greatest percentage improvement of range of motion in left lateral flexion (14.89%) and left rotation (17.19%) compared to manual cervical traction. This may be due to the fact that most participants, who received manual cervical traction, presented with a right sided restriction. The same occurred with mechanical cervical traction. Most of the participants in that group presented with a left sided restriction, hence the increase in range of motion in left lateral flexion and left rotation. Most participants in Group 1 presented with right sided restrictions, which resulted in the greatest percentage improvement in right lateral flexion and right rotation. Likewise, most participants in Group 2 presented with left sided restrictions which resulted in the greatest percentage improvement in left lateral flexion and left rotation.

Overall, lateral flexion and rotation had the most percentage improvement which follows the results as mentioned above.
5.7 Conclusion

Group 1 received manual cervical traction, whereas Group 2 received mechanical cervical traction for the treatment of chronic neck pain. Both Group 1 and Group 2 demonstrated a statistically significant and clinical improvement over time.

Both Group 1 and Group 2 received spinal manipulative therapy delivered to the restricted motion segments before cervical traction treatment. The greatest percentage improvement with regards to range of motion was in lateral flexion and rotation. Both groups proved a statistically significant improvement over time with regards to pain and neck disability. As a result it can be concluded that both manual cervical traction and mechanical cervical traction in combination with spinal manipulative therapy prove to be effective in the treatment of chronic neck pain.
CHAPTER SIX – CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The aim of this randomized comparative study was to determine the effect of manual cervical traction versus mechanical cervical traction in the treatment of chronic neck pain.

After this study, it was concluded that both groups demonstrated statistical significant improvement equally in their subjective and objective sensitivity of pain, neck disability and improvement in their cervical spine range of motion. Therefore both treatments are effective in the treatment of chronic neck pain or cervical facet dysfunction. Due to the small sample size of the population used in this study, the subjective and objective data showed very little statistical significance. Both manual cervical traction and mechanical cervical traction in combination with spinal manipulative therapy showed increased percentage improvement over the duration of this study.

According to these results, it can be concluded that either manual cervical traction or mechanical cervical traction can be used as part of a chiropractic treatment protocol to treat chronic neck pain. At the end of this study, it could not be statistically proven whether manual cervical traction is more effective than mechanical cervical traction or vice versa. Any of these two cervical traction techniques in combination with spinal manipulative therapy could be used in a clinical site as both have advantages and disadvantages. It can now be up to the chiropractor’s discretion as to which type of cervical traction technique they choose.

6.2 Recommendations

Improvement of these results for future studies may be accomplished through the following recommendations:
• Use a study that consists of a large population group, therefore more adequate and sufficient data to work with which would result in a statistical significance.

• When the participants are allocated into their specific group, age and gender should be taken into account as this could affect the study.

• The use of control groups who only receives spinal manipulative therapy and the other group who only receives manual/mechanical cervical traction; this will determine whether cervical traction be needed or not.

• Conduct this study with different treatment times; this will determine the adequate time needed to see results.

• Narrow the effects of cervical traction down to only myofascial pain and dysfunction as chronic neck pain includes a wide variety of mechanical neck conditions.

• Conduct this study over a longer period of time to determine the effects of cervical traction in the long term.

• Compare manual cervical traction with mechanical cervical traction without chiropractic manipulative therapy.

• Correlate cervical spine motion segment restrictions to either manual cervical traction or mechanical cervical traction.
REFERENCES


Martini, F.H. *Fundamentals of Anatomy and Physiology.* 7th ed. San Francisco: Peason Education, p. 120.


APPENDIX A

DO YOU SUFFER FROM CHRONIC NECK PAIN????

Get free treatment now !!!!

You may qualify to partake in a research study. If you are between the ages of 18 and 45 and suffering from chronic neck pain, please contact me to schedule your first FREE visit at the Chiropractic Day Clinic at the University of Johannesburg.

Marike Rinke
Cell phone number: 082 310 0722
APPENDIX B

Contra-indications to cervical spine traction: (Wyatt, 2005)

- Spinal cord injuries or compression
- Cervical spine fractures
- Any Malignancies
- Acute inflammation in the cervical spine
- Ruptured ligaments
- Severe Rheumatoid arthritis
- Hypermobility
- Osteoporosis, osteomyelitis
- TMJ pathologies, as manual cervical traction require pressing against the chin
- Abnormal dental occlusions
APPENDIX C

Contra-indications to spinal adjustive therapy: (Esposito & Philipson, 2005)

Vascular causes:
- Vertebrobasilar insufficiency
- Abdominal aortic aneurysm
- Tumours
- Bone infection

Trauma:
- Fractures
- Hypermobility, instability
- Severe sprains

Arthritides:
- Rheumatoid
- Psoriatic
- Ankylosing spondylitis
- Osteoarthritis

Psychological:
- Malingering
- Hysteria
- Dependent personality

Metabolic:
- Clotting disorders
• Osteoporosis

Neurologic:
• Advancing neurological deficit
• Cauda equine syndrome
APPENDIX D

DEPARTMENT OF CHIROPRACTIC

INFORMATION AND CONSENT FORM

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

This study aims to compare the effect of manual cervical traction versus mechanical cervical traction in the treatment of chronic neck pain.

If you suffer from chronic neck pain, you may qualify for this research study and may volunteer to partake. On the first day a complete case history will be taken with a full physical examination and a cervical spine regional examination. You are going to be asked to complete a questionnaire regarding how your neck pain influences your daily living (Vernon-Mior Neck Disability Index). You are also going to be asked to rate your neck pain which you are currently experiencing on a scale from 0-10 (Numerical Pain Rating Scale). A CROM instrument will be used to measure your neck range of motion and the measurements will be recorded. You will receive spinal manipulative therapy to any restrictions found in the cervical spine. You will then either receive manual cervical traction or mechanical cervical traction. Traction is used to separate vertebral joints, decrease pressure on the vertebral discs, and
stretch the neck muscles. You will be required to partake in seven trial sessions, six treatments, over a period of two weeks. On the first, fourth and seventh visit, you will be required to complete the questionnaires, and CROM readings will also be recorded.

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

All procedures will be explained to you and participation is entirely on a voluntary basis; withdrawal at any stage will not cause you any harm. With regards to this particular study, you may experience some discomfort including aggravation of symptoms with muscle stiffness. Benefits include relief of pain, increased range of motion of the cervical spine and improvement of function. After this study is complete, I will provide you feedback regarding the outcomes if you so wish. This study was approved by the University of Johannesburg Health Sciences Ethics Committee.

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.

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researcher</td>
<td>Marike Rinke</td>
<td>082 310 0722</td>
</tr>
<tr>
<td>Supervisor</td>
<td>Dr. C. Bester</td>
<td>011 559 3696</td>
</tr>
</tbody>
</table>
APPENDIX E (Magee, 2008)

Vernon-Mior Neck Disability Index:

<table>
<thead>
<tr>
<th>1. Pain Intensity</th>
<th>6. Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have no pain at the moment.</td>
<td>I can concentrate fully when I want to with no difficulty.</td>
</tr>
<tr>
<td>The pain is very mild at the moment.</td>
<td>I can concentrate fully when I want to with slight difficulty.</td>
</tr>
<tr>
<td>The pain is moderate at the moment.</td>
<td>I have a fair degree of difficulty in concentrating when I want to.</td>
</tr>
<tr>
<td>The pain is fairly severe at the moment.</td>
<td>I have a lot of difficulty in concentrating when I want to.</td>
</tr>
<tr>
<td>The pain is the worst imaginable at the moment.</td>
<td>I have a great deal of difficulty in concentrating when I want to.</td>
</tr>
<tr>
<td></td>
<td>I cannot concentrate at all.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Personal Care</th>
<th>7. Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can look after myself normally without causing extra pain.</td>
<td>I can do as much work as I want to.</td>
</tr>
<tr>
<td>I can look after myself normally but it causes extra pain.</td>
<td>I can do my usual work, but no more.</td>
</tr>
<tr>
<td>It is painful to look after myself and I am slow and careful.</td>
<td>I can do most of my usual work, but no more.</td>
</tr>
<tr>
<td>I need some help but manage most of my personal care.</td>
<td>I cannot do my usual work.</td>
</tr>
<tr>
<td>I need help every day in most aspects of self care.</td>
<td>I can hardly do any work at all.</td>
</tr>
<tr>
<td>I do not get dressed, I wash with difficulty and stay in bed.</td>
<td>I cannot do any work at all.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Lifting</th>
<th>8. Driving</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can lift heavy weights without extra pain.</td>
<td>I can drive my car without any neck pain.</td>
</tr>
<tr>
<td>I can lift heavy weights but it gives me extra pain.</td>
<td>I can drive my car as long as I want with slight pain in my neck.</td>
</tr>
<tr>
<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>
<td>I can drive my car as long as I want with moderate pain in my neck.</td>
</tr>
<tr>
<td>Pain prevents me from lifting heavy weights, but I can manage to lift medium weights if they are conveniently positioned.</td>
<td>I cannot drive my car as long as I want because of moderate pain in my neck.</td>
</tr>
<tr>
<td>I can lift very light weights.</td>
<td>I can hardly drive at all because of severe pain in my neck.</td>
</tr>
<tr>
<td>I cannot lift or carry anything at all.</td>
<td>I cannot drive my car at all.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Reading</th>
<th>9. Sleeping</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can read as much as I want to with no pain in my neck.</td>
<td>I have no trouble sleeping.</td>
</tr>
<tr>
<td>I can read as much as I want to with slight pain in my neck.</td>
<td>My sleep is slightly disturbed (less than 1 hour sleepless).</td>
</tr>
<tr>
<td>I can read as much as I want to with moderate pain in my neck.</td>
<td>My sleep is mildly disturbed (1-2 hours sleepless).</td>
</tr>
<tr>
<td>I cannot read as much as I want, because of moderate pain in my neck.</td>
<td>My sleep is moderately disturbed (2-3 hours sleepless).</td>
</tr>
<tr>
<td>I can hardly read at all because of severe pain in my neck.</td>
<td>My sleep is greatly disturbed (3-5 hours sleepless).</td>
</tr>
<tr>
<td>I cannot read at all.</td>
<td>My sleep is completely disturbed (5-7 hours sleepless).</td>
</tr>
</tbody>
</table>
5. Headaches
   - I have no headaches at all.
   - I have slight headaches that 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.

10. Recreation
    - I am able to engage in all my recreational activities with no neck pain at all.
    - I am able to engage in all my recreational activities, with some pain in my neck.
    - I am able to engage in most but not all, of my usual recreational activities because of pain in my neck.
    - I am able to engage in a few of my usual recreational activities because of pain in my neck.
    - I can hardly do any recreational activities because of pain in my neck.
    - I cannot do any recreational activities at all.
APPENDIX F

Name : ______________________________
File nr : ________________
Group : ________________

Numerical Pain Rating Scale

This is a scale of 0 to 10. A score of 0 indicate no pain at all. A score of 10 indicate the worse pain you have ever felt in your life. Please mark with a cross how you would describe your neck pain at the moment.

Visit 1

Date : ________________

<table>
<thead>
<tr>
<th>0)</th>
<th>1)</th>
<th>2)</th>
<th>3)</th>
<th>4)</th>
<th>5)</th>
<th>6)</th>
<th>7)</th>
<th>8)</th>
<th>9)</th>
<th>10)</th>
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Visit 4

Date : ________________

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<th>3)</th>
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<th>5)</th>
<th>6)</th>
<th>7)</th>
<th>8)</th>
<th>9)</th>
<th>10)</th>
</tr>
</thead>
</table>

Visit 7

Date : ________________

| 0) | 1) | 2) | 3) | 4) | 5) | 6) | 7) | 8) | 9) | 10) |
**APPENDIX G**

Name: ___________________________
File nr: __________________
Group: __________________

**CROM MEASUREMENTS (DEGREES)**

<table>
<thead>
<tr>
<th>Movements</th>
<th>1st VISIT</th>
<th>4th VISIT</th>
<th>7th VISIT</th>
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<tbody>
<tr>
<td>Flexion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Rotation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Rotation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Lateral Flexion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Lateral Flexion</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**APPENDIX H (summary)**

Name: _________________________________
File nr: ________________
Group: ________________

**NECK DISABILITY INDEX SCORING CHART**

<table>
<thead>
<tr>
<th></th>
<th>1ST VISIT</th>
<th>4TH VISIT</th>
<th>7TH VISIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDI SCORE (%)</td>
<td></td>
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</table>

**NUMERICAL PAIN RATING SCALE SCORING CHART**

<table>
<thead>
<tr>
<th></th>
<th>1ST VISIT</th>
<th>4TH VISIT</th>
<th>7TH VISIT</th>
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APPENDIX I – CASE HISTORY FORM

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

CASE HISTORY

Date: ________________

Patient: ___________________________ File No: ___________

Age: _____   Sex: _________   Occupation: _______________

Student: ___________________________ Signature: ___________________________

Complies with Inclusion criteria of the research:

Clinician: ___________________________ Signature: ___________________________

Examination:

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X-ray Studies:

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Clinical Path. Lab:

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<tr>
<td>Other</td>
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</table>

Case status:

PTT: Conditional: Signed off: Final sign out:

Recommendations:
**Students case history**

1. *Source of history:*

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

3. *Present illness:*
   
   **Location**

   **Onset**

   **Duration**

   **Frequency**

   **Pain (character)**

   **Progression**

   **Aggravating factors**

   **Relieving factors**

   **Associated Sx’s and Sg’s**

   **Previous occurrences**

   **Past treatment and outcome**
4. *Other complaints:*

5. *Past history*
   - General health status
   - Childhood illnesses
   - Adult illnesses
   - Psychiatric illnesses
   - Accidents/injuries
   - Surgery
   - Hospitalisation

6. *Current health status and lifestyle*
   - Allergies
   - Immunizations
   - Screening tests
   - Environmental hazards
   - Safety measures
   - Exercise and leisure
   - Sleep patterns
   - Diet
   - Current medication
   - Tobacco
   - Alcohol
   - Social drugs
7. Family history:
   Immediate family:
   Cause of death
   DM
   Heart disease
   TB
   HBP
   Stroke
   Kidney disease
   CA
   Arthritis
   Anaemia
   Headaches
   Thyroid disease
   Epilepsy
   Mental illness
   Alcoholism
   Drug addiction
   Other

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

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

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

(NOTE: only if Cervical Spine Regional is complete)

Underline abnormal findings in **RED**.

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<th>File No:</th>
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<tr>
<td>Student:</td>
<td>Signature:</td>
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</table>

Date: ________________

Height: __________
Weight: __________
Temp: __________

Rates: Heart: __________
Pulse: __________
Respiration: __________

<table>
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<tr>
<th>Blood pressure:</th>
<th>Arms:</th>
<th>L</th>
<th>R</th>
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<tbody>
<tr>
<td></td>
<td>Legs:</td>
<td>L</td>
<td>R</td>
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General Appearance:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

1
STANDING EXAMINATION

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

5. Romberg’s sign
6. Pronator drift
7. Trendelenburg’s sign
8. Gait: - rhythm
   - balance
   - pendulousness
   - on toes
   - on heels
   - tandem
9. Half squat
10. Scapular winging
11. Muscle tone
12. Spasticity/Rigidity
13. Shoulder:
   - skin symmetry
   - ROM
   - glenohumeral
   - scapulo-thoracic
   - acromioclavicular
   - elbow
   - wrist

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

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<tr>
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<tbody>
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15. Visual acuity

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

**SEATED EXAMINATION**

1. Spinal posture
2. Head
   - hair
   - scalp
   - skull
   - face
   - skin

3. Eyes:
   Observation
   - conjunctiva
   - sclera
   - eyebrows
   - eyelids
   - lacrimal glands
   - nasolacrimal duct
   - position and alignment
   - corneas and lenses

- corneal reflex
- ocular movement

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<td>III</td>
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<td>IV</td>
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- visual fields
- accommodation
- Ophthalmoscopic
- Examination
  - iris
  - pupils
  - red reflex
  - optic disc
  - vessels
  - general background
4. Ears:
   • Inspection
     - auricle
     - ear canal
     - drum
     - auditory acuity
     - Weber test
     - Rinne test

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

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

7. Mouth and pharynx:
   • lips
   • buccal mucosa
   • gums and teeth
   • roof
   • tongue
     - inspection
     - movement
     - taste
     - palpation
   • pharynx
     - CN X
     - inspection
     - carotid arteries (thrills, bruit)
     - Cranial Nerves
       - CN V
       - CN VII
       - CN VIII (nystagmus)
       - CN IX
       - CN XI
       - CN X11

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

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

10. Musculoskeletal:
   (i) ROM
   • hip

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   | plantar Flex | L   | R   |
   |              |     |     |
   | dorsiflex    | 45  |     |
   | inversion     | 20  |     |
   | eversion      | 30  |     |

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<th>Apparent Actual</th>
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</table>

• knee
• ankle

(ii) leg length

• Co-ordination  
  - point to point  
  - dysdiachokinesia

9. TMJ
• Inspection  
  - ROM  
  - deviation
• Palpation  
  - crepitus  
  - tenderness
10. Thorax
   - Inspection
     - skin
     - shape
     - respiratory distress
     - rhythm (respiratory)
     - depth (respiratory)
     - effort (respiratory)
     - intercostals/supraclavicular retraction
   - Palpation
     - tenderness
     - masses
     - respiratory expansion
     - tactile fremitus
   - Percussion
     - lungs (posterior)
     - diaphragmatic excursion
     - kidney punch
   - Auscultation
     - (i) breath sounds
       - vesicular
       - bronchial
     - (ii) adventitious sounds
       - crackles (rales)
       - wheezes (rhonchi)
       - rubs
     - (iii) voice sounds
       - broncophony
       - whispered pectoriloquy
       - egophony
   - Cardiovascular
     - auscultation (aortic murmurs)
     - Allen’s test

**SUPINE EXAMINATION**

1. JVP
2. PMI
3. Auscultation heart
   (L. lat. Recumbent)
4. respiratory excursion
5. percussion chest
   (anterior)
6. breast palpation
7. Abdominal Examination
   - Inspection
     - skin
     - umbilicus
     - contour
     - peristalsis
     - pulsations
     - hernias (umbilical/incisional)
• Auscultation
  - bowel sound
  - bruit

• Percussion
  - general
  - liver
  - spleen

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

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

Mental Status

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

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

(ii) Mood

(v) Memory and attention
  • orientation (time, place, person)
  • remote memory
(vi) Higher cognitive functions

- recent memory
- new learning ability
- information and vocabulary
- (general and specialised knowledge)
- abstract thinking

### Neurological Examination (Lumbar Spine)

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<th>Right</th>
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<td>Hip Flexion (L1/L2)</td>
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<td>Patellar (L3, 4)</td>
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<td>Medial Hamstring (L5)</td>
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<td>Hip Int. Rot (L4/L5)</td>
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<td>Hip Ext. Rot (L5/S1)</td>
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<td>Hip Adduction (L2, 3, 4)</td>
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APPENDIX K – CERVICAL SPINE REGIONAL EXAMINATION FORM

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

REGIONAL EXAMINATION
CERVICAL SPINE

Date: ______________________
Patient: ______________________ File No: ________________
Clinician: ______________________ Signature: ________________
Student: ______________________ Signature: ________________

OBSERVATION
• Posture
• Size
• Swellings
• Scars
• Discolouration
• Hairline
• Bony and soft tissue contours
• Shoulder level
• Muscle spasm
• Facial expression

5. RANGE OF MOTION

Flexion = 45° - 90°
Extension = 55° - 70°
L/R Rotation = 70° - 90°
L/R Lat Flexion = 20° - 45°
PALPATION
- Lymph nodes
- Trachea
- Thyroid gland
- Pulses/thrills
- Tenderness
- Muscle Tone
- Active MF Trigger Points
  - SCM
  - Trapezius
  - Scaleni
  - Levator Scapulae
  - Posterior Cervical musculature

ORTHOPAEDIC EXAMINATION
1. Doorbell Sign
2. Max. Cervical Compression
3. Spurling’s manoeuvre
4. Lateral Compression (Jackson’s test)
5. Kemp’s Test
6. Cervical Distraction
7. Shoulder abduction Test
8. Shoulder depression Test
9. Dizziness rotation Test
10. Lhermitte’s Sign
11. O’ Donoghue Manoeuvre
12. Brachial Plexus Tension
13. Carpal tunnel syndrome:
   - Tinel’s sign
   - Phalen’s Test
14. TOS:
   - Halstead’s test
   - Adson’s test
   - Eden’s (traction) test
   - Hyperabduction (Wright’s) test – Pec minor
   - Costoclavicular test

Remarks:

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<td>WALLENBERG’S TEST</td>
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COMMENTS:

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__________________________
__________________________
### MOTION PALPATION

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### NEUROLOGICAL EXAMINATION

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<th>REFLEXES</th>
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<td>Lat. Neck Flexion</td>
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**APPENDIX L – SOAP NOTE FORM**

**CHIROPRACTIC DAY CLINIC**

**SOAP NOTE:**

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<td>O:</td>
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| A:         | P:        |

**Comments:**

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Group 1: Manual cervical traction; Group 2: Mechanical cervical traction

Gender: 1 – Female, 2 – Male

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