A Comparison of Mobilisation and Exercise in the Treatment of Chronic Non-Specific Neck Pain

By

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

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DEDICATION

I dedicate this dissertation to my parents, who have taught me life's most valuable lessons, loved me dearly and gladly sacrificed for me at every opportunity.

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ABSTRACT

Background:

Chronic non-specific neck pain is a common condition that negatively affects cervical muscle functioning and activities of daily living. Combined exercise and mobilisation are currently recommended as the most effective treatment for this condition. Mobilisation, such as mobilisation of the cervical spine, provides short-term pain relief and affects neural activity, while the craniocervical flexion exercise provides immediate pain relief and activates the deep cervical flexors. The short-term effect of mobilisation and the craniocervical flexion exercise have not been compared.

Objectives:

This study aimed to compare mobilisation and craniocervical flexion exercise in terms of subjective and objective outcome measures at a short-term follow-up consultation for the treatment of chronic non-specific neck pain. The null-hypothesis was that the mobilisation group would not respond differently to the craniocervical flexion exercise group.

Method:

A group of thirty females between the ages of 20 and 35 complaining of non-specific neck pain for more than three months were randomly allocated into either the mobilisation or craniocervical flexion exercise groups. During the first two consultations, a mobilisation was administered to the mobilisation group. Whereas the craniocervical flexion exercise and a posture correcting exercise were taught to the participants of the craniocervical flexion exercise group. The Numerical Pain Rating Scale, Neck Disability Index, Neck Bournemouth Questionnaire, cervical range of motion and algometer readings were taken at each of the three consultations. The Patient Global Impression of Change Scale was administered at the last consultation one week after the first consultation.

Results:

Both the mobilisation and craniocervical flexion exercise groups showed significant improvements in all of the subjective outcomes. The Neck Disability Index score of the craniocervical flexion exercise group was the only subjective outcome that did not decrease enough to be considered clinically significant. The PGIC score of the mobilisation group was slightly higher than that of the craniocervical flexion exercise group. There was no statistically significant improvement in the objective outcomes of either group. All ranges of motion decreased in both groups, while pain pressure threshold improved in both groups. There was no significant difference between the results of the subjective and objective outcomes of the mobilisation and craniocervical flexion exercise groups.

Conclusions and Recommendations:

The two interventions were found to have a similar effect in the treatment of chronic non-specific neck pain in terms of subjective and objective outcome measures. Participants of both groups indicated on the subjective scales that their conditions improved, even though objective outcomes showed no significant change. In future studies, a larger sample size should be used and the sample should be stratified for ethnicity to increase validity of the results.

Key words: Neck pain, mobilisation, craniocervical flexion exercise, short-term

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LIST OF ABBREVIATIONS

CCFE	Craniocervical flexion exercise
CNSNP	Chronic non-specific neck pain
CROM	Cervical range of motion
Group A	Cervical mobilisation
Group B	Craniocervical flexion exercise
LES	Left erector spinae
LLS	Left levator scapula
LTr	Left trapezius
NBQ	Neck Bournemouth Questionnaire (Bolton, 2002)
NDI	Neck Disability Index (Cleland, 2008)
NRS	Numeric Pain Rating Scale (Farrar, 2001)
PGIC	Patient Global Impression of Change Scale (Dworkin, 2010)
PPT	Pain pressure threshold
RES	Right erector spinae
RLS	Right levator scapula
ROM	Range of motion
RTr	Right trapezius

DEFINITION LIST

Chronic neck pain	Neck pain of more than 3 months duration (Binder, 2007).
Concentric contraction	A type of muscle contraction where the length of the muscle shortens as the muscle contracts, eg. the biceps shortens when a bag is lifted (Como and Myers, 2002).
Eccentric contraction	A type of muscle contraction where the muscle is actively lengthened, eg. the biceps lengthens when a bag is lowered to the floor (Como and Myers, 2002).
Effectiveness	The power of a tool to produce the effect that it is intended for (Como and Myers, 2002).
Endurance	The ability to continue an activity despite increasing physical stress. Increased endurance would results in more muscle contractions before the onset of fatigue. Endurance and strength are different qualities; however weaker muscles tend to have less endurance than strong muscles (Como and Myers, 2002).
Fatigue	A loss of strength or endurance that is reached due to strenuous activity (Como and Myers, 2002).
Fatigability	When muscles undergo periods of excessive activity, some muscles tend to become exhausted at a faster rate than other muscles, meaning that these muscles are more fatigable than the latter group (Como and Myers, 2002).

Incidence	The number of new cases of a condition over a certain period of time divided by the number of people at risk (Streiner and Norman, 2009).
Lordosis	A normal curve of the lumbar and cervical spine that is convex anteriorly (to the front) (Moore and Dally, 2006).
Kyphosis	A normal curve of the thoracic spine that is concave anteriorly (to the front) (Moore and Dally, 2006).
Mobilisation	A low-velocity and small- or large-amplitude manipulative therapy applied anywhere within a joint range of motion. In this text mobilisation and cervical mobilisation refer to the same procedure (Maitland, Hengeveld, Banks, English, 2005).
Muscle strength	The capability of a muscle to generate or resist a physical force (Como and Myers, 2002).
Non-specific neck pain	Pain felt predominantly in the cervical region, that has a postural or mechanical basis. It is associated with poor posture, depression and anxiety, muscle strain, sporting and occupational activities (Binder, 2007).
Prevalence	The amount of people in a population that are affected by a condition at a specific point in time (Streiner and Norman, 2009).

CHAPTER ONE
INTRODUCTION

1.1 THE PROBLEM AND ITS SETTING

The cervical spine is particularly vulnerable to injury due to its extensive range of mobility and relative lack of stability (Jull *et al*., 2008). Chronic non-specific neck pain is thought to be caused by multiple factors, including neck strain, occupational or sporting activities, poor posture, anxiety and depression (Binder, 2007), and is considered to be a chronic condition with periods of relapses and remissions (Côté *et al*., 2004).

Neck pain affects nearly two thirds of the population during their lifetime (Gross *et al*., 2009). A study of the greater Durban area by Ndlovu (2005) revealed that the incidence of neck pain amongst indigenous South Africans in the greater Durban area was 50%.

Individuals with neck pain have been observed to have altered cervical muscle structure and muscle group activation patterns (O'Leary *et al*., 2009). These changes cause the muscles of the neck to lose their ability to generate and sustain sufficient force during contractions (O'Leary *et al*., 2009).

Although neck pain could be a symptom of a number of conditions (Guzman *et al.,* 2009), this study focused on neck pain of a muscular or mechanical nature, also known as non-specific neck pain (Binder, 2007).

Tu¨zu¨n (2007) found that chronic pain impacts on many aspects of a pain sufferer's daily life: Pain interrupts sleep and causes physical fatigue, making it difficult to focus on demanding activities during the day; chronic pain and impairment also lead to anxiety, activity avoidance, fear and feelings of depression, negatively affecting their social interactions.

Low-load exercise such as the craniocervical flexion exercise causes immediate pain relief and selectively activates the deep cervical flexors, making it the ideal exercise for the first stage of rehabilitation (O'Leary *et al*., 2009). Mobilisation, such as cervical mobilisation, has been found to provide short-term pain relief (Gross *et al*., 2010), and has been shown to affect motor activity (Schmid *et al*., 2008; Soon *et al*., 2010). Gross *et al*. (2009) recommended mobilisation combined with exercise therapy as suitable treatment modalities for neck pain of mechanical origin.

Therefore, the aim of this study was to investigate whether there was a difference in outcome between cervical mobilisation and the craniocervical flexion exercise (CCFE) for the management of chronic non-specific neck pain (CNSNP).

1.2 AIM OF THE STUDY

The aim of the study was to determine the effects of cervical mobilisation compared to the craniocervical flexion exercise in the treatment of patients with chronic non-specific neck pain on pain, range of motion and disability at short-term follow-up in the greater Durban area.

1.3 OBJECTIVES AND STUDY HYPOTHESIS

As the evidence base on the short-term effect of mobilisation and low-load exercise relative to each other in the management of chronic non-specific neck pain is currently limited and current literature supports the use of these treatment modalities for this condition (Dziedzic *et al*., 2005), the following objectives were set out for this study:

Objective One:

To determine the effectiveness – the relative effect of the one treatment versus the other - of cervical mobilisation in terms of subjective outcome measures (Numeric Pain Rating Scale, Neck Disability Index, Neck Bournemouth Questionnaire and Patient Global Impression of Change Scale) and objective outcome measures

(Algometer and Cervical Range of Motion Goniometer) for the treatment of chronic non-specific neck pain.

Objective Two:

To determine the effectiveness of the craniocervical flexion exercise in terms of subjective and objective measures for the treatment of chronic non-specific neck pain.

Objective Three:

To compare the two treatment groups in terms of subjective and objective measures in the treatment of chronic non-specific neck pain.

Null-Hypothesis:

It was hypothesised that the results of the two treatment groups would show no difference in terms of subjective and objective measures in the treatment of chronic non-specific neck pain.

1.4 RATIONALE

Chronic neck pain impacts on sufferers' social and psychological quality of life (Tu¨zu¨n, 2007). Neck pain also leads to physical changes in the muscles of the cervical spine, including muscle inhibition and atrophy (Hopkins and Ingersoll, 2000), and to a lesser degree, fatty replacement of one or more of the cervical extensor muscles (Elliott *et al.*, 2008). As a result of muscle inhibition, spinal muscles exhibit decreased strength, endurance and precision (O'Leary *et al.*, 2007b).

Miller *et al.*, (2010), in a systematic review, concluded that combined exercise and mobilisation had a greater effect than no care or conventional care. Mobilisation causes immediate and short-term hypoalgesia, as well as improved function for neck pain sufferers (Gross *et al*., 2010). The CCFE may cause immediate and short term local hypoalgesia and decreased pain rating scores in neck pain sufferers (Sterling, Jull and Wright, 2001; O'Leary *et al*., 2007a).

Although mobilisation or manipulation combined with exercise is the recommended treatment intervention for chronic non-specific neck pain, and has been well researched as such (Hurwitz *et al.,* 2009; Miller *et al*., 2010), upon review of the literature, there is a paucity of literature comparing the effects of manipulative therapy and exercise therapy for treating chronic non-specific neck pain. Gross *et al*., (2009) recommended that individual interventions need to be assessed to determine the contribution of each intervention in the treatment of chronic non-specific neck pain.

1.5 ASSUMPTIONS AND/OR LIMITATIONS

This study was conducted on patients who suffer from chronic non-specific neck pain. Therefore, the results should not be generalised to other types of neck pain. Conclusions of the long-term effects of the interventions could not be made as only the short-term effects were measured.

Since the craniocervical flexion exercise was meant to be done at home, participants in the exercise group may have negatively influenced results by not being able to perform the exercise correctly, or not performing the exercise for long enough.

Participants were asked not to change their normal daily activities or take pain medication. This could not be controlled and the researcher was reliant on participants' honesty to declare any discrepancies.

It was assumed that participants answered the questions honestly and without withholding any information from the researcher. The researcher knew to what group the participants were allocated and therefore bias may not have been controlled.

The study aimed to investigate the changes in pain and disability of CNSNP sufferers over a one week follow-up. Although both cervical mobilisation (Gross *et al*., 2010) and the CCFE (O'Leary *et al*., 2009) have been shown to have some immediate or short term effect on CNSNP, it was more likely to detect clinically significant changes after a minimum of six weeks of treatment (Vernon, 2007).

1.6 CONCLUSION

Neck pain can be unremitting and disabling (Côté *et al*., 2004; Tu¨zu¨n, 2007) and is commonly managed by mobilisation and exercise therapy (Gross *et al*., 2009).

However, the relative effect of cervical spine mobilisation *versus* the craniocervical flexion exercise on subjective and objective outcome measures has not previously been studied. Thus, the purpose of this study was to investigate the relative effect of cervical spine mobilisation versus the craniocervical flexion exercise for treating chronic non-specific neck pain in terms of subjective and objective outcome measures at short-term follow-up.

1.7 OUTLINE OF CHAPTERS

Chapter One provided an outline as to the literature that will be discussed in Chapter Two, namely the anatomy and biomechanics of the neck and the treatments investigated in this study. Chapter Three describes the research methodology of the study. Chapter Four presents the results of the study and Chapter Five is a discussion of the results. Chapter Six includes the study recommendations and conclusion.

CHAPTER TWO
LITERATURE REVIEW

2.1 INTRODUCTION

This chapter focuses on the clinical trials conducted and current literature on the subject of chronic non-specific neck pain (CNSNP) and its management. Particular focus is directed at the relationship between cervical spine mobilisation, the craniocervical flexion exercise and the outcome measures used to assess these treatment modalities.

2.2 ANATOMY

2.2.1 Introduction

The neck is the region of the spine between the base of the skull and the inferior border of the mandible to the thoracic inlet (Standring, 2008). The spine protects the spinal cord and spinal nerves, supports the weight of the body, provides a semi-rigid and flexible axis for the body, as well as a base for the head (Jull *et al*., 2008), and it plays an important role in posture and movement of the body (Moore and Dalley, 2006). The neck supports the head and positions it in space to accommodate vision and hearing (Jull *et al*., 2008).

The cervical spine consists of seven vertebrae that are structurally and functionally divided into two regions: the craniocervical region (the occipito-atlantal and atlantoaxial articulations) and the typical cervical region extending from the second to seventh cervical vertebrae (Isaacs and Bookhout, 2002; Jull *et al*., 2008). The two regions differ slightly in terms of anatomy and function (Bogduk and Mercer, 2000). The functioning of the cervical spine is closely related to that of the thoracic spine, shoulders, and the temperomandibular joints (Jull *et al*., 2008).

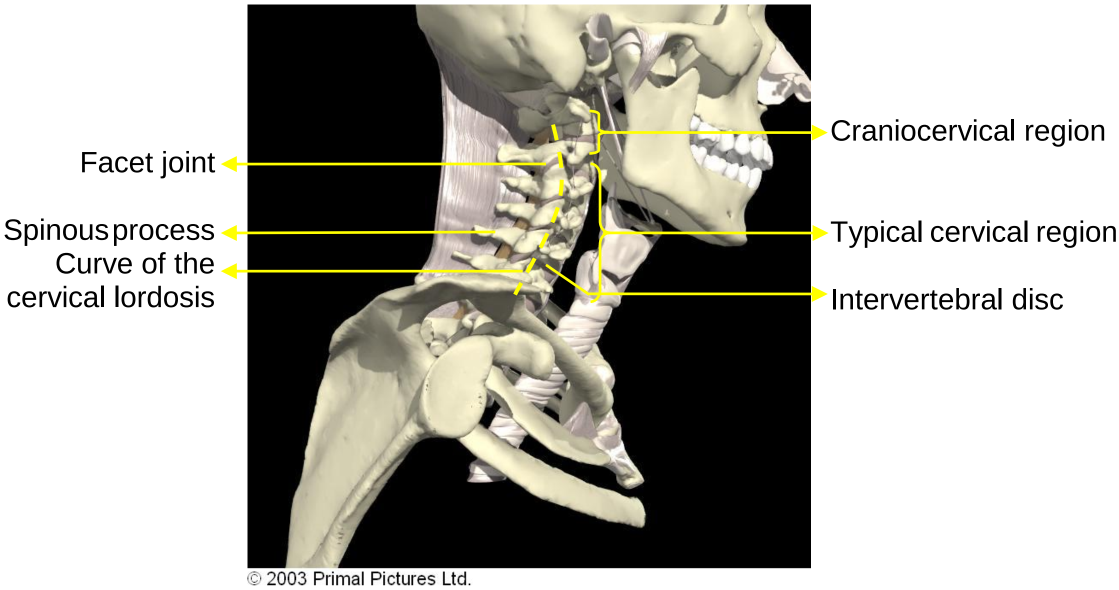

Figure 2.1: Lateral view of the cervical spine

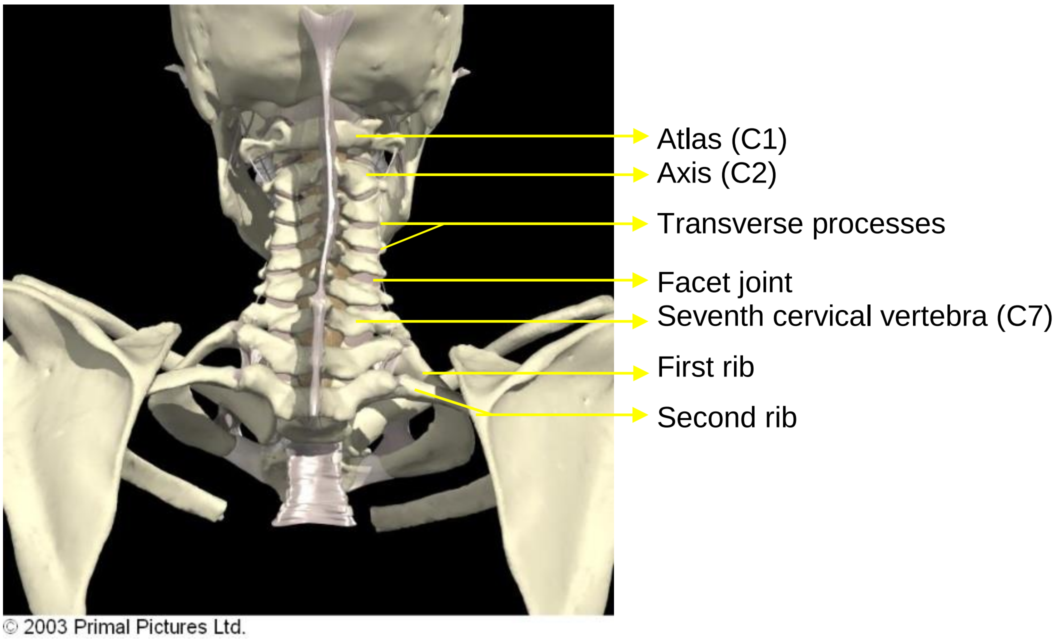

Figure 2.2: Posterior view of the cervical spine

The cervical spine has a lordotic curve, meaning that the curve is concave anteriorly (see Figure 2.1). At birth the spine is kyphotic from the occiput to the coccyx, seen as the flexed foetal position (Cramer and Darby, 1995). The lordosis develops as infants start to extend their heads while prone, enabling them to hold their heads up while sitting (Cramer and Darby, 1995; Moore and Dalley, 2006). The lordosis is mostly maintained by the difference in thickness of the anterior and posterior parts of the intervertebral discs (IVDs) (Moore and Dalley, 2006). The curves of the spine provide a shock absorbing quality to the spine (Moore and Dalley, 2006). The morphology and strength of the deep cervical musculature, such as the semispinalis cervicis and longus colli, and ligaments also play an important role in maintaining the lordotic curve of the cervical spine (Sasai *et al*., 2000).

A description of the cervical bones, joints and ligaments, movement patterns and muscles follows from section 2.2.2 through to 2.2.5. The muscles of the cervical spine pertaining to neck pain and the CCFE are presented in Tables 2.1 – 2.4.

2.2.2 Bones of the cervical spine

The seven vertebrae of the cervical spine are relatively small and consist of a vertebral body and vertebral arch (Moore and Dalley, 2006). There are also seven processes that project from each vertebra: one spinous process, two transverse processes and four articular processes (Standring, 2008). The spinous process projects postero-inferiorly from the vertebral arch (Murphy, 2000). The two transverse processes project posterolaterally from the junction of the pedicle and lamina (Standring, 2008).

The spinous and tranverse processes provide attachment sites for intrinsic cervical muscles as mentioned in Tables 2.1 - 2.3. The articular processes are set close to adjacent articular processes and form facet joints (Moore and Dalley, 2006). The vertebral canal, formed by the vertebral body and vertebral arch, contains the spinal cord, spinal nerve roots, meninges, and arteries, veins and nerves to supply these structures (Moore and Dalley, 2006). The notch formed by the superior and inferior surfaces of the pedicles along with the posterolateral surface of the IVD forms the intervertebral foramen at each vertebral level (Cramer and Darby, 1995). The spinal root ganglion is located in this space, and the spinal nerve, sinuvertebral nerve, a spinal branch of the vertebral artery and an intervertebral vein pass through each intervertebral foramen (Standring, 2008).

The cervical vertebrae differ to those of the other spinal regions: The most distinctive feature of a cervical vertebra is the transverse foramina in the transverse processes (Moore and Dalley, 2006). These foramina transmit the vertebral arteries and accompanying veins, except C7, which only transmits small accessory veins (Moore and Dalley, 2006). The transverse processes end in an anterior and posterior tubercle to which the lateral cervical muscles attach. The anterior rami of the spinal nerves cross over the tubercles in a groove between the anterior and posterior tubercles (Standring, 2008).

The cervical vertebral bodies are elongated transversely (Moore and Dalley, 2006). The superior borders of the vertebral bodies are elevated laterally and posteriorly, but depressed anteriorly (Rook, 2003). The lateral elevations of the vertebral bodies are called uncinate processes. The inferior border of the vertebral body is shaped to reciprocate the superior border of the adjacent vertebra. This orientation restricts both lateral and antero-posterior intervertebral gliding movements (Standring, 2008). These joints may also prevent posterior and posterolateral disc herniation (Rook, 2003).

The first cervical vertebra, the atlas (C1), is a ring-like, kidney-shaped bone that supports the head and consists of two lateral masses connected by anterior and posterior arches with no spinous process or vertebral body (Cramer and Darby, 1995). The axis possesses a superior projection called the odontoid process (Moore and Dalley, 2006). The posterior half of the vertebral canal is occupied by the spinal cord and its meninges (Moore and Dalley, 2006). The superior articular surfaces are located on the lateral masses (Standring, 2008). The vertebral artery accompanies the first cervical nerve through the groove on the superior surface of the posterior arch (Standring, 2008).

The second cervical vertebra, the axis (C2), acts as a pivot for the atlas to rotate on the odontoid process: a peg-like process that is a superior continuation of the vertebral body of the axis (Moore and Dalley, 2006). The odontoid process is kept in place by the strong transverse ligament that passes posterior to the odontoid process and attaches between the tubercles on the medial aspects of the lateral masses of the atlas (Standring, 2008). This ligament prevents posterior displacement of the odontoid process which would compromise the vertebral foramen of the atlas (Standring, 2008).

The third to sixth cervical vertebrae are classified as typical cervical vertebrae (Murphy, 2000). They have small vertebral bodies that are elongated transversely (Murphy, 2000). The vertebral foramina are large and triangular (Moore and Dalley, 2006). The spinous processes are short and bifid (Standring, 2008).

The seventh cervical vertebra is called the vertebra prominens (Standring, 2008). It has a long spinous process that ends in a prominent tubercle for the attachment of the nuchal ligament and posterior cervical muscles (Standring, 2008).

2.2.3 Cervical joints and ligaments

The intervertebral joints that connect the cervical vertebrae provide flexibility and rigidity to the cervical spine (Moore and Dalley, 2006). The vertebral bodies, except that of C1 and C2, are connected by anterior and posterior longitudinal ligaments and by fibrocartilaginous IVDs that are situated between the hyaline cartilage end-plates (Standring, 2008). These joints are called symphyses (Isaacs and Bookhout, 2002).

The IVDs are strong weight-bearing structures (Moore and Dalley, 2006). These discs receive their blood supply to the periphery of the disc by branches of the spinal arteries that supply the spinal column (Standring, 2008). They are otherwise avascular and depend on diffusion of nutrients from the adjacent vertebral bone (Standring, 2008). Venous blood drains into the internal and external vertebral venous plexuses to the intervertebral veins (Moore and Dalley, 2006). The outer third of the IVDs are innervated by the sinuvertebral nerves of the corresponding spinal vertebra or the vertebra below (Standring, 2008).

The cervical IVDs are relatively thick, contributing to 40 percent of the length of the cervical spine. The thick IVDs, as well as the small amount of body mass surrounding the cervical vertebrae, contribute to the cervical spine’s large range of movement (Rook, 2003; Moore and Dalley, 2006).

The annulus fibrosis of the cervical spine is well-developed and is thicker anteriorly than posteriorly, but tapers laterally into only a few fibers (Cramer and Darby, 1995). The fibers do not have a criss-cross pattern like in the lumbar IVDs but are orientated in an inverted 'V' shape (Bogduk and Mercer, 2000). The transverse clefts in the IVDs facilitate rotation (Bogduk and Mercer, 2000).

The atlanto-occipital joints consist of the occipital condyles and the superior articular surfaces of the lateral masses of the atlas. These are synovial condyloid joints that have reciprocal curves and permit about 15° of flexion-extension (Standring, 2008), and approximately three degrees of lateral flexion in each direction (Isaacs and Bookhout, 2002). The joints are covered by fibrous capsules (Moore and Dalley, 2006). The anterior and posterior atlanto-occipital membranes connect the anterior and posterior arches of the atlas to the margins of the foramen magnum. These membranes prevent excessive movement of the atlanto-occipital joints (Standring, 2008). The atlanto-occipital joints receive blood supply from anastomoses between branches of the deep cervical, vertebral and occipital arteries and are innervated by branches of the anterior ramus of the first cervical spinal nerve (Standring, 2008).

The atlas articulates with the axis between the lateral masses and the median atlantodental articulation (Murphy, 2000). The lateral masses of the atlas articulate with the superior articular facets of the axis (Standring, 2008). These articular surfaces are synovial plane joints (Standring, 2008). The median joint is a pivot joint between the anterior surface of the odontoid process of the axis and a ring formed by the posterior surface of the anterior arch of the atlas and the transverse ligament (Murphy, 2000).

The capsule of the atlantodental ligament is thin and loose (Moore and Dalley, 2006). A weak longitudinal ligament attaches the occipital bone to the odontoid process and axis (Moore and Dalley, 2006). The alar ligaments attach to the sides of the odontoid process and the lateral margins of the foramen magnum to prevent excessive rotation of the atlanto-occipital joints (Moore and Dalley, 2006). The tectorial membrane is a superior continuation of the posterior longitudinal ligament which ends at the body of C2 (Cramer and Darby, 1995). It courses across the median atlantoaxial joint, alar and transverse ligaments and through the foramen magnum to insert into the floor of the cranial cavity (Standring, 2008).

Movements occur at all three joints simultaneously to allow rotation on the axis (Standring, 2008). The two lateral joints glide on each other in opposite directions while the atlas pivots around the odontoid process at the atlantodental joint (Standring, 2008).

The atlantoaxial joints receive arterial supply from the anastomoses between the occipital, deep cervical and vertebral arteries and are innervated by branches from the anterior ramus of the second cervical spinal nerve (Standring, 2008).

The facet joints of the cervical spine are plane synovial joints lined with hyaline cartilage and are covered by loose fibrous joint capsules (Standring, 2008). The loose capsules permit a wide range of movement in the cervical spine (Standring, 2008). The facet joints permit gliding movements between the articular processes (Bogduk and Mercer, 2000). The orientation of the articular surfaces and the size of the IVD relative to that of the vertebral body determine the types of movement possible in the particular spinal region (Moore and Dalley, 2006). In the cervical spine, the facet joints are oriented at approximately 40° to the vertical, except for the facets of C3 and C7 that have a steeper inclination (Standring, 2008).

They facet joints keep the vertebrae aligned by preventing the superior vertebra from slipping anteriorly on the vertebra below (Moore and Dalley, 2006). The craniovertebral joints especially provide flexibility to the neck (Maitland *et al.*, 2005).

The vertebral arches of adjacent vertebrae are connected by accessory ligaments that connect the laminae, transverse processes and spinous processes (Murphy, 2000). The laminae are joined by the ligamentum flavum, a thin, broad, pale yellow elastic band-like ligament, which prevents sudden separation of the laminae to protect the IVD from injury (Moore and Dalley, 2006). The spinous processes are joined by thin interspinous ligaments that connect each process (Moore and Dalley, 2006). The nuchal ligament is a thick fibroelastic cord, situated superficial to the interspinous ligament (Standring, 2008). It extends from the foramen magnum and external occipital protuberance, connecting to the tips of spinous processes and blends with the supraspinous ligament at C7 (Cramer and Darby, 1995). The scattered fibres of the intertransverse ligaments connect adjacent transverse processes (Standring, 2008).

The anterolateral aspects of the vertebral bodies and IVDs are connected by the strong, broad anterior longitudinal ligament. This ligament extends from the pelvic surface of the sacrum to the anterior tubercle of the atlas and the occipital bone anterior to the foramen magnum (Murphy, 2000). This ligament maintains the stability of the intervertebral joints and it is the only ligament that prevents hyperextension of the spine (Standring, 2008).

The posterior longitudinal ligament is a narrower, weaker band that runs within the vertebral canal on the posterior aspect of the vertebral bodies (Moore and Dalley, 2006). It extends from the vertebral bodies of C2 to the sacrum to weakly prevent or redirect posterior herniation of the nucleus pulposus and has nociceptive nerve endings for proprioception (Standring, 2008).

The facet joints of the lower cervical spine are innervated by articular branches from the medial branches of the posterior rami of spinal nerves and receive arterial supply from the posterior spinal branches that supply the vertebral column (Standring, 2008).

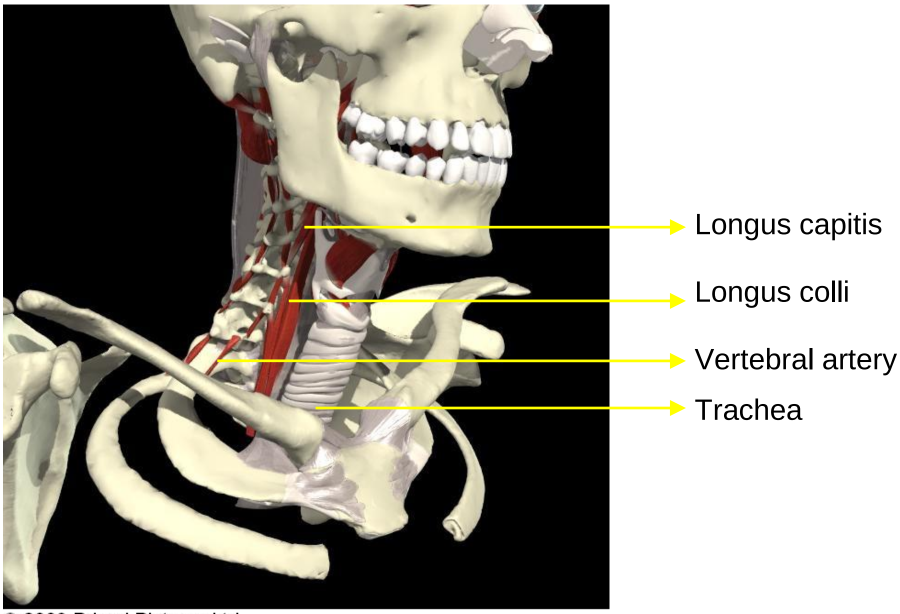

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Figure 2.3: Anterior cervical muscles

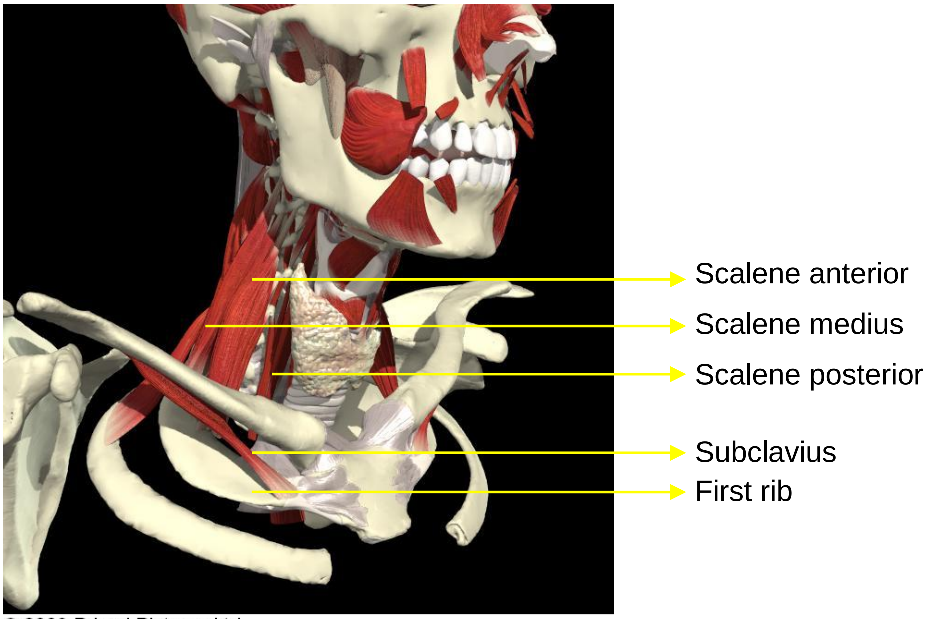

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Figure 2.4: Lateral cervical muscles

2.2.4 Muscles of the cervical spine

Table 2.1: Anterior vertebral muscles (adapted from Moore and Dalley, 2006; Standring, 2008)

Muscle	Origin	Insertion	Innervation	Action
Longus colli	Arch of atlas, bodies of C1-C3	Transverse processes of C3-C6	Anterior rami of C2-C6 spinal nerves	Flexion (nodding) and lateral flexion (ear-to-shoulder)
Longus capitis	Transverse processes of C3-C6	Occipital bone	Anterior rami of C1-C3	Flexion of the head
Rectus capitis anterior	Lateral mass and transverse process of atlas	Occipital bone	Anterior rami of C1 and C2	Flexion of the head and neck
Rectus capitis lateralis	Transverse process of atlas	Jugular process of occipital bone	Anterior rami of C1 and C2	Lateral flexion to the same side

Table 2.2: Lateral vertebral muscles (adapted from Moore and Dalley, 2006; Standring, 2008)

Muscle	Origin	Insertion	Innervation	Action
Scalene anterior	Transverse processes of C3-C6	Scalene tubercle of first rib	Anterior rami of C3-C8	Flexion of the neck Rotation to the opposite side
Scalene medius	Transverse processes of C3-C7	Superior surface of first rib between tubercle and groove for subclavian artery	Anterior rami of C3-C8	Lateral neck flexion Elevates first rib
Scalene posterior	Transverse processes of C4-C7	Outer surface of second rib	Anterior rami of C4-C6	Lateral neck flexion Elevates second rib
Scalene minimus	Transverse processes of C7	Inner border of first rib and pleural dome	Anterior rami of C4-C6	Tenses pleural dome Elevates first rib

Table 2.3: Posterior cervical muscles (adapted from Moore and Dalley, 2006; Standring, 2008)

Muscle	Origin	Insertion	Innervation	Action
Splenius capitis	Mastoid process of occipital bone	Spinous processes of C7-T3 and supraspinous ligament	Dorsal rami of C2-C3	Extension of the head Lateral flexion of head
Splenius cervicis	Transverse processes of C1-C3	Spinous processes of T3-T6	Dorsal branches of C3-C6	Extension and rotation of C1-C3 vertebrae
Erector spinae group				
Spinalis cervicis and capitis	Spinous processes of C2-C4	Nuchal ligament and Spinous process of C7	Lateral branches of the posterior rami of cervical nerves	May play a role in correcting the spine to neutral from lateral rotation
Longissimus cervicis and capitis	Mastoid process and Transverse processes of C2-C6	Transverse processes of T10-T12 and T1-T4		
Iliocostalis cervicis	Transverse processes of C4-C6	Angles of ribs 3-6		
Spinotransverse group				
Rotatores cervicis	Lamina of superior vertebra	Transverse process one or two levels below	Medial branches of posterior rami of corresponding spinal nerves	Extension of the head and neck
Multifidus	Spinous processes of adjacent vertebrae	Transverse process two to four levels below		
Semispinalis cervicis and capitis	Spinous process of C2-C5 and occipital bone	Transverse process of T1-T5. Superior facets of C4-C7	Greater occipital nerve and the C3 spinal nerve	
Interspinales	From C2, joins adjacent spinous processes		Medial branches of posterior rami of corresponding spinal nerves	No movement; proprioceptive centres to control movement and position
Intertransversarii	From C1, joins adjacent transverse processes.			

Table 2.3: Posterior cervical muscles continued (adapted from Moore and Dalley, 2006; Standring, 2008)

Muscle	Origin	Insertion	Innervation	Action
Suboccipital group				
Rectus capitis posterior major	Spinous process of C2	Inferior nuchal line of the occiput	First cervical nerve	Proprioception and posture control
Obliquus capitis superior	Transverse process of C1	Between superior and inferior nuchal lines		
Obliquus capitis inferior	Spinous process of C2	Transverse process of C1		
Rectus capitis posterior minor	Posterior tubercle of the posterior arch of C1	Inferior nuchal line of the occiput		

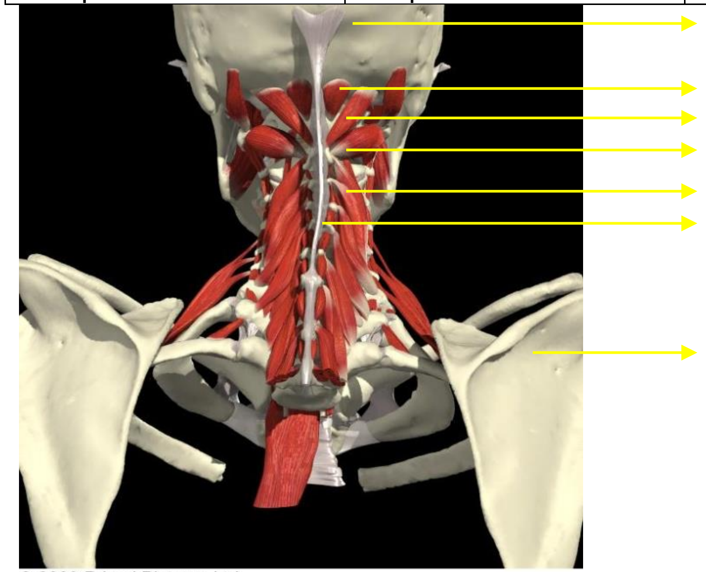

Figure 2.5: Posterior cervical muscles

The anterior vertebral muscles receive their vascular supply from branches of the ascending pharyngeal, inferior thyroid and vertebral arteries (Standring, 2008). The scalene muscles receive vascular supply from the ascending branch of the inferior thyroid artery (Standring, 2008). The superficial cervical artery supplies the scalene posterior (Standring, 2008).

The posterior muscles of the neck are arranged in layers, the deep layer being the intrinsic neck muscles, integrally related to the nuchal ligament as an arrangement of tendons and fascia between the posterior muscles of the neck (Standring, 2008).

The intrinsic muscles of the neck receive their vascular supply from the vertebral artery, deep cervical artery, superficial cervical and deep descending branches of the occipital artery, superior intercostal artery and dorsal branches of the subcostal arteries (Standring, 2008).

The muscles that attach to C1 mainly use C1 as an anchor to move the head or scapulae (Murphy, 2000). The suboccipital triangle is formed by the rectus capitis posterior major, obliquus capitis superior and obliquus capitis inferior (Moore and Dalley, 2006). The vertebral artery and the posterior ramus of the first cervical nerve lie in a groove on the superior surface of the posterior arch of the atlas. The suboccipital muscles receive their blood supply from the vertebral artery and deep descending branches of the occipital artery (Standring, 2008).

2.2.5 Movement patterns of the cervical spine

The cervical spine can be divided into four units that act together to produce synchronised movement (Bogduk and Mercer, 2000). These units are: the cradle, axis, root and column (Bogduk and Mercer, 2000). The atlas acts as a cradle for the occiput to rest on, forming the atlanto-axial articulation (Bogduk and Mercer, 2000). The atlanto-occipital joints are condylar joints that permit flexion and extension by rolling and gliding, to produce a nodding movement, (Rook, 2003), as well as allowing slight lateral flexion (Standring, 2008). During all other movements, the occiput and atlas move as a unit (Bogduk and Mercer, 2000). The head and atlas rotate on the medial joint of the axis, also called the atlantodental joint (Cramer and Darby, 1995; Bogduk and Mercer, 2000).

The upper cervical spine, comprised of C0-C1 and C1-C2, is a dynamic region of the spine in terms of neurophysiologic control (Murphy, 2000). Almost 50% of rotation of the cervical spine, or shaking the head, occurs at the atlanto-axial joints, the remainder of the rotation occurring cumulatively at each joint of the cervical spine (Bogduk and Mercer, 2000). The atlanto-axial joints allow a small amount of flexion-extension, but their principle movement is rotation of the head (Standring, 2008).

Owing to the oblique orientation of the facet joints, Standring (2008), movement in the upper cervical spine occurs as coupled motion – rotation to the one side is coupled with lateral flexion in the opposite direction (Cramer and Darby, 1995; Murphy, 2000).

The C2 and C3 vertebrae, with their articulation are known as the root of the cervical spine as it anchors it and the head (Bogduk and Mercer, 2000). Due to the unique orientation of the articular surface of the third cervical vertebra, the root moves in the opposite direction to the lower cervical spine during lateral flexion (Bogduk and Mercer, 2000).

The column of the cervical spine consists of C3 to C7 (Bogduk and Mercer, 2000). These segments differ in their function of flexion and extension by the following traits: The antero-inferior border of the vertebral body forms a lip that hangs down like a hook, and the superior surface of the vertebral body slopes downward and forward (Bogduk and Mercer, 2000). The IVD plane is oblique to the long axis of the vertebral bodies (Bogduk and Mercer, 2000).

Flexion and extension of the cervical spine do not occur as smooth continuous movements, but rather as a series of movements (Bogduk and Mercer, 2000). During the first phase of flexion, motion starts at the cervical column (Bogduk and Mercer, 2000). During the second phase the cradle, root and axis start moving into flexion. In the final stage of flexion, movement occurs at the lower cervical spine

(Bogduk and Mercer, 2000). There may be slight extension at the C0-2 segments during the final phase of flexion (Bogduk and Mercer, 2000). A similar series of movements occur during extension (Bogduk and Mercer, 2000). Motion starts at the column, then the cradle and axis. In the final stage, movement occurs at all levels to achieve full extension (Bogduk and Mercer, 2000).

The greatest range of intervertebral movement occurs at the IVD, which also limits excessive motion by means of compression or torsional stress placed on the disc (Rook, 2003; Moore and Dalley, 2006). Regional variations of the facet joint orientation and laxity of ligaments allow large degrees of flexion and extension to occur in the cervical spine (Standring, 2008).

Craniocervical flexion is flexion of the head on the neck: while the neck is stationary, the cranium nods forward toward the chest (Jull *et al*., 2008). It is achieved by synchronised action of all the deep cervical flexors; the longissimus colli, longissimus capitis and rectus capitis anterior (Cagnie *et al.*, 2008). Some muscles are more active than others – the longus capitis is the principle muscle to cause flexion at the occipital-axial region (Cagnie *et al.*, 2008). The longus colli is responsible for flattening the cervical lordosis (Cagnie *et al.*, 2008). Cervical flexion is flexion of the head and neck towards the chest (Jull *et al*., 2008). During cervical flexion, the deep cervical flexors are recruited along with the superficial sternocleidomastoid (Cagnie *et al.*, 2008).

The average range of flexion in the cervical spine ranges from 45° to 58° (Standring, 2008). Extension is checked by locking of the facet joints (Moore and Dalley, 2006). Lateral flexion ranges from 32° to 47° and rotation ranges from 63° to 78° (Standring, 2008). Female gender is associated with decreased ranges of motion; however both males and females lose some range of motion from the age of 45 (Standring, 2008).

The specific range and sequence of movements are controlled by the central nervous system and proprioceptive feedback systems (Murphy, 2000). After injury or an episode of pain, the normal muscle activation patterns are disrupted, leading to improper load distribution and diminished active support of the neck by the cervical muscles (Falla, Bilenkij and Jull, 2004; Blouin *et al.*, 2007).

2.3 CHRONIC NON-SPECIFIC NECK PAIN

2.3.1 Definition of neck pain

The Bone and Joint Decade 2000-2010 Task Force defined neck pain as an unpleasant physical or emotional sensation felt between the head above and the shoulder blades below (Guzman *et al.*, 2009). A person is said to suffer from chronic neck pain if they have suffered with neck pain for more than three months (Guzman *et al.,* 2009). Although neck pain could be a symptom of a number of conditions (Guzman *et al.,* 2009), in this study, non-specific neck pain referred to pain of a mechanical or muscular nature, usually associated with muscle tenderness in the neck and shoulders and referred pain to the occiput, interscapular region and upper limbs (Binder, 2007).

2.3.2 Incidence and prevalence of neck pain

Neck pain affects about two thirds of the population during their lifetime (Gross *et al.*, 2009) and is more prevalent in females (Côté *et al.*, 2004). The annual incidence and prevalence of neck pain has been investigated in a number of studies. The findings are summarised below in terms of incidence which Redwood and Cleveland (2003) defined as "the proportion of a clearly defined group that is initially free of a condition but develops the condition over a period of time":

- Muchna (2011), in an unpublished study, found the incidence of neck pain amongst Indian South Africans was 28.8 percent.
- Ndlovu (2005), in an unpublished study, found the incidence of neck pain among Black South Africans in the Durban area to be 50 percent.
- In a study performed in the Netherlands among 375 899 patients the incidence of neck pain was 23.1 per 1 000 person-years. Additionally, the incidence of neck pain was higher for females than males (Bot *et al.*, 2005).

- Côté *et al.*, (2004), reported in a questionnaire completed by 513 adults in Saskatchewan, that there was a 14.6 percent incidence of neck pain, with the incidence being higher in females than males. This may be the reason why females are more likely than males to have persistent neck pain (Carroll *et al.*, 2009)
- In a questionnaire of pain free preadolescents 21.3 percent reported neck pain at least once a month over the past three months (Stahl *et al.*, 2004).
- Croft *et al.*, (2001) reported, in a questionnaire completed by 7 669 adults at a general practice in the United Kingdom, that there was an incidence of 17.9 percent.

Prevalence:

The prevalence of neck pain varies greatly depending on the time period (point or period prevalence) (Redwood and Cleveland, 2003) and the severity of neck pain involved. To this end various studies have reported a variety of outcomes in this regard, which include but may not be limited to:

- The typical 12 month prevalence of neck pain that does not greatly interfere with daily activities varies between 30 percent and 50 percent (Palmer *et al.*, 2003; Picavet and Schouten, 2003; Chiu and Leung, 2006).
- Slabbert (2010), in an unpublished study of the White population of the Durban area, reported the prevalence of neck pain to be 45 percent.
- Muchna (2011) reported, in an unpublished study of the Durban Indian population, the prevalence was 36.8 percent, with slightly more males than females affected.

2.3.3 Course and progression of neck pain

Neck pain was previously thought to be an isolated incident that would, in most cases, resolve completely (Binder, 2003). More recently it has since been accepted that it is a chronic condition with frequent relapses and remissions (Côté *et al.*, 2004; Muchna, 2011). More than half of patients report recurrence of neck pain, one to five years after an initial episode of neck pain (Carroll *et al.*, 2009).

Females are more likely than males to have persistent neck pain (Carroll *et al.*, 2009). Younger patients are also less likely to suffer from continued neck pain and disability than patients older than 45 years (Carroll *et al.*, 2009).

Ethnic differences to pain sensitivity have been observed in studies on the subject. In a clinical trial African American individuals were found to have lower experimental pain sensitivity than White Americans (Green *et al.*, 2004). In another study, African American patients with chronic pain reported higher disability than White patients with similar levels of chronic pain (Rahim-Williams *et al.*, 2007). Other factors affecting the incidence and progression of neck pain are summarised in Table 2.4.

This variance in the presentation of neck pain may be related to the aetiology of neck pain, which may predispose certain population groups to particular causative agents for the development of neck pain (Foreman and Croft, 1995; Murphy, 2000). Thus the next section defines possible aetiological causes of neck pain.

2.3.4 Aetiology of chronic non-specific neck pain

The aetiology of non-specific neck pain is poorly understood and is thought to have a multifactorial aetiology (Binder, 2007). This is summarised in Table 2.4.

Table 2.4: Risk factors associated with neck pain

Risk factor	**Comments**
Age	Peak prevalence between 40 and 59 years (Hansson and Jensen, 2004; Bot *et al.*, 2005) Younger age groups (younger than the 45-59 year age group) are associated with better outcome (Carroll *et al.*, 2009).
Comorbidities	History of neck pain (Carroll *et al.*, 2009; Slabbert, 2010) History of low back pain, headaches or other musculoskeletal complaints (Croft *et al.*, 2001; Muchna, 2011) Previous neck or shoulder injury (Croft *et al.*, 2001; Andersen *et al.*, 2002) Poor self-assessed health (Hansson and Jensen, 2004)
Marital status	Married/divorced increases risk of neck pain (Croft *et al.*, 2001; Slabbert, 2010)
Occupation	Occupational posture (Hansson and Jensen, 2004; Binder, 2007; Slabbert, 2010)

	Heavy occupational work load (Andersen *et al.*, 2002) Repetitive or high force tasks (Andersen *et al.*, 2002)
Psychological factors	Psychosomatic symptoms (Siivola *et al*., 2004) Poor psychological health (Croft *et al.*, 2001)
Smoking	Current smoker or second-hand smoke during childhood (Côté *et al.*, 2000; Eriksen, 2004)
Posture	Carrying heavy bags on one side (Muchna, 2011)
Watching television	Questionnaire in the local Durban white population (Slabbert, 2010)
Wearing glasses	Questionnaire in the local Durban white population (Slabbert, 2010)

The structural and functional changes associated with neck pain, discussed under Section 2.3.7, may result in or be due to the presence of pain, injury and inflammatory response to injury, nerve pathology or disuse (Elliott *et al.*, 2008). In this context, aberrant neuromuscular control (Hillerman *et al.*, 2006; Suter *et al.*, 2000) of the cervical spine is thought to irritate the pain-sensitive structures of the cervical spine, which aggravates and perpetuates neck pain (Hurwitz *et al.*, 2009) and results in a negative spiral effect where the pain then perpetuates the aberrant neuromuscular control patterns (Hopkins and Ingersoll, 2000). This syndrome and clinical cycle presents as neck pain and / or asymptomatic dysfunction (Sahrmann, 2010), which will be presented in the following section.

2.3.5 Diagnosis of chronic non-specific neck pain

In terms of the varied aetiology (Section 2.3.4) it can be seen that there are a number of causes of chronic neck pain. With these varied causes the impact is such that there are also a number of possible clinical presentations that result in the patient seeking care (Binder, 2007; Guzman *et al.*, 2009). These include, but may not be limited to:

- mechanical neck pain lesions (viz. acute neck strain, postural neck pain, whiplash, cervical spondylosis, prolapsed discs and diffuse idiopathic skeletal hyperostosis);
- inflammatory disease (viz. rheumatoid arthritis, ankylosing spondylitis and polymyalgia rheumatica);

- metabolic disease (viz. gout, osteoporosis, Paget's disease and pseudo-gout);
- infections such as osteomyelitis and tuberculosis;
- malignant disease (viz. including primary tumours, secondary deposits and myeloma).

In the above context, non-specific neck pain is seen as a mechanical disorder of ligamentous and capsular sprain caused by a sudden unanticipated movement or poor postural habit (Foreman and Croft, 1995; Murphy, 2000; Maitland *et al.*, 2005). This leads to local aching pain, intermittent sharp local pain, or referred pain, as well as pain through or at the end of range of motion (Maitland *et al.*, 2005).

Mechanical movement disorders are typically caused by irritation of the facet joint and its capsule, causing aching and pain during both rest and movement (Maitland *et al.*, 2005). Mechanical blocking of intervertebral movement, caused by torn, displaced joint tissue, is another cause of disordered joint movement (Maitland *et al.*, 2005). These may result in degeneration of the facet joints, which may or may not complicate the patient's complaint and therefore modify the presentation of the patient's condition (Binder, 2007).

Therefore patients presenting with the above, usually complain of neck pain that is localised to a particular / specific segment or region of the spine, along with segmental painful movement abnormalities and regional movement loss (Jull *et al.*, 2008). Additionally, Binder (2007) found non-specific neck pain to be associated with stiffness, aggravated by movement, poorly localised tenderness, and referred pain to the occiput, interscapular region and upper limbs.

More distally, the painful stimuli from the involved joints and soft tissue structures may cause reflex cervical muscle hypertonicity, which prevents joint movement (Murphy, 2000). Neck pain is often associated with muscle involvement, known as myofascial trigger points (Travell and Simons, 1983; Murphy, 2000).

Perhaps the most important aspect of diagnosing non-specific neck pain is to exclude more sinister causes of neck pain (Binder, 2007). Many conditions can manifest as neck pain and it is important to look for indicators of these conditions, which include inflammatory disease, infections, malignant or metabolic diseases, neurologic or cardiovascular conditions, as well as structural or traumatic causes (Binder, 2007; Michaleff *et al.*, 2009).

2.3.6 Psychosocial effects of chronic pain

Health is defined as ‘a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity’ (World Health Organization, 1948). By contrast, chronic pain has been shown to significantly affect physical, mental, and social aspects of life (Andersen *et al.*, 2002; Ang, Kroenke and McHorney, 2007). This is because it is strongly associated with sleep disturbance, causing daily tasks to be more challenging and stressful (Tu¨zu¨n, 2007). Furthermore, neck pain impairs work capacity and makes it difficult to maintain social and personal relationships (Tu¨zu¨n, 2007). Thus, Bibby (2006) stated that as personal relationships become hard to maintain patients feel isolated and depressed.

Therefore, over time, pain may lead to symptoms of anxiety, pain-related fear and activity avoidance, and negative affectivity (Tu¨zu¨n, 2007), which lead to fear-avoidance behaviour increasing disability and maintaining pain (Tu¨zu¨n, 2007). These symptoms also impact on patients’ perception of their pain and response to treatment, as well as their adherence to treatment and the likelihood of recovery in treatment (Tu¨zu¨n, 2007).

The Neck Disability Index (NDI) and Neck Bournemouth Questionnaire (NBQ) are subjective measurement tools which are used by health practitioners to measure patients’ pain. The NDI is used to measure the impact of pain on activities of daily living and the NBQ was designed to measure physical social and psychological functioning and pain (Schellingerhout *et al.*, 2011).

2.3.7 Effects of neck pain on structure and function

In healthy subjects, a consistent muscle activation strategy generates the appropriate amounts of torque and force for neck movements (Blouin *et al.*, 2007). O'Leary *et al,* (2009) observed that shortly after the onset of neck pain, changed muscle behaviour become obvious: the normal motor activation strategy for performing tasks is altered. This altered strategy is known as a disturbance of the neural control mechanism (Falla, Bilenkij and Jull, 2004): The superficial sternocleidomastoids and anterior scalenes become more active during craniocervical flexion and arm movements than in pain free controls (Falla, Bilenkij and Jull, 2004); the superficial cervical flexors and extensors, including the sternocleidomastoids and suboccipital muscles show increased co-activation during neck movements; the deep cervical flexors (longus colli, longus capitis and rectus capitis anterior) show signs of being inhibited, with delayed activation speed during changes in body position (Murphy, 2000; Falla *et al.*, 2007).

Endurance and precision are vitally important during low intensity activities to perform smooth, efficient and pain free movements (O'Leary *et al.*, 2009). These muscle changes may lead to further injury as the muscles do not lend support when needed to support the neck during fast movements (Treleaven, Jull and LowChow, 2005).

2.4 TREATMENT PROTOCOLS

2.4.1 Mobilisation Therapy

Mobilisation is defined as a low-velocity, small- or large-amplitude movement applied manually over a contact point anywhere within the joint's range of motion (Maitland *et al.*, 2005; Gross *et al.*, 2010). Mobilisation is applied to facet joints that are restricted and painful during active or passive movement (Maitland *et al.*, 2005). It has been shown to provide some immediate- and short-term pain relief and improved function for subacute and chronic neck pain (Gross *et al.*, 2010). Mobilisation was found to be more effective for the treatment of CNSNP than usual interventions, such as soft collars or general advice to keep active (Hurwitz *et al.*, 2009). Cervical spine mobilisation has been shown to improve pain pressure threshold (PPT) on the side of mobilisation immediately post-treatment (Sterling, Jull and Wright, 2001). In a systematic review Schmid *et al.,* (2008) found consistent evidence that cervical mobilisation improves PPT, both locally and distal, to the site of the mobilisation.

Mobilisation therapy is hypothesised to have an effect on pain and range of motion (Maitland, 1998) by way of both local and segmental neurological responses (Maitland, 1998; Leach, 2004; Schmid *et al.*, 2008). Evidence that passive joint mobilisation stimulates the central nervous system to cause a neurophysiologic effect by sympathetic excitation (Leach, 2004), hypoalgesia (Bergman, Peterson and Lawrence, 1993), and changes in motor activation (Hillerman et al., 2006; Hopkins and Ingersol, 2000; Palmieri *et al*., 2003); are thought to be the mechanisms behind the manner in which mobilisation facilities improvement in a patients clinical presentation. To this end, Schmid *et al.* (2008) reported that cervical mobilisation decreases pain at rest and at 24 hour follow-up and also decreases the painful area by 43.3% (clinically significant (Cleland *et al.*, 2008)). This phenomenon was also demonstrated by Aquino *et al.,* (2009), in a randomised clinical trial that compared cervical spinal mobilisations given at the most symptomatic level to mobilisations given at a randomly chosen level – Aquino (2009) observed no significant difference in pain reduction between the two groups.

Snodgrass *et al.* (2009), in a clinical trial, observed the force used during cervical Grade I-IV mobilisations to range between 22 Newton and 92 Newton (Snodgrass *et al.*, 2009).

In a systematic review investigating mobilisation and manipulation, Gross *et al.* (2010), found that the most common side effects that were reported in clinical trials were neck pain, headaches and radicular symptoms. These symptoms occurred at a rate of between 58 and 102 per 1 000 treatments, while more serious adverse symptoms, including strokes and neurological deficits rarely 28ccurred (Gross *et al.*, 2010).

2.4.2 Craniocervical Flexion Exercise

The craniocervical flexion exercise is a gentle exercise designed to train coordination of the deep and superficial cervical flexors and provide low-load endurance training for these muscles (O'Leary *et al.*, 2007a). Gentle contractions are done to activate the postural deep cervical flexors while keeping superficial muscle contraction to a minimum (Jull *et al.*, 2008).

During craniocervical flexion the head is flexed toward the neck which tucks the chin in (O'Leary *et al.*, 2007a). The longus capitis is the prime flexor of the craniocervical joint while the longus colli acts as a synergist during craniocervical flexion by flattening the cervical lordosis (Cagnie *et al.*, 2008).

The craniocervical flexion exercise has been shown to provide immediate local mechanical hypoalgesia (O'Leary *et al.*, 2007a). In a randomized clinical trial that investigated the effect of specific craniocervical flexion training, it was found that activation of superficial cervical flexor muscles decreased and that of deep cervical flexors increased to a near-normal ratio of superficial-to-deep muscle activation (Jull *et al.*, 2009). Long-term endurance training has been observed to improve cervical PPT and decrease cervical muscle pain at long-term follow-up (Ylinen *et al.*, 2005).

Falla *et al.*, (2007), in a clinical trial, found that correcting the sitting posture of chronic neck pain sufferers, rather than giving general advice about good sitting posture, led to efficient activation of participants' deep cervical flexor and multifidus muscles. For this reason, a precise posture correcting exercise was taught to the participants in the CCFE group, in order to promote more regular activation of the deep cervical flexor muscles.

2.4.3 Exercise Therapy and Cervical Mobilisation

Combined exercise and mobilisation or manipulation is the most researched treatment protocol for managing chronic non-specific neck pain in terms of restoring function and reducing pain (Gross *et al.*, 2009; Hurwitz *et al.*, 2009; Miller *et al.*, 2010). In a summary of key findings, the Bone and Joint Decade Task Force on neck pain and its associated disorders 2000-2010, recommended a variety or combination of therapies to bring relief from neck pain (Haldeman *et al.*, 2008).

According to Haldeman *et al.* (2008) patients need to be encouraged to focus on self-management by way of exercise and pain relief to regain function as early as possible during a treatment protocol. Multimodal treatment results in quicker recovery and return to work than passive treatment alone, and also reduces the cost of health care for whiplash-associated neck pain sufferers (Hurwitz *et al.*, 2009).

Borders *et al.* (2005) found that patients who actively participate in decisions about their pain management minimise the effect of their condition on their quality of life and are more likely to have a successful outcome. However, short episodes of care may be recommended, as longer periods of treatment are not associated with greater improvements in neck pain and disability (Haldeman *et al.*, 2008).

Other treatment modalities commonly used include medication, acupuncture, low-level laser therapy, intermittent traction and advice. All of these modalities have been shown to be beneficial for pain relief and restoration of function (Gross *et al.*, 2009). Certain medications such as non-steroidal anti-inflammatories, acetaminophen and opiates are commonly used, even though evidence of their benefit is insufficient (Gross *et al.*, 2009).

2.5 OUTCOME MEASURES

Outcome measures have been found to be useful in establishing the efficacy of treatment modalities. It is important to know not only which modalities are effective, but also what effect to expect from a certain modality. It makes testing and retesting more applicable and is an encouragement to the patient when a treatment effect is detectable (Jull *et al.*, 2008). A treatment modality may be considered successful if a measurable change in functional status, pain levels and physical impairments has been demonstrated (Jull *et al.*, 2008). This change is necessary to justify implementing a specific treatment protocol (Jull *et al.*, 2008).

Subjective outcome measures show good psychometric validity (Nordin *et al.*, 2009). It is important to measure patient progress and satisfaction, especially in the early phase of treatment, as these factors influence patient compliance to treatment and prove valuable at predicting treatment outcomes (Jull *et al.*, 2008).

Participants rated their pain in the subjective Numeric Pain Rating Scale. The minimum clinically important change (MCIC) for the NRS is a change of two points out of 11 over time (Cleland *et al.*, 2008). Ferreira-Valente *et al.,* (2011), in a comparison of four pain rating scales, found the NRS to have good validity. This scale has been shown to be responsive and sensitive over a wide variety of patient populations (Farrar *et al.*, 2001). It is the recommended measurement tool for pain intensity (Misialidou *et al.*, 2010; Ferreira-Valente, Pais-Ribeiro and Jensen, 2011).

Both the NDI and NBQ measure subjective symptoms of pain and disability in activities of daily living (Bolton, 2004). The NDI is a well-researched questionnaire and has been shown to have adequate internal consistency, validity, and responsiveness (Howell, 2011; Schellingerhout *et al.*, 2011). The NDI has a minimum clinically important change (MCIC) of 5/50 points (Vernon, 2008; MacDermid *et al.*, 2009) and moderate reliability with an intra-class correlation coefficient (ICC) of 0.64 (Young *et al*., 2009).

In addition the NBQ measures aspects of social functioning, the psychological aspects of depression and anxiety and the cognitive aspects of pain locus of control and fear-avoidance behaviour (Bolton and Humphreys, 2002). The NBQ has been found to have good internal consistency and convergent validity (Gay *et al.,* 2007) when compared to the NDI, which is a more widely researched tool (Vernon, 2008). It has been shown to have positive findings for individual hypothesis testing and responsiveness (Schellingerhout *et al.*, 2011). A gross change of nine points or more is necessary for a change in the NBQ score to be considered clinically significant (Hurst and Bolton, 2004).

The Patient Global Impression of Change Questionnaire was used to establish the overall effect of the treatment at the end of the treatment period (Dworkin *et al.*, 2010). This scale is recommended as a core outcome measure of global response to treatment by the IMMPACT Task Force and has been shown to be responsive and valid (Dworkin *et al.*, 2010). The change score of the PGIC should not be considered as a number, but each participant's should be considered individually – a score of 'minimally improved' or 'very much improved' should be considered to be a statement, not a rating (Dworkin *et al.*, 2010).

Participants' cervical ranges of motion and pressure pain threshold were objectively measured, however only weak correlations have been found to exist between neck pain and cervical range of motion (Howell, 2011). Williams *et al*., (2010), in a review of the literature, found both the validity – the degree to which a tool measures what it has been designed to measure – and reliability of the CROM to be moderate to good – for the measurement of neck range of motion (Tousignant *et al.*, 2006; Schellingerhout *et al*., 2011). Normal cervical spine active range of motion in females is presented in Table 2.5. Kumbhare *et al.* (2005), in a study of whiplash sufferers, found that CROM correlated with NDI scores only unilaterally, and that there were no correlations between NDI and flexion, extension and rotation. In a study of women with CNSNP, a weak correlation between neck pain and decreased CROM was found to exist only with extension and left lateral flexion (Ylinen *et al.*, 2004). Schmid *et al.* (2008) found that cervical mobilisation increases pain free range of motion.

Table 2.5 Normal Cervical Spine Active Range of Motion in Females Aged 20-40

Plane of motion	**Range**
Flexion	55-65°
Extension	75-85°
Left lateral flexion	40-45°
Right lateral flexion	40-50°
Left rotation	65-72°
Right rotation	70-76°

(Youdas *et al.,* 1992)

The algometer has been found to have good within-session reliability with an intra-class correlation coefficient of more than 0.91 and good between-session reliability with an intra-class correlation coefficient of more than 0.87 (Potter, McCarthy and Oldham, 2006). An instrument is deemed reliable if its scores do not change significantly over time in patients whose condition hasn't changed (Schellingerhout *et al*., 2011). A change in PPT of more than 6.6 lb per square cm on a given muscle was considered to be clinically significant (Potter, McCarthy and Oldham, 2006).

2.6. CONCLUSION

In conclusion the literature points out that neck pain is a common condition (Côté *et al*., 2004) with a multifactorial onset (Binder, 2007), that contributes significantly to disability and work-absenteeism (Gross *et al.*, 2009) and often becomes chronic instead of resolving completely (Côté *et al*., 2004). Muscle strength, endurance and activation pattern may be negatively affected by neck pain (O'Leary *et al.*, 2009). These deficits may be corrected by low-load endurance exercise (Jull *et al.*, 2009), while both the CCFE and mobilisation may relieve pain and improve function (O'Leary *et al*., 2009; Gross *et al.*, 2010).

For these reasons mobilization or manipulation combined with therapeutic exercise is currently prescribed as the most effective method to regain function and relieve pain for chronic non-specific neck pain (Gross *et al.*, 2009; Hurwitz *et al.*, 2009).

CHAPTER THREE
MATERIALS AND METHODS

3.1 INTRODUCTION

This chapter describes the interventions used and the procedures followed for data collection and statistical analysis.

3.2 STUDY DESIGN

A quantitative randomised controlled trial was performed to compare the effects of cervical mobilisation with those of the craniocervical flexion exercise for the treatment of chronic non-specific neck pain in females.

The above research design was approved (Appendix P) by the Institutional Research and Ethics Committee (IREC) of the Durban University of Technology, indicating that the proposal and hence the research that was undertaken was compliant with the Helsinki Declaration of 1975.

3.3 RECRUITMENT

Participants were recruited by means of advertisements (Appendix A) that were posted and handed out on the Durban University of Technology, Durban campuses and at local libraries and pharmacies, with permission, as well as by word of mouth.

3.4 PARTICIPANTS

3.4.1 Sample size and allocation

Convenience sampling was used to obtain 30 participants with chronic non-specific neck pain. The participants were randomly allocated into one of two treatment groups, A and B, of 15 participants per group and attended three consultations each over eight days. All participants volunteered as per the ethical requirements of the Helsinki Declaration, 1975. They were informed that they could withdraw from the study at any stage and that their withdrawal would not affect their treatment at the DUT Chiropractic clinic in the future.

3.4.2 Participant Screening

The participant screening process started with a telephonic interview with prospective participants in which the following questions were asked. Permission was sought from the patient before commencement of the interview. The questions and their desired responses are presented in Table 3.1.

Table 3.1: Questions and desired responses from the telephonic interview

Question	**Response**
1. What is your gender?	Only females were included to control for differences in exercise physiology (Deschenes *et al.*, 2009; Wüst, 2008).
2. How old are you?	Between 20 – 35 years.
3. How long have you been suffering with neck pain?	More than three months to be classified as having chronic neck pain (Guzman *et al.*, 2009).
4. Are you currently taking any pain medication?	'No.' If the participant answered 'yes' to question four, the participant was required to have a three day wash out period before participating in the study (Seth, 1999).

If the participant was eligible to participate in the study, an initial consultation was scheduled to establish if the participant complied with the inclusion and exclusion criteria. Participants were informed that they could not use any pain medication or receive pain treatment during the course of the study. If they chose to break this agreement, they would be excluded from the study and referred for further treatment if necessary. This was explained to the participants at the first consultation, and was stated in the letter of information (Appendix B).

3.5. INCLUSION AND EXCLUSION CRITERIA

3.5.1 Inclusion Criteria

The following inclusion criteria were used:

- The participants had to be female and between the ages 20 - 35 years. Once gender was chosen, in order to control for the differences in exercise physiology, (Wüst, 2008; Deschenes *et al.*, 2009), the age group was limited to persons aged 20 to 35 years to further increase homogeneity of the sample.
- The participants had to have complained of chronic non-specific neck pain, characterised by mechanical and muscular symptoms. This was ascertained through thorough history taking and examination.
- The participants had to have read and signed the Letter of Information and Informed Consent Form (Appendix B).
- The participants were required to be able to attend the scheduled treatment visits.
- The participants had to have an NRS score of between three and eight to ensure clinically significant changes would be detected as well as for sample homogeneity (Farrar *et al.*, 2001). No restriction was placed on the NDI score of potential participants, to guard against excluding too many patients. However, Vernon (2008) reported that pain rating and NDI scores were correlated.

3.5.2 Exclusion Criteria

Participants were excluded from this study if:

- Their neck pain was not of mechanical origin, examples include but are not limited to the following: inflammatory, infectious, malignant, metabolic, neurologic or structural causes (Binder, 2007).
- They had any contra-indications to exercise, including pregnancy, uncontrolled hypertension, severe osteoporosis, myocardial infarction, cerebrovascular disease and spinal tumours (Michaleff *et al.*, 2009).
- They had any contra-indications to cervical mobilisation: rheumatologic conditions, previous spinal surgery, dizziness and previous trauma to the cervical spine (Maitland *et al.*, 2005).
- They could not receive any other form of treatment for their neck pain for the duration of the study (Michaleff *et al.*, 2009).
- They were experiencing excruciating pain, increasing pain or intractable night pain and required other treatment outside the scope of this study (Binder, 2007).
- They suffered from any signs or symptoms indicative of vertebro-basilar artery insufficiency, including dizzy spells, especially when moving the neck (Binder, 2007).

The participants of this study had no further limitations, e.g. ethnicity or occupation.

3.6 RESEARCH PROCEDURE

At the first consultation the female participant was given a Letter of Information and Informed Consent Form (Appendix B) to read and the researcher verbally explained the nature of the study. She was given the opportunity to ask questions about the research and the treatment that she would receive. If she agreed to participate in the study, she was required to sign the informed consent form stating that she was willing to participate in the study. All participants were informed that they were free to leave the study at any stage and it would not affect their future care at the Chiropractic Day Clinic.

The researcher then took a case history and performed a physical examination and a cervical regional examination (Appendix C, D and E)

Pressure algometer and cervical range of motion (Appendix G) were assessed and the Numerical Pain Rating Scale (Appendix H), Neck Disability Index (Appendix I) and Neck Bournemouth Questionnaires (Appendix J) were administered by an independent assessor. The outcomes measures were taken in exactly the same order at each consultation to prevent confounding of the results.

The participants were randomly allocated into one of two treatment groups (Group A – cervical mobilisation and Group B – craniocervical flexion exercise) by a random allocation chart. All the participants were treated by the researcher.

3.6.1 Treatment Group A – Mobilisation

Consultation One

Participants in group A received cervical mobilisation therapy at the first consultation. The upper cervical spine (cervical spinal levels one and two) was motion palpated to ascertain the level and side that was most tender and had the greatest loss of local segmental movement. This level and side was noted and an oscillatory grade III postero-anterior movement with the participant in the supine position was performed at that level (Sterling, Jull and Wright, 2001). The first and second cervical segments were selected as the craniocervical flexion motion occurs in the upper cervical region (Cagnie *et al.*, 2008).

Consultation Two

Participants of group A returned for a second consultation two days after the first consultation. Numerical Pain Rating Scale, Neck Disability Index and Neck Bournemouth Questionnaires were administered to participants and algometer and cervical range of motion readings were taken by the independent assessor. The participants were motion palpated and the most symptomatic level and side in terms of pain and loss of motion was mobilised using a grade III mobilisation.

Consultation Three is described in section 3.6.2 as the same procedure was followed for both groups.

3.6.2 Treatment Group B – Craniocervical Flexion Exercise

<u>Consultation One</u>

The participants for Group B were instructed on how to perform the craniocervical flexion exercise at home: Lying supine the participants were instructed to find the neutral spinal position and then perform a small nodding motion that moves their occiput towards the top of the bed, while lying on the bed. They had to hold the contraction for 10 seconds and repeat 10 times. The participants were instructed to perform these exercises twice a day (Jull *et al.*, 2008). The participants performed this exercise in the consultation room to ensure they could perform the exercise correctly and correct any faulty movements.

After the researcher was satisfied that the participant could perform the craniocervical flexion exercise correctly, a posture correcting exercise was taught to Group B participants. In order to obtain the appropriate spinal position, the participant was placed in a seated position; the researcher then corrected her pelvic orientation from the hyper flexed or –extended position in order to correct her lumbar lordosis. As a result of the above procedure, the thoracic and cervical spinal postures were corrected (Jull *et al.*, 2008), allowing for appropriate cervical spine posture in which to complete the craniocervical flexion exercise. The participant was then instructed to lift her sternum to neutralise the thoracic kyphosis or drop her sternum if the thoracic spine was hyperextended (Falla *et al.*, 2007 Jull *et al.*, 2007). The participant had to perform this exercise twice a day along with the craniocervical flexion exercise (Jull *et al.*, 2008). She performed the explained exercises in the consultation room so that the researcher could correct any incorrect/misunderstood exercise methods (Jull *et al.*, 2008).

A typed out information sheet (Craniocervical flexion exercise instructions, Appendix L) with instructions on how to perform the exercises was given to the participants of Group B to refresh their memories at home. They also received an exercise diary (Appendix M) to diarise their exercise sessions. This was done to ensure patient compliance (Jull *et al.*, 2008). Patients were encouraged to put up a reminder, e.g. a bright sticker so they would remember to perform their exercises twice a day (Jull *et al.*, 2008).

Consultation Two

Participants returned for a second consultation two days after the first consultation. Numerical Pain Rating Scale, Neck Disability Index and Neck Bournemouth Questionnaires were administered to participants and algometer and cervical range of motion readings were taken by the independent assessor.

The participants were asked by the researcher to demonstrate the craniocervical flexion exercise and posture correcting exercise to ensure their technique was still satisfactory. They were also asked about their compliance with the exercise programme to ensure that they were being compliant.

Consultation Three

Participants in both groups A and B returned seven days after the initial visit to complete the Numerical Pain Rating Scale, Neck Disability Index, Neck Bournemouth Questionnaire. The Global Impression of Change scale was also administered at this consultation. Algometer readings and cervical range of motion were assessed by the independent assessor. All participants were asked about any side effects during the treatment. None were reported. The research process is illustrated in Figure 3.1.

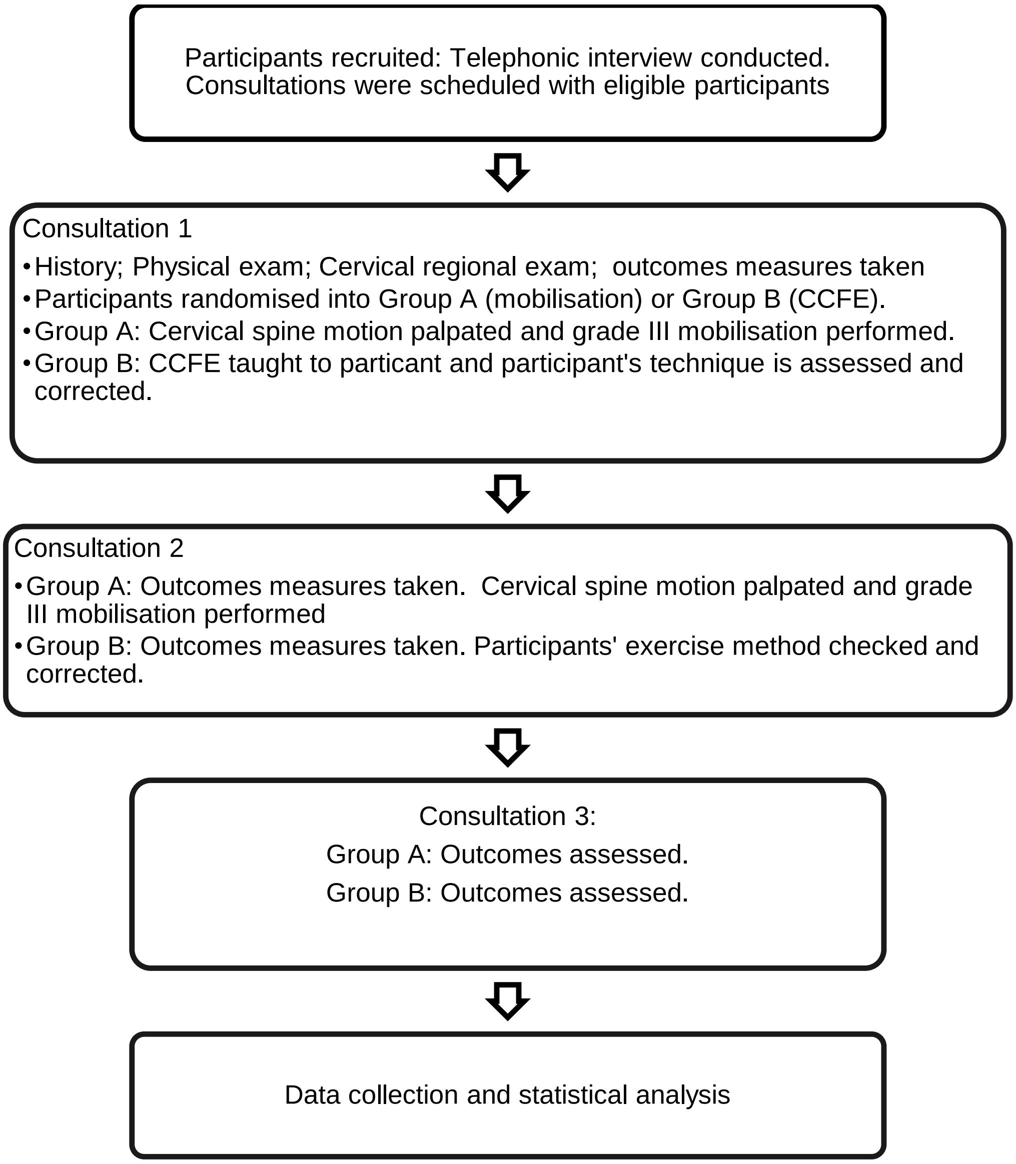

Figure 3.1: Summary of the research process

3.7 MEASUREMENTS

Outcome measures for treatment modalities play a significant role in the management of a patient's condition. Outcome measures provide insight into the impact of patients' neck pain on their daily lives and perceived functional deficit, monitor change of the condition over time and help with selecting appropriate treatment modalities (Nordin *et al.*, 2009).

3.7.1 Frequency

Data collected comprised of both subjective and objective measurements documented at three measurement intervals: At the initial consultation (before treatment was administered), before the second treatment two days later, and at the third consultation seven days after the first consultation. The data collected was documented in the data collection sheets.

3.7.2 Outcome Measures

3.7.2.1 Numeric Pain Rating Scale

The Numeric Pain Rating Scale (NRS) is an 11-point scale that characterises a participant's pain with '0' being 'no pain' and 10 being 'most severe pain'. Participants were asked to rate their usual pain out of 10 at the first, second and third consultations. The data was collected on the collection sheet (Appendix H) which was later transferred onto spreadsheets for statistical analysis.

3.7.2.2 Neck Disability Index

The Neck Disability Index (NDI) measures the impact of participants' neck pain on activities of daily living, including driving, work and sleep. It consists of ten sections with six response categories (0-5) with a total score of 50 points. Participants completed the questionnaire on the data collection sheet (Appendix I) at all three consultations. The data was then transferred to spreadsheets for statistical analysis.

3.7.2.3 Neck Bournemouth Questionnaire

The Neck Bournemouth Questionnaire was designed to measure complainants' non-specific neck pain and their physical, social and psychological functioning (Bolton and Humphreys, 2002). It has seven sections which must be answered on a ten point scale.

Participants completed the questionnaire on the data collection sheets at all three consultations (Appendix J). The data was then transferred to spreadsheets for statistical analysis.

3.7.2.4 Patient Global Impression of Change Scale (PGIC)

The PGIC is a seven point scale that ranges from ‘no change or worse’ to ‘a great deal better’. It is used to measure the participant’s impression of the treatment effect at the end of the intervention period, including pain relief, improvement in function and any side effects experienced during the trial (Dworkin *et al.*, 2010). All participants completed this questionnaire at the third consultation (Appendix K). The data was then transferred to spreadsheets for statistical analysis.

3.7.2.5 Cervical Range of Motion Goniometer

Active range of motion was measured with the cervical range of motion goniometer.

The participants were seated and the measurer ensured their lumbar spine was in the neutral position and their back was supported by the chair’s back support. Measurements were then taken with the cervical spine actively flexed, extended, laterally flexed to the left and right and rotated to the left and right, in this order (Strimpakos, 2009). Warm up exercises were not performed. The measurements were recorded in the data collection sheets (Appendix G) and later transferred onto spreadsheets for statistical analysis.

3.7.2.6 Algometer

The algometer was used to measure pain threshold at specified locations on the left and right erector spinae, left and right levator scapula and left and right upper trapezius muscles and marked with a henna pen to ensure the same point was used at the next visit. The algometer readings were taken in the same order at each consultation. The participant gave a verbal indication as soon as the sensation changed from pressure to pain (Potter, 2006). The readings were taken in a specific order, moving from left to right and superior to inferior (Left erector spine first and right trapezius TP 2 last). These results were recorded on the data collection sheets and later transferred onto spreadsheets for statistical analysis.

3.8 STATISTICAL ANALYSIS

IBM SPSS was used to analyse the data. A p value <0.05 was used to indicate statistical significance. Independent samples t tests were used to compare the control and intervention groups in terms of baseline characteristics and baseline outcomes in order to ensure adequate randomization. Repeated measures ANOVA testing was used to perform intra- and inter-group analyses, when data was normally distributed. Non-normally distributed data (which was not expected), was controlled for and reported as such in the event that it occurred. Inter-group analysis was used to compare the effect of the intervention to the control over time, with a significant time x group effect indicating a significantly different effect in the intervention group over time compared with the control group. Profile plots were used to assess the direction and trend of the effect (Esterhuizen, 2012).

CHAPTER FOUR

RESULTS

4.1 INTRODUCTION

This chapter presents the results obtained from the statistical analysis of the data that was collected during the study. There was an intra- and inter-group analysis to determine the superior treatment method. The demographics, inter-group and intra-group data are presented in the form of figures and tables.

1.2 RESPONSES, INCLUSIONS AND EXCLUSIONS

The following diagram demonstrates the research process in terms of sample recruitment and follow-through.

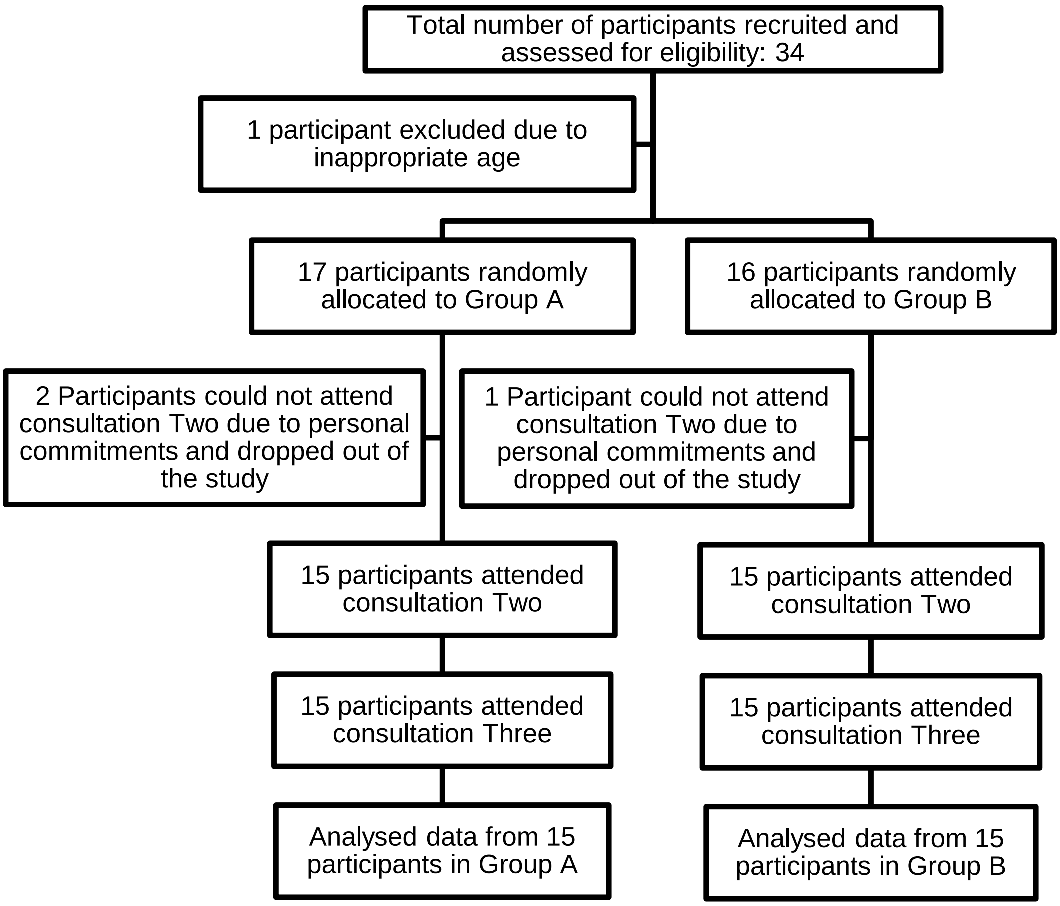

Figure 4.1: Consort diagram of research process

4.3 DEMOGRAPHICS

The participants of the study were randomly allocated into either Group A (cervical spinal mobilisation therapy) or Group B (craniocervical flexion exercise) with 15 participants in each group. The demographics of the two groups were compared and no significant difference was found to exist between the two groups.

Table 4.1: Demographic characteristics of the treatment groups and total sample

		Group A		Group B		Total	
		Count	Column (%)	Count	Column (%)	Count	Column (%)
	Mean age (years)	25,5		24,3		24,9	
Ethnicity	African	3	20	8	53,3	11	36,7
	Coloured	0		0		0	
	Indian	4	26,7	5	33,3	9	30
	White	8	53,3	2	13,3	10	33,3
	Total	15	100	15	100	30	100

4.4 OBJECTIVE ONE: TO DETERMINE THE EFFECTIVENESS OF CERVICAL MOBILISATION FOR THE TREATMENT OF CNSNP

The NRS, NDI and NBQ were filled out at each of the three consultations that took place over seven days. There was a significant decrease in the scores of all three measures at the second and third consultations. The *p*-values are presented in Table 4.2. Group A refers to the cervical mobilisation group.

4.4.1 Numeric Pain Rating Scale

There was a statistically significant change over time in the NRS values for Group A (p=0.009) with a score change of 2.1 out of a total of 11 points. The p value is the probability that the test statistic could be reproduced, given that the null-hypothesis is accepted. A value of p<0.05 would mean that the null-hypothesis is highly unlikely to be true (Streiner and Norman, 2009).

4.4.2 Neck Disability Index

There was a statistically significant change over time in the NDI values for Group A (p=0.003). The values are scores out of 50.

4.4.3 Neck Bournemouth Questionnaire

There was a statistically significant change over time in the NBQ values for Group A (p=0.002). The values are scores out of 70.

Table 4.2: Mean subjective values over time for Group A

	Wilk's lambda	*p* value
NRS	0.481	0.009
NDI	0.401	0.003
NBQ	0.374	0.002

4.4.4 Cervical Range of Motion

The CROM measurements were taken at each of the three consultations over seven days. The participants were seated and performed the movements actively, without assistance. The planes of motion were done in the same order at each consultation. The *p*-values are presented in Table 4.3.

Flexion

There was a statistically significant decrease in flexion ROM over time (p=0.035).

Extension

There was a statistically significant decrease in extension over time (p=0.004).

Left lateral flexion

There was a statistically significant decrease in left lateral flexion over time (p=0.002).

Right lateral flexion, left rotation and right rotation

There was no statistically significant change over time (p=0.589).

Left rotation

There was no statistically significant change over time in left rotation ROM (p=0.404).

Right rotation

There was no statistically significant change in right rotation ROM over time (p=0.590).

Table 4.3 Mean ROM values over time for Group A

	Wilk's lambda	*p* value
Flexion	0.597	0.035
Extension	0.425	0.004
Left lateral flexion	0.395	0.002
Right lateral flexion	0.922	0.589
Left rotation	0.870	0.404
Right rotation	0.922	0.590

4.4.5 Algometer

The algometer readings were taken at each of the three consultations over seven days. The scores in the figures are the mean PPT of the group measured in pounds. The *p*-values are presented in Table 4.4.

- The algometer readings of the participants' left and right erector spinae muscle were taken at the level of C2 (Travell and Simons, 1983).
- The algometer readings for the participants' right and left levator scapula were taken at the inferior portion of the levator scapula muscle, adjacent to its attachment to the scapula (Travell and Simons, 1983).
- The algometer readings for the participants' left and right upper fibers of the trapezius were also taken (Travell and Simons, 1983).

Left Erector Spinae
There was a statistically significant change over time (p=0.011) in the form of increased PPT (improved PTT). This was the only muscle point that showed significant change over time in the cervical mobilisation group.

Right Erector Spinae
There was no statistically significant change over time (p=0.439).

Left Levator Scapula
There was no statistically significant change over time (p=0.261).

Right Levator Scapula
There was no statistically significant change over time (p=0.982).

Left Trapezius
There was no statistically significant change over time (p=0.861).

Right Trapezius
There was no statistically significant change over time (p=0.920).

Table 4.4 Mean Algometer readings over time for Group A

	Wilk's lambda	*p* value
LES	0.503	0.011
RES	0.881	0.439
LLS	0.813	0.261
RLS	0.997	0.982
LTr	0.977	0.861
RTr	0.987	0.920

4.5 OBJECTIVE TWO: TO DETERMINE THE EFFECTIVENESS OF THE CRANIOCERVICAL FLEXION EXERCISE FOR THE TREATMENT OF CNSNP

The NRS, NDI and NBQ were filled out at each of the three consultations that took place over seven days. There was a statistically significant decrease in the scores of all three measures at the second and third consultations. The *p*-values are presented in Table 4.5.

4.5.1 Numeric Pain Rating Scale

There was a statistically significant change over time in the NRS values ($p<0.001$).

4.5.2 Neck Disability Index

There was a statistically significant change over time in the NDI values ($p=0.011$).

4.5.3 Neck Bournemouth Questionnaire

There was a statistically significant change over time in the NBQ values ($p=0.006$).

Table 4.5: Mean subjective measures over time in Group B

	Wilk's lambda	*p* value
NRS	0.295	<0.001
NDI	0.499	0.011
NBQ	0.458	0.006

4.6.3 Cervical Range of Motion

The *p*-values are presented in Table 4.6.

Flexion

There was no significant change over time (*p*=0.171).

Extension

There was no significant change over time (*p*=0.810).

Left Lateral Flexion

There was no statistically significant change over time (*p*=1.000).

Right lateral flexion

There was no statistically significant change over time (*p*=0.721).

Left rotation

There was no statistically significant change over time (*p*=0.323).

Right rotation

There was no statistically significant change over time (*p*=0.177).

Table 4.6: Mean ROM values over time for Group B

	Wilk's lambda	*p* value
Flexion	0.762	0.171
Extension	0.968	0.810
Left lateral flexion	1.000	1.000
Right lateral flexion	0.951	0.721
Left rotation	0.841	0.323
Right rotation	0.766	0.177

4.5.4 Algometer

Left erector spinae

The algometer reading for LES showed a statistically significant change over time (*p*=0.015) in the form of decreased PPT. This point was the first point to be assessed at each consultation – this may have interfered with the results.

Right erector spinae

The algometer reading for RES showed no statistically significant change over time (*p*=0.365).

Left levator scapula

The algometer reading for LLS showed no statistically significant change over time (*p*=0.692).

Right levator scapula

The algometer reading for RLS showed no statistically significant change over time (*p*=0.013).

Left trapezius

The algometer reading for LTR showed no statistically significant change over time (*p*=0.085).

Right trapezius

The algometer reading for RTR showed no statistically significant change over time (*p*=0.395).

The *p*-values are presented in Table 4.7.

Table 4.7: Mean algometer values over time for Group B

	Wilk's lambda	*p* value
LES	0.526	0.015
RES	0.856	0.365
LLS	0.945	0.692
RLS	0.510	0.013
LTr	0.684	0.085
RTr	0.867	0.395

4.6 OBJECTIVE THREE: TO COMPARE THE RESULTS OF THE TWO TREATMENT GROUPS IN TERMS OF SUBJECTIVE AND OBJECTIVE MEASURES IN THE TREATMENT OF CNSNP

An inter-group analysis was performed to compare the results of the two groups. The *p*-values are presented in Table 4.8.

4.6.1 Numeric Pain Rating Scale

There was no statistically significant difference between the NRS scores of the two groups (*p*=0.922).

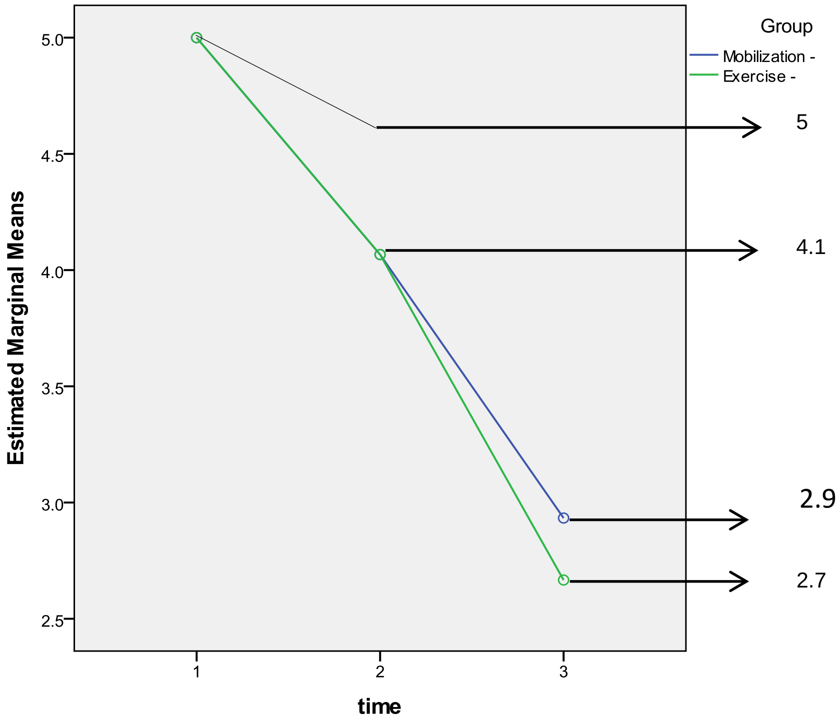

Figure 4.2: NRS values over time for Groups A and B

Table 4.8: Subjective measures between treatment groups

	Wilk's lambda for time x group	*p* value
NRS	0.994	0.922
NDI	0.970	0.664
NBQ	0.993	0.909

4.6.2 Neck Disability Index

There was no statistically significant difference between the NDI scores of Groups A and B (*p*=0.664).

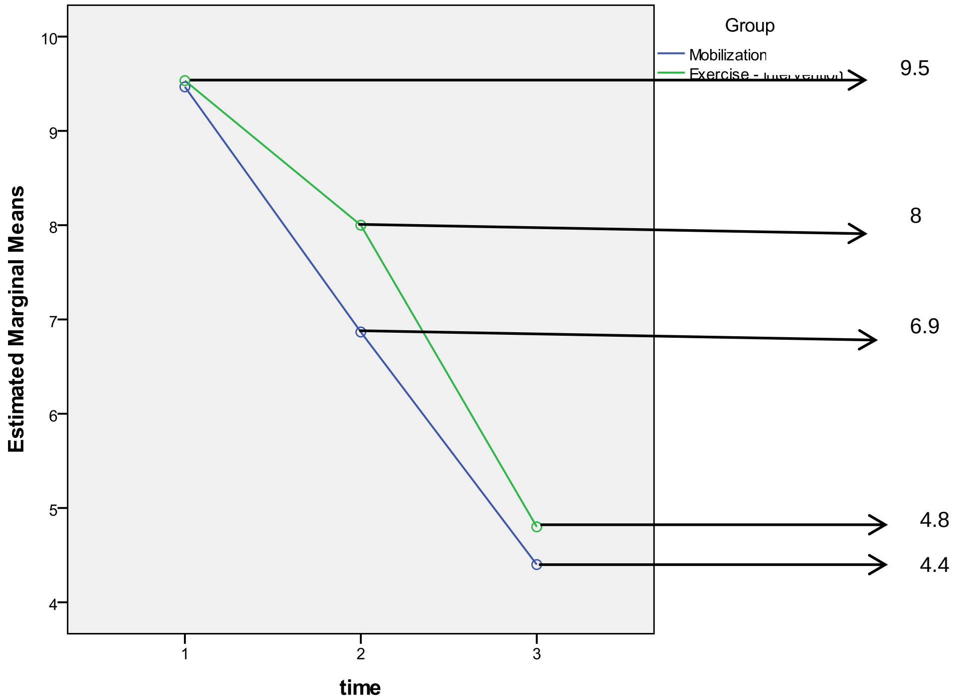

Figure 4.3: NDI over time for Groups A and B

4.6.3 Neck Bournemouth Questionnaire

There was no statistically significant difference between the NBQ scores of Groups A and B (*p*=0.909).

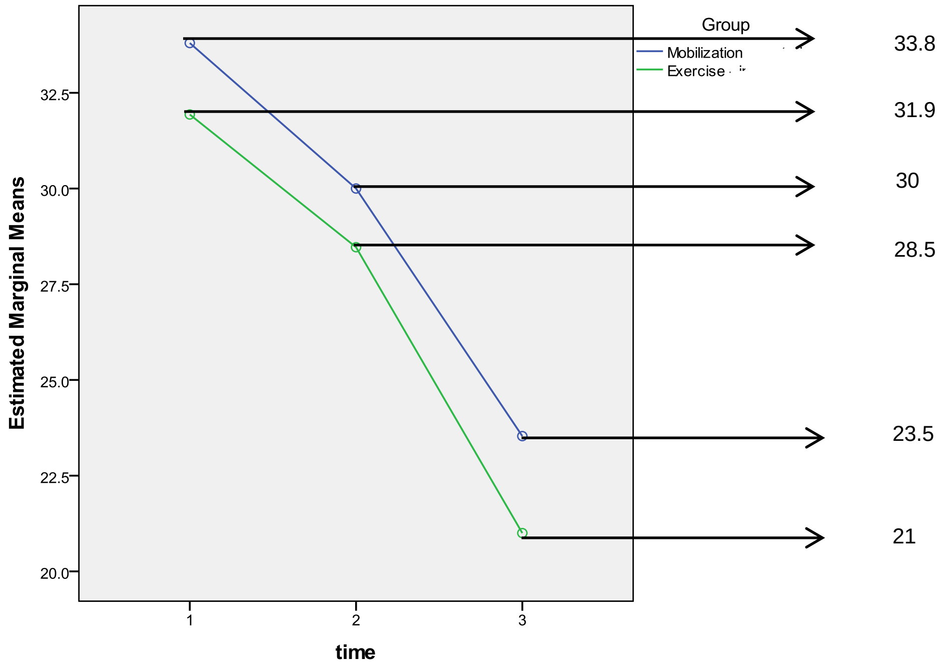

Figure 4.4: NBQ over time for Groups A and B

4.6.4 Patient Global Impression of Change Scale

The PGIC scale was administered at the third consultation seven days after the first consultation. Therefore, a comparison over time was not possible. A summary of the PGIC scale results of the two groups is presented below. There was no significant difference between the PGIC of Groups A and B (p=0.200). The mean score of the mobilisation group was slightly higher than that of the CCFE group. There was one participant in Group B who scored their PGIC as 1, the lowest possible score, meaning her condition was unchanged or had gotten worse. No participants in the mobilisation group scored 1.

Table 4.9: Summary of PGIC scores of Groups A and B

	Group	Participants	Mean	Mode	Standard Deviation	Standard Error Mean
PGIC	Mobilization - control	15	5.27	5	1.033	0.267
	Exercise - intervention	15	5.07	6	1.486	0.384

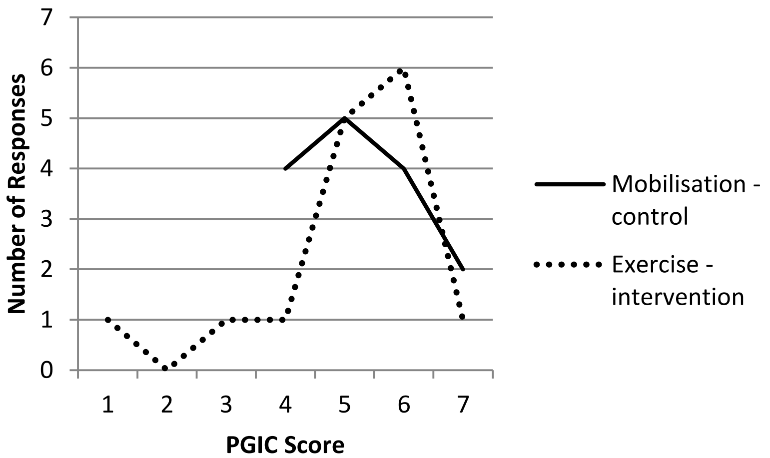

Figure 4.5: Summary of PGIC values of Groups A and B

4.6.5 Cervical Range of Motion

Flexion

There was no significant difference in flexion ROM over time between Groups A and B (p=0.322).

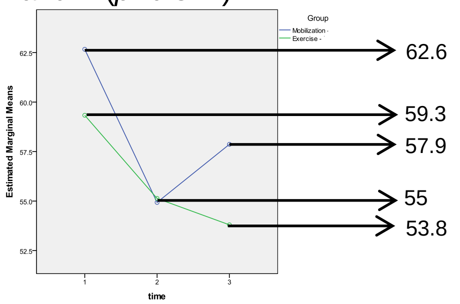

Figure 4.6: Flexion values over time for groups A and B

Extension

There was no significant difference in extension ROM over time between Groups A and B (p=0.105).

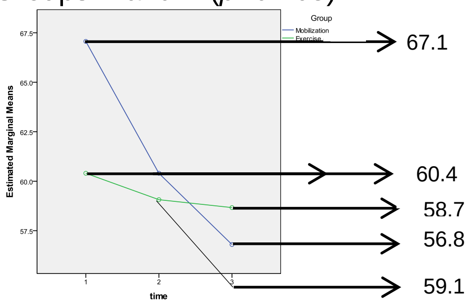

Figure 4.7: Extension values over time for groups A and B

Left lateral flexion

There was no significant difference in left lateral flexion ROM over time between Groups A and B (p=0.209).

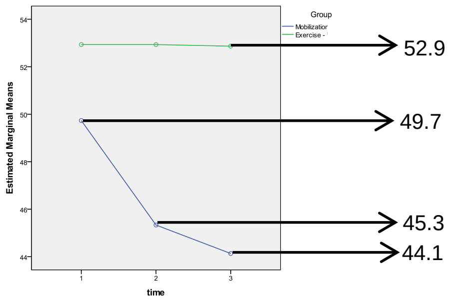

Figure 4.8: Left lateral flexion values over time for groups A and B

Right lateral Flexion

There was no significant difference in right lateral flexion ROM over time between Groups A and B (p=0.496).

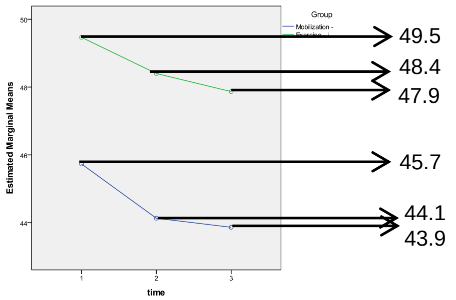

Figure 4.9: Right lateral flexion values over time for groups A and B

Left rotation

There was no significant difference in left rotation ROM over time between groups A and B (p=0.163).

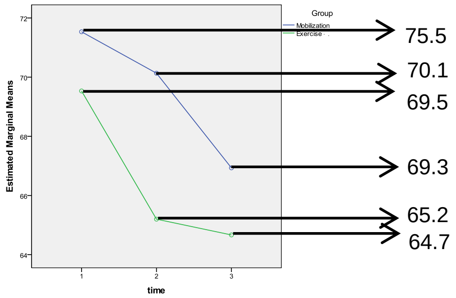

Figure 4.10: Left rotation values over time for groups A and B

Right rotation

There was no significant difference in right rotation ROM over time between groups A and B (p=0.160).

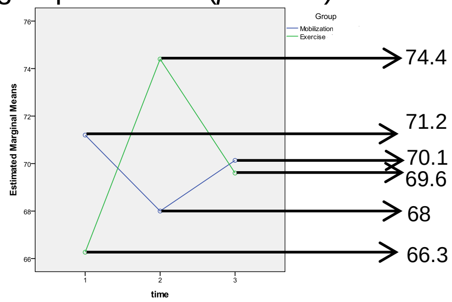

Figure 4.11: Right rotation values over time for groups A and B

The p-values are presented in Table 4.10.

Table 4.10: CROM values of groups A and B

	Wilk's lambda for time x group	p value
Flexion	0.922	0.322
Extension	0.846	0.105
Left lateral flexion	0.891	0.209
Right lateral flexion	0.949	0.496
Left rotation	0.874	0.163
Right rotation	0.873	0.160

4.6.6 Algometer

There was no significant difference in the change in pain pressure threshold of the two groups. Both groups showed a trend of increased (improved) PPT at the third consultation when compared to the first consultation. There was also a trend of decreased PPT at the second consultation compared to the first and third consultations. The *p*-values are presented in Table 4.11.

Left Erector Spinae

There were no significant difference in the values for LES between Groups A and B (*p*=0.257).

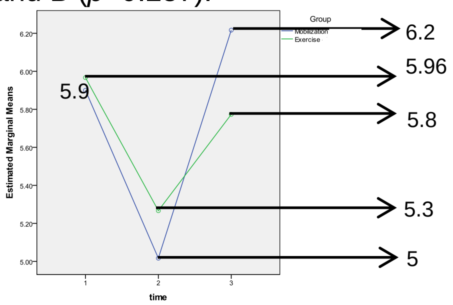

Figure 4.12: Mean algometer readings of LES over time for Groups A and B

Right Erector Spinae

There were no significant difference in the values for RES between Groups A and B (*p*=178).

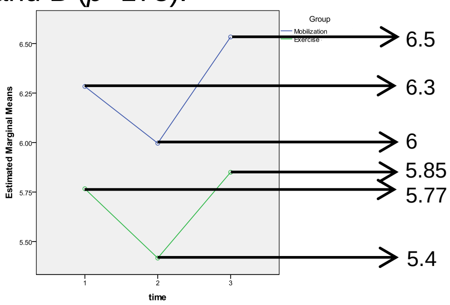

Figure 4.13: Mean algometer readings of RES over time for Groups A and B

Left Levator Scapula

The algometer values for LLS showed no significant difference between Groups A and B (*p*=0.948).

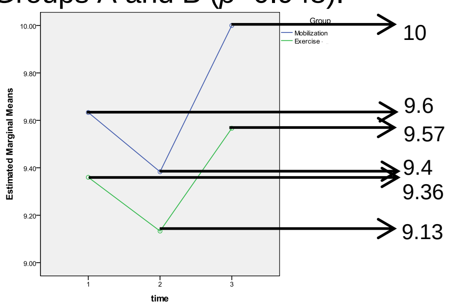

Figure 4.14: Mean algometer readings of LLS over time for groups A and B

Right Levator Scapula

The algometer values for RLS showed no significant difference between Groups A and B (*p*=0.260).

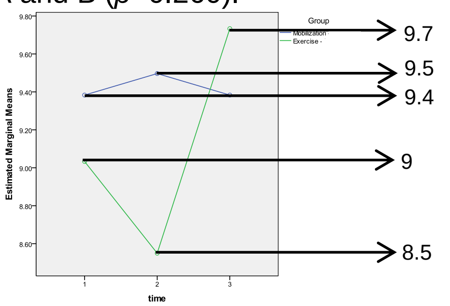

Figure 4.15: Mean algometer readings of RLS over time for groups A and B

Left Trapezius

The algometer values for LTr showed no significant difference between the two treatment groups (*p*=0.340).

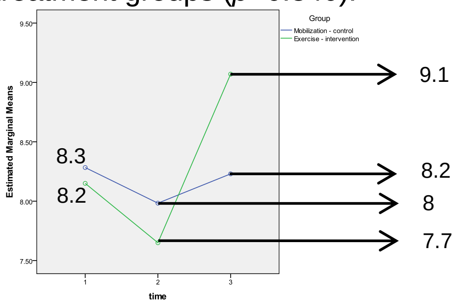

Figure 4.16: Mean algometer readings of LTr over time for groups A and B

Right Trapezius

The algometer values for RTr showed no significant difference between the two treatment groups (*p*=0.954).

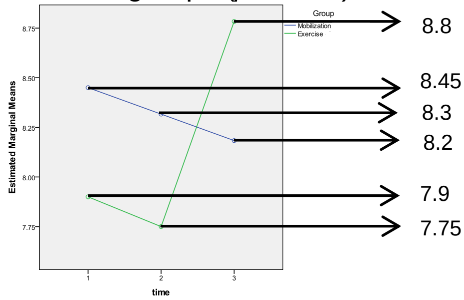

Figure 4.17: Mean algometer readings of RTr over time for groups A and B

Table 4.11: Algometer values of Groups A and B

	Wilk's lambda for time x group	*p* value
LES	0.904	0.257
RES	0.880	0.178
LLS	0.996	0.948
RLS	0.905	0.260
LTr	0.923	0.340
RTr	0.962	0.954

4.7 CONCLUSION

Both interventions produced statistically significant changes in the NRS, NDI and NBQ scores. There was a statistically significant decrease in flexion, extension and left lateral flexion for the mobilisation group only. The only muscle point that showed statistically significant change was left erector spinae, which showed increased (improved) PPT in the mobilisation group and decreased (worsened) PPT in the CCFE group. Although both treatment groups showed change over time, upon comparison of the groups cervical mobilisation and craniocervical flexion exercise were equally effective in the treatment of CNSNP, with no significant difference between the treatment effects of the two treatment modalities. A discussion of the results follows in the next chapter.

CHAPTER FIVE
DISCUSSION OF RESULTS

5.1 INTRODUCTION

As the study was done to determine the effectiveness of cervical mobilisation compared to the craniocervical flexion exercise for the treatment of chronic non-specific neck pain in improving pain, disability and range of motion at short-term follow-up, this chapter looks at the following points: The results of the clinical trial are discussed under the relevant objectives and is followed by a discussion of the study hypothesis.

As both cervical mobilisation and the CCFE have been shown to provide pain relief for CNSNP (Sterling, Jull and Wright, 2001; O'Leary *et al.*, 2007a; Gross *et al.*, 2010), the aim of this study was to determine whether either of the treatment modalities significantly improved the participants' perceived condition compared to the other modality.

5.2 DEMOGRAPHICS

The sample consisted of 30 females between the ages of 20 and 35. All the participants were diagnosed with chronic non-specific neck pain. They were randomly allocated into either treatment group. The two groups were statistically compared and found to be similar. The participants' demographic information is summarised in Table 4.1.

The average age of Group A participants was 25,5 years and the average age of Group B participants was 24,3 years.

The majority of the participants in Group A were White (53.3%), with 26.7% being Indian and 20% Black. The majority of the participants in Group B were African

(53.3%), with 33.3% Ind-ian and 13.3% White. According to the Census (2001) 60.2% of the greater Durban population are Black, 22.8% are Indian and 12.3% are White. The ethnic differences between the two intervention groups may have influenced results (Rahim-Williams, 2007).

Slightly more than half of the participants were students (n = 16). The study was conducted at a tertiary education institute, which may possibly explain this occurrence. The occupations were not compared statistically, since there were a large number of categories with too few responses per category.

5.3 OUTCOMES

As this study aimed to measure the effect of cervical mobilisation and the CCFE in CNSNP sufferers at short term follow up, the results are discussed in the following context: Neck pain is considered to be a chronic condition with relatively frequent relapses (Carroll *et al.,* 2009), however both mobilisation and the CCFE have been shown to have some treatment effect in the short term (O'Leary *et* al., 2007a; Gross *et al*., 2010). The long term effect of the CCFE, namely improved muscle strength (Ylinen *et al.*, 2005), was not expected to be present, and was not tested for. Thus the study did not aim to address these two treatment modalities comprehensively, but rather to assess a certain dimension of said modalities.

5.3.1 Numeric Pain Rating Scale

The numeric pain rating scale was used to establish participants' baseline pain levels and to monitor changes in pain levels over time. It was also used as an exclusion factor for those whose pain rating score was inappropriate to be included in the study (Farrar *et al.*, 2001). The NRS was completed at each of the three consultations, resulting in three sets of data.

There was a clinically and statistically significant decrease in the NRS scores of Group A (p=0.009) with a mean change of 2.1 points.

There was a clinically and statistically significant decrease in the NRS scores of Group B over time (*p*<0.001).

The baseline score and change in score of the two groups were similar (*p*=0.922). The CCFE group showed a slightly larger, but statistically insignificant, change in score than the cervical mobilisation group at the third consultation. This trend may have continued at long-term follow-up.

In a clinical trial investigating the effects of cervical mobilisation for neck pain sufferers, Sterling, Jull and Wright, (2001) observed a decrease in the visual analogue scale pain rating and decreased superficial neck flexor activity with a low-load craniocervical flexion test. The larger decrease in NRS scores of the CCFE group may be attributed to the mechanical hypoalgesic effect of exercise (O'Leary *et al.*, 2007a).

5.3.2 Neck Disability Index

The NDI was used to subjectively measure the impact of neck pain on participants' activities of daily living. The NDI was completed at all three consultations and the results of the two groups were compared. The NDI scores of the mobilisation group showed a decrease of 5.5 points over time. This is considered a clinically and statistically significant change (*p*=0.003).

There was a statistically significant decrease in the NDI scores of Group B (*p*=0.011). The change was not clinically significant.

The mobilisation group showed a greater rate of change in NDI scores than the CCFE group (Figure 4.33). There was however no statistically significant difference between the NDI score change of the two groups (*p*=0.664). The improvement in NDI scores correlated with the improved NRS scores. This is in line with Vernon (2008), who stated that pain rating is moderately strongly correlated with NDI scores.

5.3.3 Neck Bournemouth Questionnaire

The NBQ was used to assess participants' pain, disability, and the affective and cognitive aspects of their neck pain (Bolton and Humphreys, 2002). The NBQ score decreased by ten points between the first and third consultations, making it a clinically and statistically change (*p*=0.002). There was a greater change in NBQ scores between the second and third consultation than the first and second consultations.

There was a clinically and statistically significant decrease in NBQ scores over time for Group B (*p*=0.006).

The baseline score and change in score over time were similar for the two groups (*p*=0.909). Although the mobilisation group rated their improvement in terms of activities of daily living to be higher than that of the CCFE exercise group, the groups fared similarly in terms of combined social, psychological and cognitive aspects of their lives.

5.3.4 Patient Global Impression of Change Scale

The PGIC scale is a seven point subjective scale used to measure the overall effect of a treatment modality. The questionnaire was completed at the last consultation. For this reason the rate of change could not be measured. The results of the two groups were compared.

None of the participants in Group A scored their PGIC as 'one, two or three,' which represent, in ascending order: 'No change (or condition has gotten worse)', Almost the same, hardly any change at all,' and 'A little better, but no noticeable change.' Four participants scored their change as 'four' (Somewhat better, but the change has not made any real difference).

The most common rating by the participants of the cervical mobilisation group was 'five' (Moderately better, and a slight but noticeable change): Five participants scored their impression of change as ‘five’. Four participants scored ‘six’ (Better, and a definite improvement that has made a real and worthwhile difference). Two participants scored ‘seven’ (A great deal better, and a considerable improvement that has made all the difference).

One participant in Group B scored their perceived ‘change’ as ‘one’ (No change; or condition has gotten worse). One participant scored ‘three’ (A little better, but no noticeable change). One scored ‘four’; five scored ‘five’; six participants scored ‘six’ and one scored ‘seven’. The most common rating by the participants of the CCFE group was ‘six’ (Better, and a definite improvement that has made a real and worthwhile difference). This may be due to the mechanical hypoalgesic effect of the CCFE (O’Leary *et al.,* 2007).

There was no significant difference between the PGIC scores of Groups A and B (*p*=0.200). The mean score of Group A was slightly higher than that of Group B, as demonstrated in Figure 4.35. Two participants in the CCFE group felt that the intervention had had no effect or had made their condition worse, while none of the participants of the cervical mobilisation group rated their change of pain as less than ‘four,’ meaning ‘Somewhat better.’’. The pain-relieving effect of mobilisation may be responsible for this discrepancy (Sterling, Jull and Wright, 2001).

In a systematic review (Miller *et al.*, 2010), mobilisation combined with exercise was found to have a greater effect on complainants’ global perceived effect in the long-term than either no treatment or traditional care (a combination of collar, advice and/or medication). They found no difference between the effects of combined exercise and mobilisation therapy versus exercise alone.

5.3.5 Cervical Range of Motion

Active CROM was measured at all three consultations. The baseline CROM values and changes over time were within normal limits for the age group of the participants (Youdas *et al.,* 1992).

There was a statistically significant decrease in flexion (p=0.035), extension (p=0.004) and left lateral flexion (p=0.002) CROM over time in the cervical mobilisation group. Right lateral flexion, left and right rotation showed a statistically insignificant decrease over time.

There was no clinically or statistically significant change in CROM in Group B. All directions of CROM decreased over time, except for right rotation which showed an overall increase of 3.3° (p=0.177). Right rotation CROM increased by 8.1° at the second consultation, and decreased slightly at the third consultation.

CROM of both groups decreased, with the mobilisation group having a slightly larger decreased CROM in extension and left lateral flexion than the CCFE group. There was no significant difference in change in CROM between Group A and Group B (Figures 4.36 - 4.41). In a literature review, Howell (2011) did not find a relation between CROM and neck function, measured by the NDI. Schmid *et al.* (2008) found mobilisation to improve pain free range of motion. Pain during range of motion was not tested in this study, however, according to the participants' self-rated change on subjective scales, it could be concluded that participants moved around with more ease during their daily activities toward the end of the study. Whether this included movements at the end of CROM is not known.

Ylinen *et al*. (2004) found long term neck muscle rehabilitation to increase muscle strength and endurance, which would protect the cervical spine from sudden injuries due to poor control, and would not necessarily lead to an increased CROM (Howell, 2011). This effect would however only be seen at long term follow up.

5.3.6 Algometer

The algometer readings were taken at all three consultations, before mobilisation was administered. None of the algometer score changes were large enough to be regarded as clinically important (Potter, McCarthy and Oldham, 2006). LES was the only point measured that showed a statistically significant increase in pressure pain threshold (PPT) over time in Group A (*p*=0.011). This may be due to the pain-relieving effect of mobilisation (Gross *et al.*, 2010), although there is insufficient data to draw a conclusion.

The LES of Group B was the only point that showed a decrease in PPT (worse PPT) at the third consultation compared to the first consultation (*p*=0.015). All the muscle points of Group B showed slight improvement (Increased PPT) between the second and third consultation. However, none of the changes were statistically or clinically significant (Potter, McCarthy and Oldham, 2006).

There was no significant difference between the changes in PPT of the two groups. Participants of both groups tended to have decreased PPT at the second consultation, and improved (increased) PPT at the third consultation. The trend of decreased PPT at the second consultation, which occurred two days after the first, may be attributable to post-mobilisation and exercise tenderness, an occasional normal effect of both treatments (Gross *et al*., 2010). The algometer readings were taken in a specific order, with LES being measured first each time. This may have had an impact on the results, as this is the only point that showed statistically significant change over time in both groups. Long-term muscle training may have had a greater effect on PPT than short-term neck muscle training (Ylinen *et al.,* 2005).

There are various possible reasons for the small changes in PPT, including:
-Short follow up period – A longer follow up could show clearer changes (Ylinen *et al.,* 2004).
-Small sample size – A larger, homogenous sample may increase the likelihood of detecting clinical changes (Schmid *et al.* 2008).

-Activities of Daily living – although participants were asked not to change their usual activities for the duration of the study, work posture and recreational sport were not controlled for (Jull *et al.,* 2008).

5.4 CONCLUSION

The participants of the two groups had similar characteristics and baseline measures. The two groups fared similarly in the subjective outcome measures, except for the NDI of group B, which showed statistically but not clinically significant change. The two groups also fared similarly in the objective outcome measures, showing no significant change over time.

The null-hypothesis stated that the results of the two treatment groups would show no difference in terms of subjective and objective measures in the treatment of chronic non-specific neck pain. This hypothesis was accepted, as no significant difference was found between the outcomes of the two groups. This is in line with the conclusions of Hurwitz *et al*. (2009) and Miller *et al*. (2010), who found that, of the recommended treatments (manual therapy, supervised exercise, low-level laser therapy and acupuncture), none are superior in the treatment of neck pain.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSION

This study aimed to investigate the difference between the effect of cervical spinal mobilisation and the craniocervical flexion exercise for chronic non-specific neck pain (CNSNP) at short-term follow-up. The study took place over seven days. Two groups of 15 female participants per group allocated to either a control or intervention group took part in the study.

In terms of subjective outcomes, there was no significant difference between the two groups. Both had statistically and clinically significant improvements in the scores of the Numeric Pain Rating Scale, Neck Disability Index and Neck Bournemouth Questionnaire.

The results of the subjective outcomes are in line with the conclusions of a systematic review that found that exercise and manual therapies, e.g. mobilisations are equally effective for the treatment of CNSNP (Hurwitz *et al*., 2009).

There was a small decrease in cervical range of motion over time for all ranges of motion in both groups; however the changes were within the normal range of motion for the age group of the participants.

None of the algometer readings showed a clinically significant change over time in either of the intervention groups.

Further investigation is needed to collect more data about this treatment, using a better study design and more participants, which may yield more conclusive results. The following recommendations are made:

6.2 SAMPLE SIZE

The small sample size may have resulted in large confidence intervals or led to errors in hypothesis testing. Testing a larger sample would increase the statistical power of the study, providing that the sample is controlled for age, level of activity and possibly ethnicity.

6.3 RANDOMIZATION

Ethnicity may have influenced participants' pain sensitivity and response to treatment (Green *et al*., 2004; Rahim-Williams *et al*., 2007). It would have increased the validity of the study if the ethnicities in the two groups were more equally divided.

6.4 METHODOLOGY

Algometer measurements were done in a set order. The LES was the first point to be measured and was the only point that showed a statistically significant change in PPT over time in both groups. It may be of benefit to randomise the order of the algometer measurements to prevent participants from getting accustomed to a set order.

Active CROM measurements were also taken in a set order. Some studies have suggested that passive CROM measurements are more reliable than active CROM (Ylinen *et al.*, 2004). Since no link as been established between neck pain, disability and range of motion (Howell, 2011), it is not known what difference this would make to the results of similar studies.

Warm up exercises were not performed, however this was done across the board and would not have affected the results of particular participants. Activities of Daily Living of the participants were not monitored. In future studies, participants should be supplied with a Daily Activities log to control for excessive or minimal exertion.

A single-blinded study design was chosen for practical reasons. In this study the measurement administrator was blinded to which group the participants were allocated. Double blinding could have been used to decrease the risk for bias, by blinding the researcher to the group to which the participants were allocated.

6.5 ADDITIONAL TESTS

It may have been useful to include muscle endurance testing in future studies to establish a change in craniocervical flexor muscle strength and endurance. This is best done by surface electromyography (Nordin *et al*., 2009).

6.6 THIRD GROUP

A third group could have been included in the study to act as a control group. This group would have used to establish the effect of no treatment (to record the natural history of the condition).

6.7 FOLLOW-UP CONSULTATION

There was no long-term follow-up in this study. A future study could be done to establish the relative effect of cervical mobilisation and craniocervical flexion exercise on subjective outcomes in the long-term.

6.8 FURTHER RESEARCH

During this study the following areas were found to be lacking in information and therefore in need of further research:

- The relationship between the effects of cervical mobilisation and manipulation/ craniocervical flexion exercise and manipulation.
- The relationship between the long-term effects of cervical mobilisation and the craniocervical flexion exercise.
- The optimal dose of treatment modalities such as cervical mobilisation and the craniocervical flexion exercise for the treatment of CNSNP.
- The relationship between the effects of different types of exercise for the treatment of CNSNP.

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JOURNAL ARTICLE

Purpose

Chronic non-specific neck pain affects cervical muscle functioning and activities of daily living. Both cervical mobilisation and the craniocervical flexion exercise provide pain relief. Combined exercise and manipulative therapy, such as mobilisation, are currently recommended as the most effective treatment for CNSNP. The short-term effects of mobilisation and the craniocervical flexion exercise have not been compared.

Objectives

This study aimed to compare mobilisation and the craniocervical flexion exercise in terms of subjective and objective outcome measures at a short term follow-up consultation for the treatment of chronic non-specific neck pain. A null-hypothesis was set that the mobilisation group would not respond differently to the craniocervical flexion exercise group in terms of subjective and objective outcomes, for the treatment of CNSNP.

Method

A group of thirty females between the ages of 20 and 35 complaining of non-specific neck pain for more than three months were randomly allocated into either the mobilisation or craniocervical flexion exercise groups. During the first two consultations a grade three mobilisation was administered to the mobilisation group and the craniocervical flexion exercise and a posture correcting exercise were taught to the participants of the craniocervical flexion exercise group. The Numerical Pain Rating Scale, Neck Disability Index, Neck Bournemouth Questionnaire, cervical range of motion and algometer readings were taken at each of the three consultations. The Patient Global Impression of Change Scale was administered at the last consultation, one week after the first consultation.

Results

Both the mobilisation and craniocervical flexion exercise groups showed significant improvements in all of the subjective outcomes. The Neck Disability Index score of the craniocervical flexion exercise group was the only subjective outcome that did

not show clinically significant changes (*p*=0.011). The PGIC score of the mobilisation group was slightly higher than that of the craniocervical flexion exercise group. There was no statistically significant improvement in the objective outcomes of either group. All ranges of motion decreased in both groups, while pain pressure threshold improved in both groups. There was no significant difference between the results of the mobilisation and craniocervical flexion exercise groups.

Conclusion

The two interventions were found to have a similar effect in the treatment of chronic non-specific neck pain in terms of subjective and objective outcome measures. Participants of both groups indicated on subjective scales that their conditions improved. Objective outcomes showed no significant change and cervical range of motion decreased over time in both groups.

Key words: Neck pain, mobilisation, craniocervical flexion exercise, short-term

APPENDIX A

Advertisement

All females of 20-35 years suffering with

NECK PAIN

for longer than 3 months

A study is being done and you may get treatment
at the Chiropractic Department
Durban University of Technology

For more information contact
ELSJE MEYER
031 373 2205/
031 373 2512

APPENDIX B

Letter of Information and Consent Form

Dear Participant

Thank you for taking the time to consider my research project.

I am doing a study on the difference in benefits of exercise and neck mobilisation in treating neck pain

You will be randomly allocated into one of two treatment groups. One group will be given neck mobilisations – a gentle movement of the neck to relieve pain. The other group will be taught how to do an exercise to strengthen the small muscles of the neck and a posture correcting exercise to relieve pain.

You will attend 3 consultations at the Chiropractic clinic. Today is Day 1, then again on Day 3 and Day 8. At the first and second visits you will receive treatment and fill in a maximum of 4 questionnaires. At the third visit you will fill in similar questionnaires again. The first consultation will take 1,5 hours and the second and third will take 45 minutes each.

Risks or discomforts to you as a participant:
There is a chance of temporary mild muscle ache or stiffness after the mobilisation or exercise. This is a normal response to treatment and is not harmful. You are requested not to take any pain medication for the duration of the study. If you do not want to carry on with the study, you are free to drop out and you may then receive regular treatment from the Chiropractic clinic.

Benefits to you as a participant:
Exercise and mobilisation both relieve pain and increase neck movement.

Remuneration and costs:
Treatment for the duration of the study will be free of charge. You will not be offered any other form of remuneration for taking part in the study.

Confidentiality:
All patient information is confidential. Your name and personal details will not be disclosed to anyone and all your questionnaires will have a code on it, not your name, to ensure your confidentiality.

The results of the study will be made available in the DUT library in a dissertation.

Persons to contact in the event of any queries:
Researcher: Elsje Meyer 031 292 7223
Supervisor: Dr Vilash Boodhoo 031 207 7968
IREC administrator: 031 373 2900

Statement of Agreement to Participate in the Study:

I, ________________________ (Full name and surname), ID number __________________ have read this document and understand it. Where I had any questions, the researcher, Elsje Meyer, clearly explained it to me.

I fully understand that I may withdraw from this study at any stage and it will not affect my future treatment at the DUT Chiropractic clinic at all. I voluntarily agree to participate in this study.

Participant's name: _________________________

Signature: __________________ Date: ____________________

Researcher name: _________________________

Signature: __________________ Date: ____________________

Witness name: _________________________

Signature: __________________ Date: ____________________

Supervisor name: _________________________

Signature: __________________ Date: ____________________

APPENDIX C

DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:________________ Date:____________

File #:_________ Age:_______ Sex :______

Occupation:___________________ Intern_________________

Signature:_____________________

FOR CLINICIANS USE ONLY:

Initial visit

Clinician:_____________ Signature :____________________

Case History:

Examination:

Previous: Current:

X-Ray Studies:

Previous: Current:

Clinical Path. lab:

Previous: Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL:

Reason for Conditional:

....

....

....

Signature: Date:

Conditions met in Visit No:	Signed into PTT:	Date:
Case Summary signed off:		Date:

Intern's Case History:

1. Source of History:

2. Chief Complaint : (patient's own words):

3. Present Illness:

	Complaint 1	**Complaint 2**

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

4. Other Complaints:

5. Past Medical History:

- General Health Status
- Childhood Illnesses
- Adult Illnesses
- Psychiatric Illnesses
- Accidents/Injuries
- Surgery
- Hospitalisations

6. Current health status and life-style:

- Allergies
- Immunizations
- Screening Tests incl. x-rays
- Environmental Hazards (Home, School, Work)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication

Analgesics/week:

- Tobacco
- Alcohol
- Social Drugs

7. Immediate Family Medical History:

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

8. Psychosocial history:

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

9. Review of Systems:

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

APPENDIX D – Physical Examination

DURBAN UNIVERSITY OF TECHNOLOGY
PHYSICAL EXAMINATION: SENIOR

Patient Name: ______________________ File no: ___________ Date: ________________

Student: ________________________ Signature: _____________________

VITALS:

Pulse rate:			Respiratory rate:	
Blood pressure	R	L	Medication if hypertensive:	
Temperature			Height	

Weight:	Any recent change? Y/N		If Yes: How much gain/loss	Over what period

GENERAL EXAMINATION:

General Impression		
Skin		
Jaundice		
Pallor		
Clubbing		
Cyanosis (Central/Peripheral)		
Oedema		
Lymph Nodes	Head and neck	
	Axillary	
	Epitrochlear	
	Inguinal	
Pulses		
Urinalysis		

SYSTEMTIC SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION

NEUROLOGICAL EXAMINATION

COMMENTS

Clinician: **Signature:**

APPENDIX E – Cervical Regional Examination

DURBAN UNIVERSITY OF TECHNOLOGY
REGIONAL EXAMINATION - CERVICAL SPINE

Patient: .... File No: ....

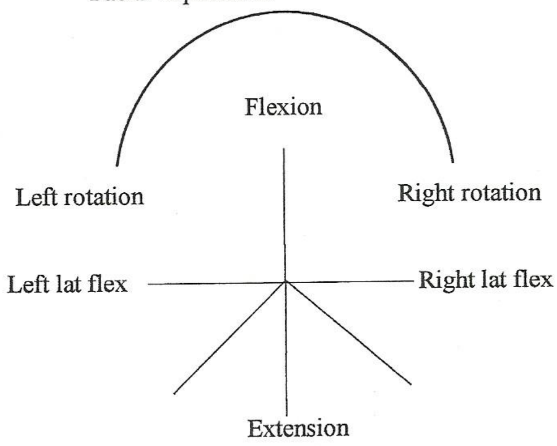
Date: .... Student: ....

Clinician: .... Sign: ....

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

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

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



PALPATION:
Lymph nodes
Thyroid Gland
Trachea

ORTHOPAEDIC EXAMINATION:

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

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

NEUROLOGICAL EXAMINATION:

Dermatomes	Left	Right	Myotomes	Left	Right	Reflexes	Left	Right
C2			C1			C5		
C3			C2			C6		
C4			C3			C7		
C5			C4					
C6			C5					
C7			C6					
C8			C7					
T1			C8					
			T1					

Cerebellar tests:	Left	Right
Disdiadochokinesis		

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

MOTION PALPATION & JOINT PLAY:

Left: Motion Palpation:
Joint Play:

Right: Motion Palpation:
Joint Play:

BASIC EXAM: SHOULDER:

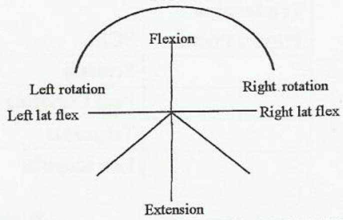
Case History:

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

BASIC EXAM: THORACIC SPINE:

Case History:

ROM:



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

APPENDIX F – SOAPE Note

DURBAN UNIVERSITY OF TECHNOLOGY

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

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

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

0: ***P:***

E:

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

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

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

O: ***P:***

E:

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

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

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

O: ***P:***

E:

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

APPENDIX G

Range of motion and pain threshold

Participant code ________________

CROM GONIOMETER			
Date			
Consultation	1	2	3
Flexion			
Extension			
L lateral flexion			
R lateral flexion			
Left rotation			
Right rotation			

Algometer reading			
Consultation	**1**	**2**	**3**
Erector Spinae (C1)			
Left			
Right			
Levator Scapula TP1			
Left			
Right			
Trapezius TP2			
Left			
Right			

APPENDIX H

Numeric Pain Rating Scale

Participant Code _______________

VISIT 1 **Date** ______________

Pain Severity: Rate your usual level of pain today by ticking the box with the number out of 10 that best describes your pain

0	1	2	3	4	5	6	7	8	9	10

0 – no pain 10 – excruciating
pain

VISIT 2 **Date** ______________

Pain Severity: Rate your usual level of pain today by ticking the box with the number out of 10 that best describes your pain

0	1	2	3	4	5	6	7	8	9	10

0 – no pain 10 – excruciating
pain

VISIT 3 **Date** ______________

Pain Severity: Rate your usual level of pain today by ticking the box with the number out of 10 that best describes your pain

0	1	2	3	4	5	6	7	8	9	10

0 – no pain 10 – excruciating
pain

APPENDIX I

Neck Disability Index

Participant code ________________ **Date ______________**

This questionnaire has been designed to give us information about 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

APPENDIX J

Neck Bournemouth Questionnaire

Participant code____________________ Date______________

Instructions: The following scales have been designed to find out about your neck pain and how it is affecting you. Please answer ALL the scales, and mark the ONE number on EACH scale that best how you feel.

1. Over the past week, on average, how would you rate your neck pain?

No pain — Worst pain possible

1 2 3 4 5 6 7 8 9 10

2. Over the past week, how much has your neck pain interfered with your daily activities (house work, washing, dressing, lifting, reading, and driving)?

No interference — Unable to carry out activity

1 2 3 4 5 6 7 8 9 10

3. Over the past week, how much has your neck pain interfered with your ability to take part in recreational, social and family activities?

No interference — Unable to carry out activity

1 2 3 4 5 6 7 8 9 10

4. Over the past week, how anxious (tense, uptight, irritable, difficulty in concentrating/relaxing) have you been feeling?

Not at all anxious — Extremely anxious

1 2 3 4 5 6 7 8 9 10

5. Over the past week, how depressed (down-in-the-dumps, sad, in low spirits, pessimistic, unhappy) have you been feeling?

Not at all depressed — Extremely depressed

1 2 3 4 5 6 7 8 9 10

6. Over the past week, how have you felt your work (both inside and outside the home) has affected (or would affect) your neck pain?

Have made it no worse — Have made it much worse

1 2 3 4 5 6 7 8 9 10

7. Over the past week, how much have you been able to control (reduce/help) your neck pain on your own?

Completely control it — No control whatsoever

1 2 3 4 5 6 7 8 9 10

Examiner ______________________Other comments____________________________

APPENDIX K

Patient Global Impression of Change Scale

Participant code ________________ Date ______________

Since beginning treatment at this clinic, how would you describe the change (if any) in ACTIVITY LIMITATIONS, SYMPTOMS, EMOTIONS and OVERALL QUALITY OF LIFE, related to your painful condition? (Tick ONE box)

No change (or condition has gotten worse) ☐ **1**

Almost the same, hardly any change at all ☐ **2**

A little better, but no noticeable change ☐ **3**

Somewhat better, but the change has not

made any real difference ☐ **4**

Moderately better, and a slight but noticeable change ☐ **5**

Better, and a definite improvement that has made a real and worthwhile difference ☐ **6**

A great deal better, and a considerable improvement that has made all the difference ☐ **7**

Reprinted from Hurst, H., Bolton, J. 2004. Assessing the clinical significance of change scores recorded on subjective outcome measures. *Journal of Manipulative and Physiological Therapeutics.* 27(ICF):26-35

APPENDIX L

Craniocervical Flexion Exercise Instructions

Neck exercise:

1. Lie on your back on a soft surface without a pillow
2. Put the thumb and index finger of your one hand on the front of your neck as the researcher demonstrated
3. Gently nod your head by bringing your chin down to your chest a little bit, while you keep the lower part of your neck still
4. Do not use the muscles in the front of your neck – if these muscles feel tense under your fingers, go back to the starting position and do the exercise more gently
5. Take deep calm breaths as you do this exercise
6. Hold the contraction for 10 seconds and repeat 10 times
7. Do these exercises twice a day

The neutral spinal posture:

1. Sit on a chair with your legs uncrossed
2. Lift your lower back off the back rest so you do not slouch forward or backward
3. Lift the your chest slightly as the researcher demonstrated to you and look at a spot straight ahead
4. Stay in this position for 15 counts while taking deep breaths
5. Do this exercise 2 times a day along with the cervical flexion exercise

APPENDIX M

Exercise diary

EXERCISE DIARY **PATIENT CODE ________________**

Fill in the date and tick the morning or evening block when you do your neck exercise

DATE	MORNING	EVENING
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Place this diary in a visible place to remind you to do the exercise twice every day

If necessary put a reminder on your fridge or set an alarm on your phone to remind you.

APPENDIX N

Contract of agreement re: research measurement taking

I, Kerisha Naidoo, agree to take all subjective and objective measurements of the participants in the study of Elsje Meyer.
I will be available to take the measurements of all the participants at all their consultations, the dates and times of which will be made known to me timeously.

I, Elsje Meyer, agree to let Kerisha Naidoo take the subjective and objective measurements of the participants of my study at all their consultations.
I will notify K Naidoo of these appointments well in advance.
I will ensure that K Naidoo understands how to take the necessary readings accurately.
I will not reveal the treatment group of the participant to Ms Naidoo and will stress to the participants of the study not to tell K Naidoo what treatment they are receiving at any time during the study.

Measurements: Kerisha Naidoo	Date
_____________________	_______________
Researcher: Elsje Meyer	Date
_____________________	_______________
Supervisor: Dr V Boodhoo	Date
_____________________	_______________
Co-Supervisor: Dr CM Korporaal	Date
_____________________	_______________

APPENDIX O

PROOF OF CONSULTATION WITH BIOSTATISTICIAN

52 Klooflands Rd
Kloof
3610

Chiropractic Department
DUT
13 June 2011

Re: Elsje Meyer's Research

I have been consulted by the above mentioned student on the 24th May 2011 regarding her proposed research design and statistical analysis. I have reviewed these and added my inputs into the proposal. I am satisfied that the planned methodology will be satisfactory in answering the research questions.

Yours sincerely

[redacted]

Tonya Esterhuizen
Biostatistician

APPENDIX P

Ethics Clearance Certificate

DURBAN UNIVERSITY *of* TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)

27 February 2012

IREC Reference Number: **REC 3/11**

Mrs E M Meyer
P O Box 1212
Bethlehem
9700

Dear Mrs Meyer

A Comparison of mobilisation and exercise in the treatment of chronic non-specific neck pain

I am pleased to inform you that Full Approval has been granted to your proposal REC 3/11.

The Proposal has been allocated the following Ethical Clearance number IREC 005/12. Please use this number in all communication with this office.

Approval has been granted for a period of one year, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's. In addition, you will be responsible to ensure gatekeeper permission.

Please note that ANY amendments in the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

[redacted]

Prof T Puckree
Chairperson: IREC