An investigation into the efficacy of a first rib manipulation in individuals experiencing mechanical neck pain – A pilot study.

By

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I, Bruce Sholto Douglas do hereby declare that this dissertation is representative of my own work.

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A dedication to my family...

My parents, Hugh and Tess, your undying love and continued support in everything I do has moulded me into the person I am today. Thank-you for this wonderful and exciting opportunity. I am eternally grateful to you both. My brother, Marc, for being my best friend and an inspiration. And my grandparents, Hugh Sr. and Denise, for your special love and belief in me.

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Abstract

Mechanical neck pain is defined as a restriction of movement of the neck, which frequently refers pain to the occiput, shoulders, nuchal muscles, interscapular region and anterior chest wall, and is usually due to a history of trauma or awkward posture of the cervical spine.

It is thought that mechanical neck pain is as a result of the cervical spine having sacrificed stability for mobility, thereby allowing it to become the most mobile segment of the spine and making it the most vulnerable to injury and /or dysfunction.

One such dysfunction that can give rise to neck pain of mechanical origin, is that of the first rib. However, a first rib dysfunction, although common, seems to be underdiagnosed or misdiagnosed due to a lack of assessment or focus of assessment, and therefore by implication remain untreated as a cause of mechanical neck pain.

Thus, the purpose of this investigation was to evaluate the efficacy of a first rib manipulation versus placebo in terms of subjective and objective clinical findings in patients with mechanical neck pain.

Sixty participants meeting the research criteria were utilized for the study. Thirty randomly selected participants received a first rib manipulation (Group A) and thirty randomly selected participants received a placebo treatment of detuned ultrasound (Group B). The participants had three visits in total. These ran over four-day period. Evaluation of results over the three visits gave the immediate and short-term effectiveness of the treatment intervention. Subjective measurements were taken using the Neck Disability Index Questionnaire (CMCC) and the Numerical Pain Rating Scale (NRS). Objective measurements were taken using a Pressure Algometer, and the Cervical Range of Motion (CROM) instrument. Further objective measurements were obtained through specific criteria and tests to diagnose both mechanical neck pain and a first rib dysfunction. These subjective and objective measurements were assessed and the differences recorded before and immediately after treatments 1 and 2, and at the 3^{rd} and final visit, where there was no treatment intervention. Concomitant findings, such as cervical and thoracic spine fixations were also recorded. Statistical analysis included various statistical methods and correlation analyses, by means of the SPSS package.

The results comparing the two groups showed that for flexion, extension, right lateral flexion and left lateral flexion, the treatment had a positive and significant increase in the above ranges of motion of the cervical spine. The results for right rotation and left rotation and overall patient improvement in terms of pain appeared to be insignificant.

A first rib manipulation appears to have an immediate and short-term effectiveness on flexion, extension, right lateral flexion and left lateral flexion ranges of motion of the cervical spine, in individuals suffering from mechanical neck pain. In terms of the pain itself, the first rib manipulation had no significant immediate or short-term relief, indicating that a first rib manipulation is not an effective treatment on its own for individuals suffering from mechanical neck pain.

However, this was a pilot study that only looked at the immediate and short-term effects of a first rib manipulation on its own in individuals suffering from mechanical neck pain, and no long term or combined effects of manipulation were measured.

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Definitions of terms

CHIROPRACTIC

A science of applied neurophysiologic diagnosis based on the theory that health and disease are life processes related to the function of the nervous system: irritation of the nervous system by mechanical, chemical or psychic factors is the cause of disease; restoration and maintenance of health depend on the normal function of the nervous system (Saunders, 1995:12).

MECHANICAL NECK PAIN

A restriction of movement of the neck, which frequently refers pain to the occiput, shoulders, nuchal muscles, interscapular region and anterior chest wall, and is usually due to a history of trauma or awkward posture of the cervical spine. (Edwards *et al*. 1995:871).

PREVALENCE

A measure of the number of people in a given population who have the syndrome or disease at that particular time (Portfield and DeRosa, 1995:2).

INCIDENCE

The rate at which individuals develop a syndrome or disease over a specific time (Portfield and DeRosa, 1995:2).

CONTRAINDICATION

Any condition, especially any disease condition that renders one particular line of treatment improper or undesirable (Gatterman, 1990:407).

FIXATION

The absence of motion of the joint in a position of motion, usually at the extremity of such motion (Gatterman, 1990:408).

DYSFUNCTION

One anatomical level the components of the joint are not functioning normally (Kirkaldy-Willis, 1992:105).

MANIPULATION

Manual procedure that involves a direct thrust to move a joint past the physiological range of motion, without exceeding the anatomical limit (Gattermann (1995:474).

PLACEBO EFFECT

A response that is unrelated to the physiological effects of the therapy applied (Jamison, 1994).

END PLAY (END FEEL)

Discrete, short-range movements of a joint independent of the action of voluntary muscles, determined by the springing each vertebrae at the limit of its passive range of motion (Haldeman 1992:623).

RANGE OF MOTION

The range of translation and rotation of a joint for each of its six ranges of freedom (Haldeman 1992:623).

Chapter 1

1.0 Introduction

This chapter will briefly introduce the problem and its sub problems, and the benefits of the study.

1.1 The Problem and its Setting

Mechanical neck pain is defined as a restriction of movement of the neck, which frequently refers pain to the occiput, shoulders, nuchal muscles, interscapular region and anterior chest wall, and is usually due to a history of trauma or awkward posture of the cervical spine. (Edwards *et al*. (1995:871).

It is thought that mechanical neck pain is as a result of the cervical spine having sacrificed stability for mobility, thereby allowing it to become the most mobile segment of the spine and making it the most vulnerable to injury and /or dysfunction (Magee, 1997:2).

According to Cote *et al*. (2000) the lifetime prevalence of neck pain in adults (ages 20-69 years) is approximately 66%, with Shelokov (1991) having previously estimated that up to half of all neck pain patients would develop chronic signs and symptoms directly related to mechanical dysfunction. Cassidy *et al.* (1992) agree that neck pain is common and state that most cases are attributed to mechanical dysfunction.

One such dysfunction that can give rise to neck pain of mechanical origin, is that of the first rib (Haley 1997). This is supported by Innes (Chiroweb.com) who indicates that the first rib has movement, therefore when dysfunctional, becomes significant in initiating a fixation complex which causes mechanical derangement locally (first rib) and some distance away (cervical spine), as a result of amongst other changes, changes in the scalene muscles (Innes, Chiroweb.com).

However, a first rib dysfunction, although common (Amitrano 1994), seems to be underdiagnosed or misdiagnosed due to a lack of assessment or focus of assessment (Haley 1997), and therefore by implication remain untreated as a cause of mechanical neck pain.

This is supported in a case report by Haley (1997), in which his first rib was assessed for joint dysfunction after his previous diagnosis and treatment to his 32 year old patients neck pain only brought temporary relief. Haley (1997) noticed immediate pain relief after the first rib was adjusted.

Therefore, the purpose of this study is to assess the efficacy of the first rib manipulation in patient's with mechanical neck pain in terms of clinical indicators for improvement.

1.2 Statement of the problem

An investigation into the efficacy of a first rib manipulation in individuals experiencing mechanical neck pain – A pilot study.

1.2.1 The first subproblem

- To evaluate the efficacy of a first rib manipulation versus placebo in terms of objective clinical findings in patients with mechanical neck pain.

1.2.2 The second subproblem

- To evaluate the efficacy of a first rib manipulation versus placebo in terms of subjective clinical findings in patients with mechanical neck pain.

1.3 Benefits of the study

This research study aims to investigate the efficacy of a first rib manipulation in individuals experiencing mechanical neck pain. This will hopefully increase awareness to the incidence and prevalence of a first rib dysfunction and its possible relation to mechanical neck pain, which, is one of the most common conditions to present to the Chiropractic Physician (Amitrano, 1994).

This is a pilot study, and it is hoped that it will pave the way to future research to this particular area of concern, making the new researcher aware of possible structures that may be directly or indirectly related the cervical spine and how they may influence its function, and cause mechanical neck pain.

Thus, by improving chiropractors understanding, it would certainly in turn benefit the patients, by improvement of treatment and management of mechanical neck pain.

Chapter 2

2.0 Review of related literature

2.1 Introduction

This chapter includes a detailed review of all the related literature to mechanical neck pain and first rib dysfunction.

2.2 Incidence and prevalence of mechanical neck pain and a first rib dysfunction

According to Cassidy *et al.* (1992) neck pain is common and state that most cases are attributed to mechanical dysfunction. This was supported by a questionnaire-based study on 1131 Saskatchewan adults, which indicated that 66% of adults had experienced neck pain in their lifetime with 54% experiencing neck pain over the previous 6 months, of which 5% were significantly disabled by their neck pain (Cote *et al.*, 2000).

Of these, it was estimated that approximately 30% of patients with neck pain would develop chronic symptoms (Shelokov, 1991). According to Cassidy *et al.* (1992) most patients improve with time, but many as one-third of them can continue to have moderate or severe pain 15 years later.

Many people who have a significant episode of neck pain from a musculoskeletal or mechanical source will seek treatment, which, annually account for more than eight million visits to allopathic physicians and millions of visits to chiropractors (Dabbs and Lauretti, 1995).

Drew (1995) conducted an epidemiological study at the Durban Institute of Technology Chiropractic Day Clinic comparing the different types of conditions seen at the teaching clinic with those seen in private chiropractic practices in South Africa. It was found that 54.4% of the patients presenting to the teaching clinic and 57.4% of the patients presenting to the private practices complained of neck pain. In a comparative study of 6 Chiropractic College teaching clinics, neck pain accounted for 19-27% of patient complaints (Nyiendo *et al.*, 1989:83).

Of all rib head fixations, those of the first rib are the most common (Amitrano, 1994:45). But, according to Johnson (1995:134), literature on rib dysfunction is limited though. This is supported by Haley (1997:134), noting that the prevalence of rib dysfunction has not been significantly documented.

2.3.0 Anatomy

2.3.1 Cervical Spine

The cervical spine consists of seven vertebra (C1-C7) consisting of two distinct regions, namely, the upper (occiput, atlas and axis) and the lower (C3-C7) cervical spine (Haldeman, 1992:137).

The cervical vertebrae (C3-C7) have the typical vertebra structure (namely two parts, a body and a vertebral arch), except for C1 and C2 (Moore, 1992:331). The cervical apophyseal joints of the mid to lower cervical spine are inclined medially to the coronal plane and oblique to the saggital plane making them approximately 45 degrees to the vertical (Schafer and Faye, 1990:80). The recurrent meningeal or sinuvertebral nerve, including nociceptive fibres, richly innervate the cervical joint capsules (Haldeman, 1992:138). This means that any injury to these joint capsules would result in pain.

The intervertebral discs (IVD) make up one fourth of the length of the cervical spine. They are stellar in shape and thicker anteriorly than posteriorly, thereby contributing to cervical lordosis (Moore, 1992).

There are eight cervical nerve roots. The C1 nerve root exists between the occiput and C1, therefore in the cervical spine each nerve root is named after the vertebra below. These spinal nerve roots run through intervertebral foramen (IVF) which are approximately one centimeter in length. There is no true IVF between the atlas and axis (Moore, 1992:331).

The cervical spine has a distinguishing feature - the uncovertebral joints or joints of Lushka. These are present from C3-C7 and give a saddle shape to the upper aspect of the cervical vertebra, which are more pronounced posterolaterally. These joints have articular cartilage, a synovical membrane, a joint space, a capsule and subchondral bone. They form a barrier to posterolateral disc protrusions, thereby protecting the spinal cord (Portefield and De Rosa, 1995:86).

2.3.2 The Thorax

In order to understand the anatomy of the first rib articulation, let us view the thorax briefly.

According to Amitrano (1994:44), the thorax is formed by the sternum, 12 pairs of ribs, costal cartilage and the centrum of the thoracic vertebra, forming a bony cage, which acts as an anchoring point for the pectoral girdle and upper extremities as well as providing protection for vital organs, such as the heart and the lungs.

The sternum is an elongated flat bone that is situated in the median line of the anterior chest wall (Moore, 1992:41). The manubrium, which is the superior portion of the sternum, articulates with the first and second ribs, while the body of the sternum (inferior to the manubrium) articulates directly with the second through seventh ribs and indirectly with the eighth, ninth and tenth ribs (Amitrano, 1994:44).

The vast majority of the thoracic cage is formed by the ribs, which comprise the entire lateral border and portions of the anterior and posterior border. The length of the ribs increase from the first through the seventh, then decreases through to the twelfth (Amitrano, 1994:44).

According to Moore (1992:35) the first seven pairs of ribs are called true or vertebrosternal ribs because they are connected to the sternum by their costal cartilage, while, the eighth to twelfth pairs of ribs are false or vertebrochondral ribs. Each of the eighth to tenth ribs is connected by its costal cartilage to the cartilage of the rib superior to it. The eleventh and twelfth ribs are often known as floating ribs because they do not have an anterior attachment. They end in the muscles of the anterior abdominal wall. Although these ribs are free, they do articulate with the body of their own vertebra (Moore, 1992:35).

A typical rib consists of a wedge shaped head at the posterior end, which has one or two facets, which articulate with the facets on the bodies of adjacent thoracic vertebra. The neck of the rib is a constricted portion just lateral to the head. On the posterior surface, where the neck joins the body is the tubercle. It consists of a non-articular part, which affords attachment to the ligament of the tubercle, and an articular part, which articulates with the facet of a transverse process of the inferior of the two vertebra to which the head of the rib is connected (Moore, 1992). The body (shaft) is the main part of the rib. Beyond the tubercle is a change in the curvature of the shaft. This point is called the costal angle. The inner surface of the rib is called the costal groove that protects blood vessels and a small nerve (Amitrano, 1994: 44-45). The 1st, 2nd and the 10th to 12th pairs of ribs are atypical (Moore, 1992:35).

The articulations of the ribs with the vertebra column are divided into two groups, one connecting the heads of the ribs with the bodies of the vertebra, called costovertebral joint, and the costotransverse joint, uniting the necks and tubercles with the transverse process (Moore, 1992:39).

2.3.3 First rib

According to Moore (1992:35-38) this is the broadest and the most curved of all the ribs. It also the shortest of the true ribs. The first rib is clinically important because so many structures attach to it. It has a prominent and flat scalene tubercle on the internal border of its superior surface for the attachment of the scalenus anterior and medius muscle. The subclavian vein crosses the first rib anterior to the scalene tubercle and subclavian artery. The inferior trunk of the brachial plexus, (a network of nerves on their way to the upper limb), passes posterior to it. The subclavian vessels and the brachial plexus on the superior surface of the first rib, form a distinct groove.

Other attachments include the clavicle by way of the costoclavicular, and medial scalene muscle on the superior surface, and the longissimus cervicis, iliocostalis thoracics, and iliocostalis cervicis posterolaterally (Haley, 1997:133).

The first rib has two articulations: posterior with the first thoracic vertebra and anteriorly with the sternum. The prominent tubercle of the first rib articulates with the transverse process of the 1st thoracic vertebra (Moore, 1992:38).

The posterior costovertebral joint is a heavily innervated synovial joint and has only one articulation with the vertebral body, compared with the 2nd through 10th ribs, which articulate with two vertebral bodies and an intervertebral disc. The first costovertebral joint capsule articulation is thin and weak, but its strength is enhanced by the interosseous and radiate ligaments that originate at the head of the first rib and insert onto the first thoracic vertebral body. Anteriorly, the first rib articulates with the costal cartilage, which in turn secures itself to the sternum via the radiate ligaments (Haley, 1997:133).

2.3.4 Neuroanatomy

The cervicothoracic or stellate ganglion is the fusion of the seventh and eighth cervical ganglia and first and second thoracic ganglia (Johnson, 1995:135). Its postganglionic fibres supply the neck as well as other important structures (Fitzgerald, 1996). The stellate ganglion lies between the base of the transverse process of C7 vertebra and the neck of the first rib posteriorly, lateral to the longus colli muscle and anteriorly to the subclavian artery and its associated veins (Amitrano, 1994:48).

According to Amitrano (1994:48) all cervical ganglia receive their white rami commicans from the upper thoracic nerves, which enter corresponding thoracic ganglia of the sympathetic trunk and transverse superiorly into the neck. Additionally, the white fibre commincans synapsing in the superior and middle cervical ganglia must pass through the stellate ganglion. Therefore, any factor affecting the stellate ganglion will probably affect the superior and middle cervical ganglia (Amitrano, 1994:48).

Thus, a first rib dysfunction, due to its close relationship with the stellate ganglion, may result in Amitrano (1994):

- Decrease function of nerve fibres
- Increase function nerve fibres

- Abnormal sensory impulses from the adjacent musculature and joints via muscle spindles, golgi tendon apparatus and joint kinetic receptors, causing irradiation or spill-over of neural impulses.

Johnson (1995:135) indicates that on occasion, the second intercostal nerve communicates with the medial supraclavicular nerve of the cervical plexus. These various communicating branches of the first through sixth thoracic nerves helps explain the relationship of the thoracocostal fixation to reported pain the neck, arm and axilla.

2.3.5 Important muscles attachments associated with the cervical spine and the first rib

Table A - Compiled from Travell and Simons' (1999) and Moore (1992):

Muscle	Proximal attachment	Distal attachment	Innervation	Function
scalenus anterior	anterior tubercles on transverse processes of C3 to C6 vertebra	scalene tubercle on inner border of 1st rib and on upper surface anterior to the groove for subclavian artery	motor branches of the anterior primary divisions of the spinal nerves C2 through C7	stabilize the cervical spine againest lateral movement and stabilize the first and second ribs during inhalation
scalenus medius	posterior tubercles on transverse processes of C2 to C7 vertebra	cranial surface of 1st rib, posterior and part of it deep to the groove for subclavian artery	motor branches of the anterior primary divisions of the spinal nerves C2 through C7	stabilize the cervical spine againest lateral movement and stabilize the first and second ribs

				during inhalation
scalenus posterior	posterior tubercles on transverse processes of the lowest two or three cervical vertebra	lateral surface of the 2^{nd} and sometimes the 3^{rd} rib	motor branches of the anterior primary divisions of the spinal nerves C2 through C7	stabilize the cervical spine againest lateral movement and stabilize the first and second ribs during inhalation
scalenus minimus	posterior tubercles on transverse processes of C7 and sometimes C6 vertebra	fascia supporting the pleural dome and beyond to the inner border of the 1^{st} rib	motor branches of the anterior primary divisions of the spinal nerves C2 through C7	stabilize the cervical spine againest lateral movement and stabilize the first and second ribs during inhalation
longissimus capitis	the skull along the posterior margin of the mastoid process	articular processes of the last 3 or 4 cervical vertebra to the transverse processes of the upper 4 or 5 thoracic vertebra	branches of the posterior primary divisions of the cervical spinal nerves	functions as an extensor that is also reported to laterally flex the head to the same side and rotate it toward the same side
longissimus cervicis	cervical transverse processes	superior thoracic transverse processes	branches of the dorsal rami of the cervical spinal nerves	functions as an extensor that is also reported to laterally flex the head to the same side and rotate it toward the same side

iliocostalis thoracis	attach to all the superior ribs	attach to all the inferior ribs	branches of the dorsal rami of the cervical spinal nerves	functions as an extensor that is also reported to laterally flex the head to the same side and rotate it toward the same side
iliocostalis cervicis	posterior tubercles of C4 to C6	superior 6 ribs	branches of the dorsal rami of the cervical spinal nerves	functions as an extensor that is also reported to laterally flex the head to the same side and rotate it toward the same side

The intrinsic or deep muscles of the back (erector spinae) are concerned with maintenance of posture and movements of the vertebral column and head. The muscles are named according to their relationship to the surface (superficial, intermediate and deep layers) (Moore, 1992:351). The above muscles, longissimus capitis, longissimus cervicis, iliocostalis thoracis and the iliocostalis cervicis are part of the intermediate layer of the erector spinae muscle group (Moore, 1992:521).

An apparent elevation of the first rib concurrent with T1 articular dysfunction may result from rotation of the vertebra by the longissimus capitis muscle that is shortened from trigger point tension (reflex spasm). This muscle, through its attachment to the transverse process, may indirectly affect the first rib through its pull on the costotransverse junction (Travell and Simons', 1999).

According to Lewit (1991), immobility or blockage of the first rib goes hand in hand with reflex spasm of the scalene muscle on the same side, which is abolished by the treatment of the first rib. This is supported by Travell and Simons' (1999:518), who mention that an articular dysfunction commonly observed with scalene muscle involvement is elevation of the first rib.

2.4.0 Mechanical Neck Pain

2.4.1 Aetiology

According to Bergmann *et al.* (1993:55) any condition or event (eg. incorrect posture, acute injury, aging, congenital or developmental defects) leading to altered joint or muscle structure and function, can result in mechanical neck pain.

Mennell (1990) is of the opinion that mechanical joint pain arises from the synovial joints of the spine, which become hypomobile due to trauma, immobilization and as a symptom of a previous pathological condition, where normal movements of the cervical spine decreased and pain results.

Haldeman (1992:206) theorized that pain may be produced due to the synovial folds being pinched within a joint cavity. This could happen through two mechanisms, firstly by traction on pain sensitive tissues such as the synovical fold or joint capsule. Secondly, by synovitis caused by trauma of being entrapped with associated tissue damaged and cell rupture, which in turn release histamine, bradykinin substance P and potassium ions. These substances all cause nociceptive nerve impulses and ischemia, which the patient perceives as pain.

Porterfield and DeRosa (1995:4) deduce that it is unreasonable to assume that one isolated tissue is responsible as the mechanism of injury and the process of degeneration affects multiple tissues rather than one structure or tissue in isolation. They site that the most common causes of neck pain to be from spasmodic torticollis, muscle or connective tissue strain, from postural overload of repetitive motion, injury from uncontrolled acceleration of the head and neck and cervical spondylosis (Porterfield and DeRosa, 1995:14).

2.4.2 Definition of joint dysfunction

The term dysfunction implies that at one anatomical level the components of the joint are not functioning normally (Kirkaldy-Willis, 1992:105).

Dysfunction has also been called other terms, such as subluxation or fixation, to describe this state of altered functioning. Gattermann (1995:475) describes a subluxation as a motion segment, in which alignment, movement integrity, and/or physiologic function are altered although contact between joint surfaces remain intact. Fixation according to Haldeman (1992:623) is a state whereby an articulation has become temporarily immobilized in a position that it may normally occupy during any phase of physiological movement.

From this definition, it would seem that the joint fixation, or loss of motion, is one part of the subluxation or dysfunctional joint.

2.4.3 Diagnosis of mechanical neck pain and a first rib dysfunction

The above two recommendations where summarized by Bergmann *et al.* (1993:63) there are five diagnostic criteria (P.A.R.T.S.) for joint dysfunction in mechanical neck pain:

- Pain/tenderness- produced by palpation of osseous and soft tissue.
- Asymmetry- noted through observation of posture and gait as well as palpation for misalignment of vertebral segments.
- Range of Motion abnormality- Change in active, passive and accessory joint motions is noted through procedures of motion palpation.

- Tissue tone, texture and/or temperature abnormality- Changes in the characteristics of contiguous and associated soft tissues are noted through the procedures of observation, palpation and instrumentation.

- Special tests- eg. Kemps

In addition to this Plaugher (1993:87) suggested a positive motion palpation finding indicating any symptomatic joint may be defined as meeting the following 3 criteria:

1) Abnormal end-feel.
2) Abnormal quality of resistance to motion.
3) Reproduction of pain (either local or referred) when passive accessory movements (end feel) are tested.

Edwards _et al_. (1995:871) added that mechanical neck pain frequently refers pain to the occiput, shoulders or nuchal muscles and is associated with restricted neck movements and a history of awkward posture or trauma. They also noted that the lower cervical spine tends to refer pain to the interscapular and anterior chest wall area.

2.4.4 Differential Diagnosis

Gattermann (1990:232) summaries the differential diagnosis to include the following:

- Muscle syndromes eg. Fibromyalgia

- Biomechanical disorders eg. joint fixation and facet joint sprain, cervical disc herniation, degenerative disc disease, cervical spondylosis, thoracic outlet syndrome and fractures.
- Imflammatory disease eg. infection, ankylosing spondylitis, rheumatoid arthritis and spondyloarthropathies.
- Congenital abnormalities eg. cervical rib and congenital stenosis.
- Systemic disease eg. anemia, leukemia, paget's disease and osteoporosis.
- Tumours (primary and secondary)

This was expanded by Edwards et al. (1995:871) to include various other structures including:

- Vascular: angina pectoris, aortic aneursym
- Respiratory: pancoast tumour
- Lymphatic: cervical lymph nodes
- Digestive: teeth, pharynx
- Other: diaphragm, acromio-clavicular joint

With the differentiation that inflammatory, neoplastic and metabolic diseases according to Edwards et al. (1995:871) are more insidious in onset and have prolonged duration and are usually not so obviously influenced by posture and movement.

2.5.0 Manipulation

2.5.1 Introduction

The chiropractic profession has been around for a century, but records of manipulation date back as far as 4000 years ago (Bergmann, 1993:1).
Chiropractors view health as a complex process whereby the different parts of the body adapt and change to the internal and external environment (Bergmann, 1993:3).

2.5.2 Definition of a manipulation

"Spinal manipulative therapy broadly defined includes all procedures where hands are used to mobilize, adjust, manipulate, apply traction, massage, stimulate, or otherwise influence the spine and the paraspinal tissues with the aim of influencing the patients health" (Haldeman, 1992:624).

Gattermann (1995:474) defines a manipulation as a " manual procedure that involves a direct thrust to move a joint past the physiological range of motion, without exceeding the anatomical limit."

2.5.3 Effects of Manipulation

Curl (1994:297) explains the therapeutic effects of the manipulation through two mechanisms:

- Mechanical, which includes mechanoreceptor stimulation, muscle spindle stretching and breaking down of articular adhesions resulting in an increase in active and passive joint motion.

- Stimulation of the autonomic nervous system, resulting in reflex inhibition of pain and muscle spasm.

Bergmann (1993:139) describes several hypotheses to explain the effectiveness of chiropractic manipulation:

- Mechanical

The cavitation is a rapid separation of two joint surfaces which results in the stretching of the periarticular tissues, releasing intra-articular and extra-articular adhesions, and stimulates joint nociceptors and mechanoreceptors (which stimulate the golgi tendon organs or results in somatic afferent receptor activity). This results in a break down of the pain cycle, leading to a decrease in pain, muscle spasm, joint hypomobility and soft tissue in-flexibility and muscle fatigue.

Manipulation stimulates the repair of the articular soft tissue and cartilage and prevents excessive fibrosis formation, atrophy and degeneration, thereby maintaining tissue extensibility.

- Analgesic

Manipulation stimulates both superficial and deep somatic mechanoreceptors, proprioceptors and nociceptors. This sends strong afferent segmental impulses to the spinal cord resulting in central pain transmission inhibition.

It has been theorized that manipulation can cause the release of enkephalins and endorphins, which decrease pain sensation. The placebo effect of having a consulation with a concerned and skilled practitioner is said to add to the analgesic effect too.

- Neurobiologic

By restoring normal joint mechanics and altering neurological reflexes associated with joint dysfunction, local and distant somatic tissues are restored to normal functioning.

- Circulatory

Disruption of normal musculoskeletal functioning will decrease the efficacy of the circulatory system, as the flow of blood and lymphatic fluid is aided by the musculoskeletal system.

It is hypothesised that the fixation complex can alter segmental sympathetic tone. This could result in vasoconstriction to the tissues at that segment. Manipulation would then remove the sympathetic irritation and therefore improve circulation (Bergmann, 1993:156).

2.5.4 Efficacy of a rib manipulation

According to Johnson (1995:134) early detection and treatment of a rib dysfunction often brings significant and lasting relief to the patient.

In a case report by Haley (1997), a 32 year old male footballer complained of right neck, shoulder and upper back pain of three and a half months duration after colliding with another player. The patient was diagnosed and treated for a cervicothoracic joint dysfunction with associated a myofascial pain syndrome. The treatment only brought temporary relief and patient returned 3 days later with the same complaint. The first rib was then assessed and was found to be fixated. The first rib was then adjusted. Immediate relief from the neck, shoulder and upper back pain was achieved. The patient was assessed 4 to7 days after the adjustment with no reoccurrences.

2.5.5 Contra-Indications to Manipulation

Gattermann (1990:67) lists the following contra-indications to manipulation:

- Vascular eg. vertebral-basilar insufficiency, atherosclerosis aneurysm

- Tumour eg. lung, thyroid, prostate and breast (all known to metastasis to the spine) and bone primary.

- Trauma eg. fracture, joint instability or hypermobility, severe sprains and unstable spondylolithesis.

- Arthritis eg. Rheumatoid arthritis (transverse ligament rupture and increased inflammation), ankylosing spondylitis (increased inflammation), psoriatic arthritis (transverse ligament rupture), severe osteoarthritis (increased instability and neurological compromise) and uncoarthrosis (vertebral artery compromise).

- Psychological eg. malingering, hysteria, hypochondriasis and pain tolerance.

- Metabolic eg. clotting disorders (spinal hematoma), osteopenia (osteoporosis or osteomalacia)

- Neurological eg. disc lesions and space occupying lesions.

2.6.0 The Placebo Effect

2.6.1 Introduction

This study involves a placebo-controlled group of detuned ultrasound over the first rib. This section briefly discusses the possibility of the placebo effect.

2.6.2 Definition of placebo effect

- A response to a patients condition that is attributable to the symbolic import of the healing intervention, rather than to the interventions specific pharmacologic or physiologic effects (Brody, 1982).

- A favourable response by patients to any intervention performed by a health professional regardless of whether the intervention has a direct effect on the condition (Jamison, 1994).

- A response, whether it be positive or negative, to a procedure which has no known therapeutic influence on the given condition (Jamison, 1994).

- Any change in a patient's condition following the administration of a placebo (Ross and Buckalew, 1985).

- A response that is unrelated to the physiological effects of the therapy applied (Jamison, 1994).

2.6.3 Explanations for the placebo effect

According to Turner *et al.* (1994), there are three general reasons for clinical improvement in a patients pain condition:

1) Natural history and regression to the mean. Most acute and some chronic pain conditions resolve on their own irrespective of treatment.
2) Specific effects attributable to the characteristic content of the intervention.
3) Nonspecific effects of treatment, attributable to factors other than specific active components. These include physician attention, interest and concern in a healing setting; patient and physician expectations of treatment effects; reputation, expense and impressiveness of the treatment; and characteristics of the setting that influence patients to report improvement.

The placebo effect is often used synonymously with the nonspecific effects (Turner *et al.*, 1994:1609).

Levin and Solomon (1990) suggest that medicine is an interpretative science and that the body is simultaneously an evolutionary biological entity and an ongoing achievement of socialization in which dynamic intercommunication can give rise to a healthy or diseased state. They maintain that it is not possible to draw a boundary between the body of nature and the body of culture. The psychosomatic body of behavioral medicine, in which mind-body (psychological-physical) dualism restricted contemplation of psychophysiological interaction to particular conditions, is being transformed by psychoneuroendoimmunology, in which the mind and the body are seen as a single system of intercommunicating organized processes.

In other words, instead of assuming that all interventions are of a physical or chemical in nature, this model indirectly implies that all the individual's experiences affect his/her health status (Levin and Solomon, 1990:484).

Placebo intervention, long thought to induce physiological change by means of its psychological properties, has now acquired a framework for an acceptable explanation. The psychoneuroendoimmunology model provides a setting in which it is conceivable that a shift in beliefs is therapeutic (Sullivan, 1993). It also provides a psychobiological basis upon which the disparate properties of placebo can be explained (Brody, 1980).

According to White et al. (1985) psychoneuroendoimmunology may thus provide a framework that can explain why:

- a person who responds to a placebo is not faking their symptoms;
- placebos can influence virtually every symptom;
- placebos can produce side-effects;
- anyone is likely to respond, given appropriate conditions

Psychoneuroendoimmunology provides a model in which placebo responses are explainable up to a certain point and link psychological and physical processes through common anatomical pathways (White et al., 1985). The complex patterns of the psychophysiological response of the placebo phenomenon, which involves motor and cognitive-verbal responses, is being clarified by deeper understanding of physiochemical relationships (Peck and Coleman, 1991).

This is supported by Levine et al. (1987), who suggests that placebo responses may be mediated by endogenous opiate release in the central nervous system.

Clinical research, therefore, must be focused on value to the patients and should be viewed from both the physical and the psychological aspects (Keating, 1987).

2.6.4 Conclusion

In most research situations, nonspecific effects of treatment are underestimated (Turner *et al.*, 1994). The potency of the placebo phenomenon in clinical care has long been recognized. It is, however, relatively recently that the legitimacy of activity promoting placebo benefits is being contemplated. Understanding of the multifactorial interactive nature of health and disease have made such progress possible (Jamison, 1996).

Therefore, it is highly possible that there will be a placebo effect in this particular study, and as a result of that, I will take it into consideration in the final write up of the results and conclusions.

Chapter 3

3.0 Materials and Methods

3.1 Introduction

This chapter includes a detailed description of the research methodology and a plan for the statistical analysis thereafter.

3.2 Subjects

3.2.1 Sampling

This study utilized the convenience sampling technique because a specific diagnosis of mechanical neck with an associated first rib dysfunction was required. Advertisements were placed at the local technikons, universities, shopping centres, sports clubs and via pamphlet distribution in the greater Durban area.

Prospective participants then phoned in and were interviewed telephonically. The interview was conducted to determine whether they met the inclusion criteria, in terms of their age, nature and location of their complaint and whether it was possible for them to make their consecutive visits.

3.2.2 Inclusion Criteria

The following inclusion criteria were adhered to, in order to increase homogeneity in the study, and ensure all participants accepted into the study suffered from mechanical neck pain with an associated first rib dysfunction.

- The participants had to be between the ages of 18 and 50 years of age, to avoid the need for parental consent, and to exclude those patients with significant degenerative changes, which occur mostly after the age of 50 (Edwards, 1995). The age group attempted to ensure a similar response to treatment by creating uniformity within the sample group.

- Only participants diagnosed with mechanical neck pain and an associated first rib dysfunction were included. This was done according to Bergmann's five diagnostic criteria for joint dysfunction in mechanical neck pain. Plaugher (1993:87) also defined a positive motion palpation finding indicating a symptomatic joint meeting 3 criteria.

- <u>Pain/tenderness-</u> produced by palpation of osseous and soft tissue.

- <u>Asymmetry-</u> noted through observation of posture and gait as well as palpation for misalignment of vertebral segments.

- <u>Range of Motion abnormality-</u> Change in active, passive and accessory joint motions is noted through procedures of motion palpation.

- Tissue tone, texture and/or temperature abnormality- Changes in the characteristics of contiguous and associated soft tissues are noted through the procedures of observation, palpation and instrumentation.

- Special tests- eg. Kemps (Bergmann *et al.*, 1993:63).

The 3 criteria for a symptomatic joint:

- Abnormal end-feel.

- Abnormal quality of resistance to motion.

- Reproduction of pain (either local or referred) when passive accessory movements (end feel) are tested (Plaugher, 1993:87).

- Any condition associated with the mechanical neck pain and the first rib dysfunction (eg. Myofasciitis and or Thoracic facet syndrome) was assessed and noted in the cervical spine regional examination but no treatment was administered for these conditions. Furthermore, no treatment was given to the cervical fixations found in the above examination, only noted.

3.2.3 Exclusion Criteria

- Participants younger than 18 or older than 50 years of age.
- Participants with any contra-indications to manipulation (Foreman and Croft 1995:469, Bergmann *et al.* 1993:133) were not included in the study as one group included a first rib manipulation.

  These contra-indications included: vertebrobasilar insufficiency, aneurysm, disc prolapse with neurological deficit, fracture, dislocation, bone tumours and bone infections.

  Relative contra-indications included: atherosclerosis, anti-coagulant therapy, advanced osteoarthritis, inflammatory arthritis, joint instability, osteomyelitis, osteomalacia and space occupying lesions.
- Any participant currently taking either anti-inflammatory or analgesic medication were required to cease this intake 48 hours prior to consultation (Bergmann, 1993). According to Schafer and Faye (1990) these particular drugs are able to provide pain relief and may thus confound the results obtained from the study.
- Any participant not naïve to ultrasound therapy. This indicated that any participant included in the study should not have received the modality within 3 months preceding the study (Assendelft *et al.*, 1992).
- Hard neurological signs.
- Any participant who had a major whiplash injury of more than 10 years previously was excluded from the study, due to possible degenerative changes post injury (Foreman and Croft, 1995).
- Participants requiring radiographic evaluation were excluded.

- Any participant who did not sign the consent form was excluded.

- Participants were not to receive any other form of treatment for the entire duration of the study, and if there were any major lifestyle changes (e.g.: rigorous exercise) while they were involved with the study, that participant was excluded from the study.

3.2.4 Subject Acceptance (Telephonic)

Those participants considered suitable for the study after the interview by the researcher were informed, and the initial consultation was scheduled for the participant. At the initial consultation, the purpose of the study was explained to the participant and a case history (Appendix B), a senior research physical examination (Appendix C) and a regional examination of the cervical spine (Appendix D) were performed. During this process, any participant who did not comply with the inclusion or exclusion criteria was excluded immediately. Those accepted, were asked to read the patient information letter (Appendix F) and sign the informed consent form (Appendix E).

3.3.0 Procedure

Sixty participants meeting the research criteria were utilized for the study. The convenience sampling technique was used. The process of randomization included pre-selection by a third party, who assigned consecutive participants presenting to the clinic into either Group A or Group B by means of drawing out of a hat. Thirty randomly selected participants received a first rib manipulation (Group A) and thirty randomly selected participants received a placebo treatment of detuned ultrasound (Group B).

The participants had three visits in total. These ran over four-day period. According to Cowie (2003), evaluation of results from the comparisons made before and after consultation one, gives the immediate effectiveness of the treatment intervention while the results obtained between the first and second consultations (first measurement interval) gives an indication of the short term effectiveness of the treatment programme. The third visit was reserved for data collection only and there was no treatment intervention.

At the initial consultation, the participant completed the NRS Pain Rating Scale (Appendix G) and the CCMC Neck Disability Index (Appendix H).

Motion palpation technique was carried out during the cervical regional examination, as referenced by Plaugher (1993:87) in order to determine the side of the fixated first rib. The same technique by Plaugher, as well as the 5 diagnostic criteria for joint dysfunction in mechanical neck pain (Bergmann 1993:63) was used to determine the level, the side and the direction of loss of motion of the fixated joint in the cervical and thoracic spine (Both were only noted, not treated).

Once identified, these areas were recorded on the regional exam. The pressure algometer readings were then taken over the area of the fixated first rib to record the participants present pain. Following these readings, the participants cervical range of motion (CROM) measurements were taken, to record the participants present CROM.

These subjective and objective measurements were assessed and the differences recorded before and immediately after treatments 1 and 2, and at the 3rd and final visit where there was no treatment intervention. The objective measurements were taken by the clinician on duty on the day to avoid any bias by the researcher to the eventual outcome to the study. The Clinicians were kept to a minimum to allow for a measure of uniformity of these objective measurements.

3.3.1 Manipulation of the first rib (Group A)

The manipulation group was motion palpated to identify the side of the fixated first rib (Bergmann *et al.*, 1993) and (Plaugher, 1993). If both sides were fixated the more tender side was treated.

According to Schafer (1990) the first rib is located:

- 4-5cm lateral to the first thoracic vertebra
- Anterior to the trapezius muscle
- Postero-superior to the clavicle
- A fingertip or a knife-edge contact can be used to produce a superior to inferior force that will elevate the first rib.
- Lateral flexion and rotation of the head of the patient towards the same side will further accentuate the movement of the first rib.

The participants were generally seated for the manipulation. The adjustment force was simply a reproduction of the motion palpation of the first rib (Schafer, 1990) combined with a high velocity, low amplitude thrust through the contact hand in a superior to inferior, lateral to medial and oblique direction (Halderman, 1992:485).

Success of an adjustment was based on post manipulative manual rib endplay assessment (Haldemann, 1992). According to Suter *et al.* (1994), an audible cavitation is not indicative of a successful adjustment.

There was a possibility that the lower cervical spine may adjust while the first rib was being manipulated on the same side. If this was the case, these participants were not excluded from the study, but put into a separate group for statistical purposes.

3.3.2 Placebo (Detuned Ultra-sound over the area of the first rib)(Group B)

The placebo group under went the same procedure as Group A in terms of the motion palpation technique in locating the first rib (Shafer, 1990) and diagnosis of joint dysfunction according to Bergmann (1993) and Plaugher (1993) separate criteria's.

The participant was then placed facing away from the ultrasound machine. The ultrasound was detuned (the settings were zero). The time allocated was five minutes per visit. The head of the detuned ultrasound was placed where the first rib was located according to (Schafer, 1990).

3.4.0 Materials

3.4.1 Objective Measurements

3.4.1.1 Pressure Algometer

A pressure algometer was used to determine and quantify localized tenderness by measurement of the pressure threshold of each participant.

Pressure threshold is referred to as the minimum pressure that induces pain or discomfort Fischer (1987). The algometer is a sensitive force gauge designed to measure forces (in kilograms per square centimeter) applied to specific locations (Livingston *et al.,* 1998) and (Fischer, 1987).

Fischer (1987) confirmed the validity of the algometer as a means to measure manipulation as an intervention, stating that the algometer can be used to quantify the participants response to manipulation. He concluded that the reproducibility of pressure threshold measurements indicates that the records of pain intensity are reliable. The higher the reading on the algometer, the less tender the underlying structure and thus the greater the participants pain tolerance.

Participants were informed of what to expect from the instrument prior to the measurements being taken. The algometer was placed over the most tender area of the fixated rib, near the tendonous insertion of the anterior scalene muscle. The instrument was held perpendicular to the skin and a slow steady pressure was applied in a superior to inferior and oblique direction. The participant was instructed to let the clinician know as soon as the first onset of pain or discomfort was felt. The algometer was then removed immediately and the readings recorded in kilograms onto Appendix J. This was done on visits 1 and 2, before and after the treatment, and at the beginning of 3rd visit.

3.4.1.2 Cervical Range of Motion (CROM) Goniometer

The CROM goniometer was used to assess changes in active cervical range of motion before and after each treatment.

The CROM goniometer used in this study was the Performance Attained Associates Mode (3600 Labore Rd, Suite 6, St. Paul, MN 55110-41144). This device has been shown to produce good intra and inter examiner reliability in measuring cervical spine range of motion (Youdas *et al.*, 1991).

To measure cervical spine range of motion, the participant was made to sit in straight back chair with their lower back pressed against the back of the chair. The CROM was then fastened in position and magnets placed around the participants neck (north/north and south/south position). Measurements in degrees were taken for each range of motion. Care was taken to ensure that the partcipants shoulders and body remained still during the procedure to ensure that each motion was purely in the direction been measured. The results of each of the six ranges of motion were recorded onto Appendix I (treatments 1 and 2, before and after each, and at the beginning of the 3rd visit) and then transferred to spreadsheets for analysis.

3.4.2 Subjective Measurements

3.4.2.1 CMCC Neck Disability Index (NDI)

The CMCC Neck Disability Index (Appendix H) was used to measure subjective pain intensity in this study.

This questionaire was used to assess the degree the participants neck pain effected their daily lives. It consisted of ten sections each consisting of six options. The first option received a zero score and the sixth option received a maximum score of five. The participant answered these questions, receiving a total score out of fifty and this value was calculated as a percentage.

This questionaire has been shown to have a high degree of validity and internal consistency (Vernon and Moir, 1991). It is applicable to a wide age range, is unaffected by gender, and has an acceptable level of validity. The results were then recorded onto spreadsheets.

3.4.2.2 NRS Pain Rating Scale (NRS-101)

The NRS-101 (Appendix G) was used to measure the subjective pain intensity when it was at its worse and when it was at its least.

Jensen *et al.* (1986) demonstrated the validity and practicality of the NRS-101. There were two sections, in both; the participant rated his/her pain on a scale of zero (no pain) to 100 (severe pain/worst pain). In the first section he/she chose a number when the pain was at its worse and in the second when the pain was at its least.

The two answers were then added together and divided by two to give a percentage. The results were then recorded onto spreadsheets.

3.5.0 Statistical Analysis

3.5.1 Introduction

A sample size of sixty participants were utilized in this study, with n1 = 30 and n2 = 30. A statistician, Mr. Charles Robert, was consulted with regards to the manner in which the data was to be analyzed. Due to the size of the samples, namely 30 in each group, parametric Statistical Tests were used. The SPSS statistical package was used for analysis of the data obtained from the CMCC Neck Disability Index, the pressure algometer and the CROM readings.

3.5.2 Inter-group Comparison

With this group, the difference was calculated between successive readings for all participants (eg: Reading 1 – Reading 2 and Reading 2 – Reading 3). The 2 new difference readings were then compared with their counterparts across both groups. To check whether or not these comparisons were significantly different, the Independent T-Tests was applied. The rate of drop in the immediate and short-term effects could be compared. The above tests were conducted for both the subjective and objective measurement scales.

3.5.2 Intra-group Comparison

With this group, it was first tested to see if a significant difference existed between all three-population means using an Analysis of Variance (ANOVA) approach. If this difference was significant, a few Paired T-Tests were to be done for each paired combination of population means. The above tests were conducted for both the subjective and objective measurement scales.

All the tests were set at type 1 error at 5%, or mentioned differently, $\alpha = 0.05$. If the p value as reported was less than 0.05 there would be a significant result and the Null Hypothesis would be rejected.

Chapter 4

Results

4.0 Introduction

This chapter includes a detailed description of the statistical analysis of both the subjective and objective data obtained from the patients who participated in this study.

Abbreviations used in the Data Analysis and Discussion:

CROM	-cervical range of motion
ALGMETR	-algometer
NRS	-numerical pain rating scale
CMCC	-neck disability index
FX	-flexion
EX	-extension
EXTENSN	-extension
RR	-right rotation
RGHTROT	-right rotation
LR	-left rotation
LFTROT	-left rotation
RLF	-right lateral flexion
RGHTLF	-right lateral flexion
LLF	-left lateral flexion
LFTLF	-left lateral flexion
C	-cervical
T	-thoracic
TR	-treatment

4.1 Data Layout

Sixty (60) patients that were diagnosed with mechanical neck pain and first rib dysfunction were randomly subdivided into two groups of 30 patients each. The one group (the treated group) was given a real treatment (first rib manipulation), while the other group (the control group) was given a placebo treatment. The real and placebo treatments were given on 2 successive days (the third successive day was reserved for just data collection) and the following information recorded for each group on each of five occasions (time1 – before day 1 treatment, time 2 – after day 1 treatment, time 3 – before day 2 treatment, time 4 – after day 2 treatment, time 5 – day 3):

1 CROM (cervical range of motion) readings which consisted of flexion, extension, right rotation, left rotation, right lateral flexion and left lateral flexion.
2 Algometer readings (objective pain measurements).

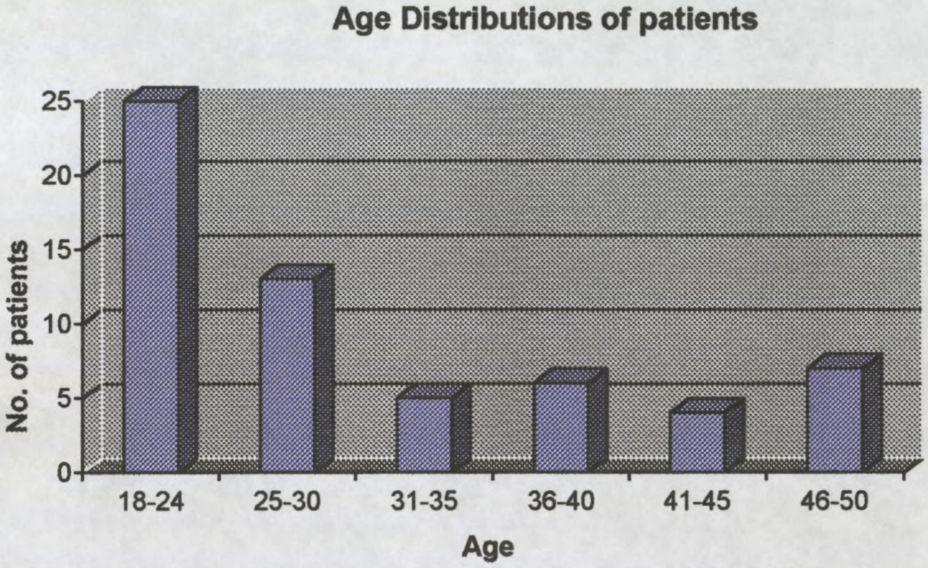
3 Results from an NRS (pain rating scale) questionnaire.

4 Results from a CMCC (neck disability index) questionnaire.

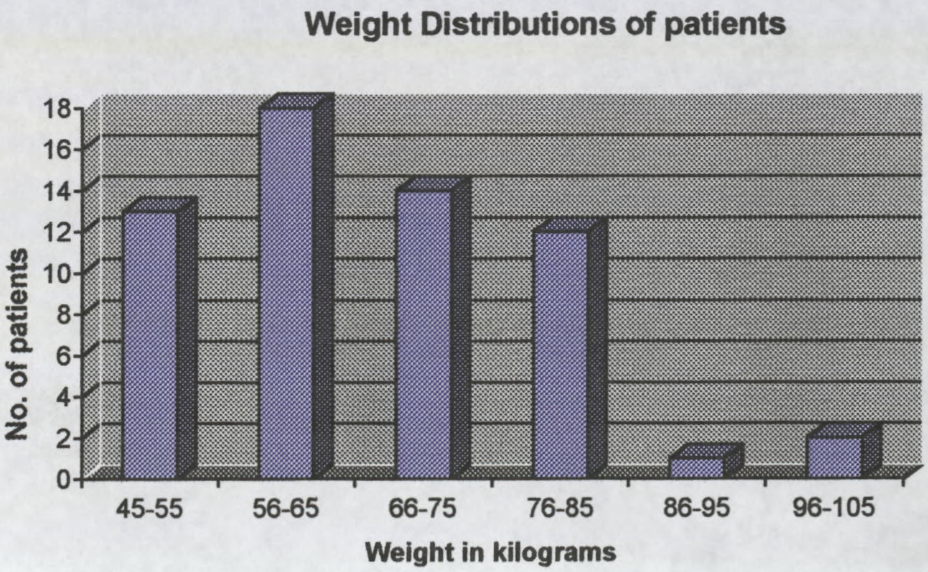
The purpose of the analysis is to compare the effectiveness of a first rib manipulation in individuals suffering from mechanical neck pain over the three consecutive days they visited.

4.1.2 Demographic Data

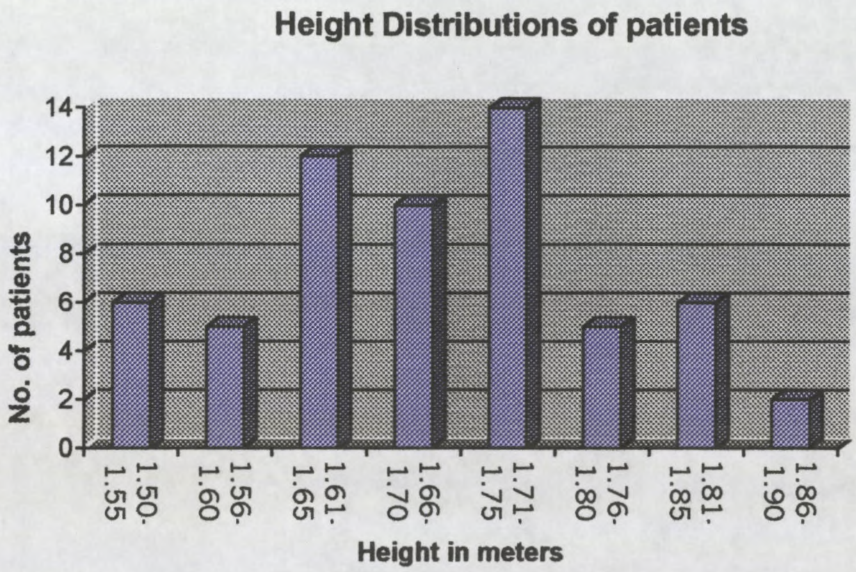
4.1.2.1 Figure A: Age Distribution (Average age of a participant: 28.5)



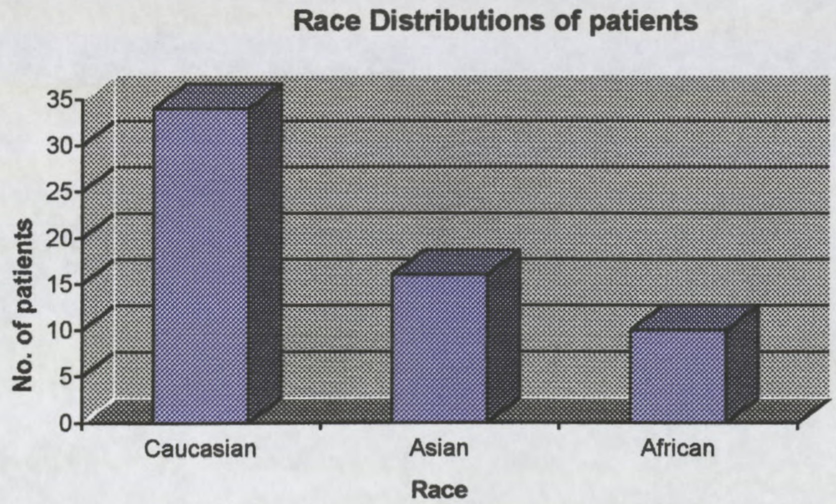
4.1.2.1 Figure B: Weight Distribution (Average weight of a participant: 66.4kg's)



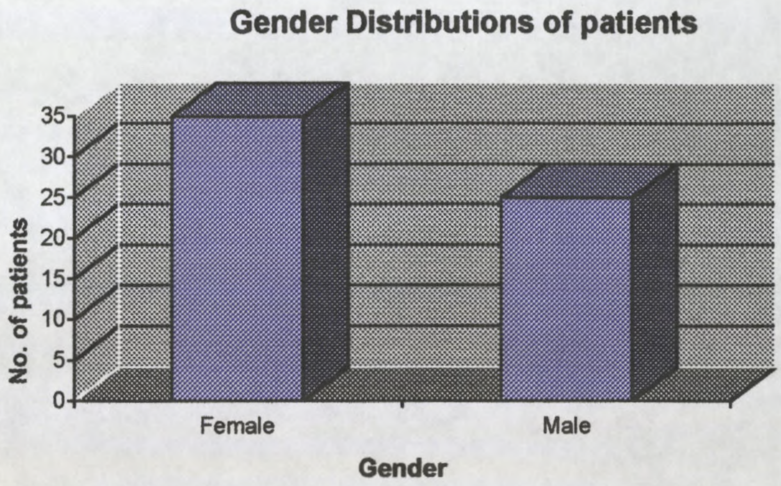
4.1.2.2 Figure C: Height Distribution (Average height of a participant: 1.66m)



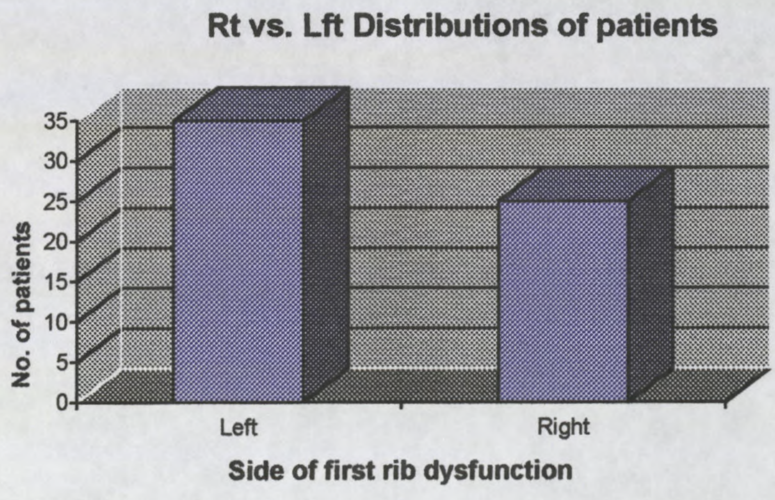
4.1.2.3 Figure D: Race Distribution



4.1.2.4 Figure E: Gender Distribution (Female 58.3% and Male 41.7%)



4.1.2.5 Figure F: Rt vs. Lft sided first rib dysfunction Distribution (Left side 58.3% and Right side 41.7%)



4.1.2.6 Table 1: Occupational Distribution

Occupation of Participant	No. per Occupation
Student	10
Librarian	8
Student*	7
Administrator	5
Sales representative	4
Chiropractor	3
Secretary	2
Manager	2
Teacher/lecturer	2
Receptionist	1
Housewife	1
Production Technician	1
Personal trainer	1
Photographer	1
Dancer	1
Self-employed	1
Therapist	1
Technician	1
Aestetician	1
Clerk	1
Computers	1
Chemical engineer	1
Travel agent	1
Yoga instructor	1
Waitress	1
Unemployed	1

* Faculty of Health students

4.2 Data Analysis

4.2.1 Comparison of the CROM readings over the Three Consecutive Days

4.2.1.1 Differences between means at time 1:

The mean readings for the various CROM variables at time 1 are shown in table 2.

Table 2 – Time 1 means for the 2 groups and overall means for each of the CROM variables.

GROUP		FX1	EX1 *	RR1	LR1	RLF1	LLF1
1	Mean	50.50	70.50	59.53	60.70	42.43	44.63
	N	30	30	30	30	30	30
	Std. Deviation	8.106	17.457	12.511	12.782	12.165	11.376
2	Mean	48.63	60.67	55.67	59.67	40.03	44.23
	N	30	30	30	30	30	30
	Std. Deviation	13.828	14.155	13.097	11.192	11.081	12.150
Total	Mean	49.57	65.58	57.60	60.18	41.23	44.43
	N	60	60	60	60	60	60
	Std. Deviation	11.277	16.518	12.847	11.923	11.600	11.671

* Significant difference (p-value = 0.01)

FX_i – flexion reading at time i = 1, 2, 3, 4, 5.

EX_i – Extension reading at time i = 1, 2, 3, 4, 5.

RR_i – Right rotation reading at time i = 1, 2, 3, 4, 5.

LR_i – Left rotation reading at time i = 1, 2, 3, 4, 5.

RLF_i – Right lateral flexion reading at time i = 1, 2, 3, 4, 5.

LLF_i – Left lateral flexion reading at time i = 1, 2, 3, 4, 5.

From table 2 it can be seen that:

(i) The mean extension, at time 1, for group 1 (treated group) is significantly higher than that for group 2 (control group).

(ii) The group 1 means for all the variables are higher or the same than those for group 2.

The above results suggest that, at the start, patients in the treated group have more neck range of motion than those in the control group.

4.2.1.2 Interaction effects present at time 1

(i) Race x Age interaction

From figures 1 and 2 it can be seen that for the Caucasian group the means for RR1 and LR1 are higher than those for the African/Asian group for age group 1 (25 or younger), while for age group 2 (above 25) these means are more or less the same.

(ii) Race x Treatment group interaction

It can be seen from figure 3 that for the treated group the mean for RLF1 is higher for the Caucasian group than for the African/Asian group, while for the control group these means are more or less the same.

Figure 1

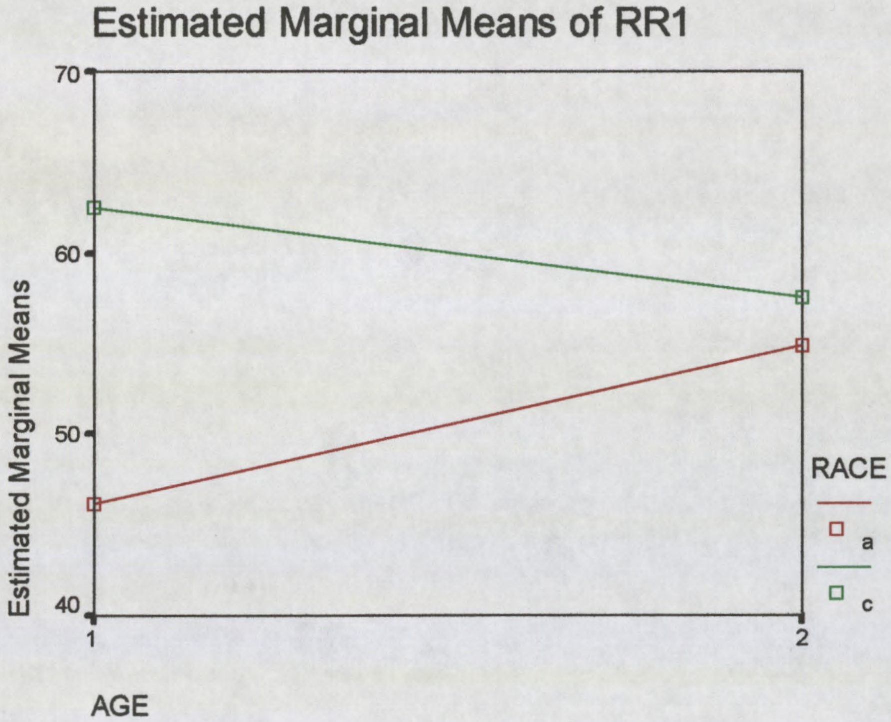


Figure 2

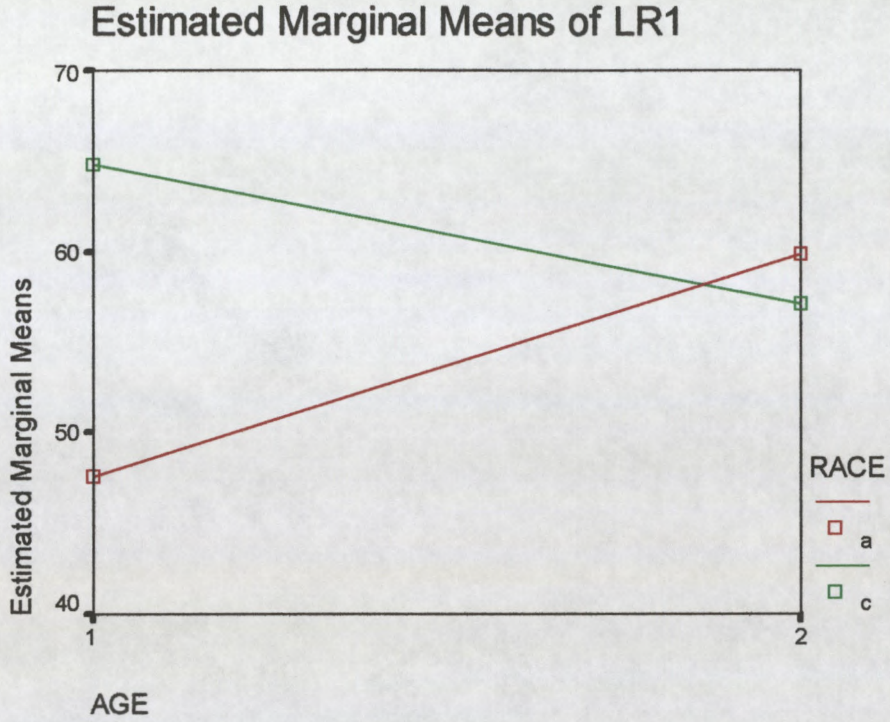
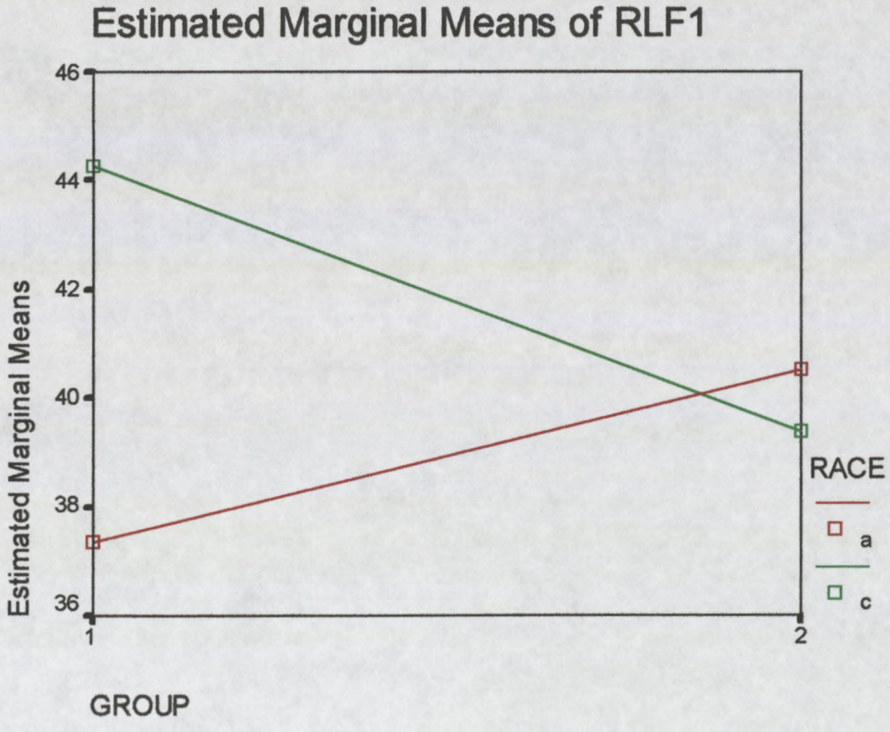


Figure 3



4.2.1.3 Analysis of profiles

The following analysis provides an overall comparison between the two groups.

For each of the 6 CROM variables the means of the treated and control groups were plotted over time (5 values). The plots are shown in figures 4 to 9. An analysis of these time profiles (broken lines joining points over time) could possibly involve

(i) A test for parallel profiles i.e. whether the changes in the mean values for the two groups occur at the same rate over time.

(ii) A test for coincident profiles i.e. whether the mean values for the two groups are the same at each point in time.

(iii) A test for level profiles i.e. whether the two profiles do not change over time.

The tests specified under (ii) and (iii) are only carried out if the test in (i) shows that the profiles are parallel. If the profiles are found to be coincident, a univariate test for level profiles will be carried out in (iii). Otherwise a multivariate test for level profiles will be carried out. The results of the profile tests are summarized in table 3.

Table 3 – Profile analysis results for CROM variables

Movement	Parallel profiles	Coincident profiles	Level profiles
Flexion	F = 4.12 (0.005)	n/a	n/a
Extension	F = 3.12 (0.022)	n/a	n/a
Right rotn.	F = 1.52 (0.2085)	F = 6.33 (0.0147)	F = 9.14 (<0.0001) [1)]
Left rotn.	F = 1.02 (0.4066)	F = 0.68 (0.4126)	F = 5.54 (0.0008) [2)]
Right lat.fx.	F = 6.41 (0.0003)	n/a	n/a
Left lat. fx.	F = 4.51 (0.0032)	n/a	n/a

F = Profile tests

1 Result of a multivariate test.
2 Result of a univariate test.
3 The p-values are shown in brackets.

For flexion, extension, right lateral flexion and left lateral flexion the profiles for the treated and control groups are not parallel. For right rotation the profiles are parallel but neither coincident nor level. For left rotation the profiles are parallel and coincident but not level.

4.2.1.4 Comparison of specific treatment effects:

For each of the variables a comparison is made between the changes in the mean for the treated and control groups between times 1 and 2 (after the first treatment) and times 3 and 4 (after the second treatment). The results of these comparisons are summarized in table 4.

Table 4 – Results of tests for specific effects of CROM variables

Variable	Times	Mean difference	t	p-value
Flexion	1 and 2	5.00	2.886	0.006*
	3 and 4	4.87	2.691	0.010*
Extension	1 and 2	5.73	3.035	0.004*
	3 and 4	3.70	2.118	0.038*
Right rotn.	1 and 2	2.97	1.606	0.114
	3 and 4	3.87	1.749	0.086
Left rotn.	1 and 2	0.77	0.426	0.672
	3 and 4	3.20	1.730	0.089
Right lat. fx.	1 and 2	6.37	4.426	0.000*
	3 and 4	3.53	2.438	0.018*
Left lat.fx.	1 and 2	6.23	3.739	0.000*
	3 and 4	3.00	2.037	0.046*

* Significant differences with treatment changes greater than control changes.

4.2.1.5 Results of the CROM readings

For flexion, extension, right lateral flexion and left lateral flexion the treatment appears to be successful. This can be seen from the non-parallel profiles found in the results summarized in table 3, figures 4, 5, 8 and 9 and the significant results in table 4.

For right rotation the profiles are parallel, i.e. same rate of change for treated and control groups, but not coincident or level. The reason for this is that treated group had a higher mean at the start and, as a result of having the same rate of change, remained higher than the control group over the 5 time periods (see figure 6). There is some evidence (see table 4) of success at the second treatment.

For left rotation the profiles are parallel, i.e. same rate of change for treated and control groups, and coincident but not level. The means for the treated and control groups appear to be approximately the same over time (see figure 7) and increase over time. There is some evidence (see table 4) of success at the second treatment.

Figure 4

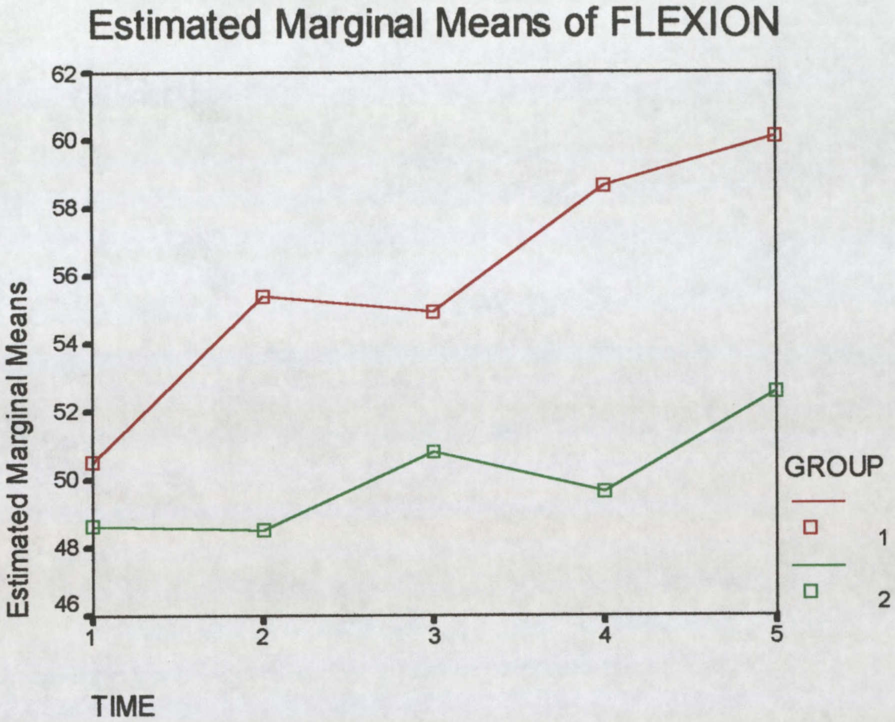

Estimated Marginal Means of FLEXION
Estimated Marginal Means
62
60
58
56
54
52
50
48
46
1
2
3
4
5
TIME
GROUP
1
2

Figure 5

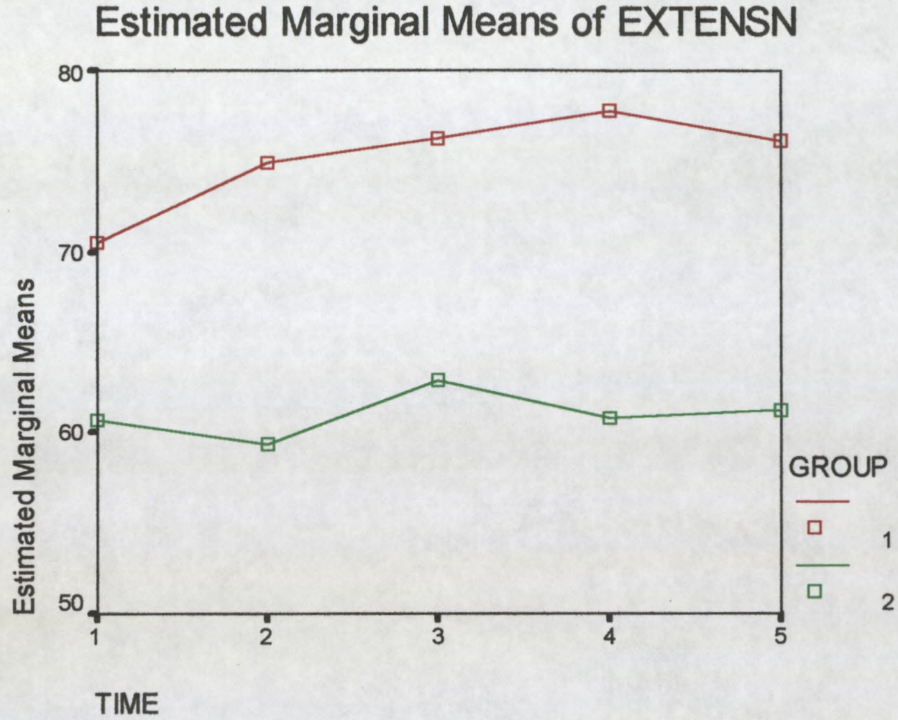


Figure 6

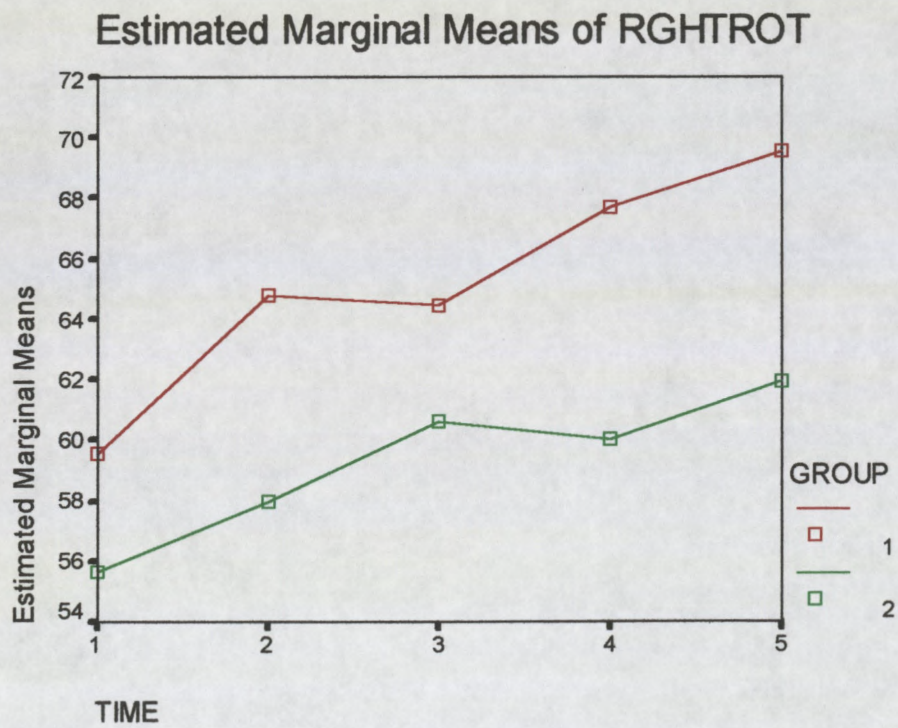


Figure 7

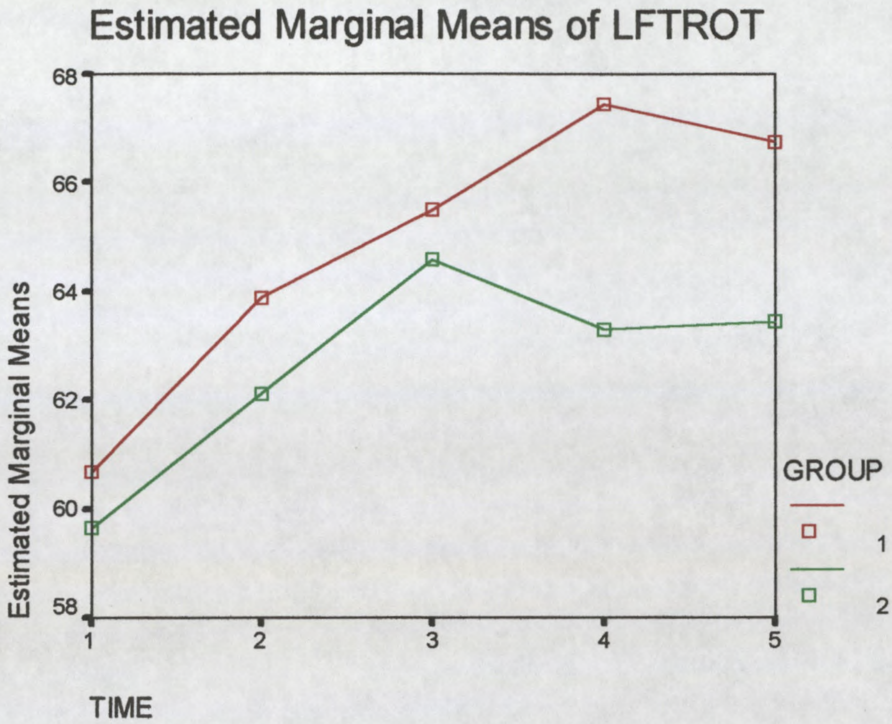


Figure 8

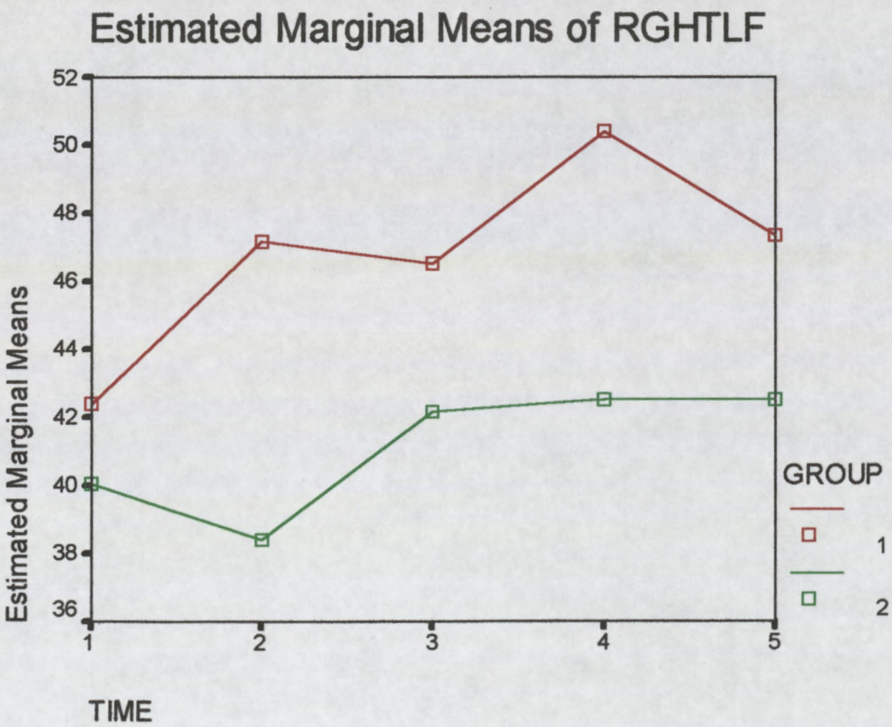
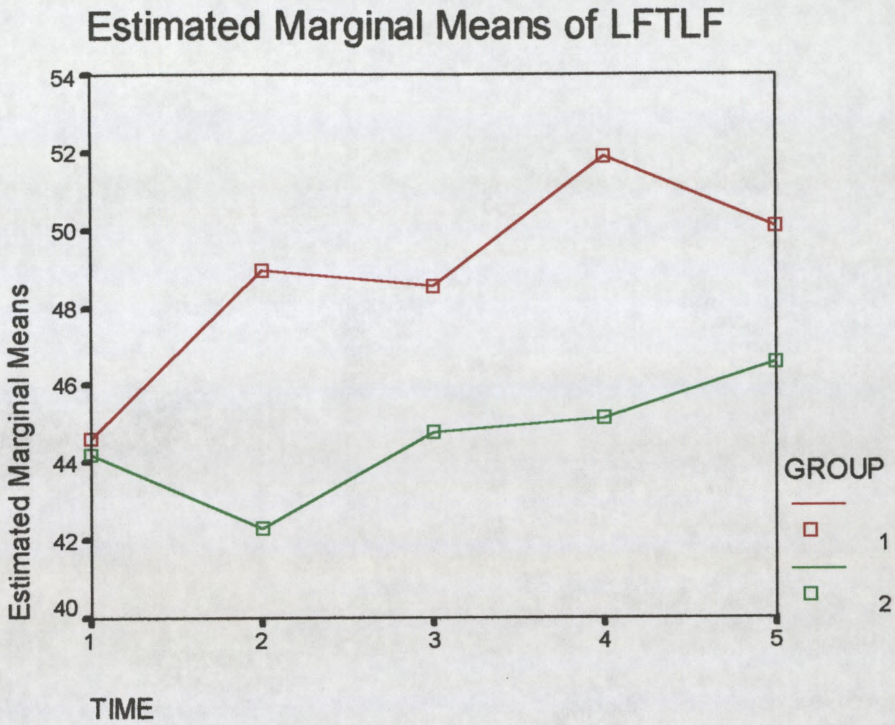


Figure 9



Estimated Marginal Means of LFTLF
Estimated Marginal Means
54
52
50
48
46
44
42
40
1
2
3
4
5
TIME
GROUP
1
2

4.3 Analysis of Algometer readings, CMCC and NRS over the Three Consecutive Days

For the algometer readings, CMCC and NRS measurements (mean of best and worst readings) the means of the treated and control groups were plotted over time (5 values). The plots are shown in figures 10 to 12. The profile analysis results for these variables are shown in the table below.

Table 5 – Profile analysis results for algometer readings

Variable	Parallel profiles	Coincident profiles	Level profiles
Algometer	F = 0.848 (0.501)	F = 3.658 (0.061)	F =1.897 (0.124)
CMCC	F = 1.348 (0.264)	F = 3.117 (0.083)	F = 21.678 (<0.0001)[1)]
NRS	F = 1.218 (0.314)	F = 0.558 (0.458)	F = 21.21 (<0.0001) [2)]

F = Profile tests

1 Result of a multivariate test.

2 Result of a univariate test.

3 p-values are shown in brackets

For all three the variables the profiles are parallel, i.e. they show the same rate of change over time, and coincident i.e. they have the same means at the different times. The algometer profiles are level, but the CMCC and NRS ones are not level (they decrease over time).

For each of the variables a comparison is made between the changes in the mean for the treated and control groups between times 1 and 2 (after the first treatment) and times 3 and 4 (after the second treatment). The results of these comparisons are summarized in table 6.

Table 6 – Results of tests for specific effects of algometer, CMCC and NRS

Variable	Times	Mean difference	t	p-value
Algometer	1 and 2	0.2167	1.145	0.257
	3 and 4	0.0433	0.375	0.709
CMCC	1 and 2	-0.2667	-0.430	0.669
	3 and 4	-0.1667	-0.411	0.683
NRS	1 and 2	-0.500	-0.299	0.766
	3 and 4	-1.333	-1.107	0.273

The results in table 6 show no difference between the effects for the treated and control groups after each treatment. These results together with those in table 5 and figures 10 to 12 suggest that the treatment has no (or very little at best) effect for these 3 variables.

Figure 10

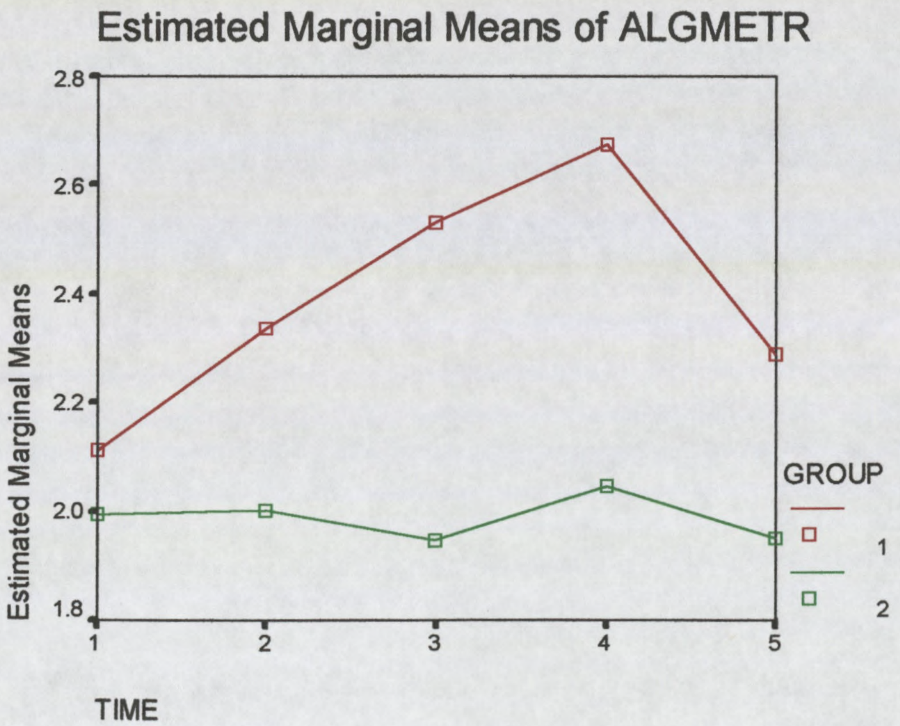
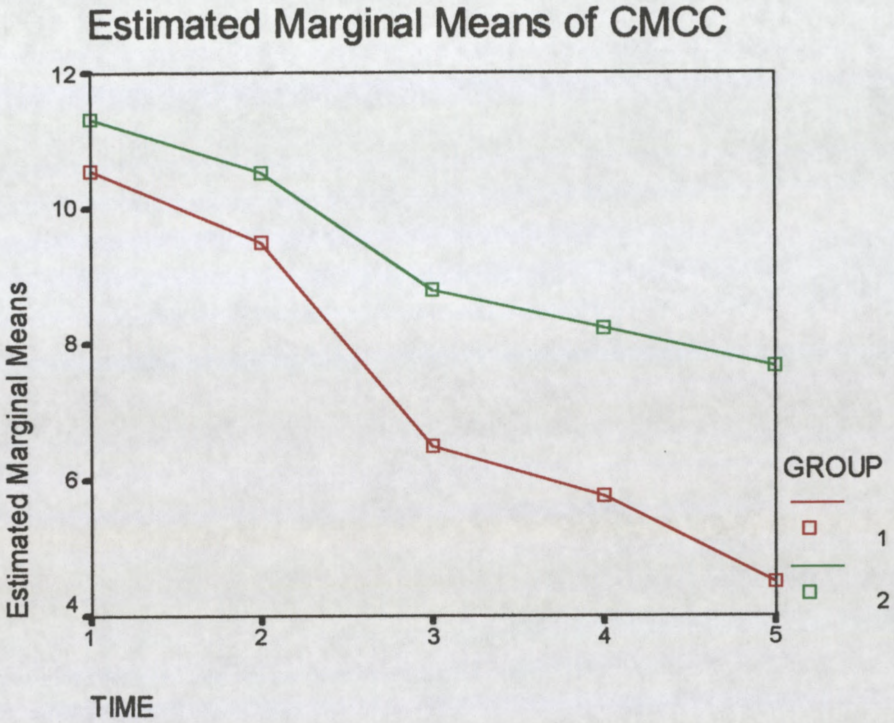
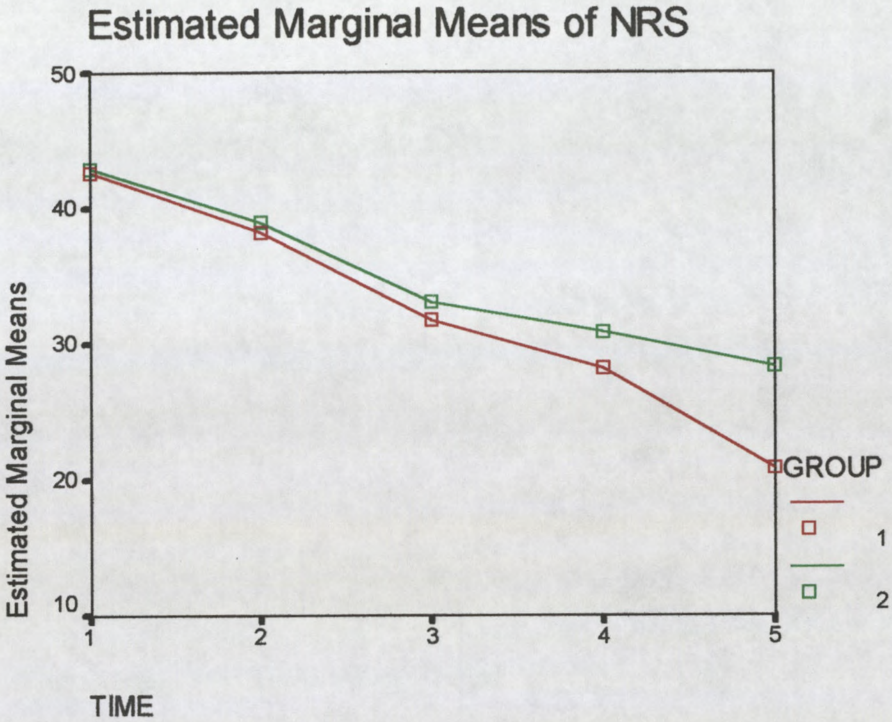


Figure 11



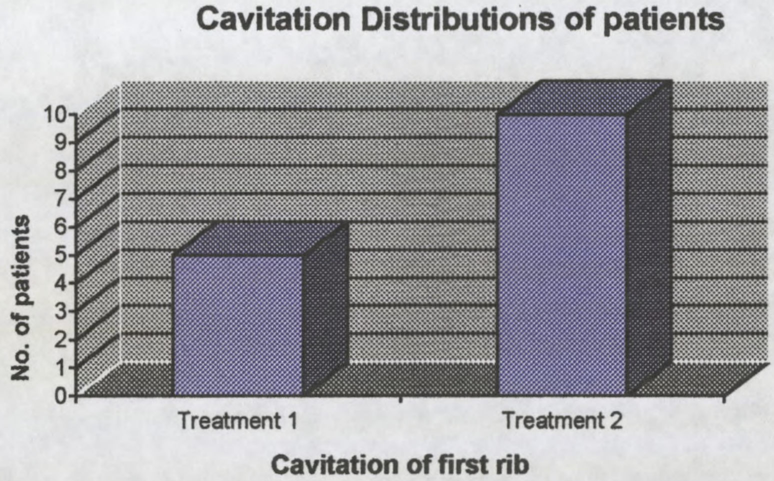
Estimated Marginal Means of CMCC
Estimated Marginal Means
12
10
8
6
4
1
2
3
4
5
TIME
GROUP
1
2

Figure 12

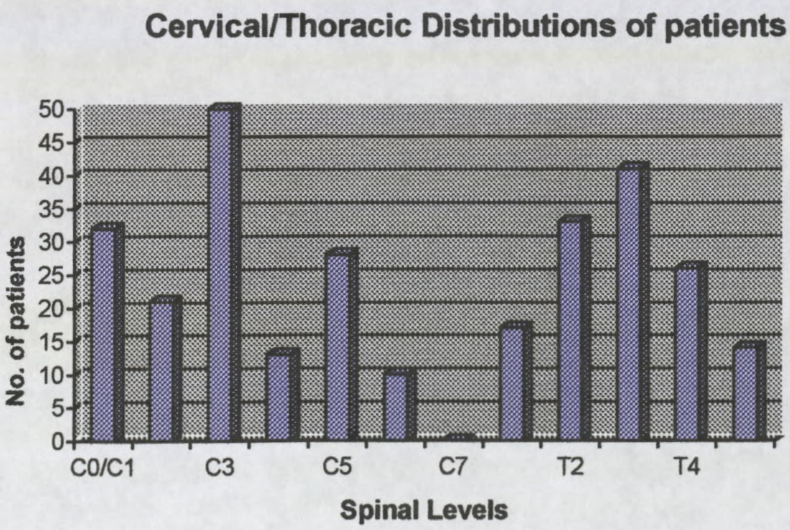

Estimated Marginal Means of NRS
50
40
30
20
10
Estimated Marginal Means
1
2
3
4
5
TIME
GROUP
1
2

4.4 Concomitant Findings

4.4.1 Figure G: Cavitation (TR1 vs. TR2) Distribution of first rib dysfunction (TR1 16% and TR2 33.3%)



4.4.2 Figure H: Cervical and Thoracic spine fixation Distribution associated with the first rib dysfunction



4.4.3 Comparison of Cervical and Thoracic fixations

For each of the two groups the number of cases where joints were fixated was recorded. This was done for each of the C-spine (C0/C1 to C7) and T-spine (T1 to T5). The results are shown in table 7, similar to Figure H above.

Table 7 - Number of Cervical and Thoracic spine fixations for two groups

Group	C-spine							T-spine				
	C0/C1	C2	C3	C4	C5	C6	C7	T1	T2	T3	T4	T5
Treated	15	12	25	8	14	4	0	10	13	20	11	7
Control	17	9	25	5	14	6	0	7	20	21	15	7

The results from a chi-square test performed (see table 8 below) shows that there is no difference between the fixation patterns for the two groups.

Table 8- Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.130(a)	10	.941
Likelihood Ratio	4.155	10	.940
Linear-by-Linear Association	.535	1	.465
N of Valid Cases	285		

a 1 cells (4.5%) have expected count less than 5. The minimum expected count is 4.88.

Chapter 5

Discussion of Results

5.0 Introduction

The aim of this study was to investigate the efficacy of a first rib manipulation in terms of subjective and objective clinical findings in individuals experiencing mechanical neck pain. This chapter is a discussion of the subjective and objective data presented in chapter 4 concerning the aim of the study.

5.1 Demographic Data

All the participants in the study were diagnosed with mechanical neck pain with an associated first rib dysfunction.

The age distribution of the participants was between 18 and 50 years of age, with an average age of 28.5 years. The average weight and height of the participants was 66.4 kg's and 1.66 m respectively. The caucasians were the majority of the participants making up 56.6% of the total, with asian and african 26.6% and 16.6% respectively. The gender distribution of the participants was 58.3% female and 41.7% male.

Of the first rib dysfunctions diagnosed, 58.3% on the left versus 41.7% on the right. Most of the participants had generalized mechanical neck, but did report pain worse on the same side of the first rib dysfunction. This could be due to the attachment of the scalene anterior and medius muscle linking the cervical spine and the first rib (Travell and Simons', 1999). In this particular study the left side was a greater percentage.

The total occupational distribution of the participants was 26, which exposed the study to a large and varied number of people suffering from mechanical neck pain. Students, librarians and administrators were the greater number of the participants. A possible reason for this could be the amount of hours these participants spend at their desks, either studying for exams or doing work on their computers. Incorrect posture or postural overload can result in mechanical neck pain (Bergmann *et al.*, 1993 and Porterfield and DeRosa, 1995).

5.2 Data Analysis

5.2.1 Comparison of the CROM readings over the Three Consecutive Days

5.2.1.1 Differences between means at time 1:

From table 2 (pg. 46) it can be seen that:

(i) The mean extension, at time 1, for group 1 (treated group) (70.50) is significantly higher than that for group 2 (control group) (60.67).

(ii) The group 1 means for all the variables are higher or the same than those for group 2.

The above results suggest that, at the start, patients in the treated group had more neck range of motion than those in the control group.

All participants in this particular study were randomly selected by a third party, who assigned the participants presenting to the clinic into either Group 1 or Group 2 by drawing out of a hat. Therefore, the above results suggesting that at the start, participants in the treated group had more neck range of motion than those in the control group was purely coincidental.

The greater range of motion at the start of the participants in the treated group compared to the control group could be attributed to numerous factors such as:

- Mechanical neck pain with cervical spine instability/hypermobility
- Muscle spasm
- Type of muscle involvement and number of muscles involved (fewer = increase range of motion of the cervical spine)
- Age of participant
- Ethnicity of participant
- Gender of participant *

* Where there were more males/females in one or the other group, it should be noted that females are generally more flexible in terms of ligament and muscle stability around joints. This could explain why at the start the treated group had more neck range of motion.

Areas of hypomobility are supplemented by areas of hypermobility, which can increase the range of motion to normal or slightly more than normal. This could also explain why the cervical range of motion was slightly increased in the treated group than the control group.

5.2.1.2 Interaction effects present at time 1

(i) Race x Age interaction (RR1- right rotation; LR1- left rotation)

From figures 1 and 2 (pgs. 48 and 49) it can be seen that for the Caucasian group the means for RR1 and LR1 are higher than those for the African/Asian group for age group 1 (25 or younger), while for age group 2 (above 25) these means are more or less the same.

All participants in this particular study were randomly selected by a third party, who assigned the participants presenting to the clinic into either Group 1 or Group 2 by drawing out of a hat. Therefore, the above results suggest that at the means for RR1 and LR1 are higher than those for the African/Asian group for age group 1 (25 or younger), while for age group 2 (above 25) these means are more or less the same is purely coincidental, or could be directly reflective of group dynamics/epidemiology.

The means for RR1 and LR1 are higher than those for the African/Asian group for age group 1 (25 or younger), while for age group 2 (above 25) the means are more or less the same could be attributed to numerous factors such as:

- Mechanical neck pain with cervical spine instability/hypomobility

- Muscle spasm
- Type of muscle involvement and number of muscles involved
- Age of participant
- Ethnicity of participant *

* Possible factors that could be race specific:
  1. Increased muscle strength in neck due to carrying loads on head
  2. Decreased time at desk
  3. Increased activity time versus caucasians, especially in the younger group

This may decrease with time as the africans/asians become more office bound and the younger ages take over the more traditional work roles in our society.

(ii) Race x Treatment group interaction (RLF1- right lateral flexion)

It can be seen from figure 3 (pg. 49) that for the treated group the mean for RLF1 is higher for the Caucasian group than for the African/Asian group, while for the control group these means are more or less the same.

All participants in this particular study were randomly selected by a third party, who assigned the participants presenting to the clinic into either Group 1 or Group 2 by drawing out of a hat. Therefore, the above results suggest that at the mean for RLF1 for the treated group is higher for the Caucasian group than for the African/Asian group, while for the control group these means are more or less the same is purely coincidental.

The mean for RLF1 for the treated group is higher for the Caucasian group than for the African/Asian group, while for the control group these means are more or less the same could be attributed to numerous factors such as:

- Mechanical neck pain with cervical spine instability/hypomobility
- Muscle spasm

- Type of muscle involvement and number of muscles involved
- Age of participant
- Ethnicity of participant
- Hand dominance of the participant *

* The demographic data does suggest that there were a greater number of caucasians in the treated group indicating that there may be a statistical tendency towards caucasians. Therefore, hand dominance may be factor due to the number of hours caucasians work at a desk, either writing or using a computer if compared to asians and/or africans.

However, all of the above is only a hypothesis into the possible reasons for the greater range of motion of the treated group, the difference in age x race interaction and the race x treatment interaction present at time 1, and therefore future research into these specific causes or effects discussed above is warranted.

5.2.1.3 Analysis of profiles

This analysis provides an overall comparison between the two groups.

For each of the 6 CROM variables the means of the treated and control groups were plotted over time (5 values). The plots are shown in figures 4 to 9 (pgs. 53-56). The results of the profile tests are summarized in table 3 below.

Table 3 – Profile analysis results for CROM variables

Movement	Parallel profiles	Coincident profiles	Level profiles
Flexion	F = 4.12 (0.005)	n/a	n/a
Extension	F = 3.12 (0.022)	n/a	n/a
Right rotn.	F = 1.52 (0.2085)	F = 6.33 (0.0147)	F = 9.14 (<0.0001) [1)]
Left rotn.	F = 1.02 (0.4066)	F = 0.68 (0.4126)	F = 5.54 (0.0008) [2)]
Right lat.fx.	F = 6.41 (0.0003)	n/a	n/a
Left lat. fx.	F = 4.51 (0.0032)	n/a	n/a

F = Profile tests

For flexion, extension, right lateral flexion and left lateral flexion the profiles for the treated and control groups are not parallel. For right rotation the profiles are parallel but neither coincident nor level. For left rotation the profiles are parallel and coincident but not level.

The above analysis was important to be able to compare the specific treatment effects and the end results of the CROM readings, discussed below.

The table above may indicate a right first rib dysfunction affects left rotation or a left first rib dysfunction affects right rotation. Could this be utilized, subject to future research, as a tool to indicate first rib involvement ie:
Right first rib dysfunction = decrease in left rotation?
Left first rib dysfunction = decrease in right rotation?

5.2.1.4 Comparison of specific treatment effects:

For each of the variables a comparison was made between the changes in the mean for the treated and control groups between times 1 and 2 (after the first treatment) and times 3 and 4 (after the second treatment). Times 1 and 2 were also taken as the immediate effect of the treatment, while times 3 and 4 were taken as the short-term effect (Cowie 2003). The results of these comparisons are summarized in table 4 below.

Table 4 – Results of tests for specific effects of CROM variables

Variable	Times	Mean difference	t	p-value
Flexion	1 and 2	5.00	2.886	0.006*
	3 and 4	4.87	2.691	0.010*
Extension	1 and 2	5.73	3.035	0.004*
	3 and 4	3.70	2.118	0.038*
Right rotn.	1 and 2	2.97	1.606	0.114
	3 and 4	3.87	1.749	0.086
Left rotn.	1 and 2	0.77	0.426	0.672
	3 and 4	3.20	1.730	0.089
Right lat. fx.	1 and 2	6.37	4.426	0.000*
	3 and 4	3.53	2.438	0.018*
Left lat.fx.	1 and 2	6.23	3.739	0.000*
	3 and 4	3.00	2.037	0.046*

* Significant differences with treatment changes greater than control changes.

Table 4 results may contradict the hypothesis on page 68 about right and left rotation. One could suggest that treatment that is directed at one or more of the muscles involved over a longer period may allow for significant rotational change. Or can one hypothesize and say that rotation is a diagnostic tool and improvement to the patient is measured principally by right and left lateral flexion movements?

5.2.1.5 Results of the CROM readings

For flexion, extension, right lateral flexion and left lateral flexion the treatment appears to be successful. This can be seen from the non-parallel profiles found in the results summarized in table 3, figures 4, 5, 8 and 9 and the significant results in table 4.

In figure 4 (pg. 53), the difference between plot 1 (before treatment) and plot 2 (after the treatment) on the graph for group 1 is substantially above that of plot 1 and plot 2 for group 2. This would indicate that a first rib manipulation has a positive, immediate effect on the flexion movement of the cervical spine. Similarly, plots 3 and 4 indicate that the treatment has positive, short- term effect on the flexion movement of the cervical spine. Plot 5 indicates the overall effectiveness of group 1.

In figure 5 (pg. 54), the difference between plot 1 (before treatment) and plot 2 (after the treatment) on the graph for group 1 is substantially above that of plot 1 and plot 2 for group 2. This would indicate that a first rib manipulation has a positive, immediate effect on the extension movement of the cervical spine. Similarly, plots 3 and 4 indicate that the treatment has positive, short- term effect on the extension movement of the cervical spine. Plot 5 indicates the overall effectiveness of group 1.

In figure 8 (pg.55), the difference between plot 1 (before treatment) and plot 2 (after the treatment) on the graph for group 1 is substantially above that of plot 1 and plot 2 for group 2. This would indicate that a first rib manipulation has a positive, immediate effect on the right lateral flexion movement of the cervical spine. Similarly, plots 3 and 4 indicate that the treatment has positive, short- term effect on the right lateral flexion movement of the cervical spine. Plot 5 indicates the overall effectiveness of group 1.

In figure 9 (pg.56), the difference between plot 1 (before treatment) and plot 2 (after the treatment) on the graph for group 1 is substantially above that of plot 1 and plot 2 for group 2. This would indicate that a first rib manipulation has a positive, immediate effect on the left lateral flexion movement of the cervical spine. Similarly, plots 3 and 4 indicate that the treatment has positive, short- term effect on the left lateral flexion movement of the cervical spine. Plot 5 indicates the overall effectiveness of group 1.

For flexion, extension, right lateral flexion and left lateral flexion the treatment appears to be successful. This could be attributed to the possible therapeutic effect of the manipulation through two mechanisms:

- Neuro-mechanical, which includes mechanoreceptor stimulation, muscle spindle stretching and breaking down of articular adhesions resulting in an increase in active and passive joint motion.
- Stimulation of the autonomic nervous system, resulting in reflex inhibition of pain and muscle spasm (Curl, 1994:297).

This is supported by (Bergmann, 1993:139) who describes the manipulation effect as the stretching of the periarticular tissues, release of intra-articular and extra-articular adhesions, stimulation of joint nociceptors and mechanoreceptors (stimulating the golgi tendon organs and somatic afferent receptor activity). The results are a decrease in muscle spasm, soft tissue in-flexibility and muscle fatigue, amongst others.

According to Korr model, focus is on the muscle spindle as the coordinator that may increase or decrease muscle contraction according to the direction of motion of the joint. The reflex muscle contraction could then produce joint motion by its action or prevent joint in an area of segmental dysfunction (Leach, 1994:98-99).

According to (Travell and Simons', 1999) the scalene muscles (anterior and medius) function to stabilize (opposite side movement) the cervical spine against lateral movement in lateral flexion. Immobility or blockage of the first rib goes hand in hand with reflex spasm of the scalene muscle on the same side (Lewit 1991). This is supported by Travell and Simons' (1999:518), who mention that an articular dysfunction commonly observed with scalene muscle involvement is elevation of the first rib.

At the same time, according to Moore (1992) the longissimus capitis muscle functions as an extensor of the cervical spine (bilateral contractor) that is also reported to laterally flex and rotate the head to the same side (unilateral contraction). An apparent elevation of the first rib concurrent with T1 articular dysfunction may result from rotation of the vertebra by the longissimus capitis muscle that is shortened from trigger point tension (reflex spasm). This muscle, through its attachment to the transverse process, may indirectly affect the first rib through its pull on the costotransverse junction (Travell and Simons', 1999).

Treatment of the first rib via manipulation relieves scalene muscle spasm (Lewit, 1991), which may indirectly cause a relief in longissimus capitis muscle spasm at the same time. This relief in muscle spasm by manipulation, is supported by Korr (1975) who proposed two mechanisms whereby manipulation would successfully relax the muscle spasm:

1. By stretching the intrafusal fibers by forcefully stretching the muscle against it spindle-maintained resistance would produce a barrage of afferent impulses intense enough to signal the CNS to reduce the gamma motorneuron discharge.
2. The golgi tendon organs would be stimulated by forced stretch of the skeletal muscle causing both gamma and alpha motorneuron inhibition.

Curl (1994), Bergmann (1993) and Korr (1975) theories may help explain why there is a substantial increase in those specific ranges of motion of the cervical spine after a first rib manipulation was performed in group 1.

For extension, right and left lateral flexion, even though there was overall improvement due to the treatment performed, plot 5 on the graphs of these movements (figures 5, 8 and 9) appears to decrease from plot 4, indicating that the participants got slightly worse on the last day.

It is hypothesized the participants could have suffered from poor posture the night before. Even though the researcher instructs the participants not to exert themselves in any way while taking part in the study, there is no way to control what they do in between the treatments. Or it could be possible that the initial neurological response in the immediate term may not back up the muscle or joint response in the long term? Or a possible recurring cervical spine instability/hypermobility account for a recurring first rib hypomobility? These could also be reasons why the participants got slightly worse on the last day.

For right rotation, the profiles are parallel, i.e. same rate of change for treated and control groups, but not coincident or level. The reason for this is that treated group had a higher mean at the start and, as a result of having the same rate of change, remained higher than the control group over the 5 time periods (see figure 6). There is some evidence of success at the second treatment.

In figure 6 (pg.54), the difference between plots 3 and 4 for group 1 versus group 2 indicates that the treatment has positive, short- term effect on the right rotation movement of the cervical spine.

For left rotation, the profiles are parallel, i.e. same rate of change for treated and control groups, and coincident but not level. The means for the treated and control groups appear to be approximately the same over time (see figure 7) and increase over time. There is some evidence of success at the second treatment.

In figure 7 (pg.55), the difference between plots 3 and 4 for group 1 versus group 2 indicates that the treatment has positive, short- term effect on the left rotation movement of the cervical spine.

The relief in muscle spasm by the manipulation as discussed previously for the other ranges of motion of the cervical spine may indicate why the treatment had positive, short- term effect on the left and right rotation movement of the cervical spine.

However, all of the above is only a hypothesis into the possible reasons for the effect of a first rib manipulation on cervical range of motion in individuals suffering from mechanical neck pain and therefore future research into these causes or effects is warranted. For example hypo/hypermobility of the cervical spine, mechanical muscle changes from immediate and short-term effects of manipulation etc.

5.3 Analysis of Algometer readings, CMCC and NRS over the Three Consecutive Days

For the algometer readings, CMCC and NRS measurements, (mean of best and worst readings) the means of the treated and control groups were plotted over time (5 values). The plots are shown in figures 10 to 12 (pgs. 58-60). The profile analysis results for these variables are shown in table 5.

Table 5 – Profile analysis results for algometer readings

Variable	Parallel profiles	Coincident profiles	Level profiles
Algometer	F = 0.848 (0.501)	F = 3.658 (0.061)	F =1.897 (0.124)
CMCC	F = 1.348 (0.264)	F = 3.117 (0.083)	F = 21.678 (<0.0001) [1)]
NRS	F = 1.218 (0.314)	F = 0.558 (0.458)	F = 21.21 (<0.0001) [2)]

F = Profile tests

1 Result of a multivariate test.

2 Result of a univariate test.

3 p-values are shown in brackets

For all three the variables the profiles are parallel, i.e. they show the same rate of change over time, and coincident i.e. they have the same means at the different times. The algometer profiles are level, but the CMCC and NRS ones are not level (they decrease over time).

For each of the variables a comparison was made between the changes in the mean for the treated and control groups between times 1 and 2 (after the first treatment) and times 3 and 4 (after the second treatment). Times 1 and 2 were also taken as the immediate effect of the treatment, while times 3 and 4 were taken as the short-term effect (Cowie 2003). The results of these comparisons are summarized in table 6.

Table 6 – Results of tests for specific effects of algometer, CMCC and NRS

Variable	Times	Mean difference	t	p-value
Algometer	1 and 2	0.2167	1.145	0.257
	3 and 4	0.0433	0.375	0.709
CMCC	1 and 2	-0.2667	-0.430	0.669
	3 and 4	-0.1667	-0.411	0.683
NRS	1 and 2	-0.500	-0.299	0.766
	3 and 4	-1.333	-1.107	0.273

The results in table 6 show no difference between the effects for the treated and control groups after each treatment. These results together with those in table 5 and figures 10 to 12 suggest that the treatment had no (or very little at best) effect for these 3 variables.

Together with the CROM (cervical range of motion), the algometer was the other objective measurement used in this study. The results show little difference between the groups, indicating that there was still pain experienced over the area of the first rib where the reading was taken.

Possible explanations why there was little difference or inaccuracy with the algometer readings between the two groups:

- The area of the first rib joint anteriorly (where the algometer reading was taken) lies in a difficult region and has structures overlying it e.g.: clavicle, scalene muscles. The brachial plexus and the subclavian vessels are naturally tender (Moore, 1992).
- Marking the precise point where the previous reading was taken over the three consecutive was difficult to do. Marking was utilized but rubbed off with time.
- The pain may have returned in between the treatments because of the muscle spasm returning. If there was inflammation present, then it would not have resolved in 2-3 days. This may be dependant on the neurological and physiological mechanism of action of the manipulation on muscle spasm

(Leach, 1994). The pain may disappear transiently and remain abated for longer periods.

- A first rib dysfunction may not cause pain over its own joint (due to little movement it has normally) but only over the muscles that attach to it (muscle spasm).

The CCMC and the NRS questionnaires were the subjective measurements for the study. They were utilized to establish from the participants the degree of neck pain at the initial consultation and whether there was improvement or not. The results show little difference between the groups, indicating that there was still pain experienced in neck region indicating that a first rib manipulation has little or no immediate or short-term effect on its own in the treatment of individuals suffering from mechanical neck pain.

Possible explanations as to the little difference with the CMCC and NRS readings between the two groups over time:

- Related cervical and thoracic spine fixations (discussed later)
- Treatment too short (two consecutive days) for manifestations of clinical/patient monitored effects.
- First manipulation not effective on it own
- Acute or chronic mechanical neck pain
- Age of patient (threshold to pain)
- Race of patient (threshold to pain)
- Gender of patient (threshold to pain)
- Incorrect measurement tools or tools not sensitive enough

However, the above is only a hypothesis in the possible reasons for the poor results, therefore future research into these areas is warranted.

5.4 Concomitant Findings

5.4.1 Cavitation (TR1 v.s TR2) Distribution of first rib dysfunction

In figure G (pg. 61), on treatment 1 (day 1) only 16% of the first rib manipulations cavitated, while on treatment 2 (day 2) 33.3% of the first rib manipulations cavitated. In this particular study a cavitation was not necessary. A successful adjustment was based on post manual rib endplay (Haldemann, 1992). All thirty participants had better post manual rib endplay after the adjustment than at the beginning.

These results support Suter *et al.* (1994), who stated that an audible cavitation is not necessarily indicative of a successful adjustment.

5.4.2 Cervical and Thoracic spine fixation Distribution associated with the first rib dysfunction

In figure H (pg.61), C0/C1, C3, C5, T2, T3, T4 spinal levels were the most restricted in this study where all participants were diagnosed with mechanical neck pain and a first rib dysfunction. C4, C6, C7, T1 and T5 spinal levels were the least restricted.

It is hypothesized that C3 to C6 restrictions could be attributed to proximal attachments of the scalene anterior and medius muscles (Travell and Simons', 1999) which, over a prolong period due to the restrictions of C3-C6, could cause C0/C1 spinal levels to increase their normal function (over-work) and in turn become fixated.

This is supported by Innes (Chiroweb.com) who states that a fixation complex can be initiated causing mechanical derangement locally at the first rib, and some distance away (cervical spine) as a result in changes of the scalene muscles.

In turn, it could be hypothesized that the thoracic spine fixations, especially T2, T3 andT4, could be the primary levels of a fixation complex causing cervical spine hypermobility, therefore, cervical spine restrictions could occur just above and below the cervical spine apex. As a result, a first rib dysfunction may occur. It also could be a difficult area to motion palpate.

However, the above is only a consideration into the many causes of cervical or thoracic restrictions and mechanical neck pain and therefore future research into these causes or effects is warranted.

5.4.3 Comparison of Cervical and Thoracic fixations

The results from a chi-square test performed shows that there is no difference between the fixation patterns for the two groups.

Table 7 - Number of Cervical and Thoracic spine fixations for two groups

Group	C-spine							T-spine				
	C0/C1	C2	C3	C4	C5	C6	C7	T1	T2	T3	T4	T5
Treated	15	12	25	8	14	4	0	10	13	20	11	7
Control	17	9	25	5	14	6	0	7	20	21	15	7

From Table 7, it can be seen that there was no difference between the fixation patterns for the groups indicating that the diagnosis of mechanical neck pain with an associated first rib dysfunction was uniform.

Chapter 6

Recommendations and Conclusions

6.0 Introduction

This chapter includes recommendations pertinent to this study and future studies including a conclusion from all the subjective and objective data obtained and discussed in Chapter's 4 and 5.

6.1 Recommendations

Study Design

This study was a pilot study that looked at the immediate and short-term efficacy of a first rib manipulation in individuals suffering from mechanical neck pain. A control or placebo group was used. Detuned ultrasound was performed over the first rib area. I would recommend a placebo that has no direct contact over the sensitive area of the first rib. Massaging the detuned ultrasound over this area could have had some influence on the end results. An asymptomatic group or shame laser therapy could be used as the control to highlight the differences of the experimental group.

Sample Size

The sample size was sixty. A larger sample size would increase the validity of any study as the results collected would improve and highlight significance levels more clearly.

Gender

This study included both male and female participants. A study involving just male or just female participants suffering from mechanical neck pain to create homogeneity could reveal more reliable results.

Race

This study included caucasian, asian and african participants. A study involving one type of race who are suffering from mechanical neck pain to create homogeneity could reveal more reliable results.

Occupation

This study was not specific to occupation. A study involving one type of occupation for those suffering from mechanical neck pain to create homogeneity could reveal more reliable results.

CMCC Questionnaire

The CMCC neck disability index questionnaire was used in the study. This particular questionnaire was designed for a longer period of treatment to neck pain and not really over three consecutive days. Participants had to fill in the same questionnaire before and straight after the treatment. Most of the questions asked could not be answered straight away as the participant had not had the opportunity to perform certain tasks e.g. reading, lifting heavy objects, driving or recreational activities. More specific questions are needed for the after treatment.

Here are some questions that could act as a guideline:

- Neck movement (range of motion), painful or painless. If so, which specific directions?

- Any increase or decrease in neck movement after the treatment?
- Pain intensity over the first rib? (Note: the NRS questionnaire was specific for the change in neck pain and not the first rib.)

Objective Measurements

The CROM and the algometer measurements in this study were taken by the clinician (qualified chiropractor) on duty on the day to avoid any bias by the researcher to the eventual outcome to the study. The clinicians were meant to be kept at a minimum to allow for a measure of uniformity of these objective measurements. This was extremely difficult to do, especially in a learning facility where the clinicians are very limited in number per shift and where every student demands their undivided attention for varied and sporadic periods of time. It was also difficult book in participants at the same time the chosen clinician was on duty.

Further more, the clinician had to be called back both before and after each treatment. In most cases, it took time to call them back to measure. This as well as the number of clinicians could have had some effect on the eventual outcome of the results.

I would recommend for future research that either the researcher takes the objective readings himself or they assign a maximum of one clinician, to allow for more accurate and efficient readings.

For the algometer instrument, I would recommend that a protective 'rubber stopper' be placed over the end of the instrument to make it more comfortable for the patient. Also, the algometer readings were specific for the changes in pain of the first rib, no algometer readings were taken for the cervical spine. This could have had some effect to the eventual outcome of the results to this particular study.

Follow up studies

A possible follow-up study comparing the long-term effects of a first rib manipulation in individuals suffering from mechanical neck pain.

In this study all the participants in the treated group had a seated first rib manipulation. The seated technique worked well in this particular study, but a possible a follow-up study comparing the seated, prone and supine techniques would be beneficial to decide which technique is more valid or reliable.

An epidemiological study of race, gender, age and occupation of participants investigating the potential differences they may have in individuals suffering from mechanical neck pain and a first rib dysfunction. (In terms of occupation, investigate if hand dominance is a possible factor for a first rib dysfunction on the same side.)

Future Research

Future research should investigate:

- the positive results on the range of motion of the cervical spine and the possible link they have to the scalene muscles and the longissimus capitus muscle .
- combining a first rib manipulation with other forms of treatment e.g. cervical manipulation, thoracic manipulation, trigger point therapy of involved muscles, P.N.F., strengthening and stretching etc.
- differences in range of motion of the cervical spine in individuals suffering from mechanical neck pain when it comes to age x race interaction and race x treatment interaction.

6.2 Conclusions

This research study aimed to investigate the efficacy of a first rib manipulation in individuals experiencing mechanical neck pain. The immediate and short-term effectiveness was also investigated. A group of sixty participants took part in the study.

The results comparing the two groups showed that for flexion, extension, right lateral flexion and left lateral flexion, the treatment had a positive and significant increase in the above ranges of motion of the cervical spine. The results for right rotation and left rotation appeared insignificant.

Overall, results suggest that a first rib manipulation has an immediate and short-term effectiveness on flexion, extension, right lateral flexion and left lateral flexion ranges of motion of the cervical spine, in individuals suffering from mechanical neck pain. In terms of the pain itself, the first rib manipulation had no significant immediate or short-term relief, indicating that a first rib manipulation is not an effective treatment on its own for individuals suffering from mechanical neck pain.

This was a pilot study, therefore further investigation is needed involving a better study design and longer periods of investigation, which may yield more conclusive results.

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Appendix A

DO YOU SUFFER FROM...

NECK AND/OR UPPER BACK PAIN?

(AND/OR BETWEEN 18-50 YRS OLD)

RESEARCH IS BEING CONDUCTED AT THE CHIROPRACTIC DAY CLINIC

DURBAN INSTITUTE OF TECHNOLOGY

TREATMENT IS FREE, SHOULD YOU QUALIFY FOR THIS STUDY!

PLEASE CONTACT BRUCE DOUGLAS AT THE CLINIC ON: 031 - 2042205 / 2042512

DURBAN INSTITUTE OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Appendix B

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

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

< Location

< Onset : Initial:

Recent:

< Cause:

< Duration

< Frequency

< Pain (Character)

< Progression

< Aggravating Factors

< Relieving Factors

< Associated S & S

< Previous Occurrences

< Past Treatment

< **Outcome:**

Complaint 1	**Complaint 2**

4. Other Complaints:

5. Past Medical History:

< General Health Status

< Childhood Illnesses

< Adult Illnesses

< Psychiatric Illnesses

< Accidents/Injuries

< Surgery

< Hospitalizations

6. Current health status and life-style:

< Allergies

< Immunizations

< Screening Tests incl. xrays

< 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

PHYSICAL EXAMINATION: SENIOR/RESEARCH

Patient Name :________________________ **File no :**___________ **Date :**
Interns Name : **Signature :**

VITALS:

Pulse rate:
Respiratory rate:
Blood pressure: R L
Temperature:
Height:
Weight: Recent change: Yes No

GENERAL EXAMINATION:

General Impression:
Skin:
Jaundice:
Pallor:
Clubbing:
Cyanosis (Central/Peripheral):
Oedema:
Lymph nodes - Head and neck:
- Axillary:
- Epitrochlear:
- Inguinal:

Urinalysis:

Clinicians Name: **Signature :**

SYSTEM SPECIFIC EXAMINATION

CARDIOVASCULAR EXAMINATION:

RESPIRATORY EXAMINATION:

ABDOMINAL EXAMINATION:

NEUROLOGICAL EXAMINATION:

COMMENTS:

Clinicians Name: **Signature :**

Appendix D

DURBAN INSTITUTE OF TECHNOLOGY
REGIONAL EXAMINATION - CERVICAL SPINE

Patient: ______________________________ File No: ____________

Date: __________ Student: ______________________________

Clinician: ______________________ Sign: ______________________

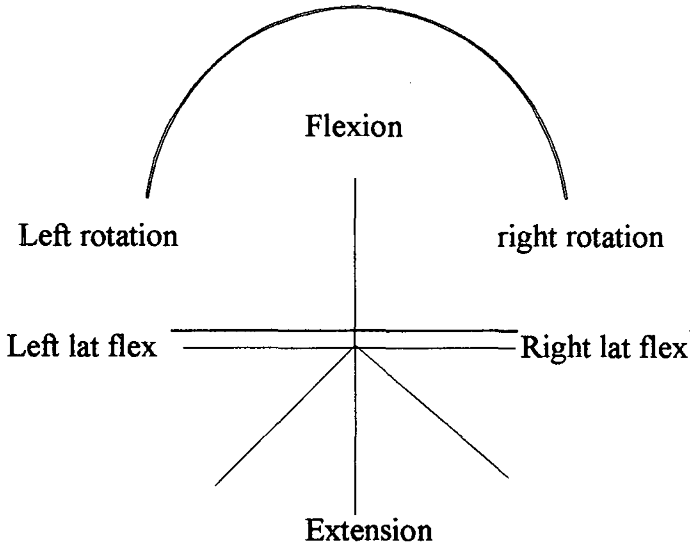
OBSERVATION:

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 :

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:

Upper Thoracics:
Motion Palpation:
Joint Play:

BASIC EXAM: SHOULDER:
Case History:

ROM: Active:
Passive:
RIM:
Orthopaedic:
Neuro:
Vascular:
Observ/Palpation:

BASIC EXAM: THORACIC SPINE:
Case History:

ROM: Motion Palp:
Active:
Passive:
Orthopaedic:
Neuro:
Vascular:
Observ/Palpation:

INFORMED CONSENT FORM **Appendix E**

Date: ____________________

Title of research project:

"An investigation into the efficacy of a first rib manipulation in individuals experiencing mechanical neck pain – A pilot study."

Names of supervisor: Dr. H. L. White (2042205 / 2512)

Name of research student: Bruce Douglas (2042205 / 2512)

Name of institution: Durban Institute of Technology

Sixty patients suffering from neck pain will be placed into two groups where they will undergo a specific treatment allocated. One group will receive a placebo treatment. The immediate and short-term effectiveness of the treatment on neck pain will be investigated.

Please circle the appropriate answer:

1. Have you read the patient information sheet? YES/NO
2. Have you had the opportunity to ask questions regarding this study? YES/NO
3. Have you received satisfactory answers to your questions? YES/NO
4. Have you had the opportunity to discuss this study? YES/NO
5. Have you received enough information about this study? YES/NO
6. Who have you spoken to? .... YES/NO
7. Do you understand the implications of your involvement in this study? YES/NO
8. Do you understand that you are free to withdraw from this study? YES/NO
    a. At any time
    b. Without having to give reason for withdrawing, and
    c. Without affecting your future health care.
9. Do you agree to voluntary participate in this study? YES/NO

PATIENT NAME: .... SIGNATURE: ....

WITNESS NAME: .... SIGNATURE: ....

RESEARCH STUDENT: .... SIGNATURE: ....

IF YOU ANSWERED NO TO ANY OF THE ABOVE QUESTIONS, PLEASE DO NOT HESITATE TO CONTACT MY RESEARCH SUPERVISOR, WHO WILL BE ABLE TO ASSIST YOU.

Appendix F

Letter of Information

Dear patient.

Welcome to my research study. My study is quite simple in that you will be randomly selected and put into two groups of thirty. I will be concentrating mainly on an area at the junction of your neck and shoulder, just behind your collar bone (clavicle). This is where your first rib is located, a structure that could possibly be a relation to your neck pain. I will be performing two types of treatment to that area. Your treatment will depend on which group you are allocated. One group will be placebo treatment.

Title of study:

"An investigation into the efficacy of a first rib manipulation in individuals experiencing mechanical neck pain – A pilot study."

Supervisor:	Dr. H.L. White	(031) 2042205 /2512
Research Student:	Bruce Douglas	(031) 2042205 /2512
Institution:	Durban Institute of Technology	

Purpose of the study:

An investigation into the efficacy of a first rib manipulation in individuals experiencing mechanical neck pain.

Procedures:

Participants shall have three visits in total. These will run over three consecutive days. The third visit is reserved for data collection and there will be no treatment intervention. It would be appreciated that participants involved in the study ensure they are able to attend these visits as it is vital for the eventual outcome of the study.

The inclusion of a placebo into this study is to make sure that the form of treatment we are investigating is as accurate as possible.
After the final consultation is completed, participants will be informed whether they were in the placebo group and given the choice of seeing a 5th year intern for a follow-up treatment.

Risks/Discomfort:

Treatments are safe. There may be slight discomfort in the area that was treated after the first and second treatments.

Benefits:

Participants may or may not benefit from their treatments. This is a pilot study and we are conducting this trial to see if this form of treatment is beneficial for individuals suffering from mechanical neck pain. Your contribution however, by volunteering to partake in this study, will help us as Chiropractors to build on our knowledge. This will benefit you as a patient in the long run, as we will be able to provide you with more effective health care in the future.

New findings:

You will be made aware of any new findings during the course of this study.

Reasons why you may be withdrawn from this study without your consent:

You may be removed from participating in this study without your consent for the following reasons:

- If you are unable to attend your follow–up appointment on the scheduled dates.
- If you have changed any lifestyle habits during your participation in this study that may effect the outcome of this research (e.g. medication, supplements or treatment).

AS A VOLUNTARY PARTICIPANT IN THIS RESEARCH STUDY, YOU ARE FREE TO WITHDRAW FROM THE STUDY AT ANY TIME, WITHOUT GIVING A REASON.

Remuneration:

You will NOT be receiving a travel allowance in order to attend your appointment at the Chiropractic Day Clinic, Durban Institute of Technology.

Cost of the study:

The testing procedure will be free of charge and your participation in this study is voluntary.

Confidentiality:

All patient information is confidential. The results from this study will be used for research purposes only. Only individuals that are directly involved in this study (Dr. H.L. White and myself) will be allowed access to these records.

Persons to contact should you have any problems or questions:

Should you have any questions that you would prefer being answered by an independent individual, feel free to contact my supervisor on the above numbers. If you are not satisfied with a particular area of this study, please feel free to forward any concerns to the Durban Institute of Technology Research and Ethics Committee.

Thank you for participating in my research study.

Bruce Douglas
(Chiropractic Intern)

Dr. H.L. White **BSc. Bed. Dipl.Ed. M.Tech: Chiropractic. CCFC.**
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Appendix G

NUMERICAL PAIN RATING SCALE 101

PATIENT NAME: ______________________________

FILE NUMBER: ________________ DATE: ________________

GROUP: ________________

Please indicate on the line below the number between 0 and 100 that best describes the pain of your major problem at this point, when it is at its **WORST**. A zero (0) would mean "no pain at all" and one-hundred (100) would mean "pain as bad as it could be."

Please write only one number.

0 ____ 100

Please indicate on the line below the number between 0 and 100 that best describes the pain of your major problem at this point, when it is at its **LEAST**. A zero (0) would mean "no pain at all" and one-hundred (100) would mean "pain as bad as it could be."

Please write only one number.

0 ____ 100

CMCC NECK DISABILITY INDEX

Patient Name:________________________File no.:____________Date:____________

This questionnaire has been designed to give the doctor information as to how your back pain has affected your ability to manage everyday life. Please answer every section and mark in each section only ONE box as it applies to you. We realize you may consider that two of the statements in any one section could relate to you, but please just mark the box which most closely describes your problem.

Section 1 - Pain Intensity

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

Section 2 - Personal Care (Washing, Dressing ...)

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

Section 3 - Lifting

G I can lift heavy weights without extra pain.
G I can lift heavy weights but it gives extra pain.
G Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, for example on a table.
G Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned .
G I can lift only very light weights.
G I cannot lift or carry anything at all.

Section 4 - Reading

G I can read as much as I want to without pain in my neck.
G I can read as much as I want to with slight pain in my neck.
G I can read as much as I want with moderate pain in my neck.
G I cannot read as much as I want because of moderate pain in my neck.
G I can hardly read at all because of severe pain in my neck.
G I cannot read at all.

Section 5 - Headaches

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

Section 6 - Concentration

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

Section 7 - Work

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

Section 8 - Driving

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

Section 9 - Sleeping

G I have no trouble sleeping.
G My sleep is slightly disturbed (<1 hour sleep loss).
G My sleep is mildly disturbed (1-2 hours sleep loss).
G My sleep is moderately disturbed (2-3 hours sleep loss).
G My sleep is greatly disturbed (3-5 hours sleep loss).
G My sleep is completely disturbed (5-7 hours sleep loss).

Section 10 - Recreation

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

Vernon/Hagino, modified from Foubister et al.,Physiotherapy, 1980

CROM Readings

Appendix I

Treatment	1	2	3	4	5
Flexion					
Extension					
Right rotation					
Left rotation					
Right lat flex					
Left lat flex					

Algometer Readings

Appendix J

Treatment	Before		After
Day 1			
Day 2			
Day 3			no reading

Appendix K

According to Bergmann *et al.* (1993:63) there are five diagnostic criteria for joint dysfunction in mechanical neck pain:

-**Pain/tenderness**- produced by palpation of osseous and soft tissue.
-**Asymmetry**- noted through observation of posture and gait as well as palpation for misalignment of vertebral segments.
-**Range of Motion abnormality**- Change in active, passive and accessory joint motions is noted through procedures of motion palpation.
-**Tissue tone, texture and/or temperature abnormality**- Changes in the characteristics of contiguous and associated soft tissues are noted through the procedures of observation, palpation, instrumentation and tests length and strength.
-**Special tests**- eg Kemps

A positive motion palpation finding indicating a symptomatic joint shall be defined as meeting the following 3 criteria:

1) Abnormal end-feel.
2) Abnormal quality of resistance to motion.
3) Reproduction of pain (either local or referred) when passive accessory movements (end feel) are tested (Plaugher, 1993:87).