CHIROPRACTIC MANIPULATIVE THERAPY AND STRIPPING MASSAGE OF THE STERNOCLEIDOMASTOID FOR THE TREATMENT OF CHRONIC MECHANICAL NECK PAIN AND ITS EFFECT ON HEAD REPOSITIONING ACCURACY.

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

Greyling Charl Botha

(Student number: 200814284)

Supervisor: ________________ **Date:** ____________

Dr Moodley

DECLARATION

I, Greyling Charl Botha, declare that this dissertation is my own, unaided work. It is being submitted as partial fulfilment of the Master's Degree in Technology, in the program of Chiropractic at the University of Johannesburg. It has not been submitted before for any degree or examination in any other Technikon or University.

____

Greyling Charl Botha

On this day the ______ of the month of ______ 2013

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TO WHOM IT MAY CONCERN

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ID number **8801295050085** Student number **200814284** enrolled student for the Qualification MTech Chiropractic Faculty of Health Sciences,

Herewith declare that my academic work is in line with the Plagiarism Policy of the University of Johannesburg. I further declare that the work presented in *Chiropractic Manipulative Therapy and Stripping Massage of the Sternocleidomastoid for the treatment of Chronic Mechanical Neck Pain and its Effect on Head Repositioning Accuracy* (dissertation) is authentic and original, and that there is no copyright infringement in the work. I declare that no unethical research practices were used or material gained through dishonesty. I understand that plagiarism is a serious offence.

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ABSTRACT

Purpose: The aim of this study was to compare the effects of chiropractic manipulative therapy with and without stripping massage of the sternocleidomastoid, with regards to pain, disability, cervical range of motion and head repositioning accuracy in the treatment of chronic mechanical neck pain. The aim was determined by using the Vernon-Mior Neck Pain and Disability Index, Numerical Pain Rating Scale and the Cervical Range of Motion measuring instrument (CROM).

Method: The study consisted of thirty participants that had an equal male to female distribution. An age range was set and individuals had to be between eighteen and fourty. Participants were chosen according to inclusion and exclusion criteria that were set before the study commenced. Treatment received by the participants was dependent on which group they were allocated to. Group One received just chiropractic manipulative therapy to three restricted segments of the cervical spine. Group Two also received chiropractic manipulative therapy to three restricted cervical segments and had stripping massage of both sternocleidomastoid muscles.

Procedure: Treatment consisted of six treatments sessions and with the seventh visit only readings were taken. Treatments were carried out twice weekly so that the treatment time period fell over a three week study period. Participants were asked to complete the subjective data before the first, fourth and seventh visit. Subjective data was gathered by using the following: Numerical Pain Rating Scale and a Vernon-Mior Neck and Pain Disability Index Questionnaire. The objective data that was recorded by the researcher consisted of the cervical range of motion that was gathered by using the Cervical Range of Motion (CROM) machine and the head repositioning accuracy. Participants then received either chiropractic manipulative therapy to the restricted cervical spinal segments or a combination of stripping massage to the sternocleidomastoid muscles as well as chiropractic manipulative therapy, depending on their group allocation. All data gathered by the researcher and then analysed by a statistician at the University of Johannesburg.

Results: Significant findings for the group which just received chiropractic manipulative therapy were present for the Numerical pain rating scale and Vernon-Mior Neck Pain and Disability Index. The group that received both chiropractic manipulative therapy and stripping massage of both sternocleidomastoid muscles had statistical significant values for the Numerical pain rating scale, Vernon-Mior Neck Pain and Disability Index, flexion as well as rotation and lateral flexion to the left. Thus the group that received both therapies had significant improvements in pain, disability and certain cervical range of motions. Therefore, the combined treatment group had a greater clinical effect compared to the group that only received chiropractic manipulative therapy.

Conclusion: Results of this study suggest that chiropractic manipulative therapy in combination with stripping massage is more beneficial in treating chronic cervical pain as well as improving cervical range of motion and head repositioning accuracy (proprioception). Thereby, concluding that the adjusting and stripping massage group overall had superior improvement in all subjective and objective clinical findings. The possible outcome/effect for the chiropractic profession suggests that chiropractic manipulation therapy in combination with stripping massage of the sternocleidomastoid muscle is sufficient in the treatment of chronic cervical neck pain as well as dysfunctional proprioception, if compared to just utilising chiropractic manipulative therapy. This provides an additional treatment modality for chiropractors to allow treatment protocols to be as effective as they can be.

DEDICATIONS

I dedicate this research to my parents, Barend and Hantie, thank you for your continuous support, love and encouragement; without your financial support and unconditional love this would not have been possible.

I would also like to thank my brothers and friends for being there throughout my studying career with your unwavering support and guidance, the journey to completing my dissertation was made much easier.

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INTRODUCTION

1.1 The Problem Statement

Neck pain commonly occurs in middle-aged individuals and it decreases in frequency with increasing age. Numerous structures can be involved and these include the cervical musculature as well as proprioceptive organs (Humphreys, 2008). In 55% of the patients suffering from mechanical neck pain, the facets are considered as the primary cause (Manchikanti, Boswell, Singh, Pampati, Damran & Beyer, 2004). Douglas-Phillips, Froese, Lorenzo, Childers, Faye and Talavera (2012) found that muscles are also a common cause of pain and disability.

When kinaesthetic sensibility is dysfunctional, it can result in movement irregularities; changes in muscle spindle discharge and it can also affect the central output of the nervous system (Cheng, Wang, Lin, Wang & Lin, 2010). The kinaesthetic sensibility co-ordinates movements of the trunk, head and the extremities. The sternocleidomastoid plays an important role in proprioception (kinaesthetic sensibility). It also plays a large role in controlling the movement of the head and neck. When this muscle is in a dysfunctional state with multiple trigger points it tends to lead to a wide pain referral pattern and proprioceptive symptoms which include spatial disorientation (Simons, Travell & Simons, 1999).

Stripping massage is an effective technique for the treatment of myofascial central trigger points and therefore is effective in treating myofascial dysfunctional syndromes. This technique is also known as deep-stroking massage as described by Simons *et al.,* (1999) and consists of deep-stroking over the muscle belly that allows the dysfunctional muscle to return to its normal length and function. Chiropractic manipulative therapy has been found to have documented positive effects on the proprioceptive system within the cervical spine (Palmgren, Sandstorm, Lundquist & Heikkila, 2006). Assendelft, Morton, Yu , Suttorp & Shekelle (2004) proved within a study conducted that manipulative therapy is effective in decreasing pain and increasing an individual's ability to perform everyday activities.

1.1 Aim

The aim of this study was to compare the effects of chiropractic manipulative therapy with and without stripping massage of the sternocleidomastoid, with regards to pain, disability, cervical range of motion and head repositioning accuracy in the treatment of chronic mechanical neck pain. The aim was determined by using the Vernon-Mior Neck Pain and Disability Index, Numerical Pain Rating Scale and the Cervical Range of Motion Measuring Instrument (CROM).

1.2 Benefits of the Study

This study would determine which treatment protocol in the form of chiropractic manipulative therapy to the cervical spine or the combination of stripping massage of the sternocleidomastoid muscle and manipulative therapy would be better suited for the treatment of chronic mechanical neck pain. Research has shown that chiropractic manipulative therapy and stripping massage (Simons *et al*., 1999) can positively affect neck pain on their own. Thus with the results of this study, combining the two treatments may provide the Doctors of Chiropractic with an additional treatment protocol for the management of chronic mechanical neck pain.

CHAPTER TWO:

LITERATURE REVIEW

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The main focus of the study was to determine which treatment protocol in the form of chiropractic manipulative therapy to the cervical spine or stripping massage of the sternocleidomastoid in combination with chiropractic manipulative therapy would be better suited for the treatment of chronic mechanical neck pain. Thus in order to provide a clearer background of this study, the literature review will discuss the following core constructs namely: anatomy and biomechanics of the cervical spine, chiropractic manipulative therapy, sternocleidomastoid muscle, stripping massage, proprioception of the cervical spine and finally chronic neck pain.

The cervical spine consists of seven vertebrae which permits optimum mobility without decreasing the stability of the cervical spine. It can be divided into two segments and this is determined by the vertebrae's different morphology and physiology (Middleditch & Oliver, 2005). All the vertebrae function together to protect the neurological as well as vascular structures (Eriksen, 2004). To fully comprehend normal function or abnormal function of the cervical spine, a good understanding of basic biomechanics is needed. Biomechanics can be defined as applying mechanical principles to biological problems. Having a clear understanding of basic biomechanics will allow a practitioner to become more efficient in diagnosing and treating (Gatterman, 2004).

Chiropractic manipulative therapy is mainly focused around the adjustment to return normal biomechanical functioning. It uses controlled force, leverage, direction, amplitude and velocity to specific joints or anatomic regions (Gatterman, 2004). As a profession the main focus is placed upon the musculoskeletal system (Bergmann & Peterson, 2011).

Another important aspect of this study is the soft tissue technique that will be utilised to treat the sternocleidomastoid. Massage is a well-known and studied manual therapy which focuses on various tissues (Salvo, 2012). There is a variety of techniques that can be utilised but this study will be focusing on stripping massage. Stripping massage is also known as a deep stroking technique; this technique is widely accepted as a treatment for the release of central trigger points (Simons *et al.,* 1999). The sternocleidomastoid which will be treated, contributes significantly to spatial orientation as well as weight perception. Due to its function and repetitive use, the muscle is frequently affected by multiple myofascial trigger points (Simons, *et al.*, 1999).

Similar to spatial orientation loss, as in the case of a dysfunctional sternocleidomastoid, when the kinaesthetic sensibility is dysfunctional it results in movement irregularities; changes in muscle spindle discharge and it can also affect the central output of the nervous system (Cheng *et al.,* 2010). Kinaesthetic sensibility is defined as the ability to judge joint position within space, which is important for coordinated movements of the head, trunk and extremities.

Neck pain commonly occurs in middle-aged individuals and it decreases in frequency with increasing age. With chronic mechanical neck pain numerous structures can be involved and these include the cervical musculature as well as proprioceptive organs (Humphreys, 2008). In 55% of the patients suffering from mechanical neck pain, the facets are considered as the primary cause (Manchikanti, *et al*., 2004).

2.2 Functional Anatomy of the Cervical Spine

2.2.1 Cervical Vertebrae

The neck is formed by seven of the twenty four moveable vertebrae; these seven vertebrae are the smallest in size compared to the rest (Moore & Dalley, 2006). Having a smaller volume indicates that they play a smaller role in weight bearing than the lower segments of the spine such as the thoracic and lumbar vertebrae. When compared to the lower segments of the spine the intervertebral discs seem smaller but when compared to the vertebral body size the ratio indicates that they are of significant volume. The large discs, horizontal orientated facets and small amount of body mass surrounding the cervical vertebrae, allow them to have significant mobility compared to the rest of the spine (Moore & Dalley, 2006).

There are a number of anatomical features that differentiate the cervical vertebrae from the lumbar as well as thoracic vertebrae. The transverse foramen being the most distinctive feature, this foramen contains the vertebral artery. Only the seventh cervical vertebra (C7) lacks the vertebral artery, but instead transmits an accessory vein but at times the transverse foramen can be absent from this vertebra (Moore & Dalley, 2006).

The cervical spine is divided into two segments namely the upper and lower, these are distinguished from one another by unique morphological and physiological features (Middleditch & Oliver, 2005). The upper segment acts as a transitional zone from the skull to the cervical spine, this segment contains the atlanto-occipital and atlanto-axial articulations. The lower segment consists mainly of typical vertebrae, these are the third to the seventh vertebrae, although, they are said to be typical; they still differ in certain features from other vertebrae (Bergmann & Peterson, 2011).

2.2.2 Atypical Cervical Vertebrae

The two most superior vertebrae known as the atlas and axis are known as your atypical vertebrae in the cervical spine. They differ in shape and function when compared to the rest of the cervical spine. Two articulations are formed between them namely the atlanto-occipital and atlanto-axial joints and these joints play a role in carrying the head and determining the movement of the head. Although they play an important weight bearing and dynamic role they also protect intimate neurological and vascular structures (Eriksen, 2004).

The atlas which is depicted in Figure 2.1 below, is the most superiorly situated vertebra and is ring shaped. The atlas is atypical because it lacks a body as well as a spinous process. This atypical vertebra consists of two lateral masses which bears the weight of the skull via two kidney shaped articular surfaces. These articulating surfaces are situated on the superior surface of the lateral masses (Moore & Dalley, 2006). The lateral masses are actually enlarged pedicles and also bear an articular facet on the inferior surface. These articulating facets form the atlanto-axial joint (Bergman & Peterson, 2011). Each transverse process arises from a respective lateral mass and thus is situated more laterally than any other transverse process in the cervical spine (Moore & Dalley, 2006).

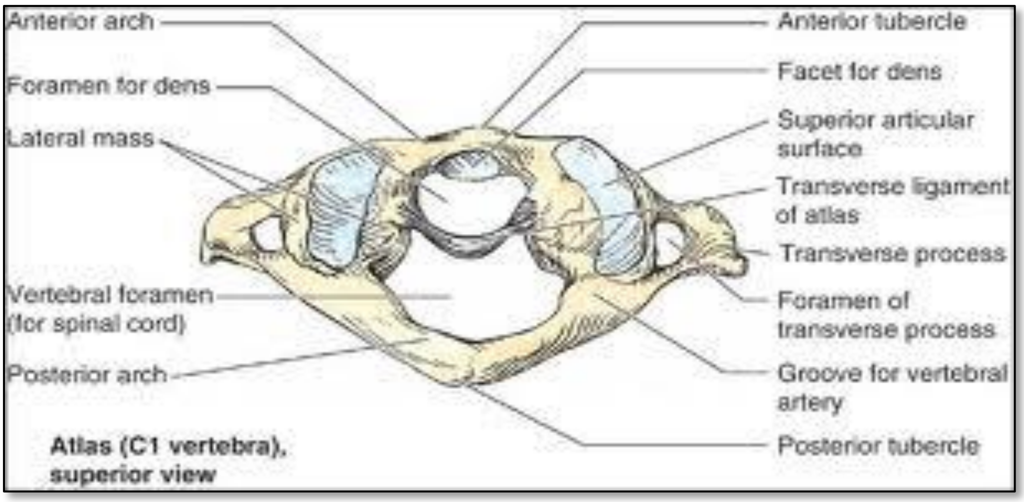


Figure 2.1: Superior View of the Atlas C1 (Netter, 2006)

An anterior and posterior arch also forms part of the atlas. The anterior arch is convex anteriorly and becomes thickened and roughened in the midline and this is known as the anterior tubercle. On the dorsal surface there is an articular surface that forms an articulation with dens of the axis (Middleditch & Oliver, 2005). The posterior arch which represents the lamina of typical vertebrae is concave posteriorly (Moore & Dalley, 2006). A tubercle is also present on the posterior arch and acts as a spinous process for the atlas. The anterior and posterior tubercles are attachment sites for various muscles and ligaments which will be discussed later in this chapter (Eriksen, 2004). As a whole the posterior arch is wider when compared to the anterior arch (Middleditch & Oliver, 2005). The posterior arch contains a groove that transmits the vertebral artery and nerve root of C1 (Moore & Dalley, 2006).

The axis (refer to Figure 2.2) which is also known as the second cervical vertebrae is the strongest of all cervical vertebrae. It contains two flat superior articulating surfaces which form an articulation with the atlas (Moore & Dalley, 2006). The inferior articulating facets arise from the junction of the pedicle and lamina, these facets face downwards and forwards similar to a typical cervical vertebrae (Middleditch & Oliver, 2005).

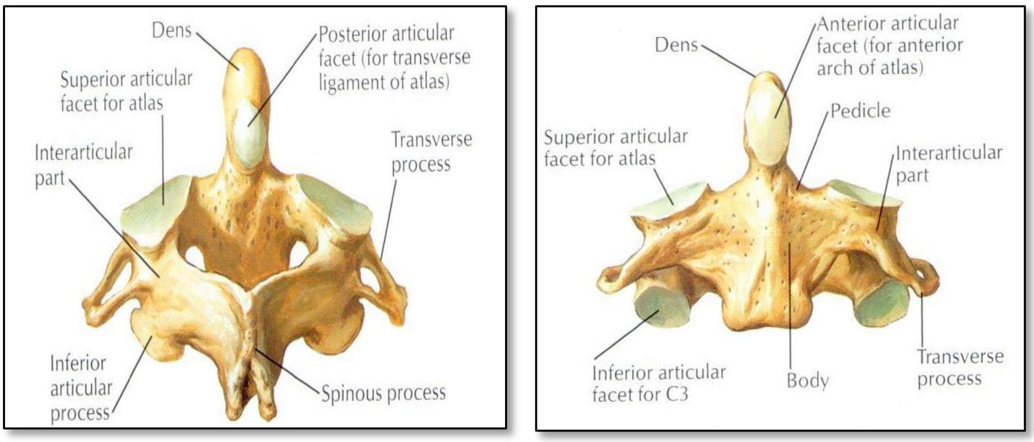


Figure 2.2: Anterior and Posterior View of the Axis (Netter, 2006)

A unique structure of the axis is the dens also referred to as the odontoid process. The odontoid process is in actual fact the remnant of the atlas's body (Eriksen, 2004). This structure projects superiorly from the body of the axis and acts as a pivot, around which the atlas rotates (Refer to Figure 2.2). At the base of the odontoid process it becomes narrow and it is here where the transverse ligament of the atlas passes behind the odontoid process and functions to prevent posterior displacement of the atlas on the axis (Moore & Dalley, 2006). On the anterior surface of the odontoid process there is an oval articulating surface where it articulates with the anterior arch of the atlas. One other differentiating factor is that it has a large bifid spinous process when compared to other vertebrae (Middleditch & Oliver, 2005).

2.2.3 Typical cervical vertebrae

Typical vertebrae in the cervical spine consist of vertebrae three to seven (C3-C7). From the second vertebrae, intervertebral discs start to appear and are then present between subsequent vertebrae. The intervertebral discs have considerable volume owing to a quarter of the cervical spine length and allow a vast amount of movement. Features of a typical cervical vertebrae as stated by Moore & Dalley (2006):

Table 2.1 The Distinctive Features of the Cervical Vertebrae (Moore & Dalley, 2006)

Parts	**Characteristics**
Body	Small and wider from side to side than anteriorposteriorly; superior surface concave with uncus of body; inferior surface convex.
Vertebral foramen	Large and triangular.
Transverse	Transverse small and absent in C7; vertebral arteries and

processes	accompanying venous and sympathetic plexuses pass through foramina, except C7 which transmits only small accessory vertebral veins: anterior and posterior tubercles.
Articular Processes	Superior facets directed superiorposteriorly; inferior facets directed inferioranteriorly; obliquely placed facets are most nearly horizontal in this region.
Spinous processes	Short (C3-C5) and bifid (C3-C6); process of C6 long, that of C7 is longer (Thus C7 called “vertebra prominence”).

The typical vertebrae consists of a body anteriorly and a posterior arch. Compared to the rest of the spine the vertebral bodies are the smallest but they contain the largest vertebral foramen (Middleditch & Oliver, 2005). The enlargement of the vertebral foramen is due to the spinal cord also becoming larger at this point and is mainly because the upper limb receives its innervation from this level (Moore & Dalley, 2006).

Typical vertebrae are cylindrical in shape and are superiorly and transversely concave and convex anteriorposteriorly. Either side contains a prominence known as uncinate processes. The uncinate processes form an articulation with the inferior surface of the superior vertebrae’s body and these articulations are referred to as the uncovertebral joints or joints of Luschka (Middleditch & Oliver, 2005). These articulations give stability as well as strength to the lower cervical articulations (Bergmann & Peterson, 2011).

The posterior arch consists of a number of elements namely the pedicles, articular processes, lamina and spinous processes (Middleditch & Oliver, 2005). The pedicles which are short and thick project posteriorlaterally from the vertebral bodies. They arise midway between the superior and inferior vertebral plateaus (Levangie & Norkin, 2011). Lamina arise from the pedicles and project posterior medially where they meet and complete the posterior arch (Middleditch and Oliver, 2005). Where the lamina and the pedicles meet, the superior and inferior articulating processes arise.

The superior articulating process contains a small oval articulating facet that faces backwards and upwards while the inferior articulating facet faces forwards and downwards (Levangie & Norkin, 2011).

Continuation of the joined lamina forms the spinous processes, these processes are short and bifid and unequal in size. With progression down the cervical spine they increase in size up to the seventh vertebra where it is the longest and known as the vertebral prominence (Middleditch & Oliver, 2005).

The most distinctive feature of the cervical vertebrae resides in the transverse processes. These processes arise from two areas which are anteriorly from the vertebral body and posteriorly from the articulating processes. They project posteriorly and laterally and they then become bifid with an anterior and posterior tubercle (Middleditch and Oliver, 2005). Transverse processes of vertebral levels C3 to C6 contain a transverse foramen that contains the vertebral artery, venous and sympathetic plexuses (Levangie & Norkin, 2011). The seventh vertebrae is not mentioned because there might or might not be a transverse foramen as mentioned above.

2.2.4 Zygapophyseal joints

Zygapophyseal joints which are also called the facet joints form part of the posterior articulations. As mentioned by Gatterman (2004), the zygapophyseal joints carry 30% of the weight subjected to the cervical spine. They are paired true diarthrodial joints that consist of articular cartilage, a loose capsule, reinforcing ligaments and related muscles (Gatterman, 2004). Levangie & Norkin (2011) state that these are true synovial joints that contain fibroadipose meniscoids and that although the capsules are loose they limit extreme range of motion as well as allow a large range of motion. These capsules are also continuous anteriorly with the ligamentum flavum and posteriorly the capsule becomes thin and fibrous and is enclosed by the deep cervical musculature (Middleditch and Oliver, 2005).

The joints are formed by the superior articular process of the inferior vertebrae and the inferior articulating process of the superior vertebra (Bergmann & Peterson, 2011). These joints lie at a 45 degree angle between the coronal and transverse planes. They allow a gliding movement between adjacent vertebrae (Moore & Dalley, 2006). The inferior facet of the superior vertebra faces forward and downwards while the superior vertebra facets face backwards and upwards (Middleditch and Oliver, 2005). As with the facets facing in corresponding directions they are also reciprocally concave and convex. The zygapophyseal joints allow flexion, extension, rotation and lateral flexion and this is all determined by the orientation of the true synovial joints.

2.2.5 Uncovertebral joints

The uncovertebral joints are said to be synovial saddle joints, they are formed by the superior vertebra's concave inferior surface and the convex superior surface of the inferior vertebra (Levangie & Norkin, 2011). Although the joints are called synovial joints they do not have a joint capsule as mentioned by Bergmann & Peterson (2011). The convex surface of the inferior vertebra is formed by the uncinate processes that develop on the anterior and lateral surface of cervical vertebrae three to six (Middelditch & Oliver, 2005).

The articular surface is covered by fibrocartilage and is situated in the inferolateral surface of the disc (Moore & Dalley, 2006). A moist film tends to cover the articulating surfaces and this is obtained from the interdisposed space. These joints allow gliding movements in flexion and extension and to a lesser extent translatory movements (Levangie & Norkin, 2011). Degeneration in the form of spurs is a common occurrence at the uncovertebral joints and is a major cause of neck pain (Moore & Dalley, 2006).

2.2.6 Intervertebral discs

The intervertebral discs are found in between the two vertebrae and are attached to the vertebral endplates via the annulus fibrosus (Levangie & Norkin, 2011). Intervertebral discs function to increase cervical motion and separate vertebral bodies from each other to avoid neural or vascular impingement (Waldman, 2009). Another main function of the intervertebral disc is to absorb shock that is placed on the vertebrae (Gatterman, 2004). It consists of three parts which are the annulus fibrosus, nucleus pulposus and the vertebral endplate (Levangie & Norkin, 2011).

The nucleus pulposus consists of 70-80% of water and as you move out towards the external part of the intervertebral disc the water density decreases to 60-70%; this indicates the different functions of the different parts (Levangie & Norkin, 2011). The nucleus pulposus consists of a viscous fluid to allow it to absorb shock and give it an elastic rebound quality that will allow the disc to regain its normal shape after deformation (Gatterman, 2004). For both of the functions mentioned prior, the intradiscal pressure needs to be maintained and this is another function of the nucleus pulposus (Waldman, 2009). The annulus fibrosus consists of less water but more dry weight in the form of type 1 collagen fibres (Levangie & Norkin, 2011) and this gives it a large amount of tensile strength as well as flexibility (Waldman, 2009).

Last to be discussed are the vertebral endplates which cover the superior and inferior part of the vertebral body. They consist mainly of hyaline cartilage and fibrocartilage and are attached more firmly to the intervertebral disc than the vertebral body. Thereby it is considered more part of the disc than that of the vertebral body itself (Levangie & Norkin, 2011). The disc receives its nutrition mainly via diffusion from the metaphyseal blood vessels that form a capillary network in the vertebral endplate as well as subchondral bone (Levangie & Norkin, 2011). To receive nutrition via diffusion the spine needs to move, when spinal motion is limited the normal fluid distribution is inhibited and thereby degeneration takes place (Gatterman, 2004).

2.2.7 Muscles of the cervical spine

The muscles of the cervical spine especially of the upper cervical spine play a supportive role as well as allowing intricate movement (Eriksen, 2004). As mentioned by Levangie & Norkin (2011) the craniocervical muscles play an important role of positioning the sensory organs so that they are optimally placed and this includes rapid, coordinated movements. Within the upper cervical spine various ligaments are lax and therefore the muscles play a role in stabilising the cervical spine (Eriksen, 2004). The deep muscles of the vertebral column mainly act as postural muscles and they function to control and direct the long superficial muscles to carry out their functions efficiently (Gatterman, 2004).

In the cervical spine the line of gravity passes anterior to the axis of rotation and thereby there is always a flexion moment produced in the vertebral column in this region (Levangie & Norkin, 2011). This movement is counteracted by the posterior cervical musculature as well as the ligamentous structures. For the muscles to be allowed to play such a number of roles their structure and function are rather complex. The following text and tables will describe the cervical musculature in more detail.

2.2.8 Posterior cervical musculature

Starting off with the trapezius muscle: Although it is part of the upper extremity it creates movement in the cervical spine when the upper extremity is fixed; this involves extension, ipsilateral lateral flexion and contra-lateral rotation of the head and neck (Muscolino, 2010). Just deep to the trapezius, the levator scapulae can be found, its function in the cervical spine is to produce a posterior sheer force to counteract anterior forces such as anterior head carriage; other functions are ipsilateral lateral flexion and rotation of the head and the neck (Levangie & Norkin, 2011). Figure 2.3 represent the posterior back muscles in different layers, starting off with the trapezius being the most superficial and the deepest layer reveals the semispinalis capitis muscle.

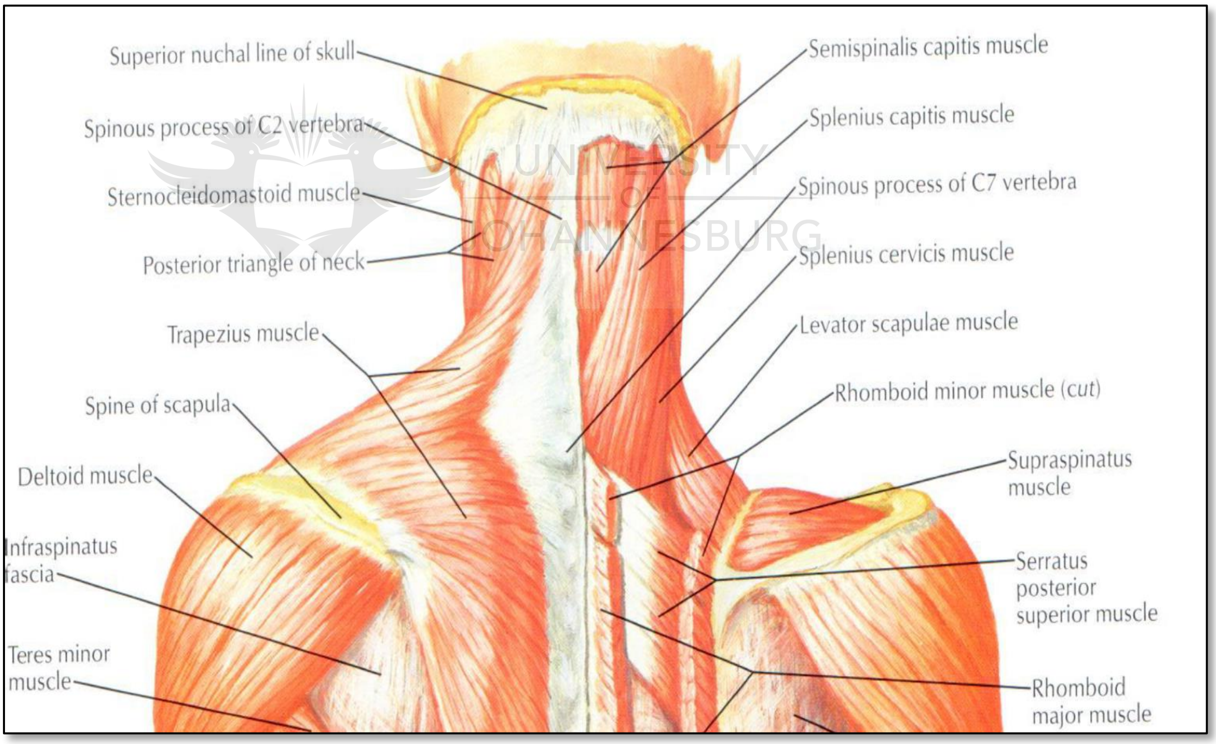


Figure 2.3: Posterior Muscles of the Back (Netters, 2006)

Table 2.2: Trapezius and Levator Scapulae muscles (Moore & Dalley, 2006)

Muscle	**Origin**	**Insertion**	**Innervation**	**Action**
Trapezius	Medial third of the superior nuchal line; external occipital protrudence: nuchal ligament: spinous processes of C7-T12 vertebrae.	Lateral third of the clavicle: acromion and spine of scapula.	Accessory nerve (CN XI) (motor fibres) and C3, C4 spinal nerves (pain and proprioceptive fibres).	Descending part elevates; ascending part depresses; middle part retracts scapula; descending and ascending part act together to rotate glenoid cavity superiorly.
Levator scapulae	Posterior tubercles of transverse processes of C1-C4 vertebrae.	Medial border of scapula superior to root of spine.	Dorsal scapula (C5) and cervical (C3, C4).	Elevates scapula and tilts its glenoid cavity inferiorly by rotating the scapula.

The next two muscles lie deeper to the levator scapula and they are named splenius capitis and splenius cervicis. They are large, flat muscles that function as the main primary movers of the head and neck (Levangie & Norkin, 2011). In certain cases the splenius capitis and cervicis can blend together and then the fibres which attach to the cervical spine are referred to as cervicis and the fibres which attach to the cranium are known as your capitis (Muscolino, 2010).

Table 2.3: Splenius Capitis and Splenius Cervicis (Moore & Dalley, 2006)

Muscle	Origin	Insertion	Innervation	Action
Splenius capitis	Inferior half of the nuchal ligament and spinous processes of superior six thoracic Vertebrae.	Lateral aspect of the mastoid process and lateral third of the superior nuchal line.	Posterior rami of middle cervical spinal nerves.	Laterally flexes and rotates the head and neck to the same side; acting bilaterally; extend head and neck.
Splenius cervicis	Spinous processes of T3-T6.	Transvers processes of C1-C3.	Dorsal rami of C2-C4.	Extend the neck bilaterally; rotation and lateral flexion to same side (unilaterally).

Semispinalis capitis and semispinalis cervicis lie deeper to the splenius group. They have an optimal line of pull and moment arm to produce extension as well as increasing the cervical lordosis. Together the two semispinalis muscles create a bundle that runs on either side of the spinous processes in the cervical spine (Levangie & Norkin, 2011). The semispinalis capitis is the largest of the semispinalis muscle groups and is the largest muscle of the neck (Muscolino, 2010)

Table 2.4: Semispinalis Capitis and Semispinalis Cervicis (Moore & Dalley, 2006)

Muscle	Origin	Insertion	Innervation	Action
Semispinalis	Arises from spinous processes from C4-C12 vertebrae.	Cervicis, capitis fibres run superiormedially to occipital bone and spinous processes in cervical regions spanning 4-6 segments.	Posterior rami of spinal nerves.	Extends head and cervical region of the vertebral column and rotates them contralaterally.

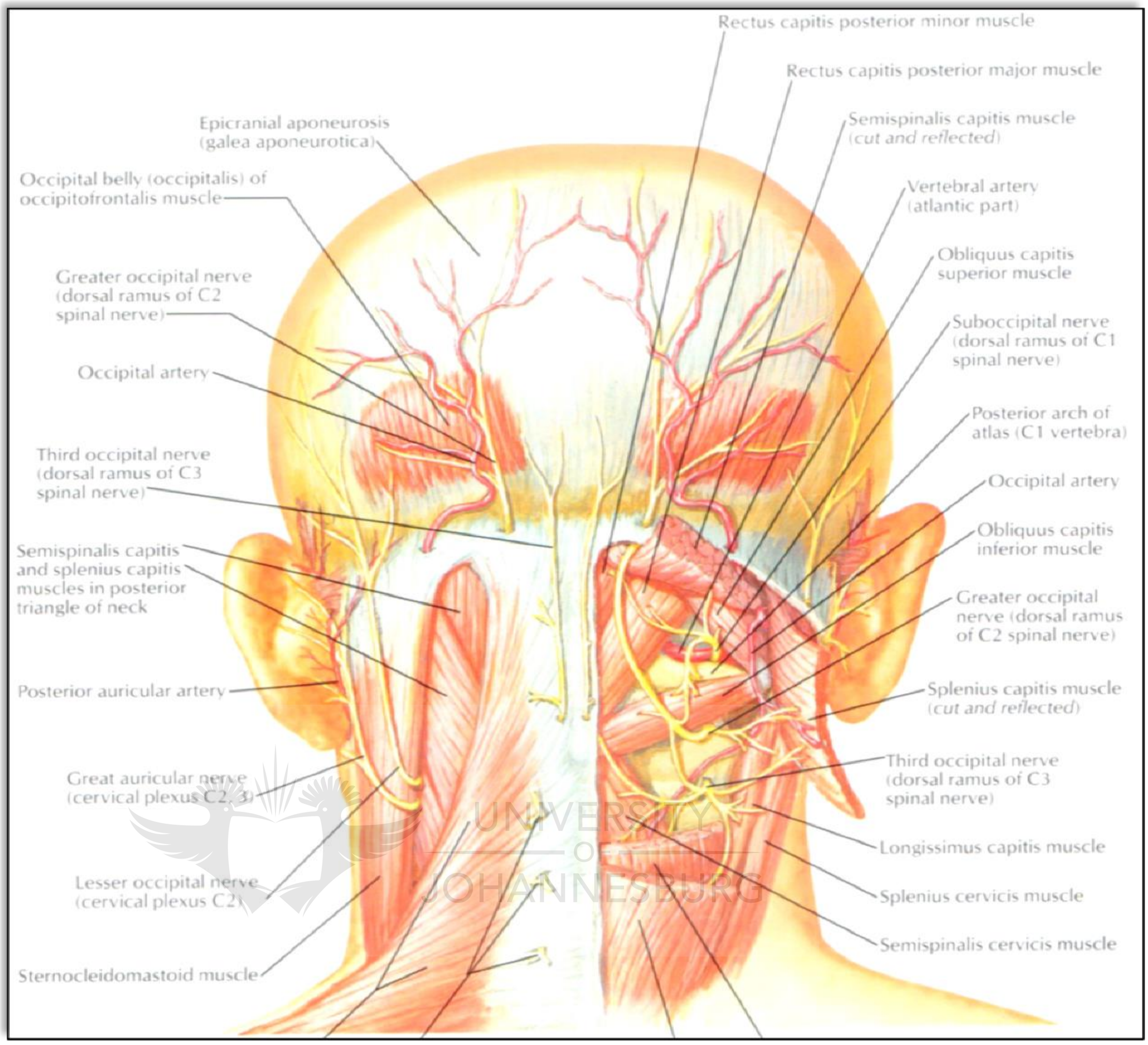
The second deepest muscles in the posterior cervical region are the longissimus capitis and cervicis (Refer to Figure 2.3). Due to the muscles' deep origin they are placed close to the axis of rotation therefore act as flexors of the head and neck but the location renders them useless as head and neck extensors (Levangie & Norkin, 2011). They also function as compressors and frontal plane stabilisers.

Table 2.5: Longissimus Capitis and Longissimus Cervicis (Moore & Dalley, 2006)

Muscle	Origin	Insertion	Innervation	Action
Longissimus capitis and longissimus cervicis	Arises by a broad tendon from posterior part iliac crest, posterior surface of sacrum, sacroiliac ligaments,	Runs superiorly to the transverse processes in the cervical region, mastoid process of	Posterior rami of spinal nerves.	Acting bilaterally extends vertebral column and head; as back is flexed control movement by

	sacral and inferior lumbar spinous processes and supraspinous ligament.	temporalis bone.		gradually lengthening. Unilaterally laterally flex vertebral column.

The last and deepest posterior cervical musculature are your suboccipitals, refer to Figure 2.4. They are namely rectus capitis posterior major and minor, inferior and superior obliques of the head (Muscolino, 2010). These muscles extend between C2 and the occiput, thereby allowing independent movement between the craniovertebral region and lower cervical segment. There is some discussion on what their actual functions are, but they are seen as movers but also as proprioceptive sources for the cervical spine and head (Levangie & Norkin, 2011).



<u>Figure 2.4: Suboccipital Triangle (Netter, 2006)</u>

<u>Table2.6: Rectus Capitis Posterior Major and Rectus capitis Posterior Minor. (Moore & Dalley, 2006)</u>

Muscle	Origin	Insertion	Innervation	Action
Rectus capitis posterior major	Spinous process of vertebrae C2.	Lateral part of inferior nuchal line of occipital bone.	Suboccipital nerve (C1).	Act on the head indirectly or directly by extending it on C1 and rotating it on C1 and C2 vertebrae.

Rectus capitis posterior minor	Posterior tubercle of posterior arch of vertebrae C1.	Medial part of inferior nuchal line of occipital bone.	Suboccipital nerve (C1).	

<u>Table 2.7: Inferior Oblique of the Head and Superior Oblique of the Head. (Moore & Dalley, 2006)</u>

Inferior oblique of the head	Spinous process of vertebrae C2.	Transverse process of vertebrae C1.	Suboccipital nerve (C1).	
Superior oblique of the head	Transverse process of C1.	Occipital bone between superior and inferior nuchal lines.	Suboccipital nerve (C1).	

2.2.9 Anterior cervical musculature

The anterior musculature that is depicted in Figure 2.5 consists of longus capitis, longus colli and rectus capitis anterior and lateralis. Longus capitis and longus colli act together with the trapezius muscle to stabilise the cervical region and to rotate the scapula (Muscolino, 2010). On the other hand the rectus capitis anterior and lateralis have a small cross section indicating a similar function as the suboccipitals which are more of a proprioceptive function rather than acting as primary movers (Levangie & Norkin, 2011).

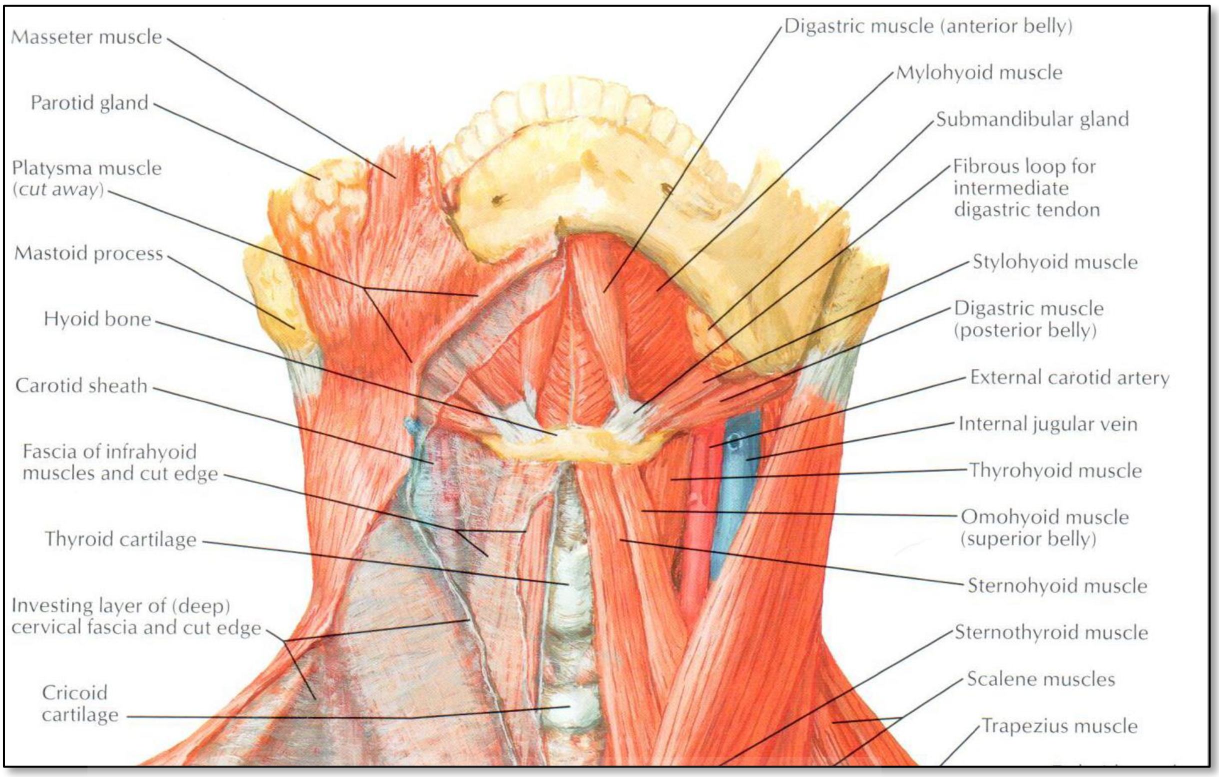


Figure 2.5: Anterior Cervical Musculature (Netters: 2006

Table 2.8: Longus Capitis, Longus Colli, Rectus Capitis Anterior and Rectus Capitis Posterior (Moore & Dalley, 2006)

Muscle	Origin	Insertion	Innervation	Action
Longus Capitis.	Basiliar part of occipital bone.	Anterior tubercles of C2-C6 transverse processes.	Anterior rami of C1-3 spinal nerves.	Flexion of the head.
Longus colli.	Anterior tubercle of C1 vertebra; bodies of C1-3 and transverse processes of C3-6.	Bodies of C5-T3 vertebrae; transverse processes of C3-5 vertebrae.	Anterior rami of C2-6 spinal nerves.	Flexes neck with rotation to opposite side if acting unilaterally.

Rectus capitis anterior	Base of skull, just anterior to occipital condyle.	Anterior surface of lateral mass of atlas.	Branches from loop between C1 and C2 spinal nerves.	Flexion of the head.
Rectus capitis posterior	Jugular process of occipital bone.	Transverse process of atlas.		Flexes the head and helps stabilize it.

2.2.10 Lateral cervical musculature

Lastly the lateral musculature in the cervical spine consists of your anterior, middle and posterior scalenes as well as the sternocleidomastoid muscle (Refer to Table 2.8 and Figure 2.6). When the scalenes act as a unit with the posteriorly placed longissimus posterior they act as frontal plane stabilisers (Levangie & Norkin 2011). Scalenes and levator scapulae can also act as a unit but then they play a role in transverse plane stabilisation. When considering the scalenes the middle scalene is the largest and the posterior scalene is the shortest and smallest (Muscolino, 2010). The sternocleidomastoid muscle will be discussed in greater detail under the following heading. The anterior scalene is normally in the inferiomedial angle of the lateral cervical region and behind the sternocleidomastoid (Moore & Dalley, 2006).

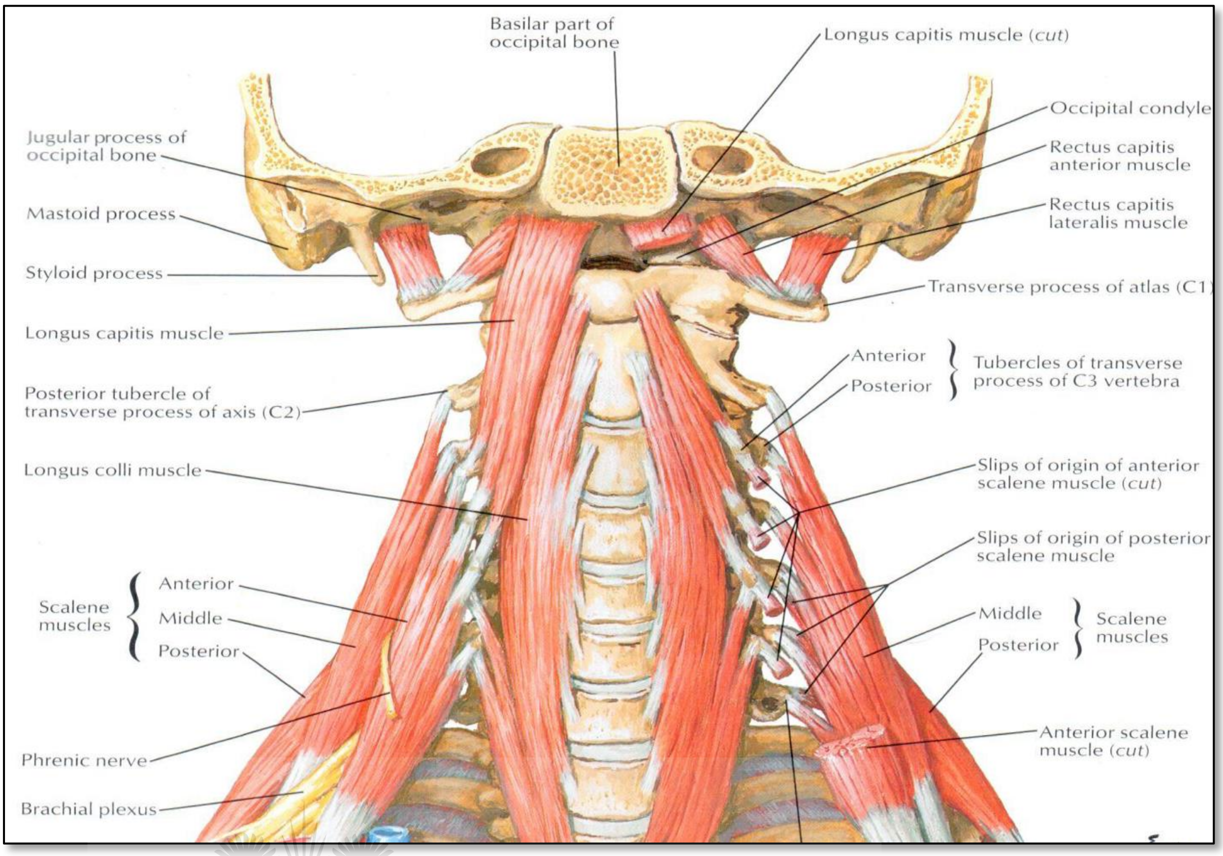


Figure 2.6: Scalenes and Prevertebral Muscles (Netter, 2006)

Table 2.9: Anterior, Middle and Posterior Scalenes (Moore & Dalley, 2006)

Muscle	Origin	Insertion	Innervation	Action
Anterior scalene	Transverse processes of C4-C6 vertebrae.	1st rib.	Cervical spinal nerves C4-6.	Flexion of the head.
Middle scalene	Posterior tubercles of transverse processes of C4-6 vertebrae.	Superior surface of first rib; posterior groove for subclavian artery.	Anterior rami of cervical spinal nerves.	Flexes neck laterally; elevates 1st rib during forced expiration.
Posterior		External border	Anterior rami of	Flexes neck

scalene		of 2nd rib.	cervical spinal nerves C7-8.	laterally elevated first rib during forced inspiration.

2.3 Sternocleidomastoid Muscle

2.3.1 Anatomy

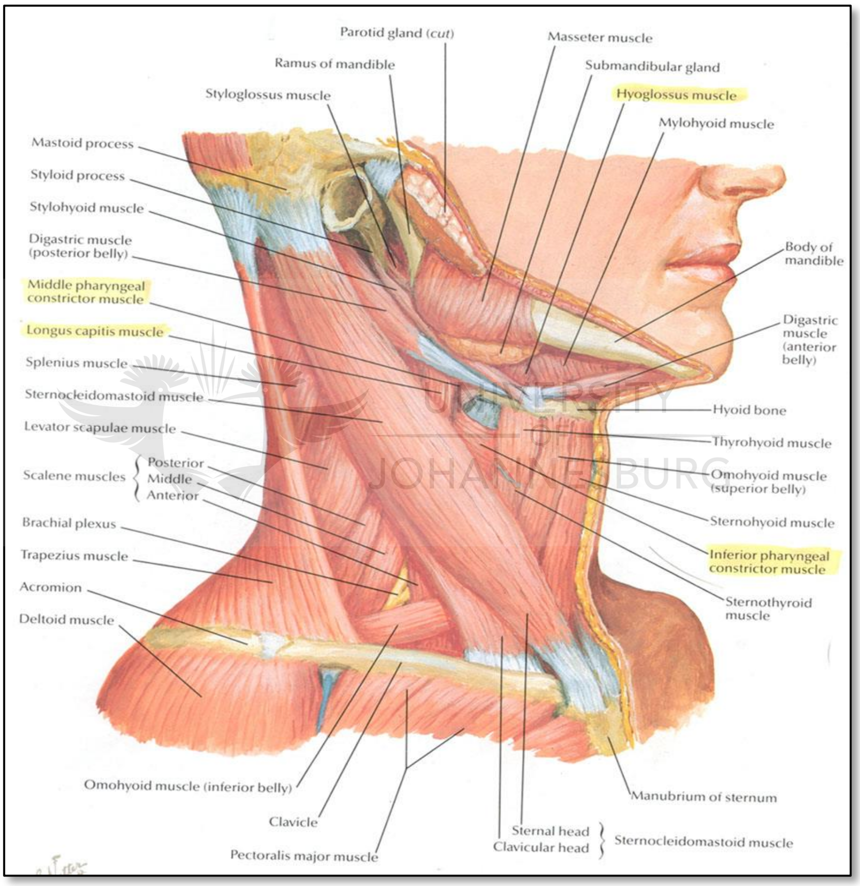


Figure 2.7: Lateral Cervical View Showing the Sternocleidomastoid Muscle (Netter, 2006)

The sternocleidomastoid muscle forms part of the lateral cervical musculature dividing the neck into anterior and lateral cervical regions, refer to Figure 2.8 (Moore & Dalley, 2006). Superiorly the muscle blends together and attaches to the occiput (Simons *et al.*, 1999). The superior attachment is the lateral surface of the mastoid process of the temporal bone as well as the lateral half of the superior nuchal ligament (Moore & Dalley, 2006). Inferiorly the muscle attaches onto two surfaces, medially it forms the sternal division which is the superficial part and then there is the lateral division known as the clavicular portion that is deep (Simons *et al.*, 1999). The sternal head attaches via a rounded tendon to the anterior surface of the manubrium of the sternum. The fleshy lateral division attaches to the superior surface of the medial third of the clavical (Moore & Dalley, 2006).

2.3.2 Action

The muscle functions individually or as a unit with the contralateral sternocleidomastoid to create movement at the craniovertebral or cervical intervertebral joints or both at the same time (Moore & Dalley, 2006). When they act bilaterally, these two muscles flex the head and bring the chin in towards the chest (Simons *et al.*, 1999). During extension movements they limit the degree of extension but can also slow the rate at which the movements occur, for example, during a motor vehicle accident. Another important function of the sternocleidomastoid muscle is to stabilise and fix the position of the head in space when the mandible moves. These muscles as a pair contribute to spatial orientation, weight perception and motor coordination of the head (Simons *et al.*, 1999).

Unilaterally the sternocleidomastoid muscle rotates and tilts the cranium towards the contralateral side (Simons *et al.*, 1999). When it acts with the upper trapezius it laterally flexes the cervical spine and also checks lateral flexion towards the contralateral side (Moore & Dalley, 2006). If a functional unit is formed with the scalenes and trapezius, they act to compensate for any tilt in the shoulder girdle that can be caused by, for example, a scoliosis.

2.3.3 Innervation

The innervation of the sternocleidomastoid consists of two parts, the motor division is supplied by the spinal accessory nerve and the sensory and pain innervation is provided by the cervical nerve two and three (Moore & Dalley, 2006).

The spinal accessory nerve, also known as the eleventh cranial nerve, originates from two roots namely the cranial and cervical roots (Missankov, 2009). The cranial root originates from the nucleus ambiguous, where the cervical root originates from the anterior horn of the cervical segments C1-C5 which is also known as the accessory nerve proper. Sternocleidomastoid and trapezius muscles receive motor innervation from the accessory nerve proper (Missankov, 2009). Some motor fibres originate from the Vagus nerve as the accessory nerve passes through the jugular foramen (Simons *et al.*, 1999).

Sensory supply to the sternocleidomastoid muscle is provided mainly by the cervical nerve two and three (Moore & Dalley, 2006). As stated by Simons *et al.*, (1999) some sensory innervation is also received from the lower cervical nerve fibres of the cervical nerve roots of the spinal accessory nerve proper. These structures are connected to the central nervous system via the pyramidal tract and medial longitudinal; fasciculus for co-ordinated movement of the head and eyes.

2.3.4 Role in proprioception and head position sense

Sensory and proprioceptive innervation travels to the central nervous system via ascending neurological pathways and it conveys information to the cerebral cortex where it will be integrated (Missankov, 2009). Proprioceptive information originates from receptors that are situated within muscles, tendons, ligaments and capsules. Cervical nerve roots two and three provide sensory innervation to the head and neck; this information is transmitted to the spinothalamic tract.

Simons *et al.*, (1999) mentioned that in man the sternocleidomastoid muscle is one of the major muscular sources of proprioception of the head. Cervical proprioception functions to the same extent as the labyrinths in orientating the head in space, when either is affected the extent of involvement is very similar and of the same magnitude. Effects of central sternocleidomastoid muscle trigger points affect the central processing of information from the upper limb and vestibular apparatus. When trigger points are present within this muscle, especially in the clavicular division, the dominating symptoms are postural dizziness or imbalance and dysmetria. The proprioceptive symptoms can be more disabling than the pain experienced by the patient.

2.4 Innervation of the cervical spine

The innervation of the vertebral column arises directly from the spinal cord as a nerve root and then exits via the neural foramina (Borenstein, Wiesel & Boden, 1996). The spinal nerve root is formed by the merging of the ventral and dorsal rami (Waldman, 2009). A nerve root contains sensory, motor as well as preganglionic nerve fibres of the autonomic nervous system. It divides into a primary posterior rami, primary anterior rami and the sinuvertebral nerve of Luschka. The anterior and posterior primary rami innervate muscles around the spine and chest wall. The sinuvertebral nerve that is also known as the recurrent meningeal or meningeal nerve (Middleditch & Oliver, 2005) consists of sensory and sympathetic fibres (Borenstein *et al.*, 1996).

Innervation supplied to the periosteum of the vertebral body and the disc above this level is obtained from the sinuvertebral nerve (Middleditch & Oliver, 2005). This nerve divides into two branches which supply two adjacent levels (Borenstein *et al.*, 1996). Although nerves normally follow a set course, the sinuvertebral nerve ascends, descends or transverses to the opposite side or to the level above (Middleditch & Oliver, 2005). Branches of the vertebral nerve supply the lateral apsects of the vertebral body (Borenstein *et al.*, 1996), in turn the anterior vertebral body as well as the annulus fibrosus is supplied by the ventral nerve plexus which is an interconnection of grey rami, perivascular vertebral arterial plexus and the sympathetic trunk.

When the atlanto-occipital and atlanto-axial joints are considered they are innervated by the ventral rami of C1 and C2 nerve roots (Middleditch & Oliver, 2005). The zygapophyseal joints are innervated by a branch of the primary dorsal rami, and they also supply a level below (Borenstein *et al.*, 1996). Thus when C3 and C4 are considered, these levels are innervated by the medial branches of the dorsal rami of C3 (Middleditch & Oliver, 2005). Medial branches of C4 to C8 dorsal rami, give off an articular branch to the level above and below thus completing the entire cervical spine innervation.

2.5 Biomechanics of the Cervical Spine

Biomechanics as described by Eriksen (2004) is the study of motion of a rigid body. Within the following subheadings the biomechanics of the upper cervical and lower cervical spine will be discussed. Movement within the cervical spine consists of flexion, extension, lateral flexion as well as rotation (Levangie & Norkin, 2011). Although they are listed individually, some movements do occur as coupled motion. Translation also occurs in the sagittal plane and increases from cervical vertebrae two to seven.

2.5.1 Biomechanics of the upper cervical spine

i Atlanto-occipital joint

This articulation allows nodding motion which is flexion and extension (Bergmann & Peterson, 2011). During flexion the occipital condyles move in a posterior-superior direction causing the cranial base to move away from the posterior arch of the atlas. When extension takes place the occipital condyles move anteriorly and the cranium moves towards the posterior arch of the atlas. Rotation at this level is limited because it occurs around two axes and is limited by tension within the capsule while the occipital condyles rise on the walls of the atlas's superior articulation on the contralateral side (Levangie & Norkin, 2011). Rotation and lateral flexion occur as a coupled movement; this is due to the convex occipital condyle moving on the concave atlas articulation (Bergmann & Peterson, 2011). The roll and slide of these movements occur in opposite directions thus rotation is coupled with contralateral lateral flexion (Eriksen, 2004).

ii Atlanto-axial joint

All movements such as flexion, extension, lateral flexion and rotation are permitted at this level. Rotation at this level is considered to be the primary movement that occurs (Bergmann & Peterson, 2011). Eriksen (2004) states that the initial 45 degrees of rotation occurs at C1 and C2, before the rest of the cervical spine rotates. Levangie and Norkin (2011) indicate that 55-58% of the cervical spine rotation is created at the C1 and C2 level. Compared to the atlanto-occipital joint, rotation only occurs at the atlanto-axial joint and lateral flexion at the former joint (Eriksen, 2004).

Rotation occurs as the occiput and C1 move as a unit on C2, the atlas pivots around the odontoid process which acts as the axis of rotation (Moore & Dalley, 2006). The lateral masses with their articulating surfaces slide posteriorly on the axis on the side of rotation and slide anteriorly on the opposite side (Bergmann & Peterson, 2011). During rotation there is a degree of vertical displacement of the atlas and this is due to the convexity of the axis's articulating surfaces.

2.5.2 Biomechanics of the lower cervical spine

The lower cervical segment allows more flexion and extension than any other movement (Bergmann & Peterson, 2011). As mentioned before, movement within the vertebral column is determined by the shape of the articular surfaces (Levangie & Norkin, 2011). The articulating surfaces slide apart and the facet joints as well as the posterior aspect of the disc are stretched and while this is occurring the anterior disc is compressed (Bergmann & Peterson, 2011). During extension the exact opposite will occur. As you move down the cervical spine the amount of flexion and extension increases.

Lateral flexion on both sides adds up to 10 degrees and as above the range decreases as you move lower down the cervical spine (Bergmann & Peterson, 2011). In the lower segments lateral flexion occurs as a coupled motion with rotation. If this was not the case movement would not be allowed because the facets will be compressed (Levangie & Norkin, 2011). The facets on the side of lateral flexion will slide together while the inferior facet slides inferior-medially and this is the product of coupled motion.

As mentioned above, rotation also decreases as you move lower down the cervical spine and is also a coupled movement (Bergmann & Peterson, 2011). The inferior facet on the side of rotation glides posterior inferiorly and on the contralateral side it moves anterior superiorly.

2.6 Chiropractic and Chiropractic Manipulative Therapy

2.6.1 Introduction

Chiropractic as a profession is mainly based on the neuro-musculo-skeletal system (Wyatt, 2005). It focuses on the restoration of function and not primarily on the reduction of pain, although pain plays a significant role (Gatterman, 2005).

Chiropractic is directed by various views such as the dominant reductionist medical world view and the holistic perspective (Gatterman, 2005). The dominant reductionist medical view dominates main stream medicine where chiropractic finds itself affected by the holistic perspective as well as the former paradigm. When considering these paradigms, chiropractic finds itself in a unique position, where it is viewed as an alternative therapy but also as a complement to modern medicine (Cooperstein & Gleberzon, 2004). This dual existence benefits chiropractic as a profession. Paradigms needs to be embraced to allow the development of a disciplinary matrix and this will glue the profession together as a whole (Gatterman, 2005).

Chiropractic is seen as a profession and not as a treatment modality (Cooperstein & Gleberzon, 2004). It is fundamentally an art, science and philosophy by integrating these concepts and applying them, the scientific understanding to chiropractic patient care is developed. Chiropractors need to apply their focus on a pathological condition as a whole rather than just on biomechanical dysfunction at a certain level. If this is not followed, the understanding as well as the extent of the pathological process is not recognised and thus effectiveness of treatments are limited (Bergmann & Peterson, 2011).

Manual therapies can be divided into various categories: these include mobilisation, adjustment, manipulation, traction and massage of visceral or somatic structures. Manipulative therapy is a therapy that encompasses manipulation (thrust) and mobilisation (non-thrust) techniques that are directed at the neuro-musculo-skeletal system (Peterson & Bergmann, 2002). Mobilisations are movements that are applied singularly or repetitively with no thrust (Leach, 2004).

2.6.2 Chiropractic manipulative therapy

The chiropractic profession is centred on manual therapies, especially the adjustment which forms part of the foundation of chiropractic as a whole (Peterson & Bergmann, 2002). Adjustments are a force that are applied to the body and are directed towards hypomobile joints which are affected by a decreased range of motion as well as quality of movement.

It's a technique that uses specific anatomical contacts and is characterised by low amplitude dynamic thrust of controlled velocity, amplitude and direction. Often associated with an audible crack or cavitation at times (Peterson & Bergmann, 2002). The adjustment is directed to certain joints that are biomechanically altered, thereby referred to as a manipulable joint lesion. Within a manipulable lesion there is altered function that can be part of a pathological condition or exist as a single lesion. Manipulable lesions that are also referred to as subluxations or joint fixations are defined as "a motion segment in which alignment, movement integrity and/or physiologic movement is altered although contact is maintained between the articular surfaces" (Gatterman, 2005).

The associated cavitation that can occur with an adjustment as described by Esposito & Philipson (2005) is said to be a mechanical phenomena. When the Sandoz model is considered, the cavitation occurs as the joint is moved beyond its elastic barrier of resistance and a sudden joint separation occurs by which a radiolucent space appears within the joint. The space is a gas bubble and while the bubble persists, a further cavitation is not possible, and this is known as your refractory period (Esposito & Phillipson, 2005).

Chiropractic manipulative therapy gives immediate relief of symptoms to patients, although, it can be short term if utilised on its own as a single modality (Coronado, Bialosky & Cook, 2010).

In a study done by Thiel & Bolton (2008) it states that 70% of patients that underwent spinal manipulative therapy indicated an improvement of symptoms, although, the improvement is dependent upon the number and type of symptoms experienced by a certain individual. Assendelft *et al.*, (2004) proved within the study conducted that manipulative therapy is more effective in decreasing pain and increasing an individual's ability to perform everyday activities than treatment received from a general practitioner, pain killers and backache classes. Krouse, Kaspin, Garman & Miller (2012) stated that chiropractic treatment promotes lower utilisation of other health care services with the added benefit of improved musculoskeletal function. In combination with decreased pain and disability, there is also an increase in active cervical range of motion post manipulative therapy (Whittingham & Nilsson, 2001).

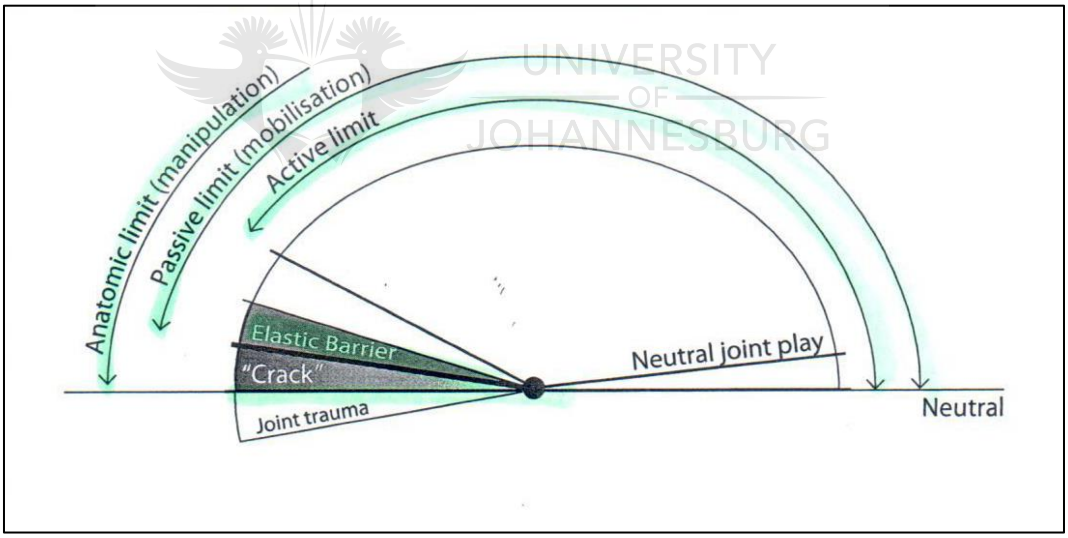
In the past as well as the present the safety of chiropractic treatment has been questioned. But Eriksen, Rochester & Hurwitz (2011) completed a study that showed results that contradict previous statements. The study proved that upper cervical chiropractic care results in more advantages than risks experienced by the patient. The discomfort experienced by the patients are transient, rare as well as minor; such side effects are headaches, fatigue, nausea and dizziness and range between 5-10% of post chiropractic care cases.

Chiropractic treatment can alter the neurological input as well as the sensori-motor integration that modulates neurological activity (Taylor *et al.*, 2010). Chiropractic manipulative therapy leads to a collection of changes that takes place within various levels of the central nervous system.

These areas where changes occur, are namely the motor cortex, premotor areas, subcortical areas and the thalamus (Taylor & Murphy, 2008).

The changes that occur, take place during the corticol processing and sensorimotor integration and it has been proven that a single chiropractic intervention will improve function by supressing somatosensory evoked potential (neurological overactivity). This proves that the central mechanism behind chiropractic manipulative therapy is a neuromodulatory effect (Taylor & Murphy, 2010). Intervention with chiropractic care is a combination of either correcting the subluxation, thereby correcting the aberrant neurological input or it could be the increased input of the adjustment itself (Taylor *et al.*, 2010).

2.7 Sandoz Model of Joint Motion



<u>Figure 2.8: Sandoz Model of Joint Motion Esposito, S. & Philipson, S. (2005).</u>

Sandoz described joint motion during a number of manual therapies by referring to four stages a joint can move through (Refer to Figure 2.9).

These stages are divided by two boundaries, namely the elastic barrier of resistance and the limit of anatomical integrity (Gatterman, 2005).

The four stages are: active range of motion which is movement that occurs during normal daily activities and this is known as voluntary movement as stated by Sandoz (1976) and cited by Vernon & Morzek. (2005). Then there is the passive range of motion which is only produced by an external force to spring the joint or to test joint play (Esposito & Philipson, 2005). The paraphysiological range forms part of motion that occurs beyond the elastic barrier of resistance and this is where manipulation occurs. Lastly pathologic movement is beyond the anatomical barrier and at this range there is failure of the capsules, ligaments and the joint integrity is damaged; this ultimately leads to joint hypermobility.

Chiropractic manipulation as mentioned by Sandoz (1976) is a passive manual manoeuvre during which the 3 joint complex suddenly moves beyond the paraphysiological range of motion but remains within the anatomical boundaries of integrity (Gatterman, 2005). With chiropractic manipulation the thrust is imparted to restore normal function and not to force the joint into abnormal anatomical movement. By influencing the biomechanics it allows normal function, but also ensures optimal neurological and physiological functioning (Gatterman, 2005).

2.8 Subluxation complex

As stated by Gatterman (2005) a subluxation is a motion segment in which alignment, movement integrity and/or physiologic function are altered, although, contact between the articular surfaces is maintained. Subluxation or segmental dysfunction is not a single entity; it forms part of a more complex process that should also be considered during treatment. Temporary alteration within the joint mechanics, if persistent, would lead to premature degeneration (Gatterman, 2004). Changes takes place in various structures and this is a result of an interaction between inflammation, degeneration and pathological changes (Bergmann & Peterson, 2011).

Within the subluxation complex, numerous pathological changes can take place within the spine. Biochemical injury due to numerous pro-inflammatory chemicals being consumed or over produced by the body leads to significant degeneration and subluxation complex development (Gatterman, 2005). The over production or consumption leads to a high concentration of these chemicals that causes excessive and persistent inflammatory responses. Cellular causes which lead to chemical over production are ATP depletion, intracellular calcium, calcium loss and irreversible mitochondria damage. Free radicles are one of the major causes of cell membrane damage and the release of inflammatory agents and forms part of the subluxation complex, this could lead to, for example, a disc herniation (Gatterman, 2005).

Increased inflammation and trauma can affect the nervous system. Continuous trauma and inflammation stimulates the complex nociceptors as well as the polymodal receptors (Gatterman, 2005). Chronic stimulation of these receptors can lead to the normal threshold to decrease; this leads to the receptors to be activated by normal activity such as movement or light touch and this phenomena is known as allodynia. With increase nociceptive activity there will be a related increase of the somatomotor activity that ultimately leads to increased muscle tension and decreased joint mobility (Leach, 2004). If inflammation persists and develops into a chronic phase, scarring and fibrosis can take place which in the end would lead to decreased range of motion, loss of power, continuous pain and an increased tendency to reinjure oneself (Gatterman, 2005).

Although subluxation as a term is widely discussed within chiropractic literature a number of concerns and doubts exist within the mainstream medical field as well as in the chiropractic profession. As stated by Huijbregts (2005) the definition as well as scientific explanation of a subluxation should be approached in an evidence based manner, this will enable the chiropractic profession to become well equipped for further scrutiny by other medical professionals.

2.9 Massage therapy

2.9.1 Introduction

Massage therapy is a manual and scientific manipulation of soft tissue which promotes and allows maintenance of health and musculoskeletal wellness (Werner, 2013). Its effects are aimed at the nervous system, muscular system, and local as well as general circulation and lymphatic system (Brault, Kappler & Grogg, 2011). It functions to enhance blood flow, decrease pain, and promote sleeping, to decrease swelling, and enhance relaxation and to increase the capacity of oxygen in the blood. The effect created by massage therapy can be specifically goal orientated or it could aid as an overall feeling of relaxation and well-being. Effects of massage are categorised into three categories namely: mechanical effects, physiological effects and psychological effects. Massage is a combination of stretching and compressing of tissues (Johnson, 2011). It is commonly used to lengthen shortened muscles, to promote increased range of motion of an associated joint.

Mechanically it affects the blood flow and changes muscle fibres and in the case of physiological effects it can lead to changes in hormones and neurotransmitters. Deep tissue massage that is applied at a constant pressure with strokes following in the direction of muscles fibres can be used to treat deep structures as well as superficial structures (Osborne-Sheets, 2007).

2.9.2 Deep Tissue Massage

Stripping massage also known as deep stroking massage is often used to treat dysfunctional musculature and is widely accepted by therapists (Simons *et al.*, 1999). It is particularly useful to treat active or latent trigger points within a muscle because of its direct manual approach and the lack of excess range of motion that is present during other treatments. It focuses on restrictive barriers within muscles and the release of them to allow elongation of the shortened muscle fibres.

Stripping massage, more commonly known as deep stroking massage, also utilises different strokes to allow optimal results from dysfunctional muscles. Strumming is a method by which a therapist can stretch fibres of a muscle by working perpendicular to its fibres and works optimally to release myofascial trigger points. Strumming works best on superficial muscles such as the masseter and the sternocleidomastoid (Simons *et al.*, 1999).

For stripping massage the patient is placed in such a way to allow the muscle to be lengthened, but in a relaxed position (Simons *et al*, 1999). The patient should not feel any pain while placed in this position but all the slack should be removed from the muscle. Oil must be applied to the skin to avoid excess friction from occurring. A number of contacts can be used when doing stripping massage; these include both thumbs and finger tips from both hands.

When the process is started the taut band that is to be treated must be trapped between the two contacts beyond the trigger point. Tension should be placed on the band until resistance is experienced, the tension should be applied at a rate at which the tension is released. By applying gentle pressure it will allow optimal lengthening of the shortened sacromeres. The tension should be applied continually along the length of the muscle and move beyond the trigger point to the attachment site of the involved muscle. The following stroke should occur in the opposite direction in a similar fashion to allow lengthening to occur in the opposite direction (Simons *et al*, 1999).

2.9.3 Mechanical and physiological effects

Effects from deep tissue massage can be divided into the different effects it has on tissue such as compression (Brault *et al*, 2011).

When considering compression that takes place during massage, several circulation changes take place. Initially a cutaneous change in blood flow can occur immediately and this is due to stimulation of the mast cells that release histamine and cause vasodilation (Brault *et al.*, 2011). When pressure is applied to a tissue it impedes the blood flow by compressing small blood vessels, as the pressure is released the blood flow returns and allows new blood to enter the area (Johnson, 2011). Stretching a muscle during massage has different effects on the blood flow and this occurs by spreading the blood across the muscle. Continuous application of the above mentioned methods creates a pumping effect on the tissue's blood supply, which allows waste products to be flushed away and new oxygenated and nutrient rich blood to enter the area. Oxygenated and nutrient rich blood allows for optimal healing and growth of a tissue (Brault *et al.*, 2011).

If an injury occurs fascia and deep connective tissue are affected and it forms scar tissue that ends up in adhesions which leads to decreased blood flow and decreased muscle activity. By breaking down adhesions and scar tissue, normal fluid dispersion can take place and thereby normal muscular function. By stretching the tissue which occurs during massage, collagen fibres are realigned and areas of scar tissue is untethered thus facilitating normal functioning (Johnson, 2011).

Pain, inactivity and debilitation are factors that affect individuals after injury. With all these factors interacting with each it leads to insufficient fluid mobilisation and accumulation of metabolic by-products. The metabolic by-product build-up stimulates pain fibres. Massage therapy disperses fluid and mobilises accumulated by-products and decreases pain stimulated by the waste products (Johnson, 2011).

2.10 Proprioception

2.10.1 Introduction

Proprioception falls under the senses that are termed somatic senses. There are three types of senses and they are known as mechanoreceptive somatic senses, thermoceptive senses and lastly pain sense. Proprioceptive sense can be defined as the awareness of the physical state of the body, which involves position sense, tendon and muscular sensations as well as pressure and equilibrium. It is further divided into two sub types known as your static sense; this is the conscious perception of orientation of different parts of one's body. The second sub type is the rate of movement occurring at a certain part of the body and this is known as kinaesthesia or dynamic proprioception (Guyton & Hall, 2006).

2.10.2 Neuroanatomical components and function of proprioception

Proprioception forms a sensory component of neurological input that allows optimum motor control (Riemann & Lephart, 2002). It also plays a vital role in neuromuscular control of dynamic constraints such as muscles. For successful development to take place, optimal coordination capabilities need to be present in which proprioception plays an important role. With both normal development and coordination successful, motor learning can occur (Frontera, Herring, Mecheli & Silver, 2007). All these factors are important to prevent injury from occurring. Afferent proprioceptive input functions to allow voluntary muscle control in order to maintain postures and an individual's balance. To maintain stability and orientation, static and dynamic information is registered and functions to modulate muscular function and initiate reflexive stabilisation of joints (Frontera, Herring, Mecheli & Silver, 2007).

Receptors involved in proprioception provide information regarding angulation of joints as well as the degree of stretch that has occurred in certain tissues; it also gathers information about the rate at which it was produced. In certain areas where there is a large collection of receptors such as the skin, proprioception is dependent on these superficial receptors. On the contrary, around large joints it is solely dependable on deep receptors surrounding the joint or within the joint capsule itself. Receptors and structures that play a part in proprioception are the Pacinian corpuscles, Ruffini's endings, Golgi tendons and muscle spindles (Guyton & Hall, 2006).

Tissue stretch is registered by Pacinian corpuscles, Ruffini's endings and Golgi tendons. Where the rate at which tension is developed, the Pacinian corpuscles and muscle spindles play an important role. Pacinian corpuscles are found within the dermis, subcutaneous tissue, ligaments and joint capsules. It is encapsulated with a nerve ending being the core and it acts as an adapting mechanoreceptor. The Ruffini's corpuscles end in a bundle of collagen and as the Pacinian corpuscle is surrounded by a capsule. Ruffini's corpuscles are slowly adapting stretch receptors (Snell, 2001).

Within joints there are 4 types of receptors situated within the capsules and ligaments. Three of these receptors are encapsulated and are similar to Ruffini's and Pacinian corpuscles, there is stretch receptors present within tendons. The receptors act to produce information of position as well as movement (Snell, 2001).

Within muscles there are muscle spindles that bring fourth the stretch reflex and also the Golgi tendon that produces muscle inhibition. Muscle spindles concentrate around the tendinouos attachment and they carry information to the central nervous system about muscle activity (Snell, 2001). The information provided by these spindles allows information about the dynamic response consisting of position as well as velocity of muscular contractions. Golgi tendons on the other hand is activated by increased pressure around the tendinouos attachment, with increased tension developed there is an increased efferent output that stimulates the central nervous system. This in turn increases the efferent output and inhibits muscle contraction and acts as a protective mechanism (Snell, 2001).

Numerous encapsulated receptors are found within the joint capsules of the cervical joints, this shows that the mechanical state of the capsule is monitored which includes information such as pressure, position and tension. There is a collection of receptor types found within joints and they include receptors I, II and III as well as type IV which is nociceptive in nature. They play an important role in proprioception, protective muscular reflexes and joint pain (McLain & Raiszadeh, 1995).

Type I is found within the joint capsules, surrounding ligaments and tendons and is similar to a Ruffini ending. They are slow adapting mechanoreceptors. Receptor type II on the other hand is a rapid adapting mechanoreceptor and is referred to as a Pacinian corpuscle. Type III is a very slow adapting receptor that is known as your Golgi tendon and is found within ligaments, tendons and dense fibrous connective tissue. Type IV is a nociceptor that is non-adapting and is found within all periarticular and intra-articular tissues (Mc Lain & Raiszadeh, 1995).

The information gathered is relayed by certain tracts that transmit the information to the cerebellum. At the cerebellum there are three routes that the information can follow (Missankov, 2009). All tracts originate from peripheral nerves that are connected to receptors of proprioception; they then form part of the spinal nerve and enter the spinal cord to follow the various routes. All the routes utilised by proprioception are situated within the posterior white column of the spinal cord (Refer to Figure 2.10).

The first route's fibres run superiorly within the inferior cerebellar peduncle and terminate within the cerebellar cortex. The second route remains on the same side as it enters the spinal cord and runs superiorly in the posterior white column and it forms the posterior spinocerebellar tract which runs to the cerebellar cortex where it terminates and provides information about limb movement and maintenance of posture (Guyton & Hall, 2006). With the third route the fibres pass into the spinal cord and cross to the opposite side and then travel superiorly within the anterior white column (Anterior Spinocerebellar tract). This tract also terminates within both sides of the cerebellar cortex and carries proprioceptive information from muscles and joints of the trunk, upper and lower limbs (Missankov, 2009).

Information within these tracts consists of information about muscle contraction, degree of tension within muscle tendons, position and rates of movement of body parts and forces acting on the body (Guyton & Hall, 2006). Other sources of information are gathered from muscles spindle as well as Golgi tendons. In the case of the ventral spinocerebellar pathway, motor information that travels down the spinal cord and arrives at the anterior horn is recognised by these pathways and in turn informs the cerebellar cortex about motor activity being initiated.

2.10.3 Effects of altered proprioception

Proprioception plays a vital role in completion of motor tasks in a safe manner (Brukner & Khan, 2007). Pathways and nerve endings which carry information to the central nervous system are subjected to injury and disease. Injuries and diseases that affect this system range from a simple ankle sprain to osteoarthritis, rheumatoid arthritis and certain neuropathies. When the components of proprioception are altered in function it leads to segmental impairment of nerve impulse transmission (Wilder, Jenkins, Seto & Statuta, 2011). When impulses are affected it ultimately leads to increased occurrence of joint damage, athletic injury, falls and progressive joint degeneration.

Functionally the impairment may lead to a loss of balance, decreased co-ordination and diminished joint position sense. This can lead to joints giving way during certain activities and alter protective reflexes that prevent injury from occurring (Brukner & Khan, 2007).

Proprioception plays an important role in stabilisation of the cervical spine (Reddy, Maiya & Rao, 2012). Muscle fatigue leads to altered cervical spine proprioceptive input and irregular integration of neurological input will take place. With impaired central integration, efferent output that is relayed, will be altered and will lead to joint instability and cervical impairment will be the end result. Ultimately individuals who suffer from a loss of proprioception are not capable of recognising the extreme range of motion thereby placing the dynamic and static stabilisers under increased tension. A study done by Reddy *et al.*, (2012) proved that muscle fatigue also plays a role in proprioception loss and by improving muscular endurance there would be a decreased reoccurrence of injury.

Individuals that suffer from pain are less likely to correctly judge neck position sense and this indicates that pain additionally interferes with proprioception (Yahia, Ghroubi, Jribi, Malla, Baklauti, Ghorbel & Elleuch, 2009). With associated chronic injury of soft tissue in the cervical spine, especially the muscular component, it will lead to proprioceptive dysfunction and this is due to the rich innervation of cervical musculature with proprioceptive receptors. With joint dysfunction and muscle hypertonicity receptor functioning is altered and leads to changed motor patterns. As stated by Yahia *et al.* (2009) when vertigo and instability are present and vestibular involvement is excluded, then functional or structural damage to the cervical proprioceptors can be considered as the primary cause.

2.11 Chronic neck pain

2.11.1 Introduction

Neck pain commonly occurs in middle-aged individuals and it decreases in frequency with increasing age. In 55% of the patients suffering from mechanical neck pain, the facets are considered as the primary cause (Manchikanti *et al.*, 2004). Numerous structures can be involved and these include the cervical musculature as well as proprioceptive organs (Humphreys, 2008). Douglas-Phillips, *et al.,* (2012) found that muscles are also a common cause of pain and disability.

2.11.2 Aetiology

Neck pain can have considerable impact on an individual, families, communities, health care systems and businesses (Hay, Protani, De & Buchbinder, 2010). A study done by Hay, *et al.,* (2010) found that in a one year period the incidence of neck pain ranged from 10,4-21,3% and that there was a higher prevalence in individuals working in offices and doing computer work. Within the population studied, it was found that in 33-65% of people the pain was episodic and that possible return of pain can occur.

Within the modern society neck pain is a common condition that individuals suffer from (Dua, 2007). In modern society with increased technology, lifestyles have changed from being physically active to sedentary. Most jobs involve sitting at a desk, driving and after work no physical activities takes place. No physical activity has a negative impact on any individual's physical health. In certain cases neck pain is acceptable and not seen as a debilitating disease, but when the pathology becomes more persistent and chronic it can affect productivity and every day activities.

Chronic mechanical neck pain forms a significant number of patients that seek medical attention. In a study done by Manchikanti *et al.,* (2004) they found facets to be the cause of chronic neck pain in 55% of the presented cases. This signifies the importance of cervical facets as a factor that can cause neck pain. Mechanical neck pain disorders can be classified into two diagnostic categories; they are neck pain with or without referral to a proximal extremity (Spitzer, 1987). It can be due to an intricate interaction between muscle, ligament, joint, disc and or as a part of a degenerative process.

Neck pain can be categorised according to its severity into acute (symptoms persist for less than 3 days), sub-acute (symptoms persist from 3 days to 2 weeks) and chronic (symptoms persist for more than 6 weeks) (Segen, 2002).

2.11.3 Clinical Presentation

Neck pain can be defined as a stiffness and/or pain felt dorsally between the occipital condyles and cervical vertebrae seven's prominence, upper thoracic region and jaws (Ferrari & Russell, 2003). Chronic cervical neck pain needs to be present for at least six weeks. Diagnosis of chronic or any cervical pain is dependable on a thorough history, physical examination and investigations.

Patients normally report about their pain referring to the location, intensity, character, radiating or referred pain and if there are any associated symptoms. Physical findings that can be observed are: decreased cervical range of motion and tenderness to palpation of the cervical spine.

Chronic neck pain is normally associated with symptoms of fatigue, headaches, dizziness, weakness and tingling (Ferrari & Russell, 2003).

2.11.3 Effectiveness of chiropractic care and chronic cervical pain

A study done by Palmgren, *et al.,* (2006) showed a positive outcome in patients who suffered from cervical pain who underwent chiropractic treatment. The improvement was not just found with pain but also in the area of cervical kinaesthetic function. Another study done by Peterson, Bolton and Humphrey (2012) showed that patients had improvement in pain levels, functional status and lifestyle parameters within the first week of treatment. The improvement was kept up until three months post the treatment.

Chiropractic manipulative therapy has been proven to be of benefit in treating mechanical neck pain. It is believed that the treatment by means of spinal manipulation corrects, or at least decreases the severity of a chiropractic subluxation. Thus manipulation acts to limit the damaging biomechanical and neurophysiological effects that can be due to dysfunctions. The detailed mechanism by which chiropractic manipulations correct such spinal dysfunction is not well understood (De Vocht, Pickar & Wilder, 2005). It is believed that treatment offered by a chiropractor is primarily a mechanical force interacting with very dynamic tissues (Haldeman, 2000).

CHAPTER THREE:

METHODOLOGY

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The discussion will include participant recruitment, sample selection and size, inclusion as well as exclusion criteria and group allocation to allow for easier understanding of the study population. This chapter will also provide an overview of the treatment approach, chiropractic techniques, subjective data, objective data, data analysis and ethical considerations utilised in this study.

3.2 Participant Recruitment

Participants, consisting of male and/or female, who presented to the University of Johannesburg Chiropractic Day Clinic, with chronic mechanical neck pain, were invited to participate in this study. Recruitment was done via word of mouth and by means of an advertisement (Appendix A) displayed in and around the Chiropractic Day Clinic at the University of Johannesburg, Doornfontein Campus.

3.3 Sample Selection and Size

Each participant who wanted to be part of the study was screened to see if they qualified for the research. The participants needed to match certain criteria that were stated in the inclusion and exclusion criteria. If a participant did match the inclusion as well as the exclusion criteria, the study was then explained to them after which they then had to sign the information and consent form (Appendix B) that outlined the purpose of the study as well as the protocols that will be followed. A total of thirty participants that were male or female and between the ages of eighteen and fourty were recruited and divided into two groups of fifteen.

3.4 Inclusion Criteria

- Participants can be male or female between 18 and 40 years of age.
- Participants must present with chronic mechanical neck pain (pain for longer than 6 weeks (Segen, 2002).

  The participants should have 2 of the 7 following criteria associated with joint dysfunction (Peterson and Bergmann 2002):

  - Localised joint pain which commonly changes with movement
  - Local tissue hypersensitivity
  - Decreased range of motion of the joint
  - Altered alignment
  - Decreased, increased or aberrant movement
  - Altered end feel on motion palpation
  - Local palpatory muscle rigidity
- Participants must have a combination of a C0 and two other cervical spine restrictions between C1 to C7 which will be confirmed by motion palpation.

3.5 Exclusion Criteria

- Participants who are contra-indicated for cervical chiropractic manipulative therapy (Appendix C)

- Participants experiencing neck pain due to (Revel, Miguet, Gergoy, Vaillant & Manuel, 1994):
    - Inflammatory (rheumatoid arthritis, ankylosing spondylitis)
    - Tumoural or Infectious diseases
    - Any sign of cervical radiculopathy or cervical myelopathy
- During the study period the participants must not be undergoing other forms of treatment that may interfere with this study and these include other chiropractic treatment or physical therapies and medication.

3.6 Group Allocation

When participants who met the inclusion criteria were recruited, they then were randomly assigned to two groups of fifteen participants each. They were assigned to their group by randomly drawing a number from a box. Group 1 received chiropractic manipulative therapy to C0 and two other restricted cervical spinal levels; Group 2 received stripping massage to the sternocleidomastoid muscle in combination with chiropractic manipulative therapy to C0 and two other restricted cervical levels.

3.7 Treatment Approach

3.8 First Visit

The first visit involved the signing of an informed consent form, explaining the study as well as the potential benefits and discomforts that could have been experienced (Appendix B). Completion of a thorough case history (Appendix D) and physical examination (Appendix E) were carried out by the researcher. After completion of the case history and physical examination the participant was subjected to a cervical spine regional examination (Appendix F). The participant was then asked to complete a Numerical Pain Rating Scale (Appendix G) and a Vernon-Mior Neck and Pain Disability Index (Appendix H) which formed part of the subjective data. The objective data that was also completed by the researcher consists of the cervical range of motion that was gathered by using the analogous Cervical Range of Motion (CROM) machine (Appendix I) and the head repositioning accuracy (Appendix J). All the data recorded was done prior to treatment. Participants then received either chiropractic manipulative therapy to the restricted cervical spinal segments or a combination of stripping massage to the sternocleidomastoid muscles and chiropractic manipulative therapy, depending on their group allocation.

3.7.1 Follow-up Visits

The participants were treated twice a week, over a three week period thus consisting of a total of 6 treatments where the seventh visit was only utilised to capture the subjective and objective data. The follow-up visits involved a re-assessment before each treatment. Participants were requested before the fourth treatment and at the seventh visit to complete the Numerical Pain Rating Scale (Appendix G) and a Vernon-Mior Neck and Pain Disability Index (Appendix H). All the cervical ranges of motion were recorded with the analogous Cervical Range of Motion (CROM) machine (Appendix I). As the above readings which were recorded before the fourth and seventh visits, the Head Repositioning Accuracy (Appendix J) also followed the same protocol. Participants then received either chiropractic manipulative therapy to the restricted cervical spinal segments or a combination of stripping massage to the sternocleidomastoid muscles or chiropractic manipulative therapy, depending on their group allocation.

3.8 Chiropractic Manipulative Therapy

There are numerous adjustment techniques that can be utilised by chiropractors. The chiropractic manipulative therapy that was carried out by the researcher was diversified technique (Kirk, Lawrence & Valvo, 1985). Various techniques were used and chosen by the researcher on grounds of patient type and doctor preference; all are found in the diversified technique and are listed in the Spinal Manual of Spinal, Pelvic and Extravertebral Technics (Kirk, Lawrence & Valvo, 1998).

3.8.1 Posterior Superior Occiput (Kirk, Lawrence & Valva, 1998)

- Patient position: Patient lies supine with the head piece in neutral.
- Doctor position: Standing on the side of the listing in a toggle stance at right angle to the patient, facing towards the patient.
- Contact hand: caudad hand only takes contact after the patient has been rotated 45 degrees. Thumb pad contact is taken on the posterior-inferior aspect of the mastoid. Palmar contact over the cheek and mandible.
- Indifferent hand: Cephalad hand, takes contact so that the patient's ear is placed between the doctor's thumb and index finger while the remaining fingers and palm support the occiput. Index and middle fingers split the SCM.
- Thrust: Traction applied by both hands. Indifferent hand laterally flexes between occiput and atlas on the same side as the listing. Contact hand then induces a quick rotation to the occiput.

3.8.2 Rotary Cervical Index (Kirk *et al.*, 1998)

- Patient position: Patient is lying supine and the head piece is placed according to the segment that needs to be adjusted. For the lower segments more flexion is required.

- Doctor position: Doctor is squatting at the head of the patient slightly towards the lesion side.
- Contact hand: It is the caudad hand that uses an index contact placed on the involved articular process.
- Indifferent hand: Cups the ear, with the fingers hooked around the occiput.
- Thrust: The head needs to be rotated 30-40 degrees and laterally flexed the cervical spine until tension is felt at the segment. Thrust is a high velocity pectoral thrust with a slight ulnar deviation that produces a rotary movement.

3.8.3 Cervical rotary thumb (Kirk, Lawerence & Valvo, 1998)

- Patient position: Patient is lying supine with the head piece in neutral or slightly elevated.
- Doctor position: Doctor is standing at the head of the patient and slightly towards the lesion side at a 45 degree angle.
- Contact hand: Caudad hand with a palmar aspect of the thumb placed on the articular process of the involved segment.
- Indifferent hand: Cephalad hand cups the ear with the fingers and palm supporting the occiput.
- Thrust: Laterally flex the cervical spine and then rotate the head to between 40-60 degrees. A pectoral impulse in an arc around the cervical spine axis is induced.

3.8.4 Cervical Break 3 (Kirk *et al.*, 1998)

- Patient position: Patient is lying supine with the headpiece in a neutral position.
- Doctor position: Doctor is on the same side as the listing in a square stance at a right angle to the patient.

- Contact hand: Caudad hand with an index contact on the anterior aspect of the involved vertebrae's transverse process.
- Indifferent hand: The cephalad hand's palm cups the patient's ear while the index and middle fingers split the SCM.
- Thrust: The break is straight across the line of the eyes. Associated pectoral impulse thrust.

3.8.5 The Bench Thumb Movement (Kirk *et al.*, 1998)

- Patient position: Patient is lying prone with the head piece in neutral and turned away from the doctor.
- Doctor position: The doctor is standing contralateral to the listing in a fencer stance with the cephalad foot in line with the patient's shoulders.
- Contact hand: Cephalad hand is used with a thumb pad contact on the lateral aspect of the involved vertebrae's spinous process.
- Indifferent hand: Caudad hand cups the ear with the palm.
- Thrust: Indifferent hand tractioned cephalad with rotation and then the thrust is straight across.

3.9 Subjective Data

3.9.1 Vernon-Mior Neck Pain and Disability Index

Vernon-Mior Neck Pain and Disability Index (Appendix H) is the most commonly used questionnaire to measure neck pain and disability. The questionnaire consists of ten categories, each category has six potential answers and this results in a total of sixty questions. It provides insight into the ability of the patient to manage their everyday life and how it has been affected by neck pain (Vernon 2008). The Vernon-Mior Neck Pain and Disability Index has been proven to be valid and reliable by Chin Ci En. (2009).

The Vernon-Mior Neck Pain and Disability Index was completed by the participants at the first, second and seventh visits. The neck pain and disability index consists of ten categories that have certain subheadings such as pain intensity, personal care, headaches and how their pain is affecting their everyday activities. These sections are completed by selecting and marking one of the six options below each part of the index and the options indicate the amount of pain and disability experienced by the patient during everyday activities. The options that can be chosen by the participant consist of six as mentioned above and the options increase from 0-5 which relate to increments of pain and disability in each category. For each section the possible score is five, if the first statement is selected the section with which it falls under counts zero and if the last statement is chosen it scores that section five. It is then calculated by adding up all the scores from each section; it is then divided by the total possible score and multiplied by a hundred to give you an end result that is a percentage.

Example: 17 (total scored)

50 (total possible score) x 100 = 34%

If one section is missed or not applicable the score is calculated:

17 (total scored)

45 (total possible score) x 100 = 38%

3.9.2 Numerical Pain Rating Scale

The individuals that were chosen to participate were asked to grade their pain level experienced at that particular moment on a scale of 0 to 10. Zero indicating “no pain” and 10 indicates the “worst imaginable pain”. The numerical pain rating scale is considered to be valid and reliable by Bolton and Wilkinson (1998) and Yeomans (2000) (Appendix G).

The exact breakdown of the pain rating scale is as follows:

- 0-3 = No pain
- 4-6 = Moderate pain
- 7-10 = Severe pain

3.10 Objective Data

3.10.1 Cervical Range of Motion Instrument

The cervical range of motion was measured by using the Cervical Range of Motion (CROM) instrument. It is fitted to the participant's head and measurements are taken in the sagittal, coronal and horizontal planes. Movements that were measured are flexion, extension, right lateral flexion, left lateral flexion, right rotation and left rotation. This device is fitted on the head and consists of three inclinometers that are attached to it; these measure all the cervical spine ranges of motion (Agarwell, Allison and Singer, 2005).

At the first, fourth and seventh visits the readings were taken in the following manner. The participant was placed in a chair seated with a back rest. The instrument was then placed firmly on the participant's head with the magnetic yoke over his/her shoulders. As the instrument was now ready, the patient was asked to move into each movement discussed above and this was recorded in degrees from the inclinometers and recorded on the CROM measurement sheet (Appendix I). The validity and reliability has been proven by Piva (2006).

3.10.2 Head Repositioning Accuracy

Methods used and described by Revel, Deshays & Minguet (1991) was utilised to determine the Head Repositioning Accuracy in right and left rotation only (Appendix J). All participants were wearing a mask to occlude their vision. A laser was attached to the top of the CROM device, while the participants were seated. The participant's shoulders and upper chest were strapped to the back of the chair and this ensured isolated cervical and head movement. They were seated ninety centimetres from a target placed on the wall; they were then instructed to memorize their starting position. At this point they were instructed to complete a maximal rotation to the right and hold for two seconds and then return to the memorized neutral position. The same procedure was repeated for left rotation of the head (Revel *et al*., 1991). This method for measuring head repositioning accuracy using the laser helmet was validated and proven to be reliable by Roren (2009).

3.11 Data Analysis

Subjective and objective data from the above mentioned methods were collected by the researcher during the study period. The data collected was analysed by statisticians located at the University of Johannesburg Kingsway Campus at STATKON. Inter- and intra-group analyses were performed using non-parametric tests. If differences were to be found between the groups, the Mann-Whitney U test was utilised. However, if there were no differences between the groups then the Independent Samples T-Test (parametric test) was used. Intra-group data was analysed using the Friedman Test and if there were differences over time, the Wilcoxon-Signed Ranks Test was used instead.

3.12 Ethical Considerations

All participants who wished to partake in this particular study were requested to read and sign the information and consent form (Appendix B) specific to this study. The information and consent form outlined the names of the researcher, purpose of the study and benefits of partaking in the study, participant assessment and treatment procedure; any risks, benefits and discomforts pertaining to the treatments involved were also explained and that the participant's safety was to be ensured (prevention of harm).

The information and consent form also explained that the participant's privacy (only the researcher, participant and clinician will be in a private room during treatment) was to be protected by ensuring their anonymity (all the participant's details were converted to data and therefore cannot be traced back to the participant). Standard doctor-patient confidentiality during the research process and when compiling the research dissertation was adhered to. 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. Should the participant have had any further questions, these were to be explained by the researcher. Thus contact details were made available to the participants of the study. 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 were made available on request.

With regards to this particular study, the following risks might have occurred: slight pain and discomfort of the neck due to cervical spine manipulation and the wearing of the Head Repositioning Accuracy helmet (CROM with laser attached) and possibly muscle tenderness after stripping massage to the sternocleidomastoid muscle.

The benefits were to include a possible decrease or relief of the mechanical neck pain and increased range of motion as well as improved cervical proprioception.

Participants were to be referred when necessary.

CHAPTER FOUR:

RESULTS

CHAPTER 4

RESULTS

4.1 Introduction

In this chapter the results that were obtained throughout the clinical trial will be discussed in detail. Comparisons were made between both groups as well as within the groups themselves.

Subjective and objective data were collected by the researcher during the study on the first, fourth and seventh visits. The subjective data was collected by utilising the Vernon-Mior Neck Pain and Disability Index as well as the Pain Rating Scale. Subjective data was collected by the researcher using the cervical range of motion instrument to measure the cervical range of motion and by recording the head repositioning accuracy in right and left rotation as described and utilised by Revel, Deshays & Minguet (1991). Some demographic information was captured by using and completing a case history, physical examination and a cervical spine examination.

The first test that was performed was the Shapiro-Wilk Test and this was to test for normality or equal distribution. Due to the small sample size and abnormal distribution non-parametric tests were used. The Mann Whitney Test was used to determine if any differences existed between the two groups initially and at each visit. After inter-group comparisons were completed, intra-group comparisons were done. This was done by using Friedman's Test and it is used to determine if any changes took place over the study period from visit one to seven. Changes were found in the period between visit one and seven therefore Post-Hoc tests were carried out to determine where changes took place. Changes could have taken place between period one to four and period one to seven. The last test that was done was the Wilcoxon Signed Ranked test and it determined if a difference was present between variables on the left and right hand side and in what particular time interval it occurred.

4.2 Demographic Data

4.2.1 Age distribution

Individuals within the study were chosen upon various criteria and age limit was one of these criteria and was set between 18-40.

Table 4.1: Age frequency and Cumulative Percentage

Valid	**Frequency**	**Cumulative Percentage**
20	2	6.7
23	3	16.7
24	12	56.7
25	3	66.7
26	8	93.3
30	1	96.7
32	1	100.0
Total	30	

The entire study population age range was between 20 and 32. Most of the individuals were 24 years of age and the least number of participants were aged 30 and 32. The mean age was 24, 73 for the whole study population. In the adjustment and stripping massage group the mean age was 24.67 and the adjustment had a mean age of 24.8. The following pie graph illustrates the age distribution within the study population as a whole.

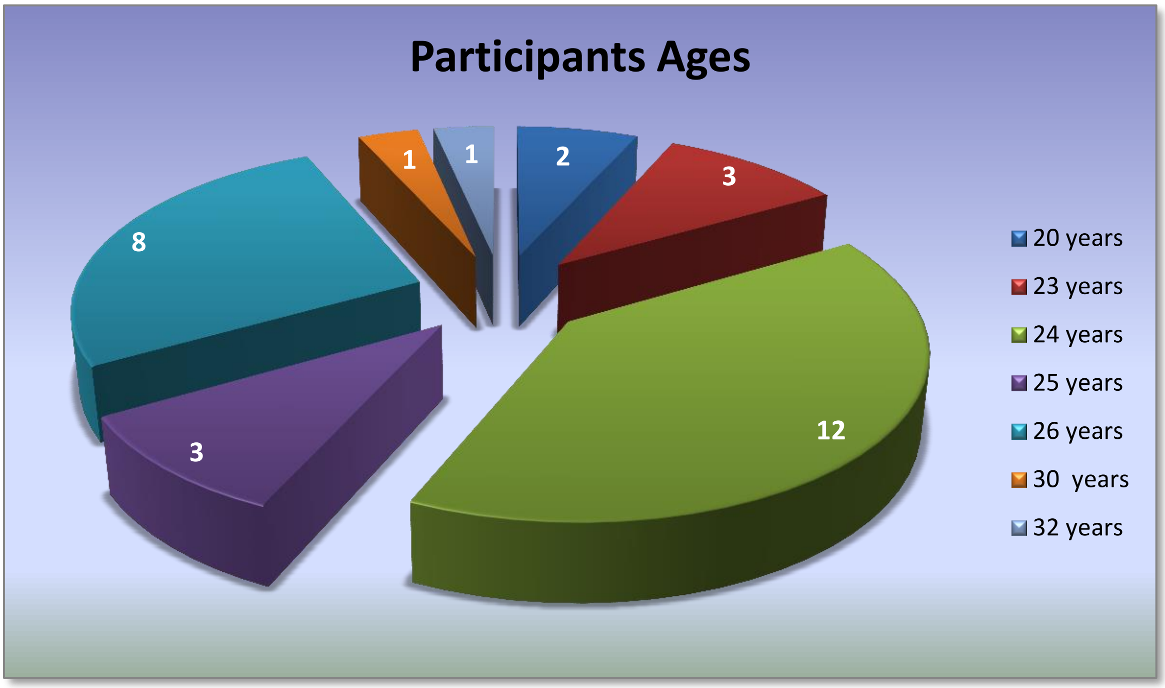


Figure 4.1: Participants' Ages

4.2.2 Gender distribution

The study population consisted of 14 females and 16 males thus males formed 53.3% of the study population and females formed the remainder 46.7% as indicated in figure 4.1. This formed a relatively equal ratio between the two sexes when considering a study population of 30 participants. Both groups had equal male and female distribution which was seven females and eight males per group as indicated in figure 4.2.

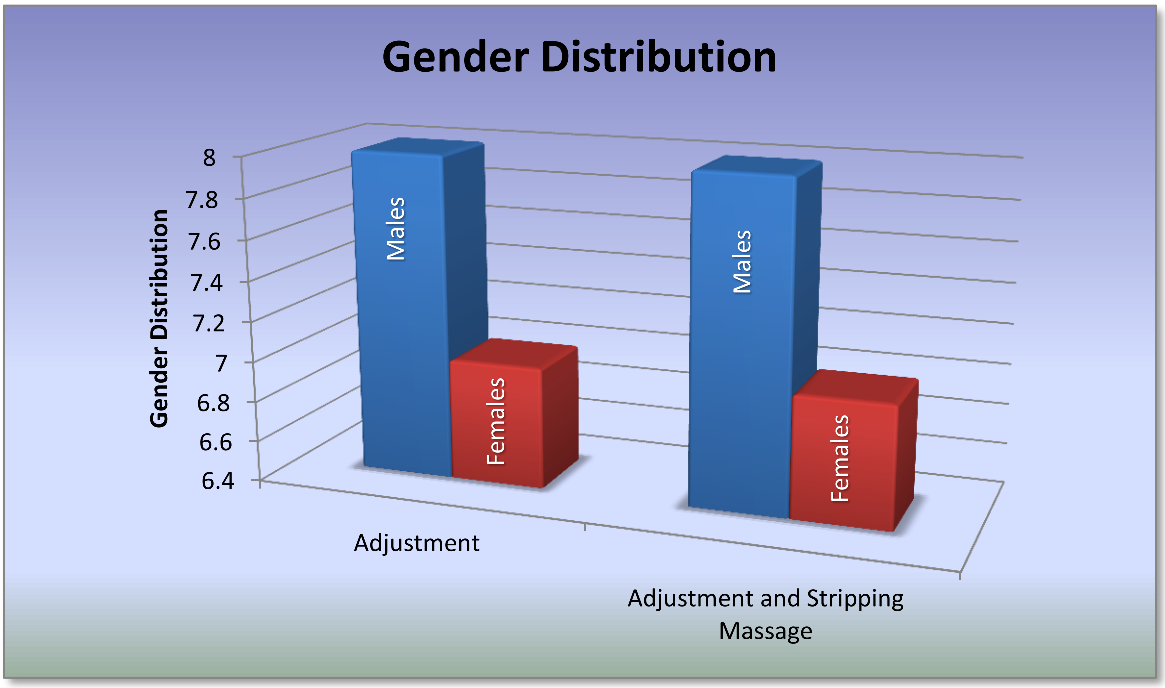


Figure 4.2: Gender Distribution

4.3 Subjective Data

4.3.1 Analysis of the normality of the data

To test normality of distribution in this study, the Shapiro-Wilk Test was utilised. According to Field (2012) the Shapiro-Wilk Test is appropriate for small sample sizes. The *p* value was set at 0.05. If the *p* value was greater than 0.05 the null hypothesis was rejected therefore there was a difference between the groups and it was not normally distributed. When the *p* value was less than 0.05 the null hypothesis was not rejected but accepted, this meant that there was no difference between the groups and that it was normally distributed.

Within the adjustment group the following *p* values were found to be significant and thus equally distributed. The Numerical Pain Rating Scale on visit 7 had a *p* value of 0.032, Vernon-Mior Neck Pain and Disability

Index was found to be significant on visit 1 (p = 0.000) and on visit 4 (p=0.006). In the case of the head repositioning accuracy with right hand side rotation on visit one the *p* value was 0.019. All other test values were found to be above the *p* value of 0.05 thus they all had uneven distributions.

In the adjusting and stripping massage group there were eight *p* values that were found to be below 0.05. Age (p = 0.004), Numerical Pain Rating Scale on visit one (*p* = 0.032) and on visit 2 the *p* value was 0.034. Right rotation had a significant *p* value on visit one (*p*=0.000), visit four (*p*=0.022) and visit seven (*p*=0.018). For left hand side rotation the only *p* value that was found to be significant and below 0.05 was on visit one and it was 0.015. The head repositioning accuracy was also found to be below the set *p* value and was 0.014.

4.3.2 Inter-group comparisons

The Mann-Whitney Test was utilised to investigate the differences between the groups on each visit. In the case of this study the Mann-Whitney Test revealed that there were no differences between the groups because the *p* values were all above 0.05.

4.3.3 Intra-group analysis

The intra-group analysis was done by using the Friedman Test. The text below provides the number of observations which is consistent throughout the visits and in both groups. The mean values are also given for each variable over the period of which the study stretched and each visit.

4.3.4 Numerical Pain Rating Scale

Table 4.2: Descriptive Statistics Pain Scale

Groups		N	Mean	Std Deviation	Mean Rank
Adjusting	Pain-Scale 1	15	4.80	1.656	2.97
	Pain-Scale 4	15	3.07	1.438	1.87
	Pain-Scale 7	15	1.47	1.125	1.17
Adjusting and Stripping massage	Pain-Scale 1	15	5.20	1.146	3.00
	Pain-Scale 4	15	3.47	1.125	1.93
	Pain-Scale 7	15	1.93	1.100	1.07

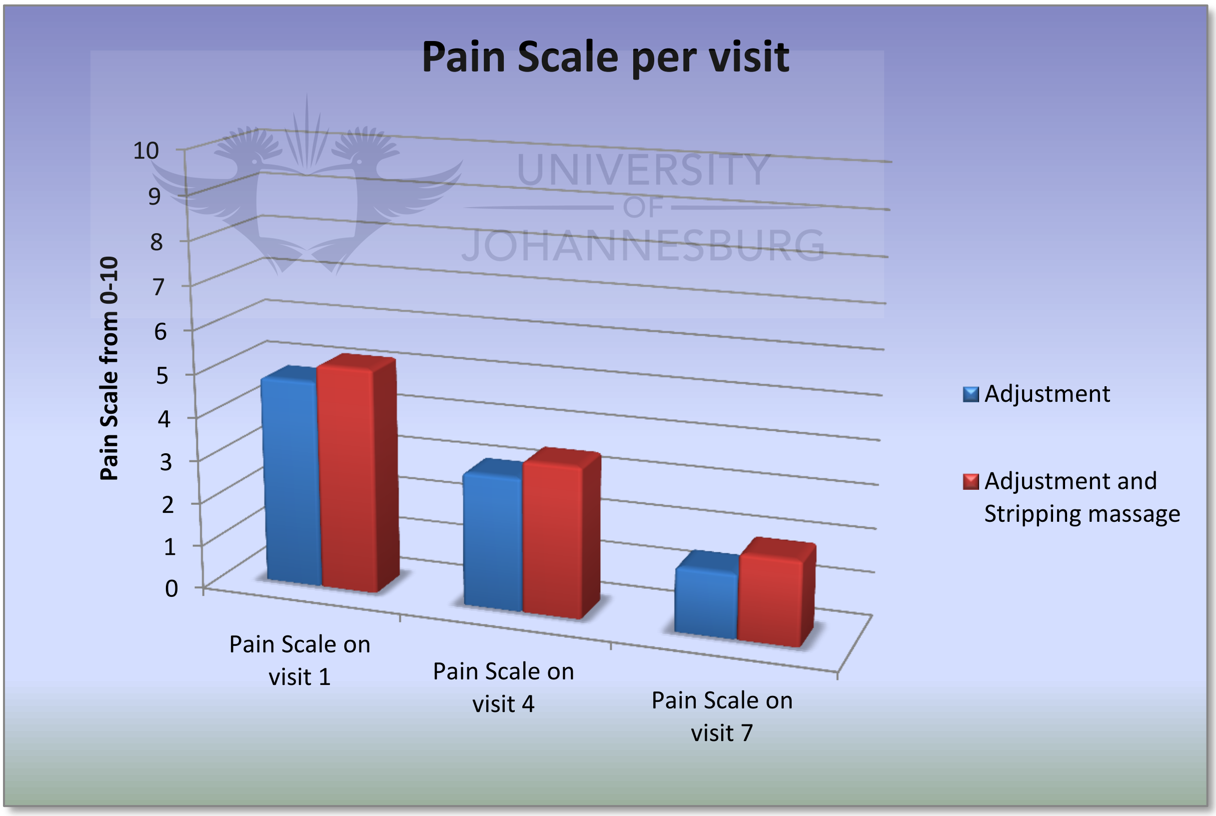


Figure 4.3: Pain Scale for both groups

Figure 4.3 and table 4.2 illustrates significant decrease in the level of pain the patients experienced from the first visit to the seventh visit. The figure above represents the numerical pain rating scale values that were recorded on the first, fourth and seventh visits. For the first visit the numerical pain rating scale value for the adjusting group was 4.80, the fourth visit it was 3.07 and the seventh visit 1.47. This indicates a 69.4% improvement of pain at the seventh visit compared to that of the first visit. The adjustment and stripping massage group had an initial reading of 5.20, at the fourth visit it decreased to 3.47 and on the final visit it ended up being 1.93. Therefore for this group there was a total of 62.9% improvement of pain at the final visit.

<u>Table 4.3: Test Statistics Pain Scale</u>

Adjusting	**N**	15
	Chi-Square	26.000
	Df	2
	Asymp. Sig	0.000
Adjusting and Stripping Massage	**N**	15
	Chi-Square	29.103
	Df	2
	Asymp. Sig	0.000

A Friedman analysis of the pain scales indicated a significant *p* value for both the adjustment $x^2(2, N = 15) = 26.000, p < .000$ and the adjustment and stripping massage group $x^2(2, N = 15) = 29.103, p = .000$ over time.

4.3.5 Vernon-Mior Neck Pain and Disability Index

The Vernon-Mior Neck Pain and Disability Index as indicated in the table below had a significant *p* value for the adjustment group ($x^2(2, N = 15) = 20.933, p < .000$) and for the adjusting and stripping massage group

(($x^2(2, N = 15) = 26.133, p < .000$). Therefore both the groups will be discussed in relation to what changes took place.

Table 4.4: Test Statistics Vernon Mior-Neck Pain and Disability Index

Adjustment	**N**	15
	Chi-Square	20.933
	Df	2
	Asymp. Sig	.000
Adjustment and Stripping massage	**N**	15
	Chi-Square	26.133
	Df	2
	Asymp. Sig.	.000

Table 4.5: Descriptive Statistics Vernon-Mior Neck Pain and Disability Index

Group	**N**	**Mean**	**Std. Deviation**	**Mean Rank**
Adjustment	15	22.67	14.416	2.87
	15	13.40	12.397	1.93
	15	4.60	4.501	1.20
Adjustment and Stripping massage	15	22.33	8.682	2.93
	15	11.60	5.152	2.00
	15	6.67	5.434	1.07

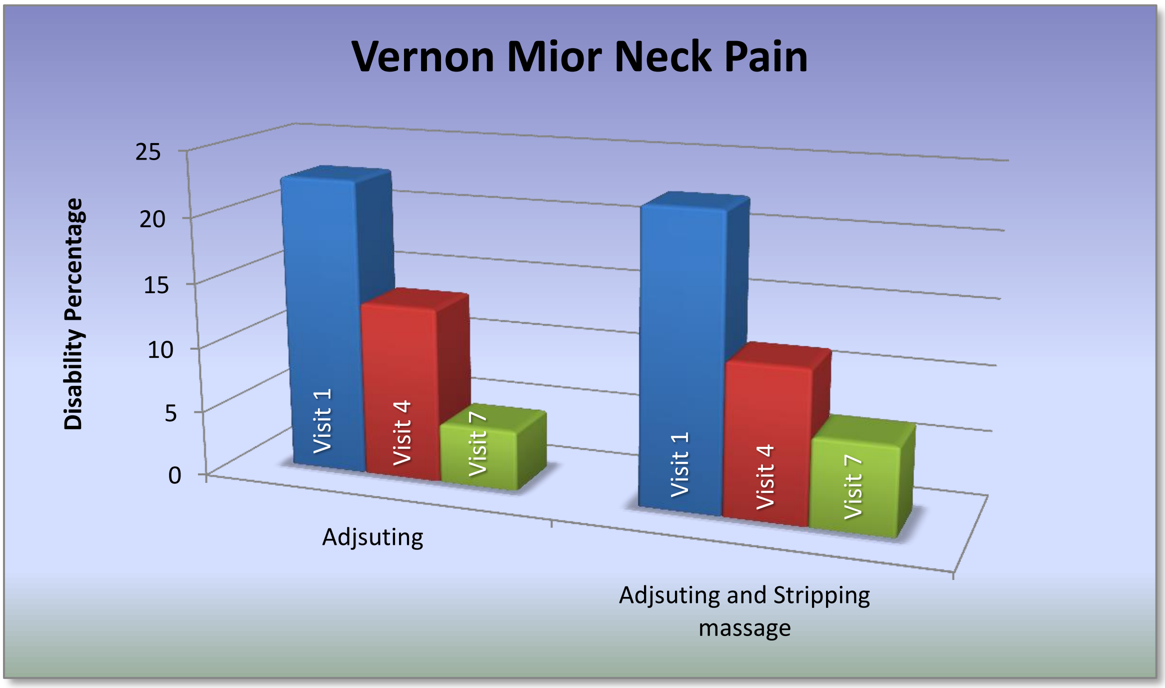


Figure 4.4: Vernon-Mior Neck Pain and Disability Index

Figure 4.4 shows a bar graph that compares the Vernon-Mior Neck Pain and Disability Index for the two groups over the three visits. For the adjustment group the mean values were as follows visit one 22.67, visit four 13.40 and visit seven 4.60 (table 4.5). In the adjustment and stripping massage group the mean values as indicated in table 4.5 were for the first visit 22.33, the fourth visit 11.60 and 6.67 on the seventh visit. This shows a 79.70% improvement in the adjustment group and a 70.12% improvement in the adjusting and massage group.

4.3.6 Clinical significance

In the case of the other variables, statistically no significant changes were noted but by examining the mean values a substantial improvement is recognised and should be mentioned. This could be due to the small sample size that was used.

Table 4.6: Head Repositioning Accuracy for Right Hand Side Rotation

Group	Variable	Means
Adjustment Group	HRA-R1	77.33
	HRA-R4	77.40
	HRA-R7	71.93
Adjustment and Stripping Massage Group	HRA-R1	92.87
	HRA-R4	94.4
	HRA-R7	66.2

Table 4.7: Head Repositioning Accuracy for Left Hand Side Rotation

Group	Variable	Mean
Adjustment Group	HRA-L1	77.00
	HRA-L4	86.40
	HRA-L7	68.67
Adjustment and Stripping Massage Group	HRA-L1	102.07
	HRA-L4	76.87
	HRA-L7	86.47

For both groups as indicated in table 4.6 and 4.7 the head repositioning accuracy indicated large improvements. The adjusting group had a mean value of 77.33mm that then ended with a mean value of 71.93mm as indicated in table 4.6 (this was with right hand side rotation). Left hand side rotation values (table 4.7) on visit one were 77.00mm and the seventh visit ended with 68.67mm. The adjusting and stripping massage group had an even greater improvement. Initial readings added to a mean value of 92.87mm and the final reading had a mean value of 66.20mm for right hand side rotation. Left hand side rotation for this group started with a mean value of 102.07mm and ended with a mean value of 86.47mm. This indicates a 26.67mm improvement with right hand side rotation and 15.6mm improvement with left hand side rotation. These are vast improvements and if ignored may lead to a loss of meaningful data.

4.4 Objective Data

4.4.1 Flexion

The following significant values were found for flexion over the three visits. In the table below the following information presented includes the number of observations, mean and standard deviation as well as the mean ranks.

Table 4.8: Descriptive Statistics for Flexion

Group		N	Mean	Std Deviation	Mean Rank
Adjustment	Flexion1	15	53.60	9.218	1.80
	Flexion4	15	55.60	10.709	2.17
	Flexion7	15	55.73	8.405	2.03
Adjustment and Stripping Massage	Flexion1	15	50.87	10.690	1.57
	Flexion4	15	54.27	8.614	2.53
	Flexion7	15	52.27	8.819	1.90

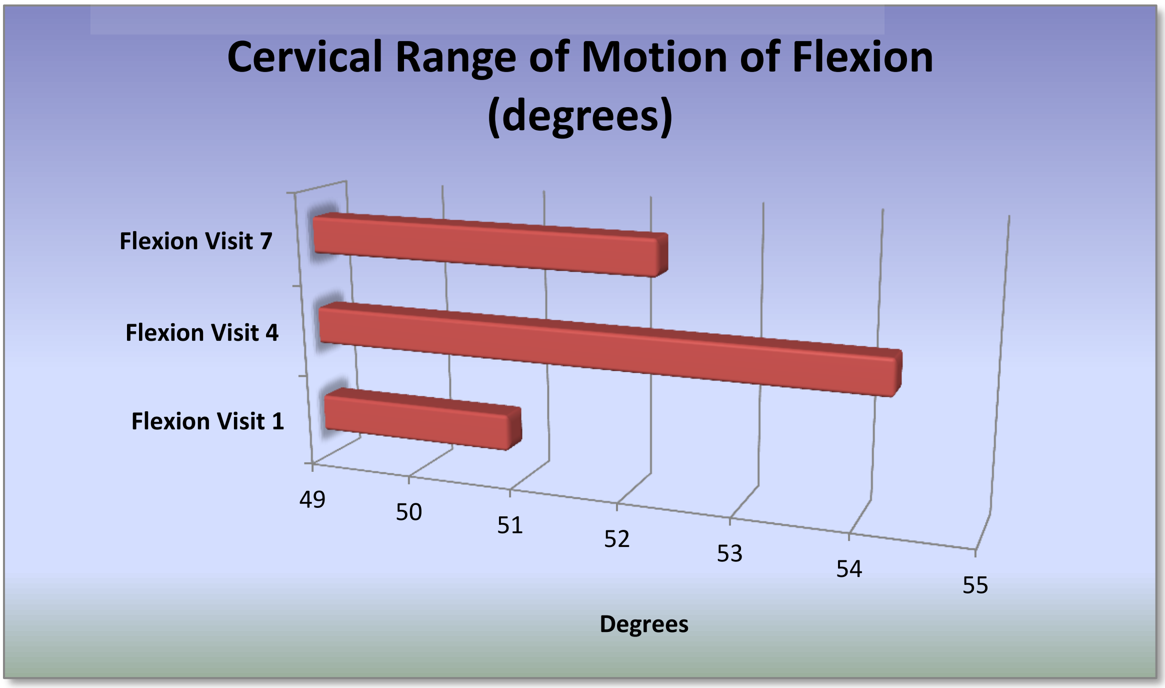


Figure 4.5: Cervical Range of Motion of Flexion

Figure 4.5 demonstrates the improvement of flexion for the adjustment and stripping massage group. The first reading was 50.87, the second reading was 54.27 and on the final visit it ended up being 52.27. This indicates a total of 1.4 degrees increase in flexion for the adjusting and stripping massage group.

Table 4.9: Test Statistics for Flexion

Adjustment	**N**	15
	Chi-Square	1.170
	Df	2
	Asymp. Sig	0.557
Adjustment and Stripping Massage	**N**	15
	Chi-Square	7.750
	Df	2
	Asymp. Sig	0.021

By looking at flexion in the adjustment and stripping massage group, the Friedman Test proved to be significant as indicated by table 4.9 the *p* value ($x^2(2, N = 15) = 7.750, p < .021$). The overall result of the treatment indicated an increase in flexion range of motion.

4.4.2 Left lateral flexion

The following significant *p* values were for left lateral flexion for the adjusting and stripping massage group. By studying the descriptive statistics in table 4.10 improvements in left lateral flexion can be seen.

Table 4.10: Descriptive Statistics Lateral Flexion to the Left

Group		**N**	**Mean**	**Std Deviation**	**Mean Rank**
Adjustment	LatFlexL1	15	50.07	8.405	1.80

	LatFlexL4	15	49.07	7.611	1.97
	LatFlexL7	15	51.47	8.167	2.23
Adjustment and Stripping massage	LatFlexL1	15	43.87	9.357	1.47
	LatFlexL4	15	48.80	7.921	2.30
	LatFlexL7	15	48.87	5.097	2.23

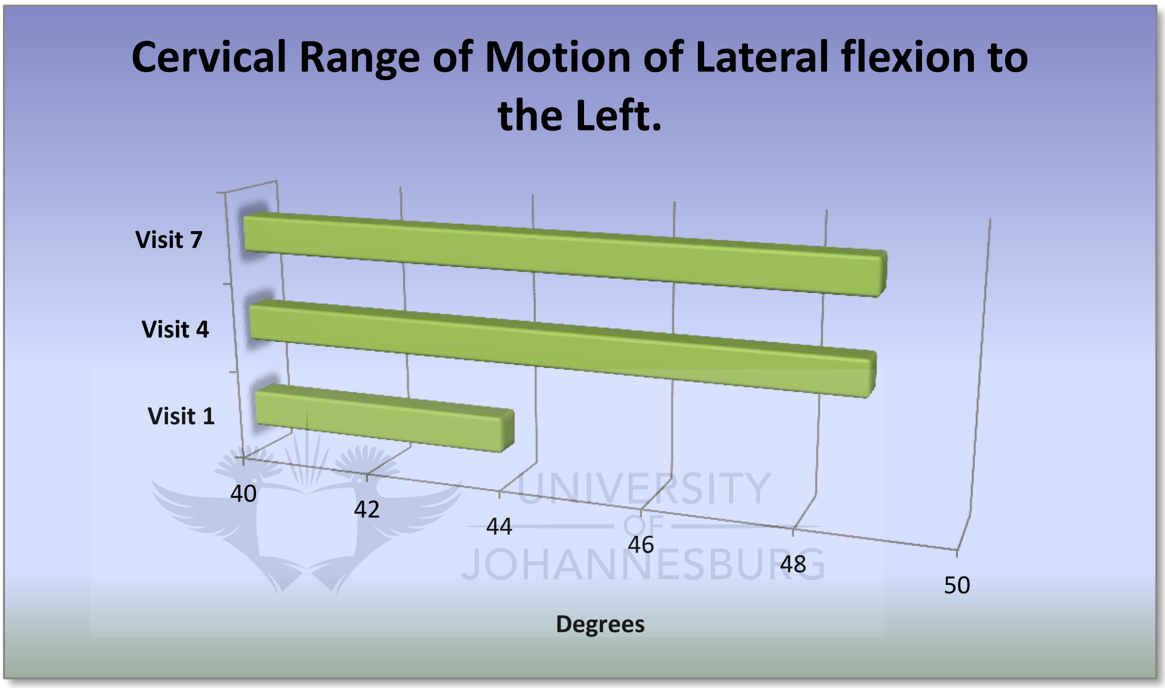


Figure 4.6: Cervical Range of Motion of Lateral Flexion to the Left

Figure 4.6 illustrates the gradual improvement of left lateral flexion for the adjusting and stripping massage group. From the graph above it can be seen that the mean readings for the initial visit was 43.87, 48.80 at the fourth visit and 48.87 at the seventh visit. This represents a steady increase from visit one to visit seven that adds up to a total of 5 degrees increase.

Table 4.11: Test Statistics for Lateral Flexion to the Left

Adjustment	**N**	15
	Chi-Square	1.623
	Df	2
	Asymp. Sig	0.444
Adjustment and Stripping massage	**N**	15
	Chi-Square	6.893
	Df	2
	Asymp. Sig	.032

When the mean as in table 4.11 is considered, the significant *p* value ($x^2(2, N = 15) = 6.893, p < .032$) for left lateral flexion increased in range over the three visits.

4.4.3 Left hand side rotation

Another significant finding was found for left hand sided rotation which was once again only found to be valid for the adjusting and stripping massage group. Only the *p* value as in table 4.12, ($x^2(2, N = 15) = 12.400, p < .002$) for the adjustment and stripping massage group was <0.05 and therefore significant.

Table 4.12: Test Statistics for Rotation to the Left

Adjusting	**N**	15
	Chi-Square	0.255
	Df	2
	Asymp. Sig	.880
Adjusting and Stripping massage	**N**	15
	Chi-Square	12.400
	Df	2

	Asymp. Sig.	.002

Table 4.13: Descriptive Statistics for Rotation to the Left

Groups		**N**	**Mean**	**Std Deviation**	**Mean Rank**
Adjustment	Rot L1	15	70.73	5.898	2.03
	RotL4	15	71.40	8.348	2.07
	RotL7	15	71.87	4.853	1.90
Adjustment and Stripping Massage	RotL1	15	63.53	11.563	1.27
	RotL4	15	68.87	7.190	2.47
	RotL7	15	69.53	6.896	2.27

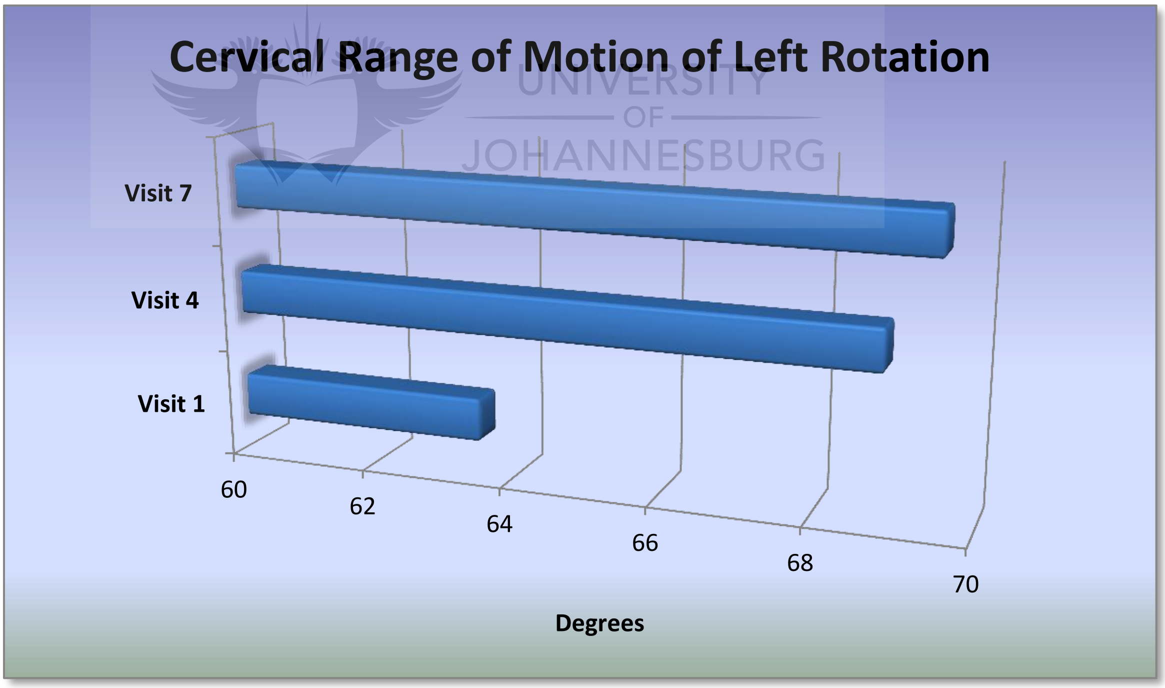


Figure 4.7: Cervical Range of Motion of Left Rotation

The bar graph (figure 4.7) above demonstrates the improvement of rotation to the left throughout the study from visit one to visit seven. As can be depicted from figure 4.7 and the means in table 4.13 the readings on visit one was 63.53, visit four 68.87 and 69.53 on the seventh visit. This indicates a gradual increase in the range of motion for rotation to the left that is consistent and gradual.

4.4 Post Hoc test

The Post Hoc tests are performed if a change was discovered over time and these tests then determine where the changes took place in time. For this study specifically it was tested to determine if changes took place between the initial visit and the fourth visit or whether the change was between the fourth and seventh visits.

Table 4.14: Paired Samples Statistics

Adjustment Group	**Pairs**	**Time interval**	**Mean**	**N**	**Std Deviation**	**Sum of Ranks**
	Pair 1	Pain scale1	4.80	15	1.656	120.00
		Pain scale 4	3.07	15	1.438	0.00
	Pair 2	Pain scale 1	4.80	15	1.656	105.00
		Pain scale 7	1.47	15	1.125	0.00
	Pair 9	Vernon Mior 1	22.67	15	14.416	100.50
		Vernon Mior 4	13.40	15	12.397	19.50
	Pair 10	Vernon Mior 1	22.67	15	14.416	120.00
		Vernon Mior 7	4.60	15	4.501	0.00
Adjustment and Stripping massage	Pair 1	Pain scale 1	5.20	15	1.146	120.00
		Pain scale 4	3.47	15	1.125	0.00
	Pair 2	Pain scale 1	5.20	15	1.146	120.00
		Pain scale 7	1.93	15	1.100	0.00
	Pair 3	Flexion 1	50.87	15	10.690	15.00
		Flexion 4	54.27	15	8.614	90.00
	Pair 5	Lat-flex L 1	43.87	15	9.357	12.50

		Lat-flex L-4	48.80	15	7.921	92.50
	Pair 6	Lat-flex 1	43.87	15	9.357	14.50
		Lat flex 7	48.87	15	5.097	90.50
	Pair 7	Rot-L 1	63.53	15	11.563	19.00
		Rot-L 4	68.87	15	7.190	101.00
	Pair 8	Rot-L1	63.53	15	11.563	12.00
		Rot – L7	69.53	15	6.896	108.00
	Pair 9	Vernon-Mior1	22.33	15	8.682	117.50
		Vernon-Mior4	11.60	15	5.152	2.50
	Pair 10	Vernon-Mior1	22.33	15	8.682	120.00
		Vernon-Mior7	6.67	15	5.434	0.00

To complete the test a Bonferroni Adjustment is needed to decrease the chance of error. So the *p* value that is found to be the smallest will be tested against a significant level of $\frac{0.05}{2}$ = 0.025. The largest *p* values of each variable will be tested against a *p* value of $\frac{0.05}{1}$ = 0.05. The Wilcoxon Signed Test was done; it is also a non-parametric test. The average positive and negative ranks are represented in the column mean ranks in the table above.

<u>Table 4.15: Test Statistics Wilcoxon Ranks Test</u>

	Group			
	Adjustment		**Adjustment and stripping massage**	
	Z	**Asymp. Sig. (2 tallied)**	**Z**	**Asymp. Sig. (2 tallied)**
Pain scale 4-Pain scale1	-3.473	0.001	-3.472	0.001
Pain Scale 7-Pain Scale 1	-3.325	0.001	-3.434	0.001
Flexion 4-Flexion 1			-2.363	0.018
LatFlex-L4-LatFlexL1			-2.525	0.012
LatFlexL7-LatFlexL1			-2.387	0.017

Rot-L4-RotL1			-2.333	0.020
RotL7-RotL1			-2.373	0.006
VernonMior4-VernonMior7	-2.317	0.021	-3.278	0.001
VernonMior7-VernonMior1	-3.413	0.001	-3.414	0.001

When the pain scale is reviewed for both groups it indicated that there was a decrease in the amount of pain experienced between visit 1 and visit 4 and visit 1 to visit 7. For the adjustment group the improvement was between visit 1 and 4 (N=15, Z=-3.473, p<0.001) and visit 1 and 7 (N=15, Z=-3.325, p<0.001) the *p* value remained the same for both time periods (table 4.15). The adjustment and stripping massage group also revealed an improvement in the time period from visit 1 to visit 4 (N=15, Z=-3.472, p<0.001) and the time period from visit 1 to 7 (N=15, Z=-3.434, p<0.001). This indicates that there was an overall decrease in the pain experienced by both groups throughout the whole study.

Flexion on the other hand illustrated an improvement in the adjustment and stripping massage group only. This occurred between the time period from visit 1 to visit 4. A *p* value of 0.012(N=15, Z=-2.363, p<0.018) is indicated and when the mean values are considered it reveals an improvement over this time period. Between visit 1 and 7 the flexion decreased but still remained increased from the initial visit as indicated by table above 4.15.

Lateral flexion to the left hand side also improved only in the adjusting and stripping massage group. During visit 1 and 4 there was an overall improvement (N=15, Z=-2.525, p<0.012) and in the time period between the initial visit and when the final readings were taken an improvement was also noted (N=15, Z=-2.387, p<0.017). If the mean values are studied in the table above there was a gradual increase from the initial visit to the final visit.

All cervical range of motion readings improved in the adjusting and stripping massage group only. Rotation to the left hand side also improved during the study period. For the period between visit 1 and 4 the *p* value was 0.020 which suggests an improvement during this time interval. Between visit 1 and 7 the *p* value was 0.006 and also indicates an improvement during this time period.

In the case of the Vernon-Mior Neck Pain and Disability Index, improvements were discovered in both the adjusting and the adjusting and stripping massage groups. For the adjusting group in the time period between visit 1 and 4 the *p* value =.021 and from visit 1 to 7 the *p* value =.001. In the adjusting and stripping massage group the improvement was noted in both time periods that was between visit 1 and 4 (N=15, Z=-3.278, p<0.001) as well as visit 1 and 7 (N=15, Z=-3.414, p<0.001).

4.5 Wilcoxon Signed Ranked Test (Comparison left and right)

The Wilcoxon Signed Ranked Test was completed to determine if a difference was found between the left and right hand side and at which visit. Here the Bonferroni Adjustment does not apply because left and right was not tested therefore the *p* value remained at <0.05.

Table 4.16: Paired Sample Statistics Wilcoxon Ranks Test

Group			**Mean**	**N**	**Std Devotion**	**Sum of Ranks**
Adjusting and stripping massage	Pair 3	LatFlex-R7	51.13	15	7.472	86.00
		LatFlex-L7	48.87	15	5.097	19.00
	Pair 9	HRA-R7	66.20	15	36.836	23.00
		HRA-L7	86.47	15	41.541	97.00

<u>Table 4.17: Test Statistics Wilcoxon Signed Ranks Test</u>

	Group			
	Adjustment		**Adjustment and stripping massage**	
	Z	**Asymp.Sig.(2-tailed)**	**Z**	**Asymp. Sig. (2-tailed)**
LatFlex-L7-LatFlex-R7	-1.008	0.313	-2.133	0.033
HRA-L7-HRA-R7	0.000	1.000	-2.101	0.036

A difference was found between left lateral flexion and right lateral flexion on visit 7 for the adjusting and stripping massage group. The *p* value was 0.033 which is smaller than 0.05, thus a significant difference was present. When referring back to the means a greater improvement was found to be on the right hand side which had a mean value of 51.13 degrees compared the left hand side which had a mean value of 48.87 degrees.

Another difference was also found on the last visit for head repositioning accuracy and it was found to be only in the adjusting and stripping massage group. The *p* value was 0.036 when returning to the mean values which are represented in a table above, the improvement was found to be on the right hand side (Mean = 66.20mm) rather than the left hand side (Mean = 86.47mm) which had a greater degree of accuracy error.

4.5 Other Findings

Statistical analysis revealed that the following measurements were not significant:

- Extension
- Right lateral flexion
- Right rotation

Data from the above readings which were recorded by using the cervical range of motion device were found to be insignificant. This could have been due to the small sample size and with some readings, improvements were found but the degree of improvement over time was not significant enough to be recognised by statistical analysis.

CHAPTER FIVE:

DISCUSSION

CHAPTER 5

DISCUSSION

5.1 Introduction

This chapter serves to discuss the statistical analysis that was performed in Chapter Four.

5.2 Demographic Data

The study population consisted of thirty participants which were divided into two groups which consisted of fifteen participants. Both groups of fifteen consisted of seven females and eight males. The age range for the study population that was recruited, was between twenty years old and thirty two years old. This gave the study population a mean age of 24.73 years.

5.3 Subjective Data

Subjective data that was collected throughout this study consisted of two components. Each participant was asked to complete both the Numerical Pain Rating Scale and the Vernon-Mior Neck Pain and Disability Index at the first, fourth and seventh visits. By collecting this data it gave a numerical value to what the participants were experiencing.

5.3.1 Numerical Pain Rating Scale

When analysing the Numerical Pain Rating Scale (refer to figure 4.3) it is evident that both of the study groups experienced a decrease in the severity of cervical pain. The decrease in severity does not differ significantly enough between both groups to determine which treatment was better suited in treating cervical pain. Initially the adjustment group reported a mean pain rating of 4.80 and the adjustment and stripping massage group reported a mean rating of 5.20. This indicates a higher rating for the adjustment and stripping massage group and at the end of the study period a rating of 1.93 for the adjusting and stripping massage group was found and the adjusting group ended with a mean of 1.47. Therefore the changes in the adjustment group was more significant but if the initial means are considered the improvement for both groups were similar.

When the Wilcoxon Rank Test was completed on the data collected for the Numerical Pain Rating Scale, it was found that an improvement was noted over time. This improvement was already present between visit one and visit four for both groups and continued through-out to visit seven. For both groups a significant *p* value of 0.001 was present.

5.3.2 Vernon-Mior Neck Pain and Disability Index

The Vernon-Mior Neck Pain and Disability Index showed a similar improvement to the Numerical Pain Rating Scale for both groups. As seen in figure 4.4 the disability and pain percentage for both groups decreased over time. The adjustment group started off with a mean of 22.67% which is higher than the adjustment and stripping massage group that had an initial mean of 22.33%. At the seventh visit the adjustment group had a mean percentage of 4.60% and in the case of the adjustment and stripping massage group a mean percentage of 6.67% was discovered. Therefore the group that just received an adjustment as part of their treatment had more improvement when considering pain and disability.

A Wilcoxon Rank Test was also completed for the Vernon-Mior Neck Pain and Disability Index. The adjusting group in the time period between visit one and four had a *p* value which was 0.021 and between visit one and seven a *p* value which was 0.001. For the adjusting and stripping massage group a *p* value of 0.001 was present for both time periods. Both results indicates that an improvement already occurred between visit one and four which then kept on improving throughout the study.

5.3.3 Decreased Pain and Disability

A study done by Mc Morland & Suter (2000) found that patients experienced an improvement in their health after undergoing chiropractic care. The study focused mainly on mechanical neck pain and lower back pain. Improvements were noted by focusing on the participant's related disability index scores and visual analogue scale results and both were found to have improved post treatment. Another study completed by Schalkwyk & Parkin-Smith (2000) also proved that undergoing chiropractic care led to an improvement in pain sensitivity and tolerance. They compared techniques within the cervical spine and ended with both adjusting techniques being as effective as the other in treating neck pain. Vernon, Humphrey & Hagino (2007) proved that chiropractic care did not just improve cervical neck pain over a short time period but found that improvements lasted up to the 6, 12 and 104th weeks post treatment follow up visits.

A study done by Coronado, Gay, Bialosky, Carnaby, Bishop & George (2012) investigated the effects of spinal manipulation. They discovered that patients responded by having an increased pain threshold that was not just local but also found to be present in distant areas. This indicates that effects do not just occur at a spinal level but also in the central nervous system. Bialosky, Bishop, Price, Robinson & George (2008) stated that changes that take place are due to a neurophysiological cascade that is placed on the central nervous system and peripheral nervous system.

An abnormal biomechanical link in the spinal column can lead to abnormal function in the receptors that are found paraspinally (Haldeman, 2000). Multiple structures that are found around the spinal column are richly innervated by receptors that respond to different stimuli. Receptors are stimulated by mechanical stimuli (position, motion and tissue distortion), inflammatory (nociceptive) and temperature changes. An aberrant functioning receptor can stimulate active neural reflexes that in the end can lead to somatovisceral responses in the sympathetic and parasympathetic nerves as well as somato-somatic responses that in the end lead to muscle spasms.

Dickenson (2002) stated that pain that originates from damaged peripheral nerves or tissues that enter the spinal cord can be altered by central and peripheral signalling mechanisms. Spinal manipulation can possibly activate the descending inhibitory pain pathways through the periaqueductal grey region (De Camargo, Alburquerque, Sendin, Berzin, Stefanelli, De Souza & de las Penas, 2011). The activation of the descending pain pathways is due to the activity of receptors in the zygapophyseal joint capsule, ligaments, muscles, cutaneous receptors, muscle spindles and Golgi tendon organs during a spinal manipulation.

Neurones that extend from the peraqueductal grey matter transmits information to the raphe magnus nucleus that is situated in the lower and upper medulla as well as to a nucleus that is situated in the lateral medulla (reticularis paragigantocellularis). Secondary order neurones then extend from these nuclei that transmit information down the dorsolateral columns that is in the spinal cord. They then end in the dorsal horn of the spinal cord that is called the pain inhibitory complex, at this point pain can be blocked before the signals travels to the brain (Guyton & Hall, 2006).

Pain signals can also be controlled by stimulation of peripheral tactile receptors that then leads to transmission of information via large A beta sensory fibres. This is referred to as the pain gate theory that was initially mentioned by Melzack in 1965 and supported by Dickenson (2002). Input from peripheral nerves due to damaged nerves or tissues can lead to marked central changes. The pain gate relates to changes that is brought forth from local or distant areas and it can be inhibitory or excitatory (Dickenson, 2002). The pain gate occurs due to altered afferent input from peripheral nerves especially your large diameter A beta fibres (Melzack & Wall, 1965). It is situated in the dorsal horn of the spinal cord opening of the pain gate and is dependent on the activity of the C and A delta fibres (pain experienced), the closing of the gate depends on activity of the large A delta fibres. If predominant activity is within the A beta fibres the gate will be closed and no pain will be experienced. They depress pain signals from the same area and prevent pain signals from reaching consciousness. This is due to local lateral inhibition at the spinal level.

Brasseau, Wells, Tugwell, Casimito, Navikov, Laew, Sredic, Clément, Gravelle, Hua, Kresic, Lakic, Ménard, Côte, Leblanc, Sonier, Clautier, McEwan, Poitros, Furlan, Gross, Dryden, Muckenheim, Côte, Paré, Rouhani, Léonard, Finestone, Laferriére, Dagenais, De Angelis & Cohoon (2012) did a study on massage and its physiological effects and found that its effective in relieving pain, improving range of motion in patients suffering from sub-acute and chronic neck pain. In this study it was also mentioned that the effect brought on by massage has a short term effect rather than long term changes. They state that massage decreases pain by the pain gate theory that was developed by Melzack & Wall in 1965. Other changes that can also lead to less pain experienced are hormonal changes in the blood post massage therapy, the release of myofascial trigger points and increased blood flow to the affected area which assists with healing.

Thereby changes that were brought on by this study could have been from central changes associated with the descending inhibitory pain pathways as well as the pain gate theory. Both the treatments administered in the adjusting and stripping massage group had a perpetual effect on each other thereby decreasing the amount of pain experienced by the participants.

5.4 Objective Data

5.4.1 Cervical Range of Motion

All improvements that were found for Cervical Range of Motion were recorded for adjusting and stripping massage group only. Improvements were discovered for flexion which had a *p* value=0.02, left lateral flexion also had a significant *p* value of 0.032 and an improvement was present for rotation to the left (p=0.002).

Decreased cervical range of motion is a common finding in individuals whom suffer from cervical pain (Rudolfsson, Björklund & Djupsjöbacka, 2012). Rudolfson *et al.* (2012) did a study with cervical manipulation of the upper and lower cervical segments and it was found that both segments responded by having an increased range of motion. A similar study done by Whittingham & Nilsson (2001) whom compared a spinal manipulation and mobilisation found that the group that received manipulation therapy had a greater improvement compared to the other group.

Numerous other studies that included cervical manipulations had similar results. Segura, de las Penas, Saez, Jimenz and Blanco (2006), found that manipulation did increase the range of motion and referred to two possible means by which it could have occurred. The initial finding was that by applying a cervical manipulation to a joint that is dysfunctional (joint with decreased mobility) will ultimately have an effect on the entire cervical kinematic chain therefore affecting the entire cervical spine. It was also mentioned that the increase of the range of motion could have been owed to the reduction of the pain intensity experienced by an individual, therefore, leading to biomechanical changes. For this study both concepts apply by maintaining that normal motion between segments will have an overall effect on the range of motion and by decreasing the participants' pain intensity levels, would allow for a greater range of motion.

A study done by Sefton, Yarar, Carpenter & Berry (2011), focused mainly on the effects of massage on cervical range of motion. The study proved that massage therapy improved the range of motion in all planes. It was also discovered that a centralised effect occurs where a modulating effect transpires within the spinal cord which decreases the neurological output of nerves that ultimately leads to a decrease in muscle electrical activity. An increased blood flow to the areas was also noted; this leads to decrease pain and allows healing. These effects are not just localised but changes were recorded proximally and distally to the treatment area.

From the above findings in previous studies and by including the sternocleidomastoid muscle into the study allowed for further relaxation and increased range of motion. If the stripping massage and manipulative therapy is combined it could have a greater centralising effect thereby permitting an overall decreased neurological effect locally as well as the surrounding areas.

Post Hoc test were also completed for the range of motion readings to discover where a change was present over time as indicated in table 4.14. For flexion it was discovered that there was an improvement between visit one and four but between visit one and seven the *p* value was not significant, but if the means are considered the range of motion did decrease on the seventh visit compared to visit four, but the range was still more than what it was on the initial visit.

Left lateral flexion did also increase but once again it only occurred in the adjusting and stripping massage group. With left lateral flexion improvement in the range was noted from the initial reading to the fourth reading as well as the time period that extends from visit one to visit seven. Refer to Figure 4.6 to see the gradual increase in the range of motion for left lateral flexion from an initial reading of 43.80 to 48.57.

The last range of motion with a significant *p* value of 0.002 was for left hand sided rotation of the cervical spine. The adjustment group did not have a significant value once again. The change for this group started to occur between visit one and four as well as between the initial visit and visit seven. The improvement is illustrated by Figure 4.7; this indicates the change that occurred. Initially the reading had a mean value of 63.53 and it improved to 69.53.

It needs to be noted for the cervical range of motion that all the ranges did not increase but it necessarily did not have to increase. Some participants had a normal range of motion and had an increase on visit four but then returned to a normal range of motion by the seventh visit. Therefore the adjustment group did not have a significant increase but it cannot be said to be inadequate in increasing the range of motion.

Segura *et al.* (2006) noted that an increase in the range of motion on a specific side or in a certain plane is not dependent on the side that the manipulation was done. In the study completed by Segura *et al* (2006) it was mentioned that an adjustment had a general effect on the cervical kinematics rather than being side specific. Therefore the findings in this study that only the left hand side motion improved is not an indication that other variables such as predominantly adjusting or massaging one side above the other changed the results.

A further analysis were done by using the Wilcoxon Rank Test to do a comparison on the right and left side. A difference was found between left and right hand sided lateral flexion. When Table 4.1.14 is considered, an improvement was found on the right hand side compared to the left hand side on the seventh visit. On the right hand side a mean range of 51.13 was recorded and on the left hand side a reading of 48.87 was found and this difference was once again only present in the adjusting and stripping massage group. If the study of Segura *et al.,* (2006) is considered this finding is of no significance, although it indicates at what point the range of motion did differ during the study period.

5.4.2 Head Repositioning Accuracy

Although the head repositioning readings did not reap any significant *p* values it needs to be mentioned. No *p* values were of any significance due to the fact that such a small study population was utilised. Both groups had a significant improvement when the means are considered (table 4.6 and 4.7). The adjusting group had a mean value of 77.33mm of accuracy error for right hand sided rotation on the initial visit and a mean value of 71.93mm of accuracy error on the seventh visit. On the left hand side rotation the initial mean was 77.00mm and ended with a mean value of 68.67mm.

For the adjusting and stripping massage group the mean reading for right hand sided rotation was 92.87mm of accuracy error and it ended with an accuracy error of 66.20 on the seventh visit. On the left hand side the mean was initially 102.07mm of accuracy error and it improved to 86.47mm of accuracy error.

So for the adjustment group the improvement was in total 13.73mm for both sides. The adjusting and stripping massage group had a sum of 42.27mm improvement for both right and left hand sided rotation. These totals were calculated by adding both left and right hand side accuracy improvements. Once again the adjusting and stripping massage group had the most noticeable improvement of the two groups.

As mentioned in Chapter Two, abnormal proprioception can lead to sustained abnormal postures or movements and it can also lead to long term abnormal physiological loads placed on the neck and its surrounding structures (Strimpakos, 2011). When proprioception is dysfunctional for long periods at a time it leads to compromised cervical function that in the end can lead to dysfunctional syndromes. For normal function to be present there needs to be a congruency between motor intention and the sensory experience which includes visual and proprioceptive input (Haavik &Murhpy, 2012). The study done by Haavik and Murphy (2012) found that a cervical dysfunction can impair the way in which proprioceptive information is processed in the central nervous system.

But Haavik & Murphy (2012) found that spinal manipulation can have an effect on the processing of sensory and motor information within the central nervous system via two possible means. The first suggested method was by only correcting any spinal dysfunctions which can normalise aberrant afferent input into the central nervous system. On the other hand an effect on the central nervous system can be brought on by the possible neurological barrage that occurs during a spinal manipulation. Thereby, manipulation leads to appropriate and accurate processing of gathered proprioceptive information. Another study done by Taylor & Murphy (2008) also discovered that spinal manipulation can have an effect on the central cortico-motor processing by being inhibitory or facilitatory.

By correcting the central processing and proprioception feedback, normal function can be restored and pain relief can occur (Taylor & Murphy, 2008). By correcting motor control the neurological processing is altered and this can form an important part of the rehabilitation treatment programmes for patients with chronic neck pain.

Another structure that played a role within this study was the sternocleidomastoid muscle. Simons *et al.* (1999) mentions that the sternocleidomastoid is a major source of proprioception and if it is affected by a central trigger point it can cause abnormal central processing of afferent information. Thereby including this structure into the study as a proprioceptive organ could have a significant effect on the results. By applying massage to the sternocleidomastoid it could have had a centralised effect which is modulating in nature. Therefore it decreases the neurological output of nerves that ultimately leads to a decrease in muscle electrical activity and therefore leads to normal proprioceptive feedback.

The head repositioning accuracy improved for both groups indicating that spinal manipulation and stripping massage both have an effect. As mentioned in previous studies this outcome is probably due to the modulating effect both treatment therapies has on the proprioceptive system. If the means are taken into account the adjustment and stripping massage group had a greater improvement and this can be due to the combined effect that the massage and adjusting create.

A Wilcoxon Signed Rank Test to compare the left hand side and right hand was also done. A difference was found on the right hand side on the seventh visit. The right hand side had a mean accuracy error of 66.20 and the left had a mean of 86.47. Once again the improvement was found to be only in the adjusting and stripping massage group.

CHAPTER SIX:

CONCLUSION AND RECOMMENDATIONS

CHAPTER 6

6.1 CONCLUSION

The aim of this study was to compare the effects of chiropractic manipulative therapy with and without stripping massage of the sternocleidomastoid muscle, with regard to pain, disability, cervical range of motion and head repositioning accuracy in the treatment of chronic mechanical neck pain.

Changes that were brought on by this study could have been from central changes associated with the descending inhibitory pain pathways as well as the pain gate theory. Both the treatments administered in the adjusting and stripping massage group had a perpetual effect on each other thereby decreasing the amount of pain experienced by the participants.

A study done by Coronado *et al.* (2012) investigated the effects of spinal manipulation. They discovered that patients responded by having an increased pain threshold that was not just local but also found to be present in distant areas. This indicates that effects do not just occur at a spinal level but also in the central nervous system. Bialosky, *et al.,* (2009) states that changes that take place are due to a neurophysiological cascade that is placed on the central nervous system and peripheral nervous system.

Spinal manipulation can possibly activate the descending inhibitory pain pathways through the periaqueductal grey region (De Camargo,*et al.,* 2011). The activation of the descending pain pathways is due to the activity of receptors in the zygapophyseal joint capsule, ligaments, muscles, cutaneous receptors, muscle spindles and Golgi tendon organs during a spinal manipulation.

It was also mentioned that the increase of the range of motion could have been owed to the reduction of the pain intensity experienced by and individual.

From the above findings from previous studies and by including the sternocleidomastoid muscle into the study allowed for further relaxation and increased range of motion. If the stripping massage and manipulative therapy is combined it could have a greater centralising effect thereby permitting an overall decreased neurological effect locally as well as the surrounding areas.

Segura *et al.* (2006) noted that an increase in the range of motion on a specific side or in a certain plane is not dependent on the side that the manipulation was done. In the study completed by Segura *et al.* (2006) it was mentioned that an adjustment had a general effect on the cervical kinematics rather than being side specific. Therefore the findings in this study where only the left hand side motion improved is not an indication that other variables such as predominantly adjusting or massaging one side above the other changed the results.

The head repositioning accuracy also improved for both groups indicating that spinal manipulation and stripping massage both have an effect. As mentioned in previous studies this outcome is probably due to the modulating effect both treatment therapies have on the proprioceptive system. The adjustment and stripping massage group had a greater improvement and this can be due to the combined effect that the massage and adjusting had on the proprioceptive structures in the cervical spine.

For normal function to be present there needs to be a congruency between motor intention and the sensory experience which includes visual and proprioceptive input (Haavik & Murphy, 2012). The study done by Haavik and Murphy (2012) found that a cervical dysfunction can impair the way in which proprioceptive information is processed in the central nervous system. Thereby manipulation leads to appropriate and accurate processing of gathered proprioceptive information.

By correcting the central processing and proprioception feedback, normal function can be restored and pain relief can occur (Taylor & Murphy, 2008). By correcting motor control, the neurological processing is altered and this can form an important part of the rehabilitation treatment programs for patients with chronic neck pain.

The results of this study suggests that chiropractic manipulative therapy in combination with stripping massage is more beneficial in treating chronic cervical pain as well as improving cervical range of motion and head repositioning accuracy (proprioception). Statistically significant differences were found between the two groups where range of motion in flexion and lateral flexion improved to a greater extent in the adjusting and stripping massage group when compared to the adjusting group. In the adjusting and the adjusting and stripping massage group the intensity of pain as well as the disability index also proved to be statistically significant. Thereby concluding that the adjusting and stripping massage group overall had superior improvement in all subjective and objective clinical findings.

The possible outcome/effect for the chiropractic profession suggests that chiropractic manipulation therapy in combination with stripping massage of the sternocleidomastoid muscle is sufficient in the treatment of chronic cervical neck pain as well as dysfunctional proprioception if compared to just utilising chiropractic manipulative therapy. This provides an additional treatment modality for chiropractors to utilise in their treatment management protocols.

6.2 Recommendations

The following recommendations are made for future studies dealing with a similar treatment protocol:

- The inclusion of a much larger sample group, to increase the statistical significance.

- All participants should have similar degrees of cervical pain and disability scores initially which would improve the comparability of the results.
- It is known that the use of any instrument can result in user error in this case the cervical range of motion measuring device.
- To improve the standards of the clinical findings within the study and to decrease the human error chance more objective questionnaires should be used in future studies.
- A one month or even two month follow up could be used to determine the long term benefits of the treatment protocol used.
- Be gender specific by isolating the study to only male or female participants between the ages of 18 to 35 years of age. This will improve statistical relevance by decreasing the amount of demographic data.
- Three participant groups should be utilised with one group just receiving an adjustment, the next group just receiving stripping massage and the third group receiving a combination of the two treatments. Thereby distinguishing which treatment has the greatest impact.
- Inclusion of thoracic spinal manipulative therapy can be included to see its effect on the variables measured.
- Research should be conducted on sample groups of equal representative ages as age and degeneration plays a significant role in outcomes of treatment.

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APPENDICES

APPENDIX A

Advertisement

Do you suffer from neck pain?

Receive free Chiropractic treatment!!! Do you suffer from chronic (6 weeks or longer) NECK PAIN?

Are you between the ages of 18 and 40?

You may qualify to take part in a research study aimed at relieving your neck pain.

Treatment is free of charge!!

University of Johannesburg Doornfontein Campus

Chiropractic Clinic

(Gate 7, Sherwell Road, Doornfontein)

Please contact Greyling Botha on 011 559 6493 if you are interested

APPENDIX B

Information and Consent Form

UNIVERSITY OF JOHANNESBURG

<u>DEPARTMENT OF CHIROPRACTIC</u>

INFORMATION AND CONSENT FORM

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

The aim of the study is to compare Chiropractic manipulative therapy and stripping massage of the sternocleidomastoid muscle, and in a combination treatment to determine whether there truly is a benefit in combining the two treatments so as to provide Doctors of Chiropractic with an additional treatment protocol for chronic mechanical neck pain and to determine the effect it may have on head repositioning accuracy.

Participants will be recruited by word of mouth and by advertisements placed within and around the Chiropractic Clinic at Doornfontein Campus. Participants will be assessed as to whether they fulfil the inclusion and exclusion criteria for this research study. Participants will be randomly assigned to two groups and receive Chiropractic manipulative therapy, or chiropractic manipulative

therapy and stripping massage. The Chiropractic adjustment involves the restoration of normal joint motion. Abnormal joint motion will be detected by the researcher via motion palpation. The Chiropractic adjustment is a safe, non-invasive treatment technique.
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 all participation is entirely on a voluntary basis; withdrawal at any stage will not cause you any harm. ***Potential benefits from this study include relief or a decrease in mechanical cervical pain. Potential discomforts are the wearing of the Head Repositioning Helmet. Risks that may occur could be slight pain and discomfort of the neck due to cervical spine manipulation and sternocleidomastoid stripping massage.*** After this study is complete, I will provide you feedback regarding the outcomes if you so wish.

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

Date: ________________ Researcher:________________

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

Date: ________________________ Participant: __________________________

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

Researcher: Greyling Botha 071 352 6116
Supervisor: Dr Moodley 083 775 7997

APPENDIX C

Exclusion Criteria

Contra-Indications of Chiropractic Adjustments (Gatterman, 1990)

Vascular complications

- Vertebral artery syndrome
- Aneurysms

Tumors

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

Bone infections

- Tuberculosis of the spine
- Osteomyelitis of the spine

Traumatic injuries

- Fractures
- Instabilities
- Dislocation
- Unstable spondylolisthesis

Arthritis

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

Psychological considerations

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

Neurological complications

- Cervical disc lesions and myelopathy
- Nerve root damage

APPENDIX D

Case History

RESEARCH

UNIVERSITY OF JOHANNESBURG

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

CASE HISTORY

Date: _______________

Patient: ______________________________ **File No:** __________

Age: ______ **Sex:** ___________ **Occupation:** ________________

Student: ________________________ **Signature:** ________________

===

Complies with Inclusion criteria of the research:

Clinician: ____________________________
Signature: ___________________________

===

Examination:

Previous:	UJ Other	Current:	UJ Other

X-ray Studies:

Previous:	UJ Other	Current:	UJ Other

Clinical Path. Lab:

Previous:	UJ Other	Current:	UJ Other

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

Haernatologic

Endocrine

Psychiatric

APPENDIX E: Physical Examination

RESEARCH

UNIVERSITY OF JOHANNESBURG

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

(NOTE: only if Cervical Spine Regional is complete)

Underline abnormal findings in **RED.** **Date:** ____________________

Patient: ________________________ **File No:** _______________

Clinician: ________________________ **Signature:** _______________

Student: ________________________ **Signature:** _______________

Height: _________ **Weight:** ________ **Temp:** _________

Rates: **Heart:** ___________ **Pulse:** _________ **Respiration:** _________

Blood pressure:	**Arms:**	**L**	**R**
	Legs:	**L**	**R**

General Appearance:

____

____

____

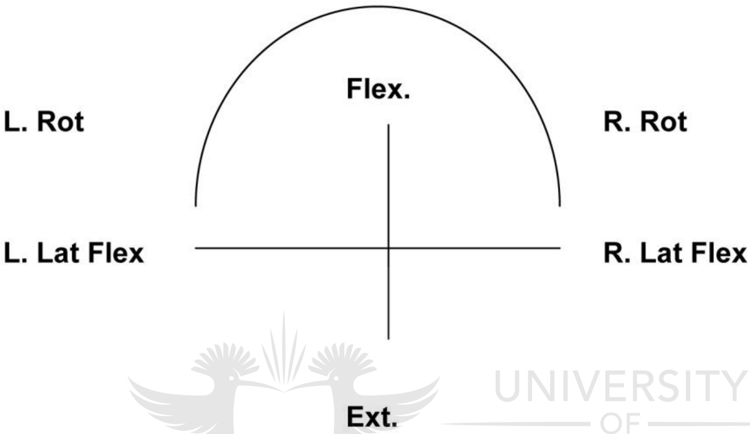
____

____

____

STANDING EXAMINATION

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



/ = pain-free limitation **// = painful limitation**

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

14. Chest measurement:

	L	R
- inspiration	cm	cm
- expiration	cm	cm

15. Visual acuity

16. Breast examination:
Inspection:
- skin
- size
- contour
- nipples
- arms overhead
- hands against hips
- leaning forward

Palpation
- axillary lymph nodes
- breast incl. tail

SEATED EXAMINATION

1. Spinal posture
2. Head
   - hair
   - scalp
   - skull
   - face
   - skin
3. Eyes:
   Observation
   - conjunctiva
   - sclera
   - eyebrows
   - eyelids
   - lacrimal glands
   - nasolacrimal duct
   - position and alignment
   - corneas and lenses

- corneal reflex

- ocular movement

L			R		
III	**IV**	**VI**	**III**	**IV**	**VI**

- visual fields
- accommodation
- Opthalmoscopic
- Examination
  - iris
  - pupils
  - red reflex
  - optic disc
  - vessels
  - general background

- macula
- vitreous
- lens

4. Ears: - auricle

- Inspection
  - ear canal
  - drum

- auditory acuity
- Weber test
- Rinne test

5. Nose:

- External
- Internal
  - septum
  - turbinates
  - olfaction

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

7. Mouth and pharynx:

- lips
- buccal mucosa
- gums and teeth
- roof
- tongue
  - inspection
  - movement
  - taste
  - palpation

- pharynx
  -CN X

  - inspection

- 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

	L	R
flex. 90/120		
ext. 15		
abd. 45		
add. 30		
int rot 40		
ext rot 45		
	L	**R**
flex. 130		
ext. 0/15		
	L	**R**
plantar Flex 45		
dorsiflex 20		
inversion 30		
eversion 20		
	L	**R**
Apparent		
Actual		

- 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)
  - diaphgragmatic excursion
  - kidney punch

- Auscultation
  (i) breath sounds
  - vesicular
  - bronchial

  (ii) adventitious sounds
  - crackles (rales)
  - wheezes (rhonchi)
  - rubs

  (iii) voice sounds
  - broncophony
  - whispered pectoriloquey
  - egophony

- Cardiovascular
  - auscultation (aortic murmurs)
  - Allen's test

<u>SUPINE EXAMINATION</u>

1. JVP
2. PMI
3. Auscultation heart (L. lat. Recumbent)
4. respiratory excursion
5. percussion chest (anterior)
6. breast palpation
7. Abdominal Examination

- Inspection
  - skin
  - umbilicus
  - contour
  - peristalsis
  - pulsations
  - hernias (umbilical/incisional)

- Auscultation
  - bowel sound
  - bruit
- Percussion
  - general
  - liver
  - spleen
- Palpation
  - superficial reflexes
  - cough
  - light
  - rebound tenderness
  - deep
  - liver
  - spleen
  - kidneys
  - aorta
  - intra-/retro-abdominal wall mass
  - shifting dullness
  - fluid wave
- Acute abdomen
  - where pain began and now
  - cough
  - tenderness
  - guarding/rigidity
  - rebound tenderness
  - rovsing's sign
  - psoas sign
  - obturator sign
  - cutaneous hyperaesthesia
  - rectal exam
  - Murphy's sign

MENTAL STATUS

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

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

(ii) Mood

(v) Memory and attention
- orientation (time, place, person)
- remote memory

- recent memory
- new learning ability

(vi) Higher cognitive functions

- information and vocabulary
- (general and specialised knowledge)
- abstract thinking

NEUROLOGICAL EXAMINATION (LUMBAR SPINE)

DERMATOMES	Left	Right	MYOTOMES	Left	Right	REFLEXES	Left	Right
T12			**Hip Flexion (L1/L2)**			Patellar (L3, 4)		
L1			**Knee Extension (L2, 3, 4)**			Medial Hamstring (L5)		
L2			**Knee Flexion (L5/S1)**			Lateral Hamstring (S1)		
L3			**Hip Int. Rot (L4/L5)**					
L4			**Hip Ext. Rot (L5/S1)**					
L5			**Hip Adduction (L2, 3, 4)**					
S1			**Hip Abduction (L4/5)**					
S2			**Ankle Dorsiflexion (L4/L5)**					
S3			**Hallux Extension (L5)**					
			Ankle Plantar Flexion (S1/S2)					
			Eversion (S1)					
			Inversion (L4)					
			Hip Extension (L5/S1)					

APPENDIX F: Cervical Regional Examination

RESEARCH

UNIVERSITY OF JOHANNESBURG

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

REGIONAL EXAMINATION
CERVICAL SPINE

Date: ______________________

Patient: ____________________________ **File No:** __________________

Clinician: ____________________________ **Signature:** ________________

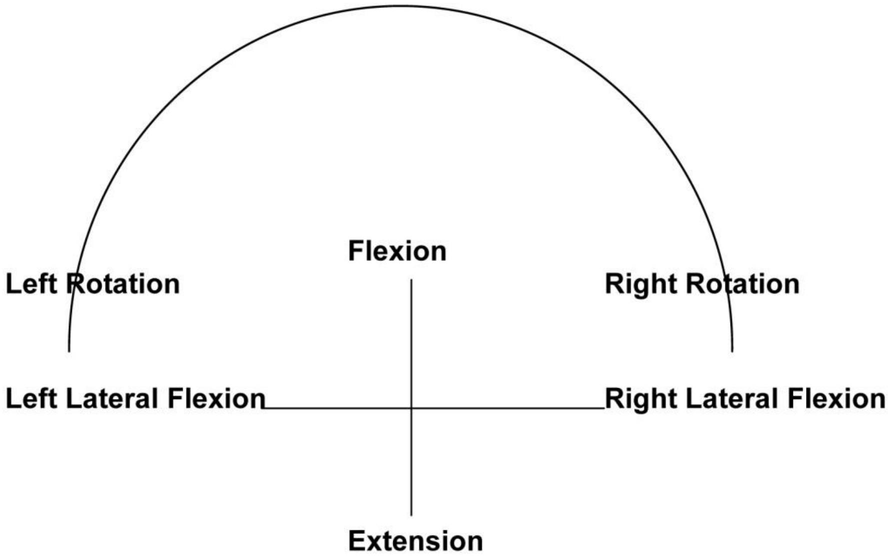
Student: ____________________________ **Signature:** ________________

OBSERVATION

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

5. RANGE OF MOTION

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



/ = Pain free limitation **// = Painful limitation**

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:

___

___

___

___

VASCULAR	**LEFT**	**RIGHT**
BLOOD PRESSURE		
CAROTIDS		
SUBCLAVIAN ARTERIES		
WALLENBERG'S TEST		

COMMENTS:

___

___

___

___

MOTION PALPATION

Jt. Play			Left					Right				Jt. Play		
P/A	Lat	Fle	Ext	LF	AR	PR		Fle	Ext	LF	AR	PR	P/A	Lat
							C1							
							C2							
							C3							
							C4							
							C5							
							C6							
							C7							
							T1							
							T2							
							T3							
							T4							

NEUROLOGICAL EXAMINATION

DERMATOMES	Left	Right	MYOTOMES	Left	Right	REFLEXES	Left	Right
C2			**Neck Flexion C1/2**			Biceps C5		
C3			**Lat. Neck Flexion C3**			Brachioradialis C6		
C4			**Shoulder Elevation C4**			Triceps C7		
C5			**Shoulder Abduction C5**					
C6			**Elbow Flexion C5**					
C7			**Elbow Extension C7**					
C8			**Elbow Flexion at 90º C6**					
T1			**Forearm Pronation C6**					
			Forearm Supination C6					
			Wrist Extension C6					
			Wrist Flexion C7					
			Finger Flexion C8					
			Finger Abduction T1					
			Finger Adduction T1					

APPENDIX G

Numerical Pain Rating Scale (McCaffery & Pasero, 1999)

Name: ________________________________

File number: __________________________

Date: _________________________________

Place a mark on the pain scale below that represents your pain at this point in time. On a scale of 0 to 10.

0 means “no pain” and 10 means the “worst possible pain”. The middle of the scale describes “moderate pain”.

A two or three rating would be “mild pain” and a rating of seven or higher would indicate “severe pain”.

Visit 1

0	1	2	3	4	5	6	7	8	9	10
No pain				Moderate pain			Worst pain			

Visit 4

0	1	2	3	4	5	6	7	8	9	10
No pain				Moderate pain			Worst pain			

Visit 7

0	1	2	3	4	5	6	7	8	9	10
No pain				Moderate pain			Worst pain			

APPENDIX H

Vernon-Mior Neck Pain and Disability Index (Vernon, 2008)

Vernon-Mior Neck Pain and Disability Index (Vernon, H., 2008).

Name: ______________________________

File number: _________________________

Date: _______________________________

Neck Disability Index

This questionnaire has been designed to give us information as to how your neck pain has affected your ability to manage in everyday life. Please answer every section and **mark in each section only the one box that applies to you**. We realise you may consider that two or more statements in any one section relate to you, but please just mark the box that most closely describes your problem.

Section 1: Pain Intensity

- I have no pain at the moment
- The pain is very mild at the moment
- The pain is moderate at the moment
- The pain is fairly severe at the moment
- The pain is very severe at the moment
- The pain is the worst imaginable at the moment

Section 2: Personal Care (Washing, Dressing, etc.)

- I can look after myself normally without causing extra pain
- I can look after myself normally but it causes extra pain
- It is painful to look after myself and I am slow and careful
- I need some help but can manage most of my personal care
- I need help every day in most aspects of self care
- I do not get dressed, I wash with difficulty and stay in bed

Section 3: Lifting

- I can lift heavy weights without extra pain
- I can lift heavy weights but it gives extra pain

- Pain prevents me lifting heavy weights off the floor, but I can manage if they are
  conveniently placed, for example on a table
- Pain prevents me from lifting heavy weights but I can manage light to medium
  weights if they are conveniently positioned
- I can only lift very light weights
- I cannot lift or carry anything

Section 4: Reading

- I can read as much as I want to with no pain in my neck
- I can read as much as I want to with slight pain in my neck
- I can read as much as I want with moderate pain in my neck
- I can't read as much as I want because of moderate pain in my neck
- I can hardly read at all because of severe pain in my neck
- I cannot read at all

Section 5: Headaches

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

Section 6: Concentration

- I can concentrate fully when I want to with no difficulty
- I can concentrate fully when I want to with slight difficulty
- I have a fair degree of difficulty in concentrating when I want to
- I have a lot of difficulty in concentrating when I want to
- I have a great deal of difficulty in concentrating when I want to
- I cannot concentrate at all

Section 7: Work

- I can do as much work as I want to

- I can only do my usual work, but no more
- I can do most of my usual work, but no more
- I cannot do my usual work
- I can hardly do any work at all
- I can't do any work at all

Section 8: Driving

- I can drive my car without any neck pain
- I can drive my car as long as I want with slight pain in my neck
- I can drive my car as long as I want with moderate pain in my neck
- I can't drive my car as long as I want because of moderate pain in my neck
- I can hardly drive at all because of severe pain in my neck
- I can't drive my car at all

Section 9: Sleeping

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

Section 10: Recreation

- I am able to engage in all my recreation activities with no neck pain at all
- I am able to engage in all my recreation activities, with some pain in my neck
- I am able to engage in most, but not all of my usual recreation activities because of pain in my neck
- I am able to engage in a few of my usual recreation activities because of pain in
  my neck
- I can hardly do any recreation activities because of pain in my neck
- I can't do any recreation activities at all

Score: /50 Transform to percentage score x 100 = %points

Scoring: For each section the total possible score is 5:

if the first statement is marked the section score = 0, if the last statement is marked it = 5. If all ten sections are completed the score is calculated as follows:

Example: 16 (total scored)

50 (total possible score) x 100 = 32%

If one section is missed or not applicable the score is calculated: 16 (total scored)

45 (total possible score) x 100 = 35.5%

Minimum Detectable Change (90% confidence): 5 points or 10 %points

NDI developed by: Vernon, H. & Mior, S. (1991). The Neck Disability Index: A study of reliability and validity. *Journal of Manipulative and Physiological Therapeutics*. 14, 409-415

APPENDIX I

Range of Motion Readings with CROM Measured in Degrees

Name: ______________________________

File number: _________________________

Date: _______________________________

Visit 1, 4 and 7

VISIT	**1**	**4**	**7**
FLEXION			
EXTENSION			
RIGHT LATERAL FLEXION			
LEFT LATERAL FLEXION			
RIGHT ROTATION			
LEFT ROTATION			

APPENDIX J

Head Repositioning Accuracy (HRA) measured in millimetres (mm)

Name: ______________________________

File number: _________________________

Date: _______________________________

Visit 1, 4 and 7

VISIT	1		4		7	
RIGHT ROTATION						
ERROR OF REPOSITIONING AVERAGE						
LEFT ROTATION						
ERROR OF REPOSITIONING AVERAGE						