The Effectiveness of Chiropractic Manipulative Therapy on Quadratus Lumborum Muscle Spasm in the Treatment of Chronic Mechanical Lower Back Pain

A dissertation submitted to the Faculty Health Sciences, Technikon Witwatersrand, in partial fulfillment for the Masters degree in Technology in the Programme Chiropractic

by

Sonja Kneppers

Supervisor: Dr C Yelverton ____________________

(M.Tech Chiro (S.A.) MCASA)

Date: ____________________

August 2004

DECLARATION

This study has not been conducted elsewhere and is the work of the researcher alone unless otherwise indicated within.

ACKNOWLEDGEMENTS

To my Mom and Dad,

Thank you for all your help and support, without you this would not have been possible. To my sisters for all your encouragement, advice and help, from the proof reading, the typing and especially the nagging, thank you.

Many thanks to my supervisors for your advice, guidance and especially your time.

To Trev, thank you for believing in me and always being there for me, I hope to do the same for you someday.

Thank you to the patients who took part in the study.

ABSTRACT

The purpose of this study was to establish the effect of spinal manipulation on the hypertonicity and myofascial trigger points of the quadratus lumborum muscle as well as the resulting relief of pain in patients suffering from chronic mechanical lower back pain.

Thirty subjects between the ages of 18 and 50 who had suffered from mechanical lower back pain for six weeks or longer were selected from the general population. They were recruited by way of newspaper advertisements. Patients were placed in one of two groups. The researcher examined each of these subjects in order to ensure that they complied with the criteria established for this study. Each of the chosen subjects were then treated six times over a two week period and underwent a one month follow up consultation to be re-examined. Subjects in the first group (Group 1) received five minutes of ultrasound treatment over the quadratus lumborum muscle with the frequency at OHz. Subjects in the second group (Group 2) received chiropractic manipulation of any fixations found in the lumbar spine between the levels of T12-L1 to L3-L4. Each group was randomly divided into fifteen subjects.

The markers detected an error in the statistical analysis for back range of motion and suggested that an alternative method of measurement be used. As a result ten clinical trials were redone on an experiment group (Group 3). The same objective and subjective assessments were done and the patients received chiropractic manipulative therapy.

An objective assessment was carried out using three measurements:

- Firstly, a measurement of back range of motion using an inclinometer;

- Secondly, a measurement of trigger point tenderness using an algometer; and
- Thirdly, a measurement of the electrical activity of the quadratus lumborum using an electromyograph.

Subjective data was collected by way of questionnaires, namely the Oswestry Lower Back Pain Disability questionnaire and the Numerical Pain Rating Scale. The results were analysed using Wilcoxon sign ranked tests and Mann-Whitney technique.

Measurements for the control group (Group 1), as hypothesized, showed no statistically significant improvements.

The results of the study indicated that the group receiving chiropractic treatment (Group 2) experienced some pain relief that was lasting and significant in nature. The mean values for back range of motion measurements indicated statistically significant increases in movement in most directions among the patients of this group. The patients experienced this relief for a minimum period of a month following the sixth treatment as indicated by the follow-up results.

The algometer readings were similar for both groups in that increased pressure could be applied to trigger points from one treatment to the next. The increase in the applied pressure was generally greater and longer lasting in the experimental group. The EMG readings showed no statistically significant differences between the control and experiment groups and also from one treatment to the next.

Group 3 showed a remarkable increase in almost all ranges of motion over the two week treatment period, but there was a slight decrease during the four week follow up period. Trigger point sensitivity as well as pain and disability levels in the patient decreased as a result of chiropractic treatment.

The results of this study demonstrated that chiropractic manipulative therapy was effective in increasing the range of motion of the lumbar spine and decreasing the patients painful episode as a consequence of a decrease in sensitivity of trigger points of quadratus lumborum.

It is suggested that further studies with larger sample sizes are needed and that the objective measurements are taken prior to and post treatment to determine the immediate effects of chiropractic treatment on back range of motion and on the trigger points of the quadratus lumborum muscle.

TABLE OF CONTENTS

Page

Page

LIST OF APPENDICES

LIST OF FIGURES

Chapter One

LIST OF TABLES

DEFINITION OF TERMS

1 Adjustment

Specific form of direct articular manipulation utilizing either long or short lever techniques with specific contacts characterized by a dynamic thrust of controlled velocity, amplitude and direction. (Gatterman. 1990: 405)

2 Fixation

2.1 Absence of motion of a joint in a position of motion, usually at the extreme of motion.

2.2 State whereby a vertebra or pelvic bone has become temporarily immobilised in a position that it may normally occupy during any phase of physiological spinal movement.

2.3 Immobilisation of a vertebra in a position of movement when the spine is at rest, or when the spine is in movement. (Gatterman. 1990: 408)

3 Manipulation

Passive manoeuvre in which specifically directed manual forces are applied to vertebral and extra-vertebral articulations of the body, with the object of restoring mobility to restricted areas.

3.1 Long-lever manipulation – high velocity force exerted on a point of the body some distance from the area where it is expected to have a beneficial effect.

3.2 Short-lever manipulation – high velocity thrust directed specifically at an isolated joint. (Gatterman. 1990: 410)

4 Myofascial Trigger Points

Small hypersensitive sites that, when stimulated, consistently produce a reflex mechanism that gives rise to referred pain or other manifestations. The response is specific, in a constant reference zone and consistent from person to person. (Travell and Simons. 1983, vol 1:3).

An active trigger point is an area that is tender when palpated in a taut band of muscle and it causes referred pain similar to the patients spontaneous pain complaint (Rachlin. 1994:147).

A latent trigger point has the same characteristics as the above, except for the absence of the referred pain similar to the patients spontaneous pain symptoms (Rachlin. 1994:147).

5 Subluxation

5.1 Partial or incomplete dislocation.

5.2 Restriction of motion of a joint in a position exceeding normal physiologic motion, even though the anatomic limits have not been exceeded.

5.3 Aberrant relationship between two adjacent articular structures, which may have functional or pathological sequlae, causing an alteration in the biomechanical and/or neurophysiological reflexes of these articular structures, their proximal structures, and/or body systems that may be directly or indirectly affected by them. (Gatterman. 1990:415)

CHAPTER ONE

INTRODUCTION

1 INTRODUCTION

1.1 The problem and its setting

Back pain is a complaint, which most people will have at some time during their lives. After the common cold it is the most common health problem in America (Frymoyer, et al. 1991).

A common cause of lower back pain is facet syndrome. Facet syndrome is dysfunction of the posterior joints of the vertebrae where there is an over-riding of facets and adjacent vertebrae. Over time muscles become hypertonic and ligaments shorten which results in contiguous parts of the adjacent vertebrae being pulled together. (Gatterman. 1995:415)

Myofascial trigger point syndrome is when changes take place in the fascia surrounding muscle tissue and result in the formation of taut bands called trigger points (Starlanyl and Copeland. 1996). Stress and tension have been named as the most common causes of trigger point formation (Rachlin. 1994), but they also occur in the presence of joint dysfunction (Pongratz and Spath. 2001). Myofascial trigger points may cause pain and a decrease in range of motion.

Quadratus lumborum functions as a stabiliser and is highly active in flexion, extension and lateral bending of the lumbar spine. Anatomically it attaches to the transverse processes of the lumbar spine. (Liebenson. 2000: 50) Mechanical low back pain associated with spinal instability has been described by Panjabi (1992) as a decrease in capacity of the stabilizing system to maintain spinal neutral zones. Myofascial syndrome of the quadratus lumborum could result in a compromised stabilising system and lead to mechanical low back pain.

Schafer and Faye (1990:7) say that normal muscle function is dependent on normal joint function and vice versa. The aim of chiropractic treatment is to restore reduced motion to the affected joint by applying an appropriate adjustment. (Gatterman. 1990:222). There is much evidence that manipulation increases joint mobility and decreases painful episodes. (Haldeman. 1992:218)

There are many theories as to why adjusting is effective, but this study is an attempt to address the apparent gaps in the literature concerned with the effect of the adjustment on the hypertonic quadratus lumborum muscle in the management of chronic mechanical low back pain.

1.2 Aim of the study

In this research study, the aim was to investigate the effect of a chiropractic adjustment on quadratus lumborum muscle spasm as a more effective treatment for chronic mechanical lower back pain.

1.3 Benefits of the study

- Gatterman (1990:331) states that high priority should be given to the physiological therapeutic procedures because they enhance chiropractic manipulative treatment. Relief of symptoms, reversal of the disease process and recovery time can all be improved by the correct use of modalities. (Gatterman. 1990:331). However, it would be beneficial, in terms of time and cost, if a chiropractic adjustment alone could be shown to have a significant effect on the trigger points and hypertonic muscles that are involved in spinal movement. This study will investigate how effective spinal manipulative therapy alone could be in treating chronic mechanical low back pain.

- To achieve a less invasive treatment method for the patient. For example dry needling the quadratus lumborum muscle to relieve muscle trigger points is invasive as well as dangerous due to the close proximity of the lungs and kidneys (Mcgill. 2000:1).

- The other method of treating trigger points is ischaemic compression, which can cause a patient a lot of pain and discomfort. (Travell and Simons. 1983: vol. 1:86).

CHAPTER TWO

LITERATURE REVIEW

1 INCIDENCE AND PREVALENCE

In the United Kingdom back pain is the nations leading cause of disability with 1.1 million people disabled by it annually. (Disability Data from Labor Force Survey, Market Trends. 1998) Palmer, et al (2000) conducted a survey over the year 2000 that showed almost half the adult population of the United Kingdom (49%) suffered from low back pain of at least twenty-four hours duration at some time during a single year.

In the United States (US) there are 13 million people who have impaired function because of spinal disorders and 2.6 million who are permanently disabled by it. About one percent of the US population is chronically disabled by back pain and another one percent is temporarily disabled. (Frymoyer, et al.1991:95,108). On any given day up to two percent of the US population is disabled by back pain (Troyanovich, et al. 2000:155).

The "Health in Detroit" study (Fymoyer, et al. 1991:78) was a survey of one adult from each probability sample of 598 white households in the Detroit metropolitan area. During the six-week period the average adult had sixteen symptomatic days, only eleven percent of males and five percent of females escaped symptom-free. Musculoskeletal morbidity ranked only second to respiratory symptomology. Nearly half the participants were experiencing musculoskeletal symptoms for one week out of six.

National statistics from European countries reveal that 10% - 15% of all sickness absenteeism is due to back pain. The number of surgical procedures for herniated discs vary between countries. The rate per 100 000 is 100 in Great Britain, 200 in Sweden, 350 in Finland and 450-900 in the United States (Frymoyer, et al. 1991:109).

Back pain can prevent or limit work and activities of daily living (Porterfield and De Rosa. 1991:2). According to Frymoyer, et al (1991:95) each year one million worker's compensation claims related to back injury are filed in the US. Cooperstein (1995) reported that annually about two percent of the United States workforce have back injuries for which they can claim compensation. This amounts to about 400 000 injuries annually.

Low back pain affects an estimated eighty percent of adults during some period of their lives (Bigos and Battie. 1987). Porterfield and De Rosa (1991:4) claim that back pain is the most frequent cause of activity limitation in people below the age of 45 years. European statistics reveal that the average age at surgery is 40-45 years and that males are operated on twice as often as females (Frymoyer. 1991:108).

There are no statistics available in South Africa, but due to similar working environments to other countries, similar statistical trends for back pain incidence can be assumed.

Looking at the above statistics one can see why back pain has become the most expensive health care problem, the most expensive industrial injury and the most common cause of disability under the age of 45 years (Porterfield and De Rosa. 1991:4). In the US the annual direct cost of treating lower back pain is $14- $18 billion per year (Cooperstein. 1995). Five million adults in the UK consult their general practitioner annually concerning back pain leading to costs in primary care of 140.6 million pounds (Maniadakis, Gray. 2000).

2 CAUSES OF LOW BACK PAIN

The causes of low back pain can be divided into organic and mechanical (Cox. 1998). Differentiating between the two may be difficult. When taking a patient's history, questions such as (1) onset, (2) character and (3) location of the pain, are necessary for an accurate diagnosis. For example local versus diffuse pain or radicular versus referred pain will give clues as to whether the pain is muscular, neural, articular or visceral in origin.

Mechanisms that intensify the pain are also important diagnostically, for example, limited range of motion will indicate a musculoskeletal or neural system problem but may be absent in an organic condition. Motion may not affect an organic or visceral condition but the pain is typically constant or worse at night. (Merck. 1992:1363).

2.1 ORGANIC

Non-mechanical low back pain due to visceral disease, for example of the rectum or bladder, may cause low back pain affected by motion and relieved by rest (Merck. 1992:1362). Pain related to renal disease will usually be felt in the back between the 12th rib and iliac crest (Merck. 1992:1363). Low back pain as a result of joint laxity and joint hypermobility may be associated with organ disorders. With conditions such as Ehlers-Danlos (Yochum and Rowe Vol. 1:611) and Marfan's syndrome, which are genetically determined or inherited, organ systems are affected and there is characteristic connective tissue weakness and joint hypermobility (Yochum and Rowe. Vol. 1:608).

2.2 MECHANICAL

Mechanical low back pain can be subdivided into discogenic, facet and myofascial causes (Cox. 1998).

When any two consecutive vertebrae are articulated they form three joints and are known as the three joint complex. One joint is formed between the two vertebral bodies and is separated by an intervertebral disc. The other two joints are formed by the articulation of the superior articular process of one vertebrae with the inferior articular process of the vertebrae above, these are called the zygapophysial or facet joints (Calliet. 1995:13), as seen in figure 1 below.

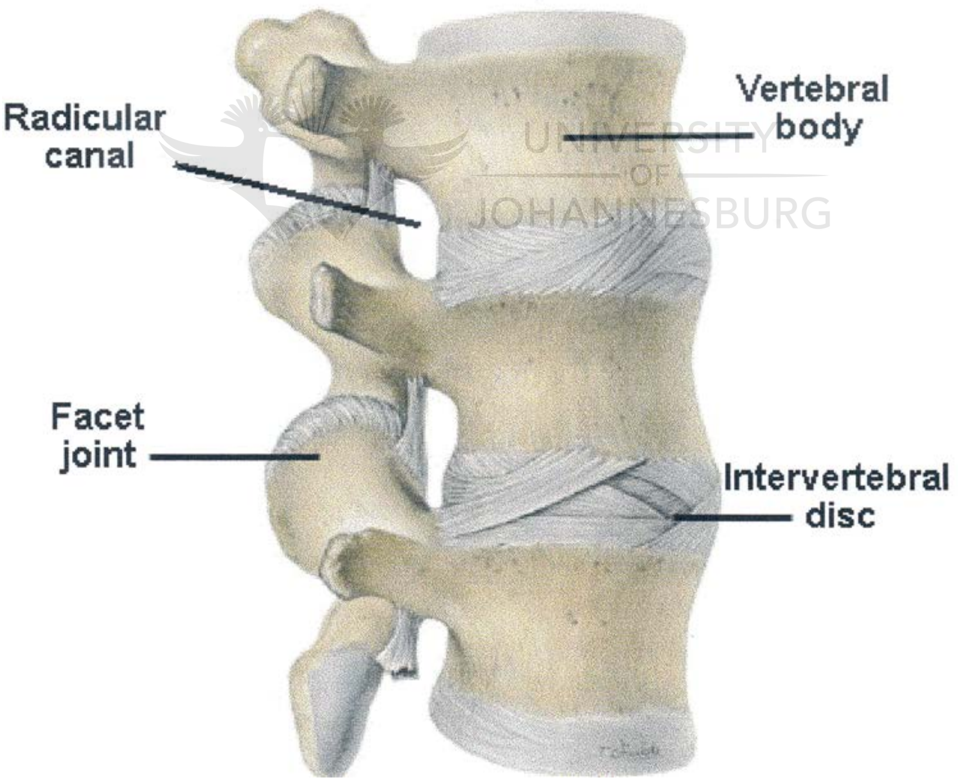


Figure 1 – The Lumbar Spine (The Backpage. 2000)

2.2.1 Discogenic causes

The foremost function of the intervertebral disc is to separate two vertebral bodies (Bogduk and Twomey. 1991:11). Other functions include weight bearing (Wiesel, et al. 1992) and movement (Bogduk and Twomey. 1991:22). The intervertebral disc forms a fibrocartilagenous articulation between the vertebral bodies and is composed of the nucleus pulposus and the annulus fibrosus (Wiesel, et al. 1992).

- The nucleus pulposus is a semi-fluid mass of mucoid material, it responds as a viscous fluid under pressure, being able to resist and redistribute compressive forces and transmit applied pressures in all directions (Bogduk and Twomey. 1991:13) (see figure 2).

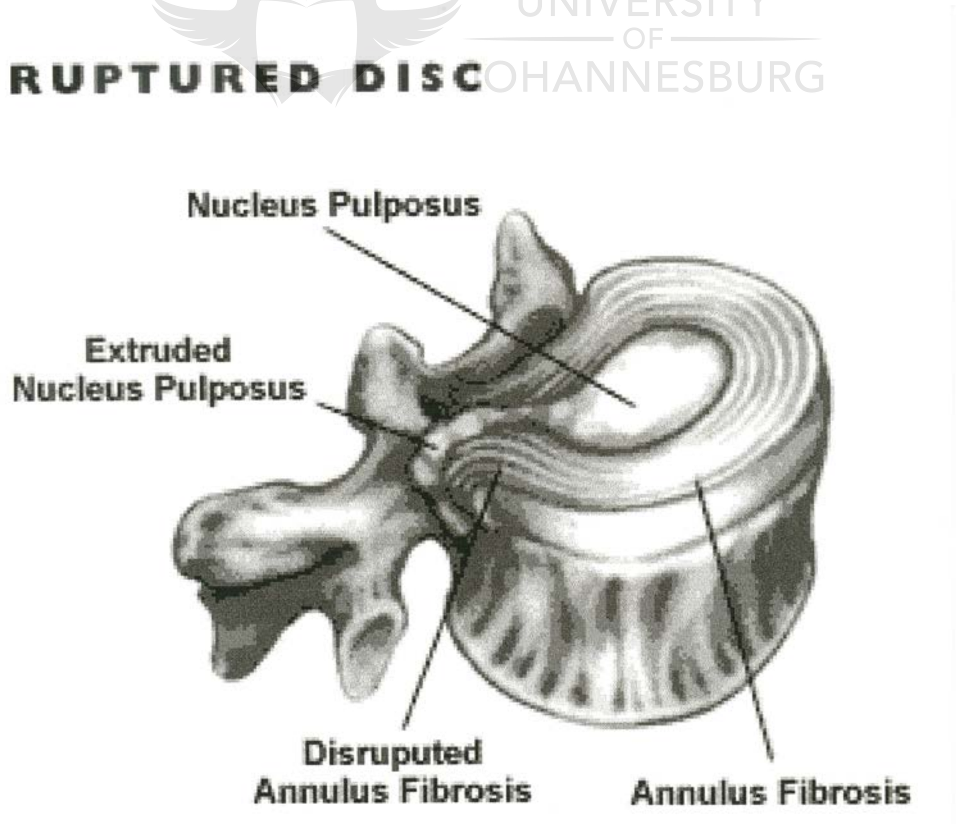


Figure 2 – Ruptured Disc (Robert Dashman)

- The annulus fibrosus consists of collagen fibres arranged in a highly ordered pattern of concentric rings called lamellae that surround the nucleus (Bogduk and Twomey. 1991:13) (see figure 2).

In discussing the lumbar intervertebral disc syndrome, Bogduk (1991) states that four elements of the nervous system may be involved in the production of this syndrome:

- The lumbosacral nerve roots which become irritated when stretched over a protruding or prolapsed disc (see figure 2). The lumbosacral nerve roots are branches of the spinal cord and they lie in the intervertebral foramina. They are numbered according to the vertebra beneath which they lie. Thus, L1 spinal nerve lies below L1 vertebra in the L1-L2 intervertebral foramen, and so on.

- The spinal nerve becomes irritated as a result of:
  - Arthrosis of the facet joints;
  - Hypertrophy of the ligamentum flavum. Ligamentum flavum is a short thick ligament that joins the laminae of consecutive vertebrae. It attaches to the superior aspect of the inferior lamina and the vertebral aspect of the superior lamina. At each intersegmental level the ligamentum flavum is a paired structure symmetrical on right and left sides;
  - Osteophyte formation. Osteophytes are degenerative exostosis secondary to musculotendinous traction. (Gatterman. 1990:412). Osteophytes are the most easily recognized alteration in degenerative joint disease. Radiographically, an osteophyte is seen as a bony outgrowth from the adjacent bone, extending towards the joint space. (Yochum and Rowe. 1996:805);

  - Intervertebral disc protrusion. This occurs when the nuclear material of the intervertebral disc becomes displaced. At first it stretches the annulus of the disc, but progresses to become herniated beyond the annulus. (Gatterman. 1990:409);
  - Subluxation;
  - Spondylolisthesis. This occurs when a vertebral body slips anteriorly relative to the vertebra below it. (Haldeman. 1992:627);
  - Infection;
  - Tumor;
  - Fracture;
  - Paget's disease. This disease of unknown origin is characterized by osteolysis (bone resorption) followed by extensive attempts at repair. (Yochum and Rowe. Vol. 2:1138); or
  - Ankylosing spondylitis. This condition presents with low back pain followed by a non-traumatic and insidious onset. The sacro-iliac joints are usually the first sites of involvement, followed by fusion of the spine in a caudad to cephalad progression. Radiographically ill-defined joint margins and articular sclerosis are visible. A "bamboo" spine appearance is evident. (Gatterman. 1990:61).

- The dorsal rami (branches of the spinal nerve that begin just lateral to the intervertebral foramina) may also become irritated by:
  - Articular facet arthrosis (degeneration);
  - Subluxation;
  - Sacroiliac joint arthrosis;
  - Spinous process impingement (an obstructing lesion causing pressure on a nerve). (Gatterman. 1990:409);
  - Strain of the sacral joints;
  - Hyperlordosis (hyper – beyond excessive, lordosis – anterior concavity in the curvature of the lumbar and cervical spine). (Haldeman. 1992:623);

- Scoliosis (an appreciable lateral deviation in the normally straight vertical line of the spine). (Haldeman. 1992:627);
- Myositis (inflammation of muscle tissue). (Merck. 1992:1369);
- Muscle spasm and reactions secondary to sclerosis (hardening of tissue, usually due to scarring). (Oxford Medical Dictionary. 1994:591); or
- Arthrosis of the articular facets.

- The sinuvertebral nerve, originating just distal to the dorsal root ganglion passes back through the intervertebral foramen. It is formed by the union of a spinal afferent and a sympathetic post ganglionic root and innervates the articular connective tissues of the vertebral canal. (Gatterman. 1990:69) (see figure 3). It also supplies the posterior longitudinal ligament (attached to the intervertebral discs posteriorly and laterally and overlying the posterior surface of the vertebral bodies, but not attached to it), as well as the annulus fibrosus of the disc. The sinuvertebral nerve may receive pain impulses if there is a lesion of these structures.

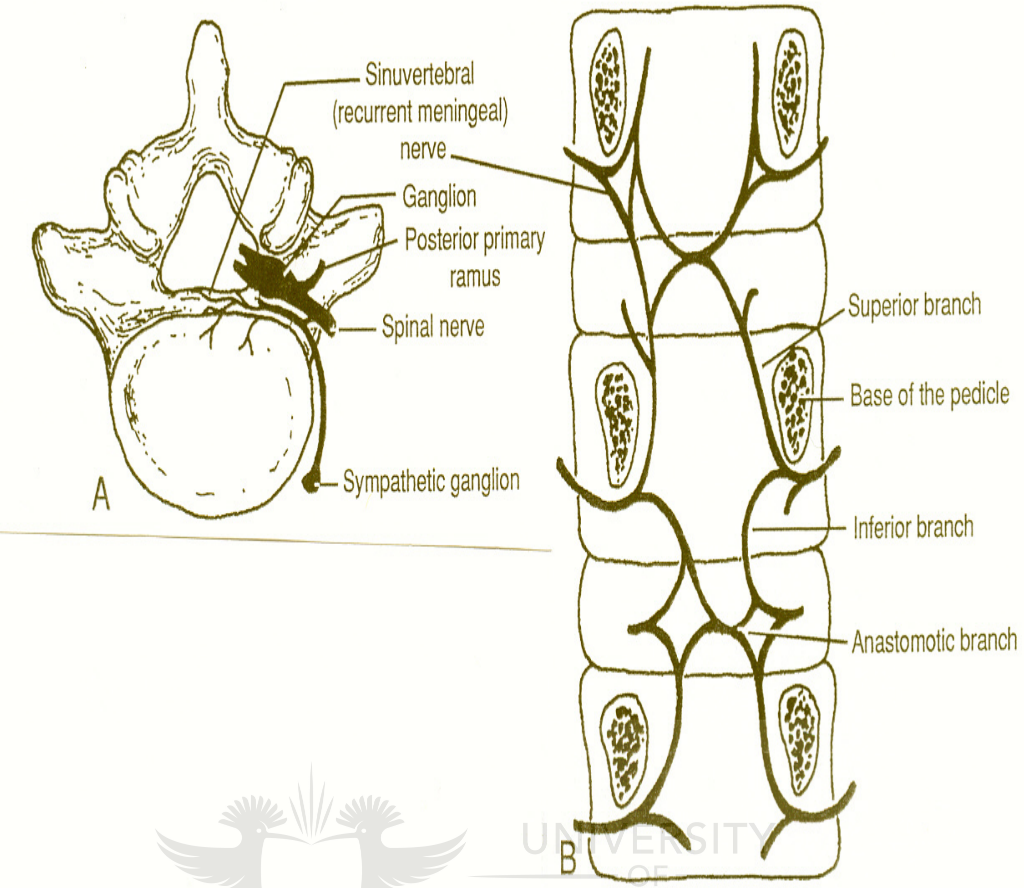


Figure 3 – The Sinuvertebral Nerve (Gatterman. 1990:19)

According to Cox (1998), the disc may be the primary source of pain, but mechanisms of pain production are uncertain. Pain in and around the disc can originate in interdiscal nerve endings, in the posterior longitudinal ligament near attachments to the disc, or in the ventral dura. Simple disc rupture, without direct nerve root compression by disc material, can account for low back pain with pain radiating to the leg. (Cox.1998)

Tears in the annulus fibrosus may cause discogenic back pain. Trauma rather than biomechanical degradation can cause peripheral tears and they develop independently of nuclear degeneration. A herniated nucleus pulposus may produce vague low back pain. (Cox. 1998)

2.2.2 Facet Syndrome

2.2.2.1 Facet joint dysfunction

Facet dysfunction following spinal hyperextension is one of the most common causes of back pain (Aprill and Bogduk. 1992). The function of the lumbar facet joints is to allow limited movement of the vertebrae and to protect the discs from shear forces, excessive flexion and axial rotation (Gatterman. 1990:131).

2.2.2.2 Definition

Cox (1998) describes the term facet syndrome as sudden onset of low back pain brought on by some activity usually involving the twisting or rotation of the lumbosacral region. He explains that superimposed loads on the lumbar spine are borne anteriorly by the body-disc-body complex and by the facets posteriorly. The spinal ligaments provide for stability of the posterior elements and the intervertebral disc. The vertebral surface areas gradually increase from T5 to L4. Thus there is increased weight bearing by the anterior column at these levels from above downwards.

However, the L5 vertebral body is significantly smaller than that of L4 indicating that force is diverted before reaching the L5 inferior surface. The mean articular facet area increases suddenly at L4-5 as compared to upper lumbar levels so there is more compressive force at the articular facets of the lower lumbar than the upper lumbar spine (Cox. 1990:437). Although only 20% of the weight is carried upon the articular facets, the resulting pressure per square inch on the facets is ten times greater than the pressure carried upon the knee of an upright person. This gives us a good idea of the strain produced on the articular facets in normal kinematics (Hellems and Keats. 1971).

2.2.2.3 The causes of lumbar facet syndrome

As described by Gatterman (1990:157,161), the causes of lumbar facet syndrome include trauma, mechanical or degenerative changes and postural factors.

a) Trauma can be subdivided into direct and indirect causes:

- Direct trauma involves activities such as lifting and carrying heavy objects, holding static positions for long periods of time, falls or strenuous exercise leads to hyperextension of the lumbar spine resulting in inflammation of the joint capsule. This results in increased intra-articular pressure, which results in acute pain.
- Indirect trauma such as pain arising from a synovial joint or intervertebral disc will evoke a splinting reflex from the surrounding muscle resulting in spasm and loss of movement in that joint. Pain from muscle pathology will produce the same effect. (Dishman. 1988).

b) Mechanical/degenerative

- As explained above, under compressive loading weight is borne by the facets as well as the intervertebral discs (Gatterman. 1990:161). Cox (1990:438) studied the percentage of weight bearing compressive load transmitted through the facets in people with normal intervertebral discs where there is no evidence of degeneration and a slightly flat lumbar lordosis. The load was shown to be 16% in two studies and between 3% and 25% in another. In degenerative disease, the articular weight bearing load ranges between 47% to 70%.
- Ligaments shorten as a result of long-standing muscle hypertonicity and eventually develop adhesions in the interarticular space. (Gatterman. 1990:45).

- Intra-articular jamming occurs when meniscoid fragments in the joints produce facet joint locking. (Gatterman. 1990:45).

c) Postural

Gatterman (1990:161) states that a faulty posture may lead to an increase in the angle of the sacral base resulting in an increased lumbar lordosis. As a result, the line of gravity shifts posteriorly and this increases weight bearing on the facets. Pain and facet syndrome may ensue.

2.2.2.4 Symptoms of a lumbar facet syndrome

- Deep aching pain that may radiate into the groin, hip, buttocks and legs.
- Increased pain when sleeping on the abdomen or standing upright and holding loads at waist height.
- If acute, sneezing and coughing will increase the pain. (Gatterman. 1990:161,162).

2.2.2.5 Signs of a facet syndrome

- Pain on lumbar extension.
- Decreased range of motion in any plane but especially in extension and rotation.
- Local facet tenderness.
- Absence of neurological deficit, or root tension signs
- Relief of pain on lumbar flexion
- A straight leg raise test may or may not be normal. (Jackson. 1992).

2.2.3 Myofascial Trigger points

2.2.3.1 Introduction

Skeletal muscle is the largest single organ system of the human body. It accounts for forty percent or more of the body weight (Travell and Simons. 1983, vol. 1:5). The myofascia is a thin, almost translucent film that wraps around the muscle tissue. It gives shape to and supports all of the body's musculature. Fascial changes are the cause of lumps and taut bands, called trigger points, developing. Once changed in this way, muscles can entrap nerves, constrict blood vessels and tighten around lymph vessels (Starlanyl and Copeland. 1996). Trigger points may occur in any muscle (Rachlin. 1994:145).

2.2.3.2 The Prevalence of Myofascial Trigger Points

Trigger points are extremely common and become a distressing part of nearly everyone's life at one time or another (Travell and Simons. 1983, vol. 1:5). Of 283 consecutive chronic pain patients who were examined independently by a neurosurgeon and physiotherapist, 85% were found to have a diagnosis of primary myofascial pain (Rachlin. 1994:145).

Among 200 unselected asymptomatic young adults, Sola, Rodenberger & Gettys (1955) found focal tenderness representing latent trigger points in the shoulder girdle muscles of 54% of the female and 45% of the male subjects. The incidence of myofascial pain syndrome appears to be higher in females than in males and although trigger points have been diagnosed in children and young adults, they are most frequently seen in the age range of 31-50 years (Rachlin. 1994:145).

2.2.3.3 The Pathophysiological Development of a Trigger Point

Stress and tension are the most common causes of trigger points (Rachlin. 1996:146). Trigger points are activated directly by acute overload, overwork fatigue or overuse, direct trauma, chilling, bruises, strains, joint problems and surgery. Acute pain creates a neuromuscular response and the muscle fibers around the pain site contract "guarding" the injured area (Pongratz and Spath. 2001). When muscles are in a state of sustained tension, they are metabolizing. A metabolizing muscle needs more nutrition and oxygen and produces more waste than a muscle at rest. A build-up of toxic waste in the myofascia is a trigger point (Starlanyl and Copeland. 1996:23).

2.2.3.4 Classification of Trigger Points

Trigger points are either active or latent (Travell and Simons. 1983, vol. 1:12).

- An active trigger point is an area that is tender when palpated in a taut band of muscle and it causes referred pain similar to the patients spontaneous pain complaint (Rachlin. 1994:147). Additionally, a local twitch response should also be visible either on manual palpation of the tender spot or following insertion of a needle into the spot (Rivner. 2001). Active trigger points are most likely to be found in the postural muscles of the neck, shoulder and pelvic girdles (Travell and Simons. 1983, vol. 1:13).

- A latent trigger point has the same characteristics as above, except for the absence of the referred pain similar to the patients spontaneous pain symptom (Rachlin. 1994:17). A latent type of trigger points does not hurt, unless it is being pressed and then it may demonstrate a local twitch response (Rachlin. 1994:147). It restricts movement and weakens and prevents full lengthening of the affected muscle. Overstretching, overuse or chilling the muscle may activate a latent trigger point. (Starlanyl and Copeland. 1996:123).

Latent trigger points may persist for years after apparent recovery from injury. Both active and latent trigger points cause dysfunction; only active trigger points cause spontaneous pain (Travell and Simons. 1983, vol. 1:12).

Trigger points are further subdivided into primary and secondary (Travell and Simons. 1983, vol. 1:13)

- Primary trigger points develop independently and not as a result of trigger point activity elsewhere (Rachlin. 1994:13).
- Secondary trigger points develop in antagonistic muscles and neighboring protective muscles as the result of chronic overloading caused by protective spasm. The spasm is maintained to decrease strain on the first muscle that is hypersensitive, shortened and weakened due to primary trigger points (Travell and Simons. 1983, vol. 1:13). Patients may receive only partial or temporary relief from trigger point management if treatment is limited to secondary trigger points (Rachlin. 1994:147).

Another type of myofascial trigger point needs to be explained and that is a satellite trigger point. Satellite trigger points are found to develop in muscles that lie in the pain referral area of other myofascial trigger points or within the pain referral area of a diseased viscus. (Travell. 1983, vol. 1: pg 14).

2.2.3.5 Characteristics and Symptoms of Trigger Points

Rachlin (1994:17) listed the following as characteristics and symptoms of trigger points:

- Localized tenderness
- Presence of a taut band
- Presence of a twitch response on palpation
- Production of referred pain on palpation of a trigger point site
- Sleep disturbance
- Stiff joints and decreased range of motion of joints
- Fatigue
- Parasthesia, which is a spontaneously occurring abnormal tingling sensation sometimes described as pins and needles. (Oxford Medical Dictionary. 483).
- Nausea
- Constipation

In addition Travell and Simons (1983, vol. 1:15) listed these characteristics and symptoms:

- Pain from a trigger point can be described as dull, deep, aching, throbbing or heavy. The intensity can range from mild discomfort to incapacitating torture. If a nerve is trapped, the pain can be sharp, burning or lightening-like
- Trigger point pain is rarely distributed equally on both sides
- Pain may also occur at both rest and motion
- Symptoms are aggravated by tension, emotional stress and exercise and alleviated by local heat, relaxing and mild exercise
- Autonomic concomitants- lacrimation, localized vasoconstriction, coryza, salivation, swelling and pilomotor activity
- Proprioceptive symptoms- imbalances, dizziness, tinnitus and a distorted perception of the weight of objects lifted in the hands

- Stiffness and weakness of involved muscles. This is most marked after a period of inactivity, especially after a nights sleep or after sitting in one position for an extended period. Muscle strength can therefore become unreliable in consistency. For example things may drop unexpectedly from the patients grasp.

3 THE LINK BETWEEN QUADRATUS LUMBORUM AND LOW BACK PAIN

The quadratus lumborum muscle is a flat, strong, moderately long, four-sided muscle that extends from the dorsal part of the iliac crest to the last rib and attaches by individual serration's of its medial border to the transverse processes of the lumbar vertebrae. The lateral border is smooth and free. The two flat surfaces of the muscle face ventrally and dorsally (Marieb. 1991) (see figure 4). Travell and Simons (1983:31) describes the groups of fibres of the muscle as being orientated in three directions:

- There are nearly vertical iliocostal fibres which attach above to the medial half of the 12th rib and below to the uppermost posterior crest of the ilium.

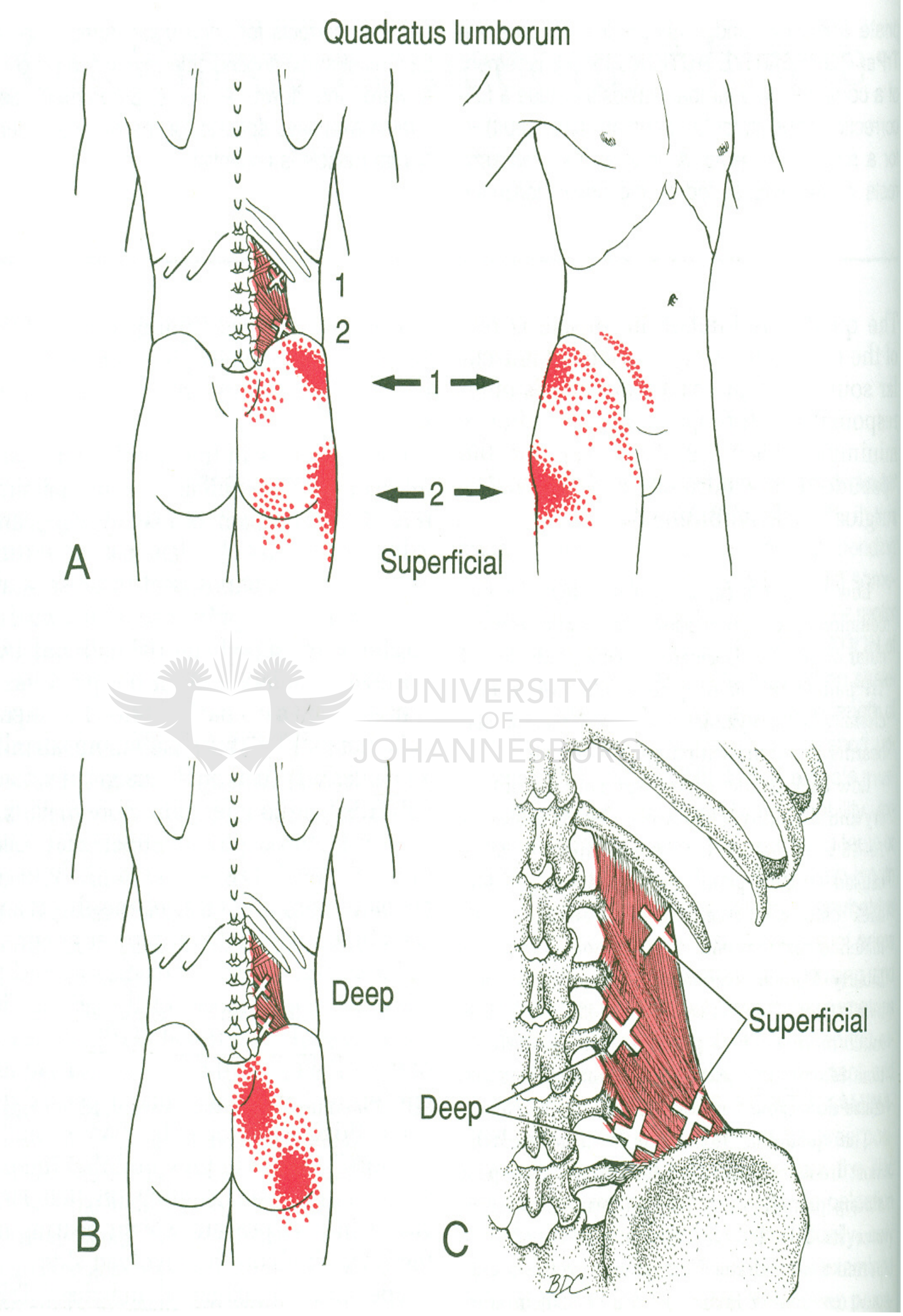


Figure 4 – Quadratus Lumborum Trigger Points (Travell and Simons. 1984, vol 2:30)

- The diagonal iliolumbar fibres attach above to the ends of the first three or four transverse processes (L1-L4) and below to the crest of the ilium;

- Thirdly, the diagonal lumbocostal fibres which intersect crosswise with the iliolumbar fibres. These fibres attach above to the 12th rib and below to most or all of the lumbar transverse processes.

There are four trigger point locations in the quadratus lumborum, two are superficial and two are deep; and each of the pairs has a cephalad and a caudal trigger point area. (Travell and Simons. 1983, vol. 2:29).

The trigger points that are found in the superficial cephalad location seem to refer pain along the crest of the ilium and sometimes the adjacent lower quadrant of the abdomen, the pain may radiate further to include the outer upper aspect of the groin (see label 1, figure 4A). (Travell and Simons. 1983:29).

The caudal superficial trigger points have been found to refer pain to the greater trochanter and the outer aspect of the upper thigh (see label 2, figure 4A). (Travell and Simons. 1983:29).

Trigger points in the deep cephalad location refer pain to the sacro-iliac joint area and if the trigger points occur bilaterally the referred pain area is that of the upper sacral region (see figure 4B). (Travell and Simons. 1983:29).

The more deep caudal trigger points refer pain to the lower buttock. (Travell and Simons. 1983:29).

Quadratus lumborum is an ideally situated stabilizer due to its unique bilateral buttressing effect on the spine. It joins the ribs, pelvis and each transverse process of the lumbar vertebrae. The quadratus lumborum is also one of the muscles that is highly active during flexion, extension and lateral bending. In addition, it forms part of a complex coordinating system of stablisers to protect the spine from instability. (Liebenson. 2000).

Panjabi (1992) has defined spinal instability as a decrease in the capacity of the stabilizing system of the spine to maintain the intervertebral neutral zones which results in pain and disability.

This stabilizing system as hypothesized by Janda(1983) divides skeletal muscle into tonic or phasic. Tonic or postural muscles maintain upright posture, these include quadratus lumborum, psoas major and erector spinae muscles. (Magee. 1987:26) With spinal dysfunction these muscles become tight or hypertonic. (Janda. 1983) Phasic muscles include almost all other muscles, these tend to become weak or inhibited with dysfunction. (Janda. 1983)

According to Janda (1991) the most common causes for short or tight muscles are chronic overuse or injury resulting in an eventual change in the elasticity of the muscle, inadequate postures or sedentary lifestyles, where the affected is unable to perform normal daily activities. Connective tissues tend to shorten when placed in a shortened position. Stress, constrained movements and chronic fatigue result in muscle imbalances that affect the programming of the central nervous system, this results in perpetuation of the imbalance through altered movement patterns. (Hammer. 1999)

Muscles can respond by either tightness and shortening or inhibition and weakness. Combinations of these tight weak muscles change joint biomechanics by creating alteration in movement patterns. (Hammer. 1999)

Pelvic crossed syndrome is an example of a muscle imbalance syndrome involving short/ tight hip flexors (iliopsoas and rectus femoris minimally) and lumbar paraspinals (erector spinae and quadratus lumborum) and weak/ inhibited gluteal and abdominal muscles. (Hammer. 1999) Tight hip flexors increase hip flexion which increases anterior pelvic tilt resulting in increased lumbar lordosis. This leads to jamming of the lumbar facets, increased distribution of pressure on the posterior discs and eventual degeneration. (Hammer. 1999)

Each movable joint requires a fixed point for normal function. The pelvis must be fixed for normal hip extension, but in this syndrome the pelvis needs to increase its anterior tilt for hip extension. The lower lumbar vertebrae usually act as the fixed point for the pelvis, but the anterior pelvic tilt may cause hypermobility of the L4 and L5 segments. Since the lower lumbar vertebrae cannot act as a fixed point for the pelvis a new fixed point is established at the thoracolumbar area which soon becomes hypomobile. (Hammer. 1999).

Liebenson (2002) said there is a normal balance of muscle groups that move joints. If this balance is disturbed the joints function will suffer. A study was conducted on patients with chronic low back pain from quadratus lumborum myofascial trigger points and it was found that thoracolumbar joint dysfunction often co-exists with quadratus lumborum myofasciitis (De Franca and Levine. 1991). Lewit (1996) related blockage of motion at the thoracolumbar junction to trigger points in iliopsoas, erector spinae, quadratus lumborum and the abdominal muscles.

Travell and Simons (1983, vol. 2:35) says that the opposite is also true, trigger point tension in these muscles can reinforce blockage of vertebral mobility at the thoracolumbar junction.

It follows then that we need to restore spinal stability to return the local muscle system to normal tonicity so that the global muscle system can be restored. As De Franca and Levine (1991) said, myofascial therapy directed at restoring muscle length and function, coupled with joint manipulation to related unstable or dysfunctional areas provides optimal results in relieving back pain.

4 CHIROPRACTIC TREATMENT OF LOW BACK PAIN

Chiropractic treatment is directed at restoring joint motion (Kirk, et al. 1991) and increasing muscle length (Korr. 1975).

4.1 The Chiropractic Adjustment

An adjustment or manipulation is a controlled, high velocity, low amplitude, dynamic thrust that moves the joint into the paraphysiological range of motion and is associated with a cavitation. The effect of a manipulation is primarily the restoration of the capabilities of normal movement to a previously restricted articulation (Kirk, et al. 1991:1). The biomechanical principals of leverage and force are utilized during chiropractic manipulation (Gatterman. 1990:51). A short-lever technique uses direct contact on the segment involved. Long-lever techniques use a specific or general primary contact on the body part but the second contact is remote from the segment forming a broad or long-leverage system of forces. (Haldeman. 1992:450). To mobilize a specific joint that is fixed a short lever arm is used. Long-lever techniques should be avoided when possible as hypermobility, an overflexible link in a series of articulated bodies, may be present at any level of the spine. The mechanical principles of force come into effect during the thrust phase of manipulation. They include the amount of force needed to release a locked joint and the direction of force. A joint should first be tractioned to tension before manipulating to reduce the amount of force required.

Direction of force is along the plane lines of the joint, which in the upper lumbar spine is in the sagittal plane and the coronal plane in the lower lumbar region (Gatterman. 1990:51). The amplitude of the thrust refers to the arc through which the lever is operated and determines the distance the thrust is set to travel (Gatterman. 1990:51). The velocity of the thrust refers to the speed of the applied force and is defined as the time rate change of displacement. (Gatterman. 1990:51).

4.2 Studies relating to the efficacy of chiropractic adjusting for low back pain

According to Cox (1990:484), 86% of patients who had back pain for at least two weeks sought professional care. The most common source of care sought was the general practitioner, followed by the orthopedic surgeon. The next most common source of care was the chiropractor with nearly one third of low back pain sufferers having sought care from the chiropractor.

Rand, a prestigious research organization in the US, reviewed the published literature on spinal manipulation and released a report on the appropriateness of spinal manipulation for low back pain. The multidisciplinary panel concluded that there was consistent support for the use of spinal manipulation for certain kinds of low back pain (Shekelle, et al. 1991).

The Manga Report (1993), commissioned by the Ontario Ministry of Health and prepared by highly respected health economists at the University of Ottawa, represents the largest most thorough analysis of the scientific literature on low back pain to date. It clearly demonstrates that chiropractic management of low back pain is more effective, more cost effective and produces higher levels of patient satisfaction than other forms of management (Manga, et al. 1993).

In 1990 the British Medical Research Council conducted a randomized controlled trial involving 741 patients. Roughly half the patients received traditional medical treatment and the other half received chiropractic care. The researchers used the Oswestry Pain and Disability Questionnaire and the results of objective range of motion testing to confirm their findings. The patients progress was measured by their ability to walk, lift, sit and conduct their lives. (Meade, et al. 1990).

The report showed that those patients who received chiropractic treatment were significantly better within six months and remained so during the two-year follow-up period (Meade, et al.1990). A follow-up study was published in 1995, which presented the full results. At three years the results confirmed the earlier findings that when chiropractic or hospital therapists treated patients with low back pain, as they would in day-to-day practice, those treated by chiropractors derived more benefit and long-term satisfaction than those treated by hospitals (Meade, et al. 1995).

Nyiendo, Haas and Goodwin (2000), conducted a prospective, observational, community-based feasibility study. The study compared practice activities and one-month outcomes for chronic, recurrent low back pain treated by chiropractors and family medicine physicians. A total of 138 patients was used, 93 chiropractic patients and 45 medical patients. The trials were done at various private chiropractic clinics, the Outpatient Department of Family Medicine at Oregon Health Services University and five other family medicine clinics in the Portland area. The treatment of choice for the chiropractors was spinal manipulation and physical therapy modalities; for the medical physician anti-inflammatory agents were most frequently used. The outcome measures as well as the results are listed below:

	Chiropractors	**Medical Patients**
Pain Severity	31% change	6% improvement
Functional disability	29%	1%
Sensory Pain Quality	36%	29% deterioration
Affective Pain Quality	57% affective	26% affective

On average chiropractic patients showed improvement across all outcomes and satisfaction scores were higher for chiropractic patients.

4.3 Studies relating to the efficacy of chiropractic adjustment on hypertonic muscles

Korr (1975) says that when articular surfaces are separated during an adjustment, the hypertonic muscle is suddenly stretched, initiating muscle spindle mediated reflexes that relieve the hypertonicity.

According to Sandoz (1981), a high-velocity manipulative thrust performed at the extreme of the restricted joint’s motion activates the Golgi tendon organs inhibiting muscle activity thereby reducing muscle spasm.

Joint fixations due to primary muscle hypertonicity respond rapidly to spinal manipulative therapy and require relatively few treatments. (Gatterman. 1990:52).

Haldeman (1992:448) claims that spinal manipulation produces significant short-term bursts of proprioceptive transmissions arising from the joint capsules, ligaments and muscle spindles of the local paraspinal muscles that results in a reduction of both pain and muscle hypertonicity.

The techniques used were all taken from States Manual of Spinal, Pelvic and Extravertebral Techniques (Kirk, et al. 1985:93-103) and they were as follows:

- Thigh transverso-deltoid – or lumbar roll, the patient lay on their side with the listing up, inferior hand under head. The upper shoulder was posterior with the arm resting on the lateral body wall. The lower thigh and leg was straight and the upper thigh and leg was flexed with the dorsum of the foot placed in the popliteal space of the lower limb. The pelvis was brought to the edge of the table. The doctor stood anterior to the patient in a fencer's stance facing cephalad, lateral thigh to thigh contact, the caudad hand was in a pisiform contact on the transverse process of the listed segment fingers parallel to the spine, forearm at right angles to the contact hand. The cephalad hand contacted the anterior aspect of the upper shoulder. The doctor then tractioned the pelvis out with the leg that was in contact with the patient and the hand that was in contact with the shoulder and was thrust anterior with the caudad hand.

- Transverso-ilio lift – the patient lay prone antigravity, the doctor was on the contralateral side of the listing, facing the table at right angles to the patient. The cephalad hand was in a pisiform contact on the transverse or mamillary process with the fingers pointing out. The caudal hand was in a broad digital contact on the anterior border of the ilium at the level of the anterior superior iliac spine. The doctor then tractioned the pelvis posteriorly into extension and the contact hand was thrust in an anterior direction.

- Transverso deltoid – the patient was seated on the headpiece, straddling the table; knees were held tight to the table sides; back, neck and head was erect. The arms were crossed with the hands on opposite shoulders, the homolateral arm on top. The doctor stood behind the patient at a 90 degree angle to the patient; the doctor's contralateral arm reached around the patient making contact on the patients' deltoid area; the elbow of the doctor's homolateral arm was held in the doctor's inguinal region for support. The contact hand was the homolateral hand and it made a pisiform contact on the transverse process or mamillary process of the listed segment. The torso was rotated until all slack was removed and the contact hand was thrust anteriorly with body weight.

- Transverso brachial – the patient was seated as before straddling the headpiece with fingers interlaced behind the neck, elbows in front of them. The doctor stood behind the patient facing caudad at a 90 degree angle and close to the patient. The contralateral hand of the doctor reached underneath the patients' contralateral arm and grasped the brachium of the homolateral arm, the homolateral hand made a pisiform contact on the transverse or mamillary process of the segment to be adjusted. The doctor tractioned and rotated the torso removing all slack and then thrust through the contact hand via the hip.

5 ELECTROMYOGRAPHY READING OF SKELETAL MUSCLE

In hypertonic muscles the rate of gamma efferent discharge is high (Khan. 1994:69). Any local irritability factor or metabolic abnormality of a muscle for example severe cold, lack of blood flow to the muscle or overexercise of muscles can elicit pain and sensory impulses that result in muscle contraction (Guyton. 1981:638). This contraction stimulates the sensory receptors more, causing an increase in the intensity of the contraction thus creating a positive feedback mechanism until muscle spasm occurs. (Guyton. 1981:638). This will result in a constant action potential while the muscle is in spasm.

Each time an action potential passes along a muscle fibre a small portion of the electrical current spreads away from the muscle as far as the skin. (Guyton. 1981:136). If many muscle fibres contract simultaneously, the summated electrical potential at the skin may be great (Guyton. 1981:136).

According to William and Ganong, activation of motor units in muscles can be studied by electromyography. This may be done on unanaesthetised humans by using small metal discs placed on the skin overlying the muscle as the pick-up electrodes. (Khan. 1994:39). Moffet, Moffet and Schauf (1993:332) say an electrode picks up muscle action potentials directly related to the level of muscle contraction. Guyton (1981:638) said, by placing two electrodes on the skin over a muscle, an electrical recording called an electromyography can be made of the muscle activity.

6 ULTRASOUND THERAPY

Therapeutic ultrasound involves transforming a current of 110V to 500V by electronic components in the ultrasound apparatus. This higher frequency is then imposed onto a crystal and vibrating sound waves are produced for therapeutic purposes. (Rachlin. 1994:480). The crystal is in contact with a metal face plate and causes it to vibrate. (Kahn. 1994:53). Any substances in contact with the face plate, such as water, oils, and gels, conduct the wave energy to adjoining surfaces such as the skin. (Kahn. 1994: 60). Ultrasound waves have been reported to penetrate as deep as 4cm to 6cm into tissues. (Kahn. 1994:64).

The physiological effects of ultrasound are:

- Chemical reactions – ultrasound vibrations stimulate tissues to enhance chemical reactions and circulation of elements.
- Biological responses – ultrasound increases the permeability of membranes which enhances the transfer of fluids and nutrients to tissues.
- Mechanical responses – the high frequency of vibration of ultrasound deforms molecular structures of loosely bonded substances, sometimes resulting in cavitation. This phenomena is therapeutically useful for the sclerolytic effects produced with a resultant decrease in muscle spasm and increase in range of motion and break up of calcific depositions thereby increasing tendon extensibility. (Kahn. 1994:70).

In this research project the patient received placebo ultrasound therapy. Peters (2001:802) defined placebo as an empty preparation or intervention imitating an effective preparation or intervention. The patient was told how ultrasound therapy works and the physiological effects gained for muscle spasm. They were then treated according to the treatment procedure with the ultrasound at OHz.

7 PLACEBO

Peters (2001:24) says the model(s) of action of placebo is (are) not known. Broome (1989) speculates that operant conditioning, classical conditioning, guilt reduction, transference, suggestion, persuasion, role demands, hope, faith, labeling, selective symptom monitoring, misattribution, cognitive dissonance, control therapy, anxiety reduction, expectancy effects and endorphin release could all produce a placebo effect.

A more scientific explanation could be that the effect of psychological factors on endorphins, gastric secretions, blood pressure and the immune system influences sexuality, breathing, posture and voluntary muscle as well as general behaviour. (Peters. 2001:115). All these systems could eventually influence a whole variety of physical symptoms and so psychological factors affecting them could easily contribute to placebo effects.

As the control group were under the impression that they were being treated it seems possible that psychological factors were at play in producing pain relief and increased range of motion.

8 CONCLUSION

A large number of people are affected by back pain as shown in the statistics provided. There are many causes of back pain, but the focus for the purpose of this study is directed at facet syndrome and myofascial trigger points.

The study investigates the effect of adjusting the lumbar spine joints and measuring the effect this has on the quadratus lumborum lying adjacent to these joints because of the possible link between muscle and joint function. Quadratus lumborum plays a major role in stabilizing the lumbar spine (Liebenson: 2000); it also functions in controlling the relationship between the intervertebral segments and the movement of these joints. It has been found that muscle pathology and joint instability go hand-in-hand, when muscle function is compromised, joint movement may be affected and vice versa (Liebenson: 2000).

The effectiveness of chiropractic manipulation on low back pain patients has been shown. It has hypothesized that by adjusting the low back with the aim of improving lumbar vertebral function, quadratus lumborum trigger points will be reduced as well as hypertonicity of the muscle.

CHAPTER THREE

MATERIALS AND METHODOLOGY

1 STUDY DESIGN

The study was a pilot, randomised, controlled clinical trial carried out in order to determine the effectiveness of chiropractic treatment on myofascial trigger points or hypertonicity of the quadratus lumborum muscle in the treatment of lower back pain. This was done by comparing one group (Group 1) receiving placebo ultrasound therapy with another group (Group 2) receiving chiropractic manipulation.

2 PATIENT SELECTION

The study population consisted of thirty subjects who were recruited by means of advertisements in the local newspapers and patients who presented themselves to the Technikon Witwatersrand Chiropractic Health Clinic with lower back pain.

2.1 INCLUSION CRITERIA

- Only those volunteers who had been suffering from lower back pain for six weeks or longer and presented with active or latent myofascial trigger points or hypertonicity of quadratus lumborum were included in the study.

- Patients were also required to have at least one fixation from the T12-L4 vertebral segments.

- Patients were required to be between 18 and 50 years of age. This criteria was stipulated in order to ensure a sufficiently wide range of ages included in the sample group, at the same time eliminating patients with osteoporosis or degenerative disease. Such patients would have to be excluded as they cannot receive chiropractic manipulative therapy.

2.2 EXCLUSION CRITERIA

- All patients with contraindications to ultrasound therapy and electromyographic studies were excluded. Even though the ultrasound therapy was placebo, the patients were instructed as if they really were receiving treatment and so they had to be informed of any contraindications they may have had to ultrasound therapy. These contraindications include the pregnant uterus, the presence of a pacemaker, diabetic patients, patients with venous insufficiency, patients with signs and symptoms of cancer, patients with metallic implants or surgical fixation materials and patients with skin disorders, especially over the lower back region.

- Patients with conditions that contraindicate spinal manipulative therapy such as aneurysms, tumours, bone infection, traumatic injuries, arthritides, osteoporosis, osteopaenia and space occupying lesions were excluded as conditions such as these may be exacerbated by chiropractic manipulation.

- Any patient that had received treatment for this condition less than 6 weeks prior to presenting for the study could not be included in the sample group.

On presentation, the potential subjects underwent a full medical history and physical examination (Appendix 1 and 2) and a lower thoracic and lumbar regional examination (Appendix 3). Following these examinations, if there were any signs or symptoms that suggested the presence of contraindications to chiropractic manipulation (such as bone infection, traumatic injuries, aneurysms, tumours or osteoporosis) (Gatterman. 1990:55-68), the patient was sent for x-ray examination of the lower lumbar region to exclude these contraindications. Anterior pelvic views were taken as well as lumbar spine anterior, lateral and oblique views.

The patients were questioned about the nature of their pain and examined by palpation in order to determine the presence of any myofascial trigger points in the quadratus lumborum muscle. The diagnosis of the trigger points were made according to the criteria set out in Travell and Simons (1983).

i) localised region of maximum tenderness;
ii) referred pain patterns specific to the quadratus lumborum (this includes the area over the sacro-iliac joint, the lower buttock, anteriorly along the iliac crest, the lower quadrant of the abdomen, groin and greater trochanter);
iii) an involuntary twitch response of the muscle that contracts;
iv) a taut palpable band in the muscle;
v) a limited range of stretching of the quadratus lumborum (lateral flexion);
vi) jump sign where the patient vocalises or withdraws from the pain evoked by the pressure the therapist applies to the trigger point;
vii) patient recognition of the pain as being the pain that effects them.

Motion palpation of the lumbar spine was conducted at each consultation prior to treatment to determine the presence of a fixation in that area. Motion palpation was conducted with the patient seated with crossed arms and the examiner standing obliquely behind on the same side that was being palpated. (Gatterman. 1990:142)

Flexion restrictions were palpated by placing the thumb in between the spinous processes while flexing the patient forward. The examiner felt for interspinous separation. (Gatterman 1990:144)

Extension restrictions were palpated with the thumb placed over the spinous process. The patient was moved into extension and the examiner pushed anteriorly with the thumb while checking for a normal springy end feel. (Gatterman. 1990:146)

Right and left flexion restrictions were palpated with the examiners thumb placed along the spinous processes on the left when palpating for left lateral flexion restrictions and vice versa for the right side. The patient was passively flexed to the left with pressure placed on the spinous processes with the palpating thumb. The examiner felt for a block in motion indicating a fixation. (Gatterman. 1990: 142)

Right and left rotation restrictions were palpated for in the same manner as above, except that the patient was rotated clockwise when palpating for left rotation restrictions and anti-clockwise when palpating the right side. (Schafer & Faye. 1990:213).

All findings were noted on the SOAP note (subjective, objective, assessment and plan) (Appendix 4).

Thirty subjects who complied with the criteria of the research after all of the examinations were chosen as the patients to represent the sample group. The patients were then divided into one of two groups of 15 by drawing a number from a hat. The even numbers were placed into Group 1 and the odd numbers were placed into Group 2. Group 1 would undergo placebo ultrasound therapy and Group 2 would receive chiropractic manipulative therapy.

All subjects were required by means of a consent form (Appendix 5) to agree to the conditions of the research. They were required to avoid all forms of analgesics, anti-inflammatories and any other form of medication or treatment that could alleviate their lower back pain, for the duration of the trial.

On completion of the statistical analysis an error was noted in the method of back range of motion measurement. As a result, a further ten candidates were examined. Subjects were recruited in the same manner as the original sample groups and the same selection procedures were followed. All of these patients received chiropractic manipulative therapy.

2.3 METHODS OF MEASUREMENT

2.3.1 Objective Measurements

The following objective measures were taken prior to treatment on the first, fourth, sixth and follow up visits: back range of motion using a digital inclinometer, electric activity of the quadratus muscle using an electromyograph and trigger point pressure using an algometer.

2.3.1.1 Back range of motion

Back range of motion was measured with a digital inclinometer. This measures the maximum range of motion of the patient in flexion, extension, right and left lateral flexion and right and left rotation. The measurements were conducted in accordance with the American Medical Association guidelines as explained in Appendix 6. Measurements of lumbar range of motion were conducted as explained on page 8 of Appendix 6 from point 5 to point 7 for gross lumbar motion. The inclinometer was placed at position B, the T12 – L1 interspace. The readings were taken and recorded on the SOAP note. Calculation of the measurements was conducted as indicated in point 12.

An error was noted on the statistical analysis in the back range of motion results and it was suggested that an incorrect method of measurement could be the reason for the error. As a result a further ten candidates were treated and back range of motion measurement repeated using the AMA guidelines as above and as stated in Appendix 6. Steps 2 – 6 were followed.

With the patient standing erect the sacral midpoint (A) and the T12-L1 interspace (B) were marked. The inclinometer was zeroed at A. The patient was then asked to flex maximally and the reading was recorded. The patient returned to an erect posture. The inclinometer was then zeroed at B and the patient was asked to flex maximally again. The reading was recorded. This procedure was repeated for extension, right and left rotation and right and left lateral flexion. All readings were recorded and the measurements worked out by subtracting (B) from (A). The resulting value presents gross lumbar motion (see Appendix 6).

The following factors may interfere with obtaining accurate measurements:

a) Pain, fear, acute muscle spasm and neuromuscular inhibition may temporarily limit spinal movement.

b) If the patient puts in less than optimal effort it will affect the measurement of mobility.

c) The possibility of faulty recording technique by the researcher.

2.3.1.2 The electromyograph

The electromyography readings provide the second objective measurement criteria. The procedure of electromyography compares the electrical activity of skeletal muscle fibres at rest and during voluntary activation of muscle. Two electrode pads were placed over the quadratus lumborum muscle belly, lateral to the paraspinal muscles, one on the left side and another on the right with the patient standing erect.

Recordings were made of the quadratus lumborum muscle unit action potentials as they pass from the neuromuscular junctions along the muscle to activate the individual muscle fibres within the motor units. These recordings were fed into a computer screen and monitored visually and stored. Clinically, it is useful to be able to demonstrate when a particular muscle is contracting. The normal pattern of activity can be recognised and it is also possible to recognise abnormalities, such as myopathic or neuropathic abnormalities or a combination of both. (Robinson and Snyder-Mackler. 1995). Measurements were taken over a fifteen-second time period and readings were then added together to obtain an average measurement for both sides.

Awad (1973) and Arroyo (1966) reported increasing numbers of polyphasic potentials during activity of muscle afflicted with trigger points. Electromyographic monitoring of the fibres in the palpable bands of trigger points reveals a sustained burst of electrical activity that has the same configuration as motor unit action potentials. (Travell and Simons. 1983). In another study, motor unit activities were found to be increased in palpable bands of trigger points. In some cases clinical twitch responses were elicited on one side but not on the normal contralateral side, which was used as a control site. (Rachlin. 1994). In active trigger points, it is believed that a trigger point is electrically silent at rest but shows abnormal electrical activity when palpated. The muscle which harbours referred pain, however, is electrically active at rest. (Rachlin. 1994).

2.3.1.3 The algometer

The algometer measures pressure threshold, pressure tolerance and tissue compliance. The purpose is to mimic the pressure applied by the examiner's thumb when palpating for myofascial trigger points. The algometer is pushed down into the trigger point until pain is felt in the trigger point and the reading is then recorded. A latent trigger point will be able to withstand a much greater pressure than an active trigger point. The algometer provides an objective measure of the effectiveness of treatment (Fischer. 1987). Boureau, et al. (2000) said that pressure algometry appears to be a reliable method for assessing pressure sensitivity in myofascial pain. Each trigger point on the left and right has a superficial and deep area, which was measured in the following manner.

The quadratus lumborum muscles trigger points were described in Chapter 2. To measure the patients' trigger points they were placed in the side-lying position on the left side, right side up to palpate right trigger points and vice versa for the left trigger points. The arm of the side to be examined was raised onto the top of the table behind the head to elevate the thoracic cage. The knee of that side was dropped onto the table behind the other knee to pull the pelvis distally and lower the iliac crest. (Travell and Simons. 1983. Vol. 2:64). According to Travell and Simons (1983 Vol. 2:65), there are three regions in this muscle to be examined for trigger points.

- The first region is a deep trigger point and is located in the angle where the crest of the ilium and the paraspinal muscle mass meet and can be found by applying deep pressure superiorly to the crest of the ilium and anteriorly to the paraspinal muscle, directing pressure towards the lumbar transverse processes.

- The second region, where many of the iliocostal fibres attach, is just along the inner crest of the ilium and can be palpated with the tip of the finger applied in the direction of the muscle fibres.

- The third region lies in the angle where the paraspinal mass and the 12th rib meet and can be felt with deep fingertip palpation applied in the direction of L1-L2 transverse process.

If the trigger point was active sustained pressure in any one of these regions elicited the trigger points pattern of referred pain. (Travell and Simons. 1983. Vol. 2:68). The algometer plunger was then placed on the trigger point and pushed down to obtain a reading of the pressure one would apply before eliciting pain. This reading was recorded on the SOAP note. If the patient did not complain of pain and the needle on the dial of the algometer reached 10mmHg, which is maximum, a maximum reading was recorded.

2.3.2 Subjective measurements

Subjective measurements were taken in the form of two questionnaires, the Oswestry Low Back Pain and Disability Questionnaire (Appendix 6) and the Numerical Pain Severity Scale (Appendix 6).

2.3.2.1 The Oswestry Low Back Pain and Disability Questionnaire

This questionnaire is commonly used in research and clinical settings to measure the pain and disability associated with chronic pain conditions. Fritz & Irrgang (2001) did a study where they compared the measurement properties of an Oswestry Low Back Pain and Disability Questionnaire and the Quebec Back Pain Disability Scale. Sixty-seven low back pain patients receiving physical therapy participated in the study.

The two scales were administered initially and after four weeks of treatment the results showed that the Oswestry Low Back Pain and Disability questionnaire had higher levels of test-retest reliability and responsiveness compared with the Quebec Disability Scale. The authors concluded that the Oswestry Low Back Pain Disability Questionnaire demonstrated superior measurement properties compared with the Quebec Back Pain Disability Scale.

In a similar study by Davidson and Keating (2002) comparing the reliability and responsiveness of five low back disability questionnaires the conclusion was that the Oswestry Disability Questionnaire was the most reliable questionnaire.

The questionnaire measures how pain associated dysfunction is affected by treatment. The questionnaire asks the patient questions relating to their ability to manage everyday tasks such as walking, sitting, etc., with their condition. The answers to this questionnaire provide the study with subjective data as to the progression of the patients' condition prior to and following treatment. Each of the ten sections is rated on a 6-point scale (0-5) to a total of 50 where a score of 0 is minimal to no disability and at a score of 50 the patient will be bed bound. By adding the individual item scores and multiplying by 2 the result can be expressed as a percentage.

2.3.2.2 The Numerical Pain Rating Scale

As with the Low Back Pain and Disability Questionnaire, the Numerical Pain Rating Scale is an indication of the patients' pain. The scale has been found to be highly reliable and valid and is recommended for pain intensity measurement in outcome based research studies. (Robinson and Snyder-Mackler. 1995). The patient is asked to indicate the level of pain they are experiencing at that moment on a scale of 1 to 10 where 1 means no pain and 10 means excruciating pain.

2.4 TREATMENT OF THE DATA

The statistical analysis was conducted on a 95% confidence level.

Objective data

Back range of motion readings were taken in degrees in flexion, extension, right and left rotation and right and left lateral flexion. The difference between the initial and fourth, initial and sixth and the initial and follow-up readings were statistically analysed.

Electromyograph readings were measured for the left and right quadratus lumborum muscle and an average obtained, the difference between the first and fourth, first and sixth and first and follow-up treatments were then statistically analysed.

Algometer readings were taken of all quadratus lumborum trigger points. The difference between the initial and fourth, initial and sixth and initial and follow-up readings were statistically analysed.

Subjective data

For both the low back pain and disability questionnaire and the numerical pain rating scale the results were worked out into percentages and the differences between the first and fourth, first and sixth and the first and follow-up treatments were statistically analysed.

2.5 TREATMENT PROCEDURES

- The patient received treatment at each consultation, except the follow-up, totalling six treatments over a two-week period with a one month follow-up period.

- The questionnaires were answered and measurements were taken prior to the first, fourth, sixth and follow-up visits

- Group 1 received five minutes of placebo ultrasound therapy over the lower lumbar region. The mechanism and effect of ultrasound treatment was explained to each patient. The patient lay prone and ultrasound gel was applied over the lower back then the ultrasound head was moved over the area for five minutes at a frequency of OHz.

- The lumbar fixations of Group 2 were corrected by way of spinal manipulation at the specific level of restriction. Due to the fact that the lumbar vertebrae may become restricted in different directions of movement, it was not possible to manipulate fixated segments in the same manner. Various manipulative techniques were used as described on page 26. For right or left lateral flexion or rotation fixations the thigh tranverso-deltoid or lumbar roll was used in most cases. When the patient was too large or in too much discomfort when placed in the lateral recumbent position the seated transverso-deltoid or transverso-brachial technique was used. For the higher T12-L2 adjustments the transverso-deltoid or transverso-brachial technique was used. The size of the patient determined whether the deltoid (smaller patients) or brachial (larger patients) contact was used. Some patients could not position themselves in a straddle position to perform the seated adjustment. In which case the prone transverso-ilio lift technique was used.

- Group 3, the additional ten subjects, were manipulated as explained in the bullet above.

CHAPTER FOUR

STATISTICAL ANALYSIS

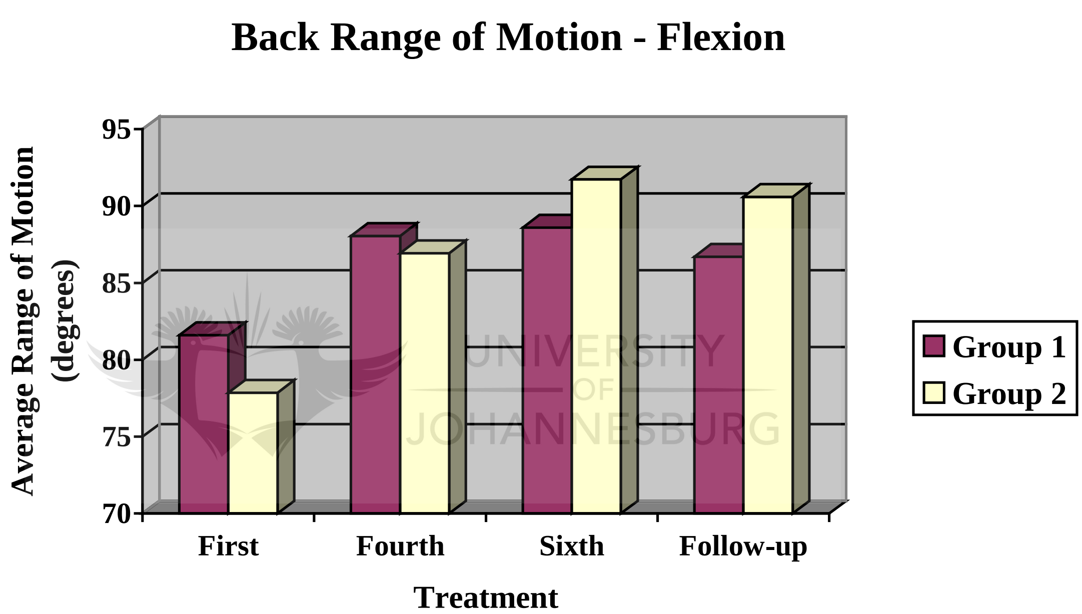
(GROUP 1 AND 2 - INITIAL TRIALS)

THE RESULTS OF THE OBJECTIVE DATA

4.1 BACK RANGE OF MOTION – FLEXION

4.1.1 Back Range of motion – flexion

Change in the degree of back range of motion in flexion between groups



4.1.2 Degree of back range of motion – flexion of Group 1

R.O.M.	Mean	Std. Dev.	95% conf.	Min.	Max.	Median
Flexion						
First	81.6	11.06	5.6	62	99	84
Fourth	88.06	20.29	10.27	55	129	89
Sixth	88.6	20.79	10.52	54	136	90
Follow-up	86.7	22.23	11.25	51	138	85

4.1.3 Degree of back range of motion – flexion of Group 2

R.O.M.	Mean	Std. Dev.	95% conf.	Min.	Max.	Median
Flexion						
First	77.86	23.68	11.98	58	98	80
Fourth	86.93	21.64	10.95	50	131	85
Sixth	91.73	24.44	12.37	49	138	92
Follow-up	90.6	24.64	12.47	46	140	91

4.1.4 P-values of the Wilcoxon signed rank test on flexion

Range of Motion	**Treatment**	**Group 1**	**Group 2**
Flexion	First- Fourth	0.16	0.05
	First – Sixth	0.17	0.08
	First – Follow up	0.13	**0.01**
	Fourth – Sixth	0.45	0.28
	Sixth – Follow up	1.34	0.45

4.1.5 P-values of the Mann-Whitney rank sum test on flexion

Range of Motion	**Treatment**	**Group 1 vs Group 2**
Flexion	Prior to the first	0.07
	Prior to the fourth	**0.03**
	Prior to the sixth	**0.0005**
	Prior to the follow-up	**0.0001**

Note: Statistically significant values in bold

4.1.6 Interpretation of the data

Flexion

Intragroup - Group 2 showed statistically significant increase in flexion from the first to the follow up treatment (P-value = 0.01). Group 2 also showed the greatest increase in overall range of motion. (see tables 4.1.2, 4.1.3 and 4.1.4)

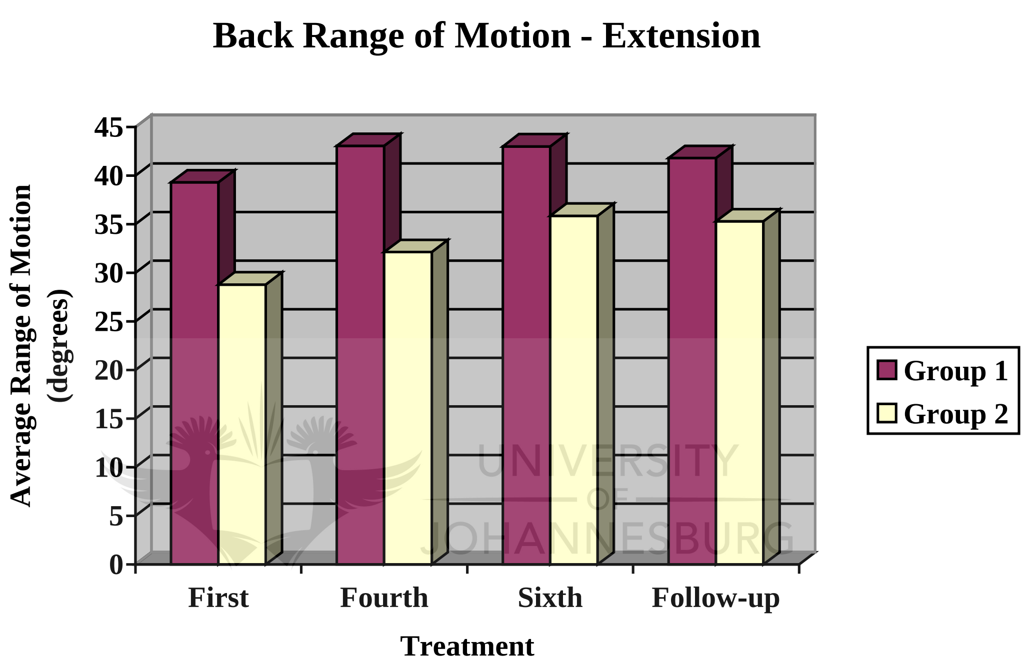
Intergroup – The groups showed a statistically significant increase in flexion between the first and the fourth, the first and the sixth and the first and the follow-up treatments (P-values = 0.003, 0.0005 and 0.0001 respectively).

Both groups showed increase in range of motion between the first and fourth and the first and sixth treatments, with the latter being greater. Both groups also showed a slight decrease in flexion from the sixth to the follow up treatment. (see tables 4.1.2, 4.1.3 and 4.1.5)

4.2 BACK RANGE OF MOTION – EXTENSION

4.2.1 Back Range of Motion – Extension

Change in degree of back range of motion in extension between groups



4.2.2 Degree of back range of motion – extension of Group 1

R.O.M.	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
Extension						
First	39.3	24.39	12.34	12	85	34
Fourth	43.06	23.82	12.05	15	89	36
Sixth	43	24.67	12.48	21	90	30
Follow-up	41.8	22.96	11.62	18	87	32

4.2.3 Degree of back range of motion – extension of Group 2

R.O.M.	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
Extension						
First	28.8	14.41	7.29	10	70	26
Fourth	32.13	15.76	7.98	15	73	30
Sixth	35.86	15.65	7.92	16	75	32
Follow-up	35.3	16.46	8.33	13	76	33

4.2.4 P-values of the Wilcoxen signed rank test on extension

Range of Motion	Treatment	Group 1	Group 2
Extension	First- Fourth	0.38	**0.01**
	First – Sixth	0.2	0.25
	First – Follow up	0.39	0.14
	Fourth – Sixth	0.41	0.26
	Sixth – Follow up	0.47	0.4

4.1.5 P-values of the Mann-Whitney rank sum test on extension

Range of Motion	Treatment	Group 1 vs Group 2
Extension	Prior to the first	0.2677
	Prior to the fourth	0.3285
	Prior to the sixth	0.2613
	Prior to the follow-up	0.5163

Note : Statistically significant values in bold

4.2.6 Interpretation of the data

Extension

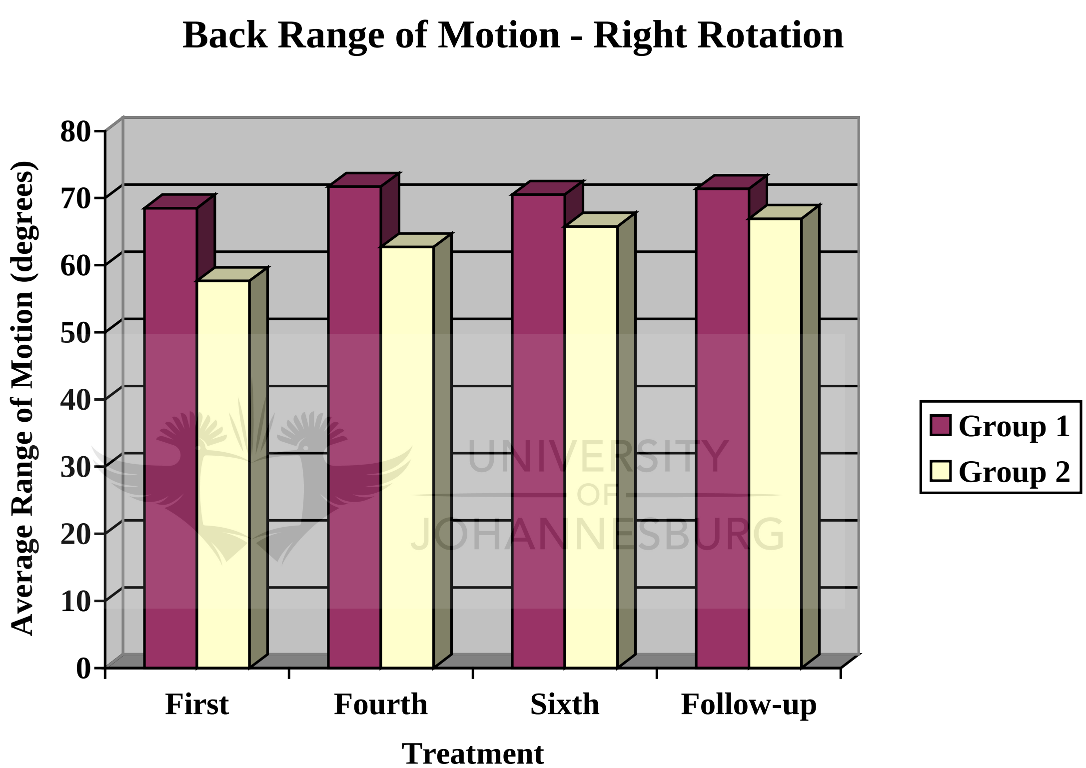
Intragroup- Group 2 showed a statistically significant increase in extension between the first and the fourth treatment (P-value = 0.01). Group 2 also showed the greatest increase in extension, with Group 1 hardly showing any change at all. (see tables 4.2.2, 4.2.3 and 4.2.4)

Intergroup- Although not statistically significant both groups showed a slight increase in range of motion prior to the sixth treatment and there was a decrease in extension prior to the follow up visit in both groups. (see tables 4.2.2 and 4.2.3)

4.3 BACK RANGE OF MOTION – RIGHT ROTATION

4.3.1 Back Range of Motion – Right Rotation

Change in degree of back range of motion in right rotation between groups



4.3.2 Degree of back range of motion – right rotation Group 1

R.O.M.	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
Right rotation						
First	68.5	25.84	13.08	26	114	63
Fourth	71.73	24.43	12.36	32	111	68
Sixth	70.53	20.38	10.31	34	112	69
Follow-up	71.4	20.76	10.51	34	109	71

4.3.3 Degree of back range of motion – right rotation Group 2

R.O.M.	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
Right rotation						
First	57.67	11.22	5.68	47	83	53.5
Fourth	62.73	11.1	5.62	44	85	58
Sixth	65.8	9.3	4.71	55	86	63
Follow-up	66.93	10.53	5.33	48	84	65

4.3.4 P-values of the Wilcoxen signed rank test on right rotation

Range of Motion	Treatment	Group 1	Group 2
Right rotation	First- Fourth	0.36	0.18
	First – Sixth	0.41	**0.02**
	First – Follow up	0.37	0.2
	Fourth – Sixth	0.47	0.08
	Sixth – Follow up	0.43	0.23

4.3.5 P-values of the Mann-Whitney rank sum test on right rotation

Range of Motion	Treatment	Group 1 vs Group 2
Right rotation	Prior to the first	**0.0161**
	Prior to the fourth	0.0567
	Prior to the sixth	**0.0001**
	Prior to the follow-up	**0.0371**

Note : Statistically significant values in bold

4.3.6 Interpretation of the data

Right rotation

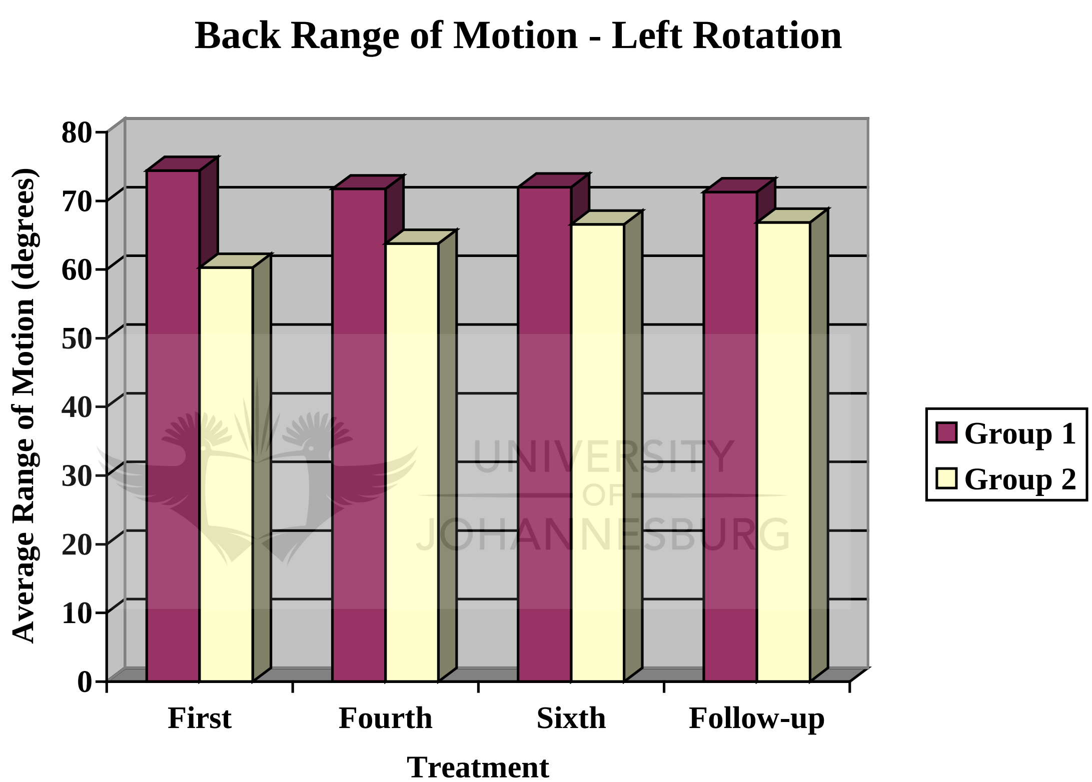
Intragroup- In right rotation group 2 showed a statistically significant change in range of motion between the first and the sixth treatment (P-value = 0.02). Both groups increased range of motion between the first and the fourth treatment, group 1 decreased in motion between the first and the sixth and increased again between the first and the follow up treatments. Group 2 showed the greatest overall increase in right rotation. (see tables 4.3.2, 4.3.3 and 4.3.4)

Intergroup – There was a statistically significant change in motion prior to the first, sixth and follow up treatments between the groups (P-values = 0.0161, 0.0001 and 0.0371 respectively). (see tables 4.3.2, 4.3.3 and 4.3.5)

4.4 BACK RANGE OF MOTION – LEFT ROTATION

4.4.1 Back Range of Motion – Left Rotation

Change in degree of back range of motion in left rotation between groups



4.4.2 Degrees of back range of motion – left rotation Group 1

R.O.M.	Mean	Std. Dev.	95% conf.	Min.	Max.	Median
Left rotation						
First	74.4	24.67	12.48	38	120	64
Fourth	71.73	23.23	11.76	40	115	64
Sixth	72	18.22	9.22	50	104	69
Follow-up	71.27	18.06	9.14	48	101	48

4.3.3 Degree of back range of motion – left rotation Group 2

R.O.M.	Mean	Std. Dev.	95% conf.	Min.	Max.	Median
Left rotation						
First	60.3	11.62	5.88	41	85	59
Fourth	63.8	11.77	5.96	45	88	63
Sixth	66.6	8.96	4.53	50	86	67
Follow-up	66.87	11.5	5.82	45	84	66

4.3.4 P-values of the Wilcoxen signed rank test on left rotation

Range of Motion	Treatment	Group 1	Group 2
Left rotation	First- Fourth	0.16	0.31
	First – Sixth	0.28	0.07
	First – Follow up	0	0.05
	Fourth – Sixth	0.42	0.22
	Sixth – Follow up	0.32	0.37

4.3.5 P-values of the Mann-Whitney rank sum test on left rotation

Range of Motion	Treatment	Group 1 vs Group 2
Left rotation	Prior to the first	**0.0001**
	Prior to the fourth	**0.0226**
	Prior to the sixth	**0.0211**
	Prior to the follow-up	**0.0371**

Note : Statistically significant values in bold

4.4.6 Interpretation of the data

Left rotation

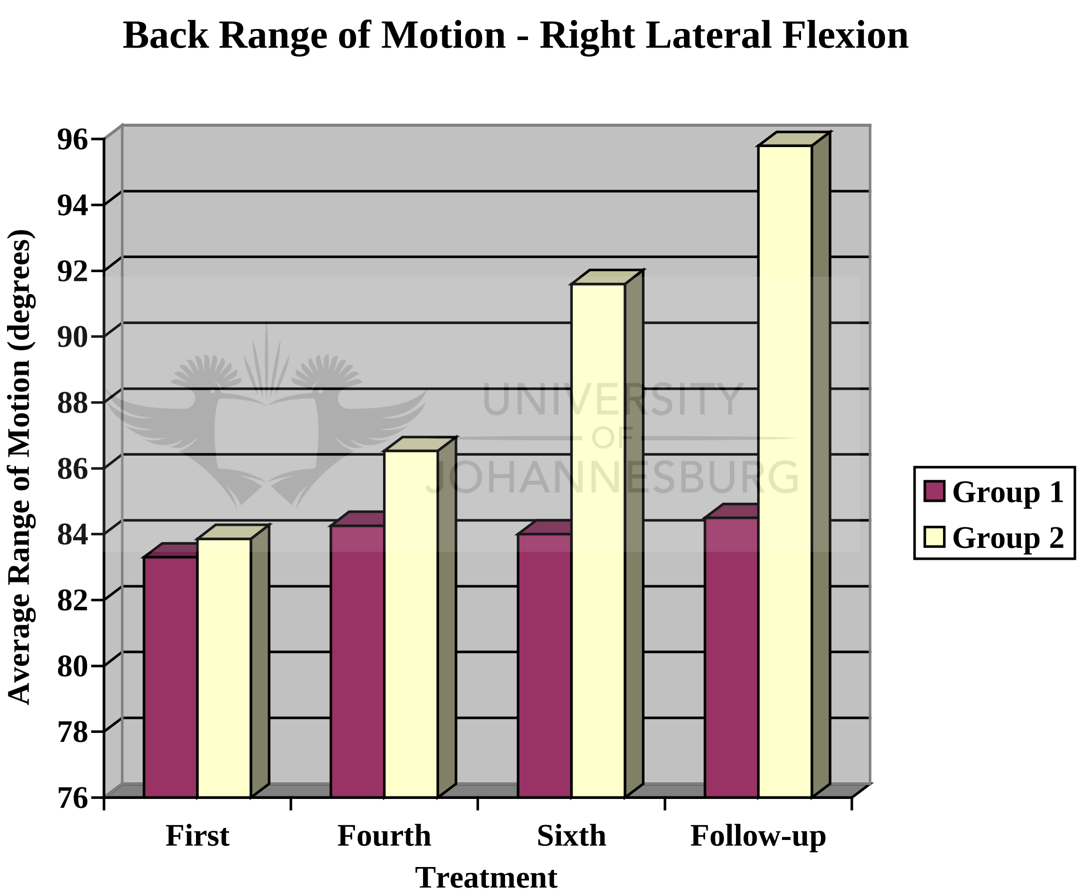
Intragroup- Neither group showed any statistically significant changes, group 2 showed the greatest increase in range of motion while Group 1 showed a decrease in range of motion from the first treatment to the follow up treatment. (see tables 4.4.2, 4.4.3 and 4.4.4)

Intergroup- The groups have shown a statistically significant increase in range of motion before all treatments (P-values = 0.0001, 0.0226, 0.0211 and 0.0371 respectively). (see tables 4.4.2, 4.4.3 and 4.4.5)

4.5 BACK RANGE OF MOTION – RIGHT LATERAL FLEXION

4.5.1 Back Range of Motion – Right Lateral Flexion

Change in degree of back range of motion in right lateral flexion between groups



4.5.2 Degrees of back range of motion – Group 1 right lateral flexion

R.O.M.	Mean	Std. Dev.	95% conf.	Min.	Max.	Median
Right lat. flex						
First	83.3	12.94	6.55	59	114	83
Fourth	84.26	10.06	5.09	61	101	85
Sixth	84	11.58	5.86	63	100	86
Follow-up	84.5	10.68	5.4	65	100.	86

4.5.3 Degree of back range of motion – right lateral flexion Group 2

R.O.M.	Mean	Std. Dev.	95% conf.	Min.	Max.	Median
Right lat. flex						
First	83.86	18.97	9.6	88	136	76
Fourth	86.53	18.71	9.47	68	136	81
Sixth	91.6	18.54	9.38	73	123	81
Follow-up	95.8	19.44	9.84	68	135	91

4.5.4 P-values of the Wilcoxen signed rank test on right lateral flexion

Range of Motion	Treatment	Group 1	Group 2
Right lateral	First- Fourth	0.49	0.83
flexion	First – Sixth	0.3	0.21
	First – Follow up	0.33	0.17
	Fourth – Sixth	0.42	0.08
	Sixth – Follow up	0.39	0.19

4.5.5 P-values of the Mann-Whitney rank sum test on right lateral flexion

Range of Motion	Treatment	Group 1 vs Group 2
Right lateral flexion	Prior to the first	**0.0096**
	Prior to the fourth	**0.0009**
	Prior to the sixth	0.0859
	Prior to the follow-up	0.1662

Note : Statistically significant values in bold

4.5.6 Interpretation of the data

Right lateral flexion

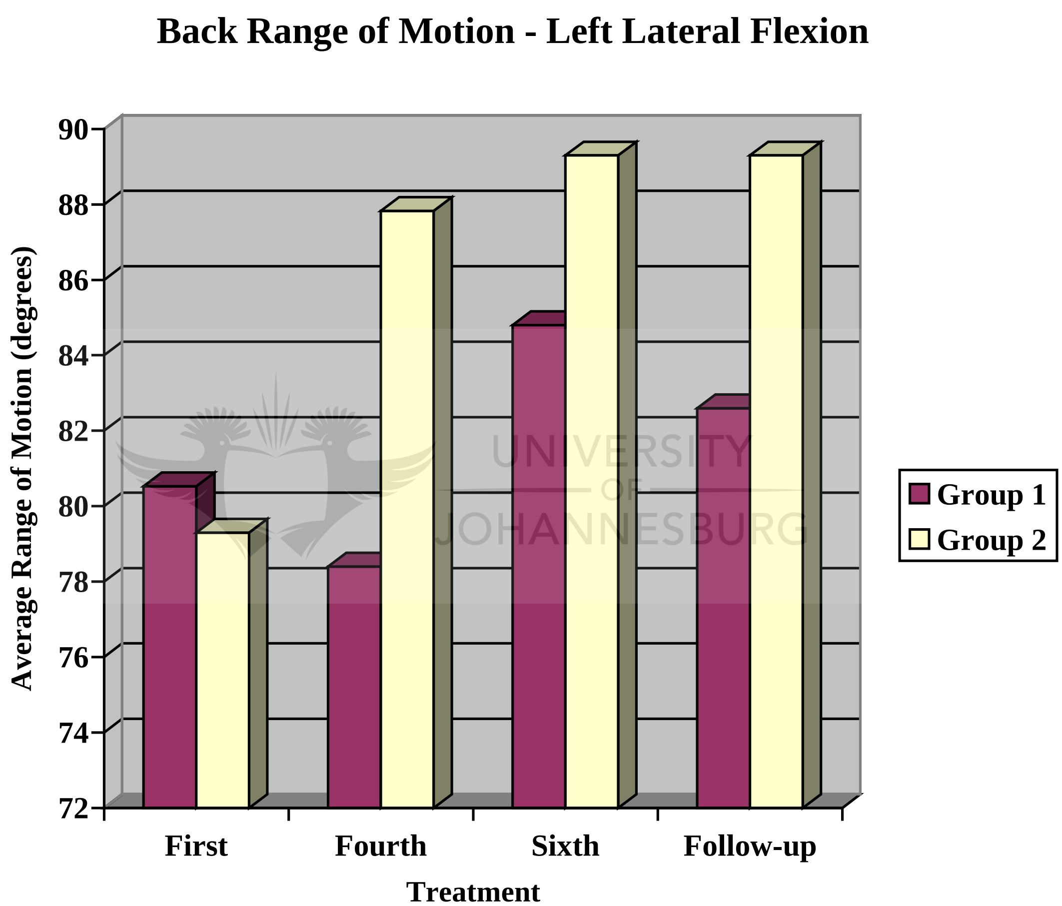
Intragroup – Although not statistically significant group 2 showed the greatest overall increase in range of motion. (see tables 4.5.2, 4.5.3 and 4.5.4)

Intergroup – The groups showed statistically significant increases in right lateral flexion prior to the first and fourth treatments (P-values = 0.0096 and 0.0009 respectively), but there were none thereafter. (see tables 4.5.2, 4.5.3 and 4.5.5)

4.6 BACK RANGE OF MOTION – LEFT LATERAL FLEXION

4.6.1 Back Range of Motion – Left Lateral Flexion

Change in degree of back range of motion in left lateral flexion between groups



4.6.2 Degrees of back range of motion – left lateral flexion Group 1

R.O.M.	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
Left lat. flex						
First	80.53	15.55	7.87	45	100	79
Fourth	78.4	13.68	6.92	57	103	78
Sixth	84.8	16.55	8.38	60	125	82
Follow-up	82.6	12.76	6.46	63	105	83

4.6.3 Degree of back range of motion – left lateral flexion Group 2

R.O.M.	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
Left lat flex						
First	79.3	11.94	6.04	59	95	78
Fourth	87.83	14	7.08	68	115	86
Sixth	89.3	10.32	5.22	69	105	89
Follow-up	89.3	12.25	6.2	68	107	89

4.6.4 P-values of the Wilcoxen signed rank test on left lateral flexion

Range of Motion	**Treatment**	**Group 1**	**Group 2**
Left lateral	First- Fourth	0.31	0.07
flexion	First – Sixth	0.29	0.17
	First – Follow up	0.39	**0.04**
	Fourth – Sixth	0.18	0.29
	Sixth – Follow up	0.35	0.33

4.6.5 P-values of the Mann-Whitney rank sum test on left lateral flexion

Range of Motion	**Treatment**	**Group 1 vs Group 2**
Left lateral flexion	Prior to the first	0.2822
	Prior to the fourth	0.5187
	Prior to the sixth	0.0859
	Prior to the follow-up	0.1662

Note : Statistically significant values in bold

4.6.6 Interpretation of the data

Left lateral flexion

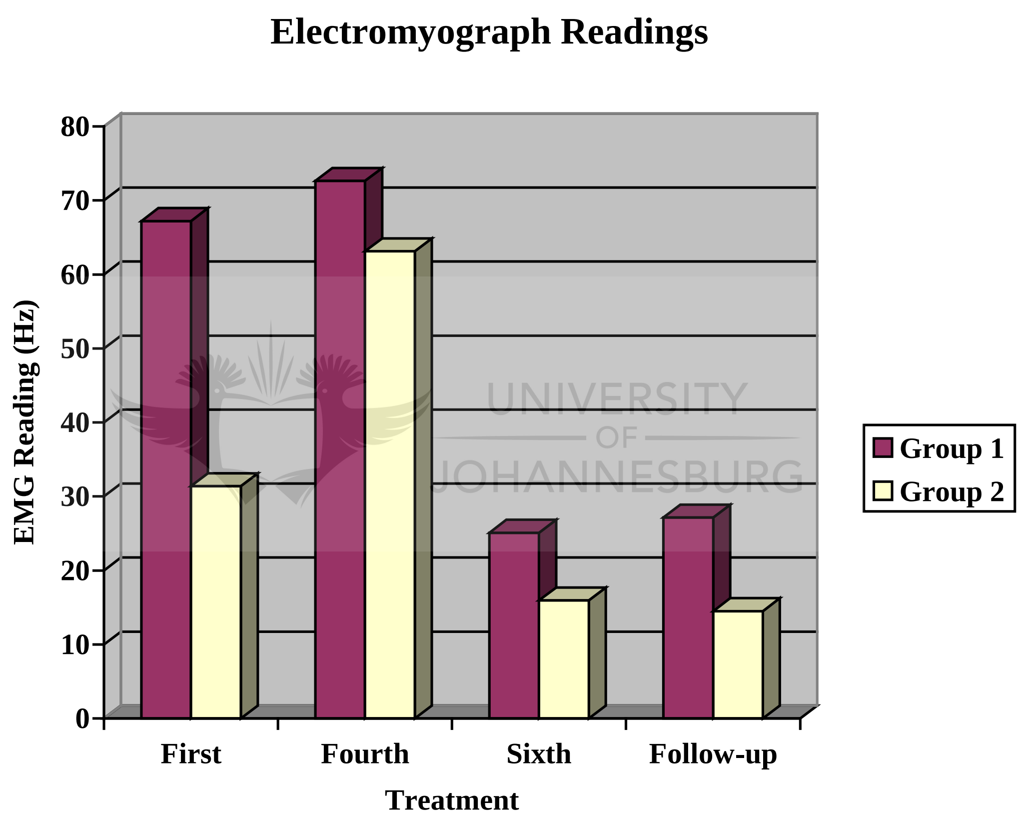
Intragroup – Group 2 showed statistically significant changes in range of motion between the first and follow up treatments (P-value = 0.04). Group 2 showed the greatest overall increase in left lateral flexion over the treatment period. (see tables 4.6.2, 4.6.3 and 4.6.4)

Intergroup – There were no statistically significant differences in the groups for left lateral flexion. (see table 4.6.5)

4.7 ELECTROMYOGRAPH

4.7.1 Electromyograph readings

Change in the average readings of the left and right electromyograph leads between groups.



4.7.2 Electromyograph Readings

Average readings of the left and right electromyography leads

GROUP 1						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	67.23	68.55	34.69	3.79	208.25	52.3
Fourth	72.64	130.23	65.9	1.34	412.25	15.25
Sixth	25.1	24.91	12.61	1.74	72.65	14.55
Follow up	27.15	23.12	11.7	4.84	31.25	21.4

GROUP 2						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	31.39	55.74	28.21	1.73	53.51	6.37
Fourth	63.13	99.47	50.34	1.88	289.1	10.46
Sixth	15.94	23.04	11.66	2.84	43.72	5.51
Follow up	14.51	23.75	12.02	2.43	37.75	6.71

4.7.3 P-values on the Wilcoxon signed rank test for EMG readings

TREATMENT	GROUP 1	GROUP 2
First- Fourth	0.29	0.21
First – Sixth	0.32	0.39
First – Follow up	0.13	0.37
Fourth – Sixth	0.44	0.32
Sixth – Follow up	0.29	0.22

4.7.4 P-values of the Mann-Whitney rank sum test for EMG readings

TREATMENT	GROUP 1 vs GROUP 2
Prior to first	0.9174
Prior to fourth	0.7856
Prior to sixth	0.7244
Prior to follow up	0.2902

4.7.5 Interpretation of the data

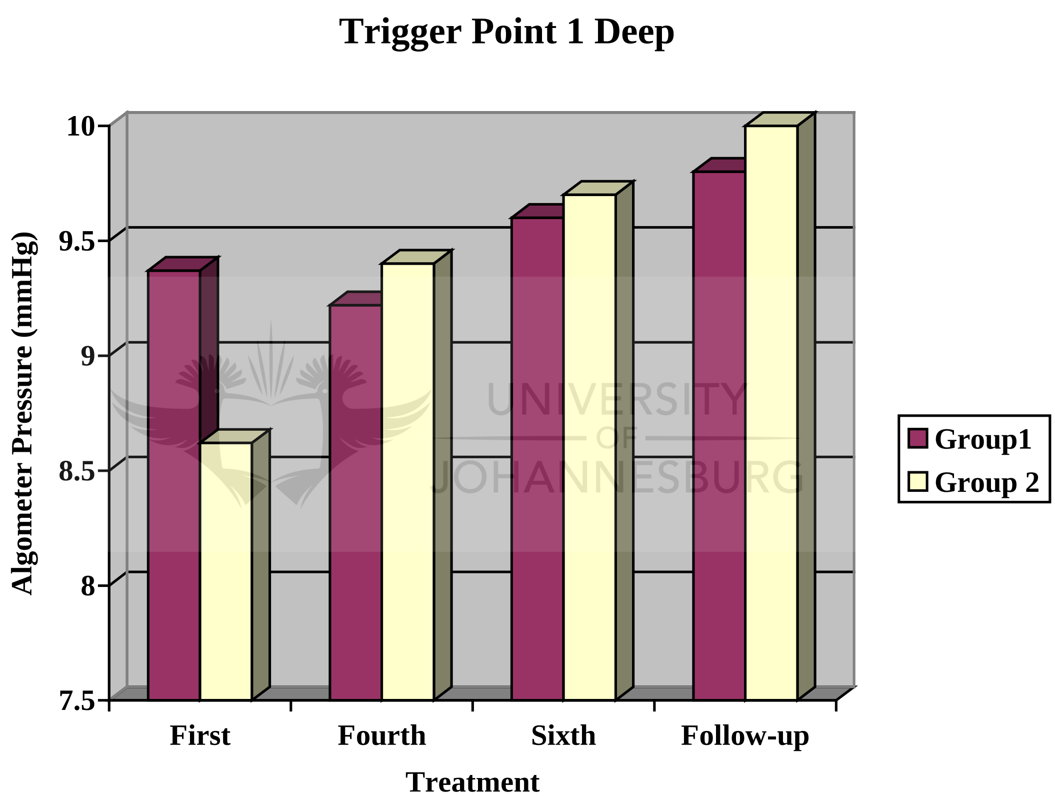
Intragroup – The average readings between the left and right electromyograph leads showed no statistically significant values. In Group 1 there was an increase in muscle activity between the first and fourth treatments and then a decrease in activity prior to the sixth treatment and then it increased slightly again prior to the follow up treatment. Group 2 showed similar findings but the increase between the first and fourth treatments was greater and there was a slight decrease between the sixth and follow up treatments. (see tables 4.7.2 and 4.7.3)

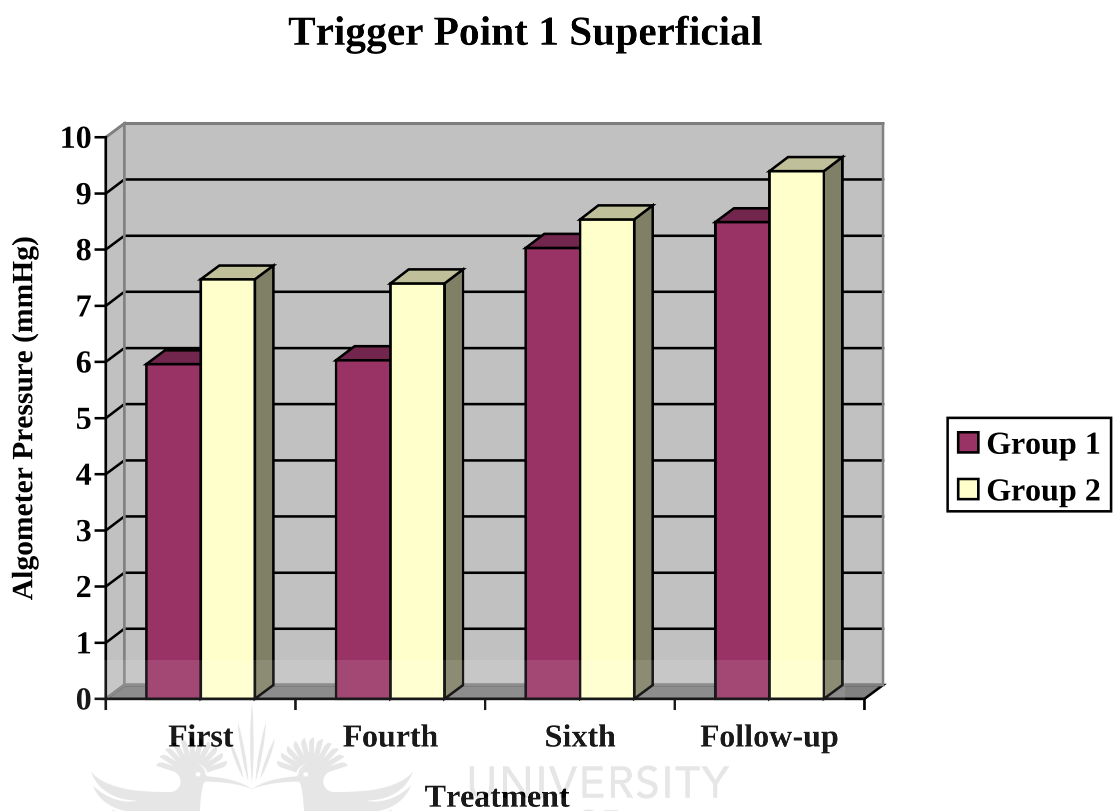
Intergroup – There was no statistically significant changes in the electromyograph readings. (see table 4.7.4)

4.8 TRIGGER POINTS

4.8.1 Algometer readings – Trigger point 1 deep and trigger point 1 superficial

Change in pressure applied to trigger point 1 between Groups.

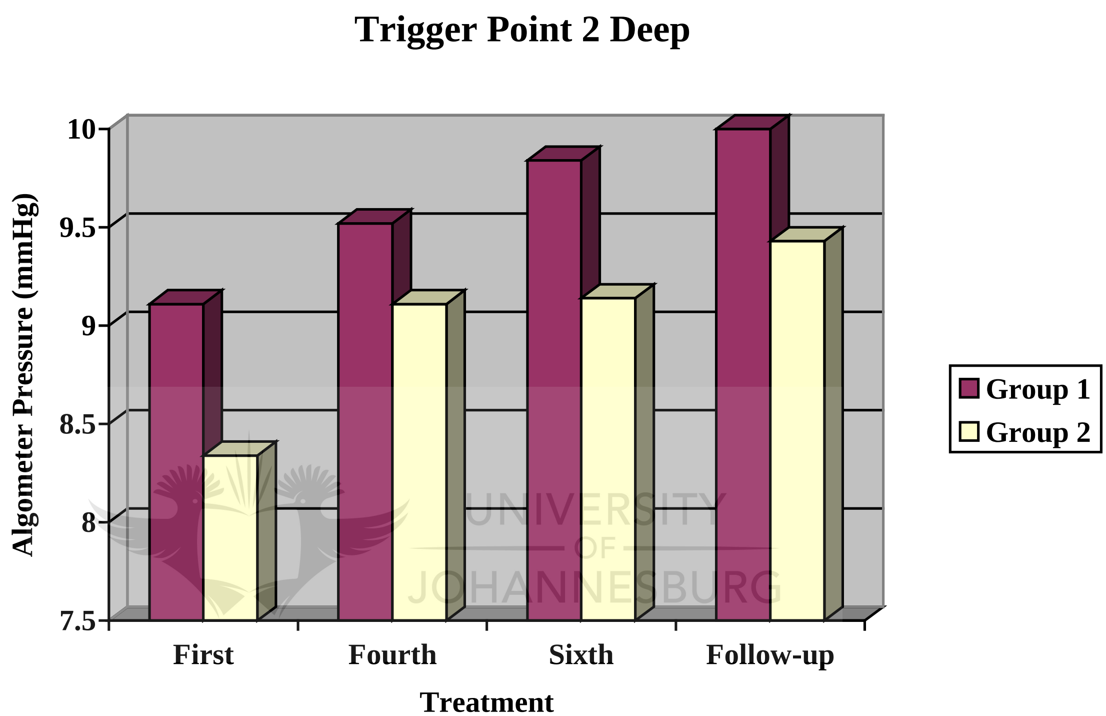


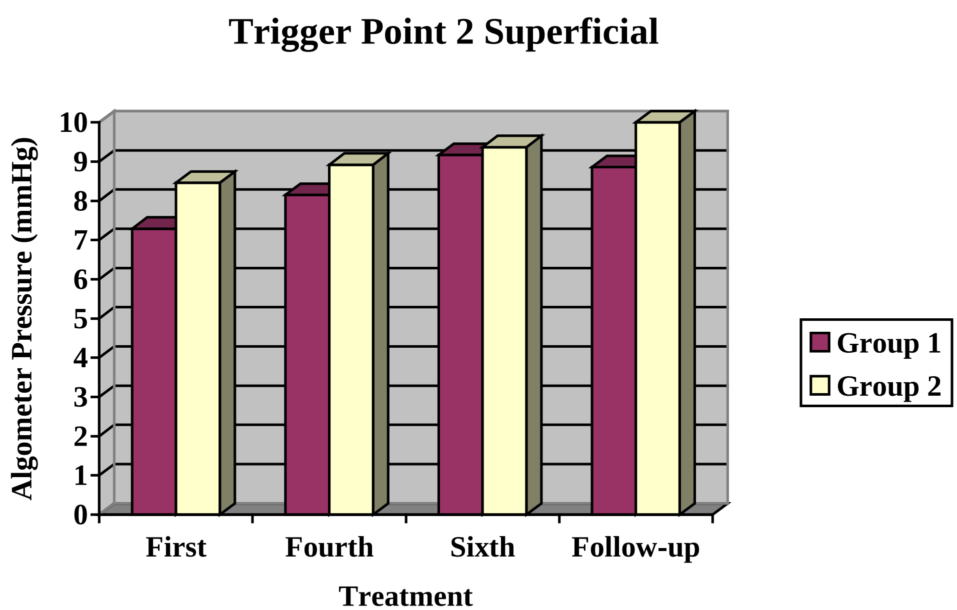


Trigger Point 1 Superficial
Algometer Pressure (mmHg)
10
9
8
7
6
5
4
3
2
1
0
First
Fourth
Sixth
Follow-up
Treatment
Group 1
Group 2

4.8.2 Algometer readings – Trigger point 2 deep and trigger point 2 superficial

Change in pressure applied to trigger point 2 between groups.




Trigger Point 2 Superficial
Algometer Pressure (mmHg)
10
9
8
7
6
5
4
3
2
1
0
First
Fourth
Sixth
Follow-up
Treatment
Group 1
Group 2

4.8.3 Algometer readings for Group 1

Average readings of left and right Trigger points 1 and 2

Group 1						
TP1 Deep						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	9.37	1.67	0.6	4.6	10	10
Fourth	9.22	1.99	0.72	3	10	10
Sixth	9.6	1.42	0.87	4	10	10
Follow up	9.8	0.645	0.23	5	10	10
TP1 Sup						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	5.96	3.23	1.16	1	10	4.55
Fourth	6.03	3.05	1.09	1	10	5.1
Sixth	8.03	2.94	1.05	1	10	10
Follow up	8.49	2.73	0.98	1	10	10
TP2 Deep						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	9.11	2.14	0.77	2	10	10
Fourth	9.52	1.88	0.67	2.5	10	10
Sixth	9.84	0.65	0.23	7	10	10
Follow up	10	0	0	10	10	10

TP2Sup						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	7.29	3.35	1.2	2	10	10
Fourth	8.15	2.87	1.03	1	10	10
Sixth	9.17	1.69	0.6	3	10	10
Follow up	8.86	2.51	0.9	1.2	10	10

4.8.4 Algometer readings for Group 2

Average readings of left and right trigger points 1 and 2.

Group 2						
TP1 Deep						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	8.62	2.74	1.14	2.5	10	10
Fourth	9.4	1.59	0.66	4.7	10	10
Sixth	9.7	0.98	0.41	3.5	10	10
Follow up	10	0	0	10	10	10

TP1 Sup						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	7.47	3.17	1.32	2	10	5.75
Fourth	7.4	2.74	1.14	2.2	10	6.2
Sixth	8.54	3.12	1.3	1.8	10	10
Follow up	9.4	2.78	0	2.3	10	10
TP2 Deep						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	8.34	2.96	1.24	1	10	10
Fourth	9.11	2.11	0.88	3.4	10	10
Sixth	9.14	2.32	0.97	3	10	10
Follow up	9.43	1.32	0.55	2.3	10	10
TP2Sup						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	8.46	3.02	1.26	1.4	10	10
Fourth	8.92	2.38	0.99	3.2	10	10
Sixth	9.37	2.1	0.88	2.5	10	10
Follow up	10	0	0	10	10	10

4.8.5 P-Values of the Wilcoxon signed rank test for all trigger points

TREATMENT	GROUP 1	GROUP 2
Trigger point 1 deep		
First – Fourth	0.52	**0.03**
First – Sixth	0.21	0.32
First – Follow-up	0.09	**0.03**
Fourth - Sixth	0.1	0.32
Sixth – Follow-up	0.25	0.33
Trigger point 1 superficial		
First – Fourth	0.65	0.48
First – Sixth	**0.02**	**0.006**
First – Follow-up	**0.03**	**0.0005**
Fourth - Sixth	**0.02**	0.06
Sixth – Follow-up	0.06	**0.03**
Trigger point 2 deep		
First – Fourth	0.09	**0.02**
First – Sixth	**0.02**	**0.04**
First – Follow-up	**0.03**	**0.02**
Fourth - Sixth	0.16	0.12
Sixth – Follow-up	0.33	0.38

TREATMENT	GROUP 1	GROUP 2
Trigger point 2 superficial		
First – Fourth	**0.01**	**0.03**
First – Sixth	**0.0003**	0.06
First – Follow-up	**0.001**	**0.03**
Fourth - Sixth	**0.005**	0.2
Sixth – Follow-up	0.29	0.16

Note: Statistically significant values in bold

4.8.6 Interpretation of the data

Intragroup – The pressure that could be applied to all trigger points in Group 1 generally increased from the first to the follow-up visits. Trigger point 1 superficial for Group 1 showed statistically significant increases from the first to sixth, first to follow-up and fourth to sixth treatments. Trigger point 2 deep for Group 1 showed the same statistically significant results except the fourth and sixth visits. Group 1's trigger point 2 superficial results showed statistically significant changes at all treatments except from the sixth to the follow-up treatment (see table 4.8.3 and 4.8.5).

For Group 2 the increase in algometer pressure applied to the trigger points was statistically significant for all trigger points. Trigger point 1 deep increased significantly in pressure from first to fourth and first to follow-up treatments.

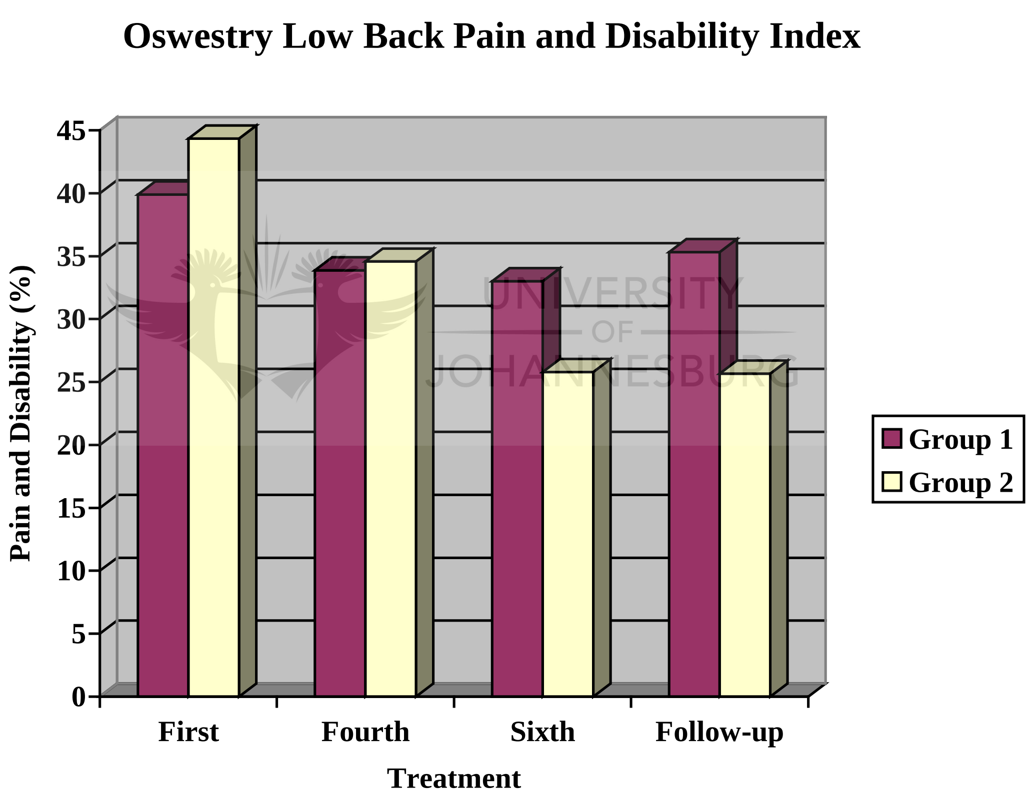
The first to sixth, first to follow-up and sixth to follow-up results were statistically significant for trigger point 1 superficial in Group 2. Trigger point 2 deep and superficial both showed statistically significant changes from the first to fourth and first to follow-up visits and the deep point was also significant from first to sixth visits (see table 4.8.4 and 4.8.5).

THE RESULTS OF THE SUBJECTIVE DATA

4.9 LOW BACK PAIN AND DISABILITY INDEX

4.9.1 Low Back Pain and Disability Index

Change in percentage pain and disability between groups



4.9.2 Low back pain and disability index for Groups 1 and 2

Percentage pain and disability

GROUP 1						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	39.9	11.5	5.82	18.3	61.7	43.3
Fourth	33.87	10.26	5.19	16.7	53.3	33.3
Sixth	33.01	11.43	5.78	16.7	53.3	31.7
Follow-up	35.33	9.15	4.63	16.7	51.7	36.7
GROUP 2						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min**	**Max.**	**Median**
First	44.35	9.92	5.02	26.7	61.7	43.3
Fourth	34.57	11.45	5.79	16.7	50	33.3
Sixth	25.78	9.7	4.91	16.7	51.7	23.3
Follow-up	25.67	8.85	4.48	16.7	45	25

4.9.3 P-Values of the Wilcoxon signed rank test for the low back pain and disability questionnaire

TREATMENT	GROUP 1	GROUP 2
First – Fourth	**0.01**	0
First – Sixth	**0.04**	0.51
First – Follow up	0.12	0.6
Fourth – Sixth	0.24	0.08
Sixth – Follow up	0.22	0.25

4.9.4 P-Values of the Mann-Whitney rank sum test for the low back pain and disability questionnaire

TREATMENT	GROUP 1 VS GROUP 2
Prior to first	0.4395
Prior to fourth	0.2164
Prior to sixth	0.3024
Prior to follow up	0.1303

Note: Statistically significant values on bold

4.9.5 Interpretation of the data

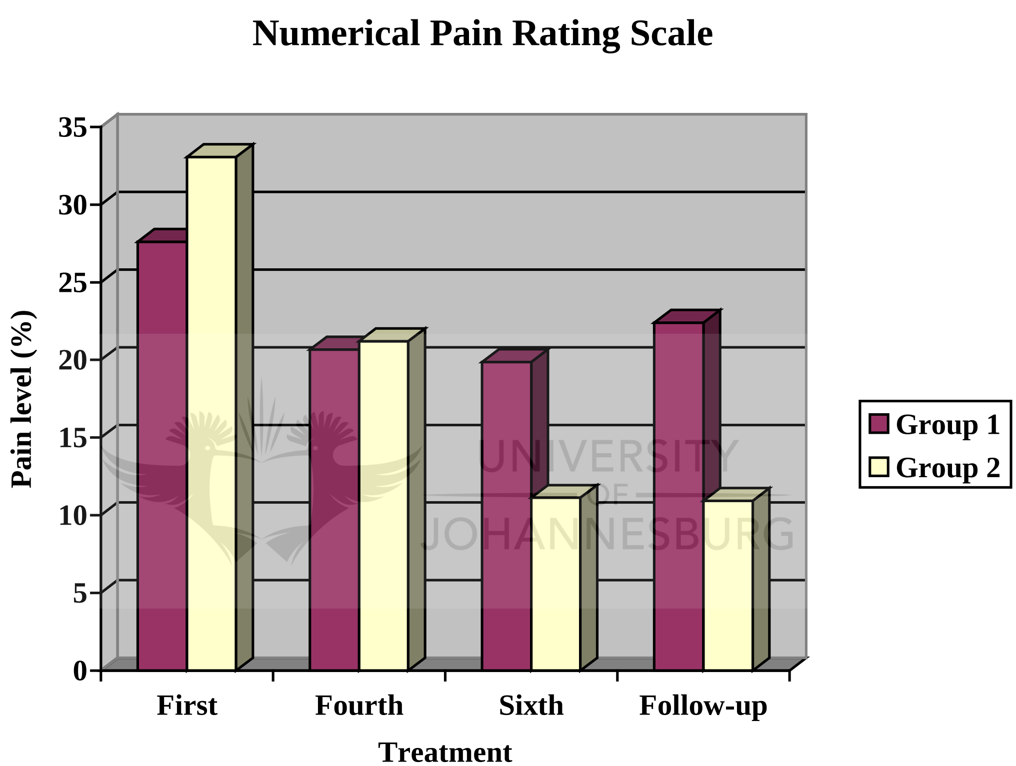
Intragroup – Group 1 showed statistically significant decreases in percentage pain and disability between the first and the fourth and the first and the sixth treatments (P-values = 0.01 and 0.04). The percentage pain decreased at the fourth and the sixth treatments, but increased slightly between the sixth and follow up treatments. Group 2, although not statistically significant, showed a decrease in percentage pain and disability at each treatment from the first through to the follow up visit. (see graph 4.9.1 and tables 4.9.2 and 4.9.3)

Intergroup – Though not statistically significant, the groups showed a decrease in pain and disability over the treatments. Group 2 showed the greater decrease at each treatment (prior to the fourth, sixth and follow up visits). Before the follow up treatment group 1 had a slight increase in the percentage pain and disability, but Group 2 continued to decrease. (see table 4.9.2 and 4.9.4).

4.10 NUMERICAL PAIN RATING SCALE

4.10.1 Numerical Pain Rating Scale

Change in percentage pain and disability between groups.



4.10.2 Numerical pain rating scale

Percentage pain and disability

GROUP 1						
Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min.**	**Max.**	**Median**
First	27.6	13.8	6.98	2	54	32
Fourth	20.67	12.32	6.24	0	44	20
Sixth	19.86	13.73	6.95	0	44	18
Follow up	22.4	10.99	5.56	0	42	24
GROUP 2						
Treatment	**Mean**	**Std. Dev.**	**95% con.**	**Min.**	**Max.**	**Median**
First	33.07	11.63	5.89	2	50	32
Fourth	21.2	13.89	7.03	0	40	20
Sixth	11.13	12.47	6.31	1	46	8
Follow up	10.93	10.66	5.39	0	34	10

4.10.3 P-Values for the Wilcoxon signed rank test on the numerical pain rating scale

QUESTIONNAIRE	TREATMENT	GROUP 1	GROUP 2
Numerical Pain	First – Fourth	0.14	0.46
Rating Scale	First – Sixth	0.26	0.86
	First – Follow up	0.35	0.73
	Fourth – Sixth	0.09	0.66
	Sixth – Follow up	0.16	0.08

4.10.4 P-Values of the Mann – Whitney rank sum test for the numerical pain rating scale

TREATMENT	GROUP 1 VS GROUP 2
Prior to first	**0.0012**
Prior to fourth	**0.0026**
Prior to sixth	**0.0052**
Prior to follow up	**0.0007**

Note: Statistically significant values in bold.

4.10.5 Interpretation of the data

Intragroup – There was no statistically significant values in the results. Group 1 showed a decrease in percentage pain and disability between the first and the fourth and the first and the sixth treatments, but there was a slight increase between the first and follow up visit. Group 2 showed a decrease in percentage pain and disability over all of the treatments. (see graph 4.10.1 and tables 4.10.2 and 4.10.3).

Intergroup – There was a statistically significant difference in the change of percentage pain and disability between the groups prior to the first, fourth, sixth and follow up treatments (P-values = 0.0012, 0.0026, 0.0052 and 0.0007 respectively). (see tables 4.10.4).

CHAPTER FIVE

STATISTICAL ANALYSIS

(GROUP 3 – AMENDED TRIALS)

INTRODUCTION

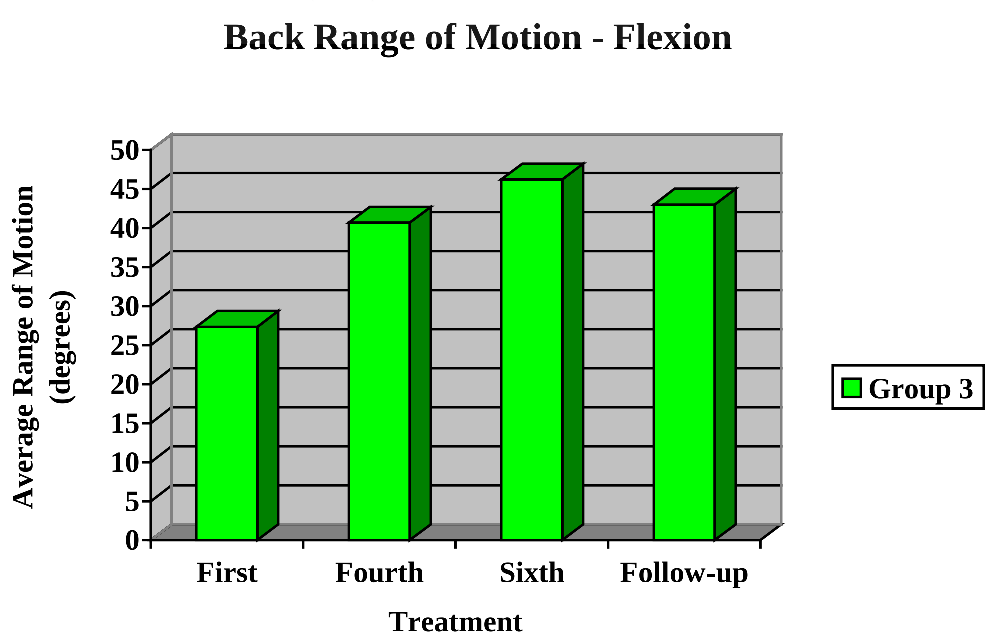
As mentioned in Chapter 3 an error was noted in the back range of motion statistics. It was requested that an additional clinical trial be conducted using ten subjects each receiving chiropractic manipulative therapy. This chapter represents the results and statistical analysis of the measurements of the group of subjects. I have called this group, Group 3.

RESULTS FOR THE OBJECTIVE DATA

5.1 BACK RANGE OF MOTION – FLEXION

5.1.1 Back range of Motion – Flexion

Change in degree of range of motion in flexion within the group



5.1.2 Degrees of back range of motion - flexion

Treatment	**Mean**	**Std. Dev.**	**95% conf.**	**Min**	**Max**	**Median**
First	27.34	11.59	7.57	7.1	52	25
Fourth	40.67	18.38	12.01	30	75	39
Sixth	46.22	22.85	14.93	33	92	38
Follow-up	43	17.92	11.71	32	80	43

5.1.3 P-Values for the Wilcoxon signed rank test on flexion

Range of motion	**Treatment**	**Group 3**
Flexion	First – Fourth	**0.025**
	First – Sixth	**0.012**
	First – Follow – up	**0.003**
	Fourth – Sixth	**0.023**
	Sixth – Follow-up	0.755

5.1.4 Interpretation of the data

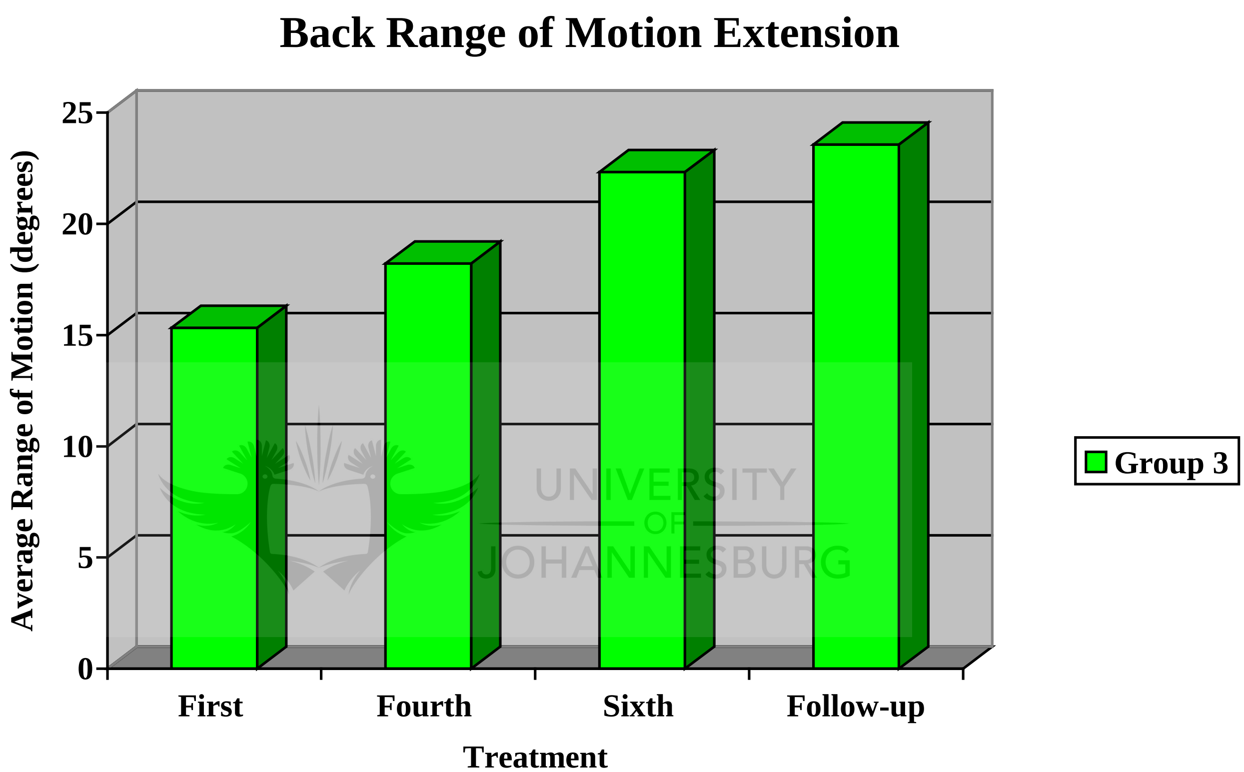
The group showed statistically significant increases in flexion from the first to the fourth and from the first to the sixth treatment. There was a slight decrease in range of motion in flexion from the sixth to the follow-up treatment. (see tables 5.1.2 & 5.1.3)

Note: Statistically significant values in bold.

5.2 BACK RANGE OF MOTION – EXTENSION

5.2.1 Back range of motion – extension

Change in the degree of back range of motion in extension within the group



5.2.2 Degree of back range of motion – extension

Treatment	Mean	Std. Dev.	95% conf.	Min	Max	Median
First	15.33	5.7	3.72	21	12	13
Fourth	18.22	7.63	4.98	17	23	17
Sixth	22.33	13.64	8.91	18	37	18
Follow-up	23.56	13.72	8.96	17	37	19

5.2.3 P-Values of the Wilcoxon signed rank test on extension

Range of motion	**Treatment**	**Group 3**
Extension	First – Fourth	0.097
	First – Sixth	0.108
	First – Follow – up	0.081
	Fourth – Sixth	0.181
	Sixth – Follow-up	0.378

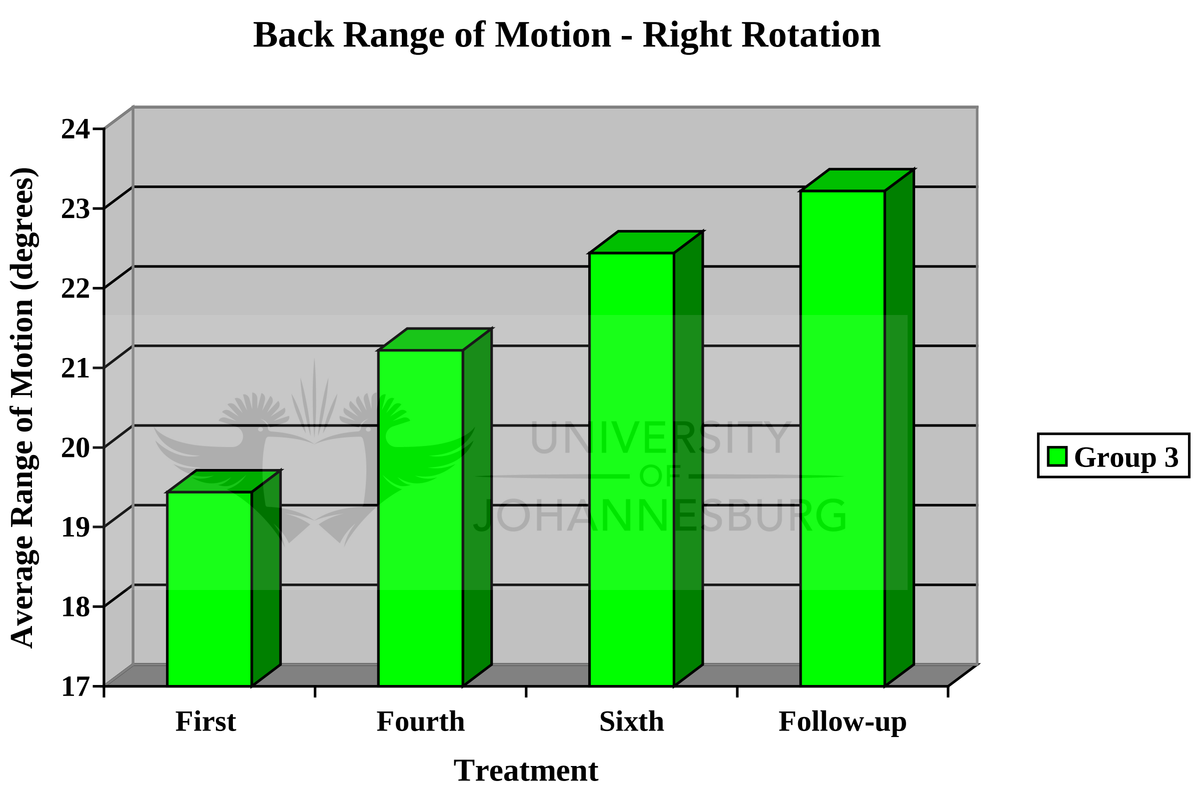
5.2.4 Interpretation of the data

The group showed a slight increase in extension from the first to the follow-up treatment, but the increase was not statistically significant. (see table 5.2.2 & 5.2.3).

5.3 BACK RANGE OF MOTION – RIGHT ROTATION

5.3.1 Back range of motion – right rotation

Change in degree of back range of motion in right rotation within the group



5.3.2 Degree of back range of motion – right rotation

Treatment	Mean	Std Dev.	95% conf.	Min	Max	Median
First	19.44	14.98	9.78	1	43	11.5
Fourth	21.22	15.65	10.22	2	44	13
Sixth	22.44	12.44	8.13	3	38	18
Follow-up	23.22	13.88	9.07	3	27	24.5

5.3.3 P-values of the Wilcoxon signed rank test on right rotation

Range of motion	**Treatment**	**Group 3**
Right rotation	First – Fourth	0.095
	First – Sixth	0.201
	First – Follow – up	0.159
	Fourth – Sixth	0.563
	Sixth – Follow-up	0.756

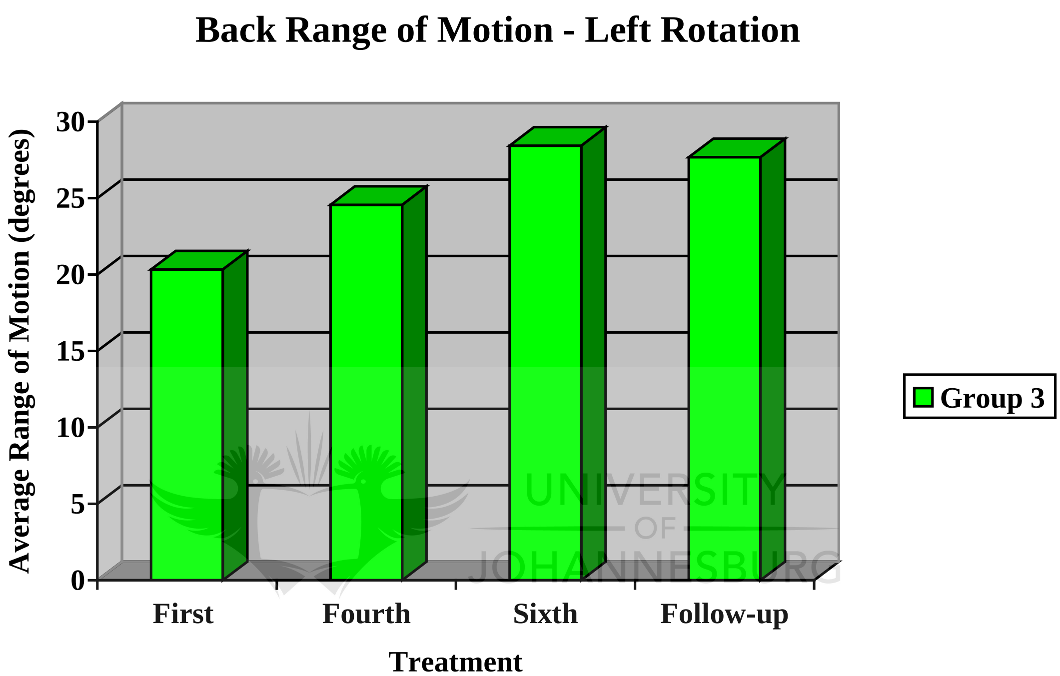
5.3.4 Interpretation of the data

The group showed an increase in right rotation throughout the trial but the increase was not statistically significant. (see table 5.3.2 & 5.3.3).

5.4 BACK RANGE OF MOTION – LEFT ROTATION

5.4.1 Back range of motion – left rotation

Change in degree of back range of motion in left rotation within the group.



5.4.2 Degree of back range of motion -left rotation

Treatment	**Mean**	**Std Dev**	**95% conf.**	**Min**	**Max**	**Median**
First	20.33	18.36	11.99	4	55	10
Fourth	24.56	19.05	12.45	9	66	16
Sixth	28.44	20.81	13.6	10	72	23
Follow-up	27.67	20.44	13.35	10	70	21.5

5.4.3 P-Values of the Wilcoxon Signed rank test on left rotation

Range of motion	**Treatment**	**Group 3**
Left rotation	First – Fourth	**0.028**
	First – Sixth	0.085
	First – Follow – up	0.135
	Fourth – Sixth	0.192
	Sixth – Follow-up	0.385

5.4.4 Interpretation of the data

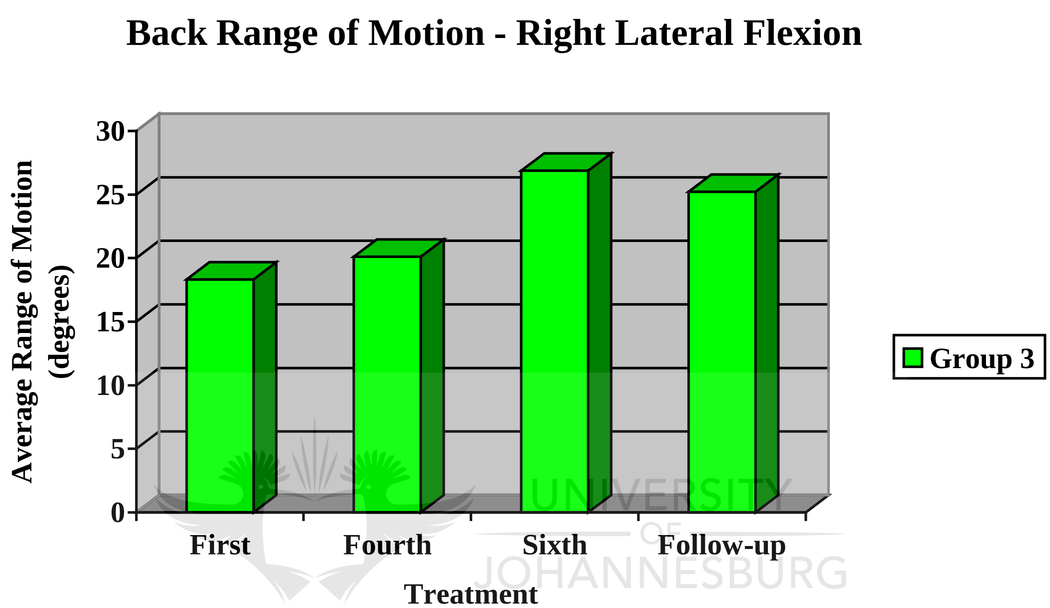
The group showed a statistically significant increase in left rotation from the first to the fourth treatment. Thereafter range of motion increased slightly from the fourth to the sixth treatment, but was not statistically significant. Left rotation decreased slightly from the sixth to the follow-up visit. (see table 5.4.2 & 5.4.3).

Note: Statistically significant values in bold

5.5 BACK RANGE OF MOTION – RIGHT LATERAL FLEXION

5.5.1 Back range of motion – right lateral flexion

Change in degree of back range of motion in right lateral flexion within the group.



5.5.2 Degree of back range of motion – right lateral flexion

Treatment	Mean	Std Dev	95% conf.	Min	Max	Median
First	18.33	17.28	11.29	2	56	11
Fourth	20.11	17.73	11.58	3	60	18
Sixth	26.89	21.87	14.29	2	60	24
Follow-up	25.22	21.25	13.88	2	60	20

5.5.3 P-values of the Wilcoxon signed rank test on right lateral flexion

Range of motion	**Treatment**	**Group 3**
Right lateral flexion	First – Fourth	0.345
	First – Sixth	**0.018**
	First – Follow – up	**0.029**
	Fourth – Sixth	0.096
	Sixth – Follow-up	0.157

5.5.4 Interpretation of the data

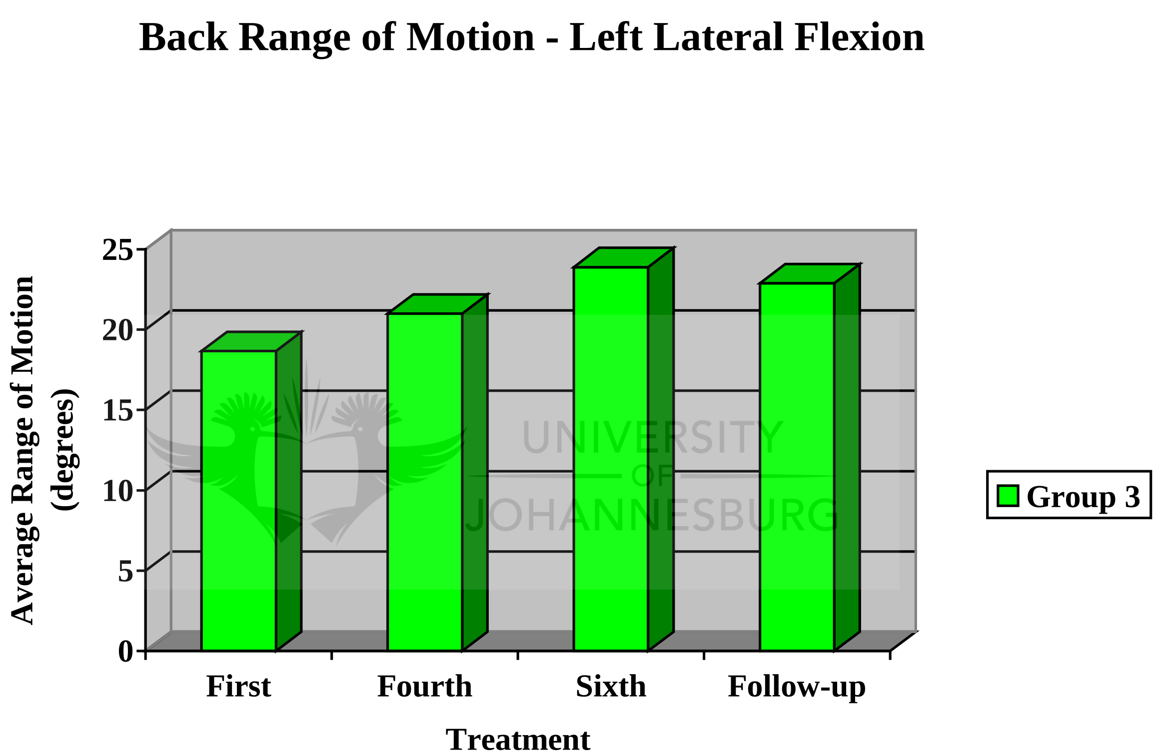
The increase in right lateral flexion range of motion was statistically significant from the first to the sixth and the first to the follow-up visits. Range of motion decreased from the sixth to the follow-up visit. (see table 5.5.2 & 5.5.3).

Note: Statistically significant values in bold

5.6 BACK RANGE OF MOTION – LEFT LATERAL FLEXION

5.6.1 Back range of motion – left lateral flexion

Change in degrees of back range of motion in left lateral flexion within the group.



5.6.2 Degree of back range of motion – left lateral flexion

Treatment	Mean	Std. dev.	95% conf.	Min	Max	Median
First	18.67	19.31	12.62	4	61	10
Fourth	21	20.67	13.50	7	60	11
Sixth	23.89	21.37	13.96	10	60	14
Follow-up	22.89	20.68	13.51	10	61	12

5.6.3 P-values of the Wilcoxon signed rank test on left lateral flexion

Range of motion	Treatment	Group 3
Left lateral flexion	First – Fourth	0.154
	First – Sixth	0.08
	First – Follow – up	0.1
	Fourth – Sixth	0.148
	Sixth – Follow-up	0.256

5.6.4 Interpretation of the data

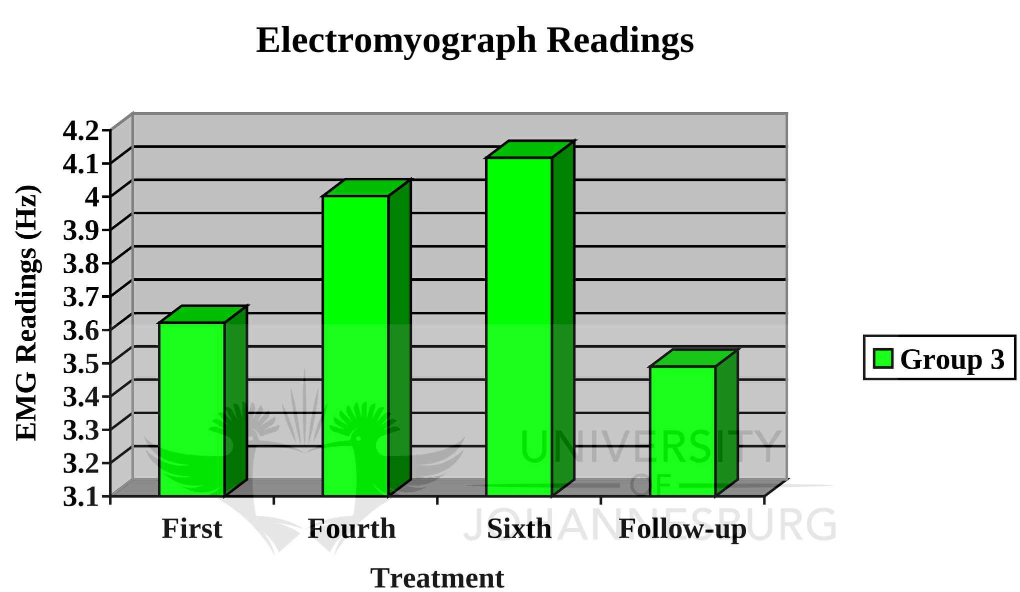
Although left lateral flexion range of motion increased from the first to the sixth treatment, the increase was not statistically significant. There was a small decrease in range of motion from the sixth to the follow-up visit. (see table 5.6.2 & 5.6.3).

Note : Statistically significant values in bold

5.7 ELECTROMYOGRAPH

5.7.1 Electromyograph readings

Change in the average readings of the left and right electromyography leads within the group.



5.7.2 Electromyograph readings

Treatment	Mean	Std dev	95% conf.	Min	Max	Median
First	3.622	2.59	1.6	0.79	9.24	4.06
Fourth	4.002	3.29	2.04	0.9	10.3	3.68
Sixth	4.117	2.47	1.53	1.24	8.21	4.92
Follow-up	3.49	2.07	1.29	1.46	6.48	4.4

5.7.3 P-values of the Wilcoxon signed rank test on the electromyography readings

Electromyograph	Treatment	Group 3
	First – Fourth	0.652
	First – Sixth	0.656
	First – Follow – up	0.845
	Fourth – Sixth	0.931
	Sixth – Follow-up	0.521

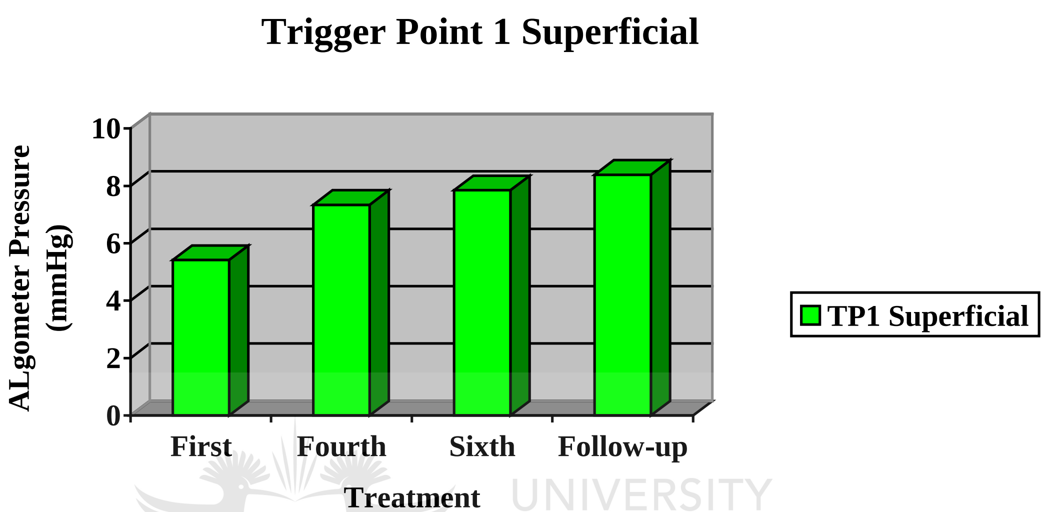
5.7.4 Interpretation of the data

The EMG readings showed an increase in muscle activity from the first to the fourth and from the fourth to the sixth treatment, but they were not statistically significant. There was a decrease in activity from the sixth to the follow-up treatment. (see graph 5.7.2 & 5.7.3).

5.8 TRIGGER POINTS

5.8.1 Algometer readings - trigger point 1 superficial

Change in pressure applied to trigger point 1 superficial in Group 3.



5.8.2 Algometer readings for trigger point 1 superficial

Treatment	Mean	Std Dev	95% conf.	Min	Max	Median
First	5.42	1.57	1.45	3.45	8.4	4.9
Fourth	7.34	2.3	2.12	3.4	10	7.95
Sixth	7.85	2.38	2.2	3.75	10	8.1
Follow-up	8.39	2.23	2.06	3.75	10	8.85

5.8.3 P-Values of the Wilcoxon signed rank test for trigger point 1 superficial

Trigger point 1 superficial	**Treatment**	**Group 3**
	First – Fourth	**0.016**
	First – Sixth	**0.008**
	First – Follow – up	**0.004**
	Fourth – Sixth	0.4
	Sixth – Follow-up	0.24

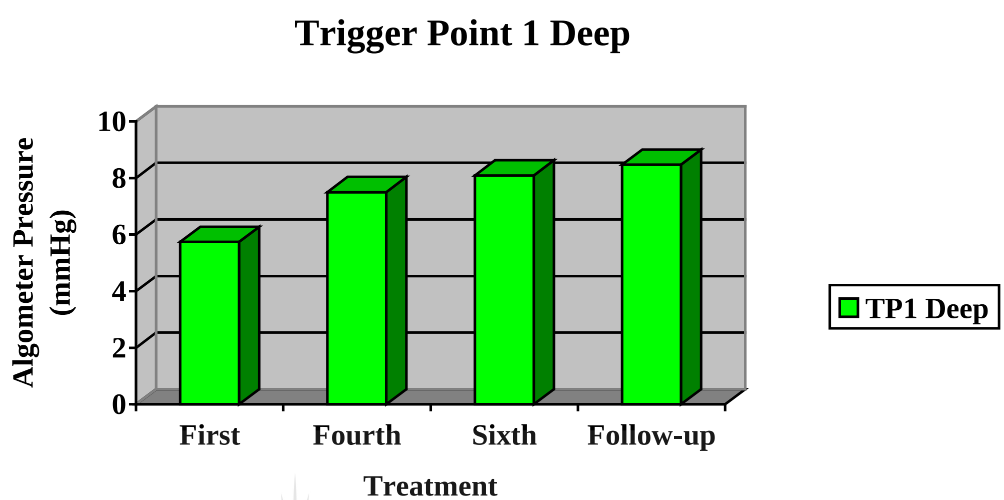
5.8.4 Interpretation of the data

The pressure applied to the trigger point showed a statistically significant increase from the first to fourth, first to sixth and first to follow-up visits. There was a steady increase in the amount of pressure applied to the trigger point throughout the treatment. (see table 5.8.2 & 5.8.3)

Note: Statistically significant values in bold

5.8.5 Algometer readings - trigger point 1 deep

Change in pressure applied to trigger point 1 deep in Group 3.



5.8.6 Algometer readings for trigger point 1 deep

Treatment	Mean	Std Dev	95% conf.	Min	Max	Median
First	5.74	1.84	1.7	3.05	8.4	5.4
Fourth	7.5	2.3	2.13	3.5	10	7.85
Sixth	8.09	2.38	2.2	3.5	10	9
Follow-up	8.47	2.21	2.04	3.6	10	8.95

5.8.7 P-Values of the Wilcoxon signed rank test for trigger point 1 deep

Trigger point 1 deep	Treatment	Group 3
	First – Fourth	**0.005**
	First – Sixth	**0.0005**
	First – Follow – up	**0.0001**
	Fourth – Sixth	0.14
	Sixth – Follow-up	0.33

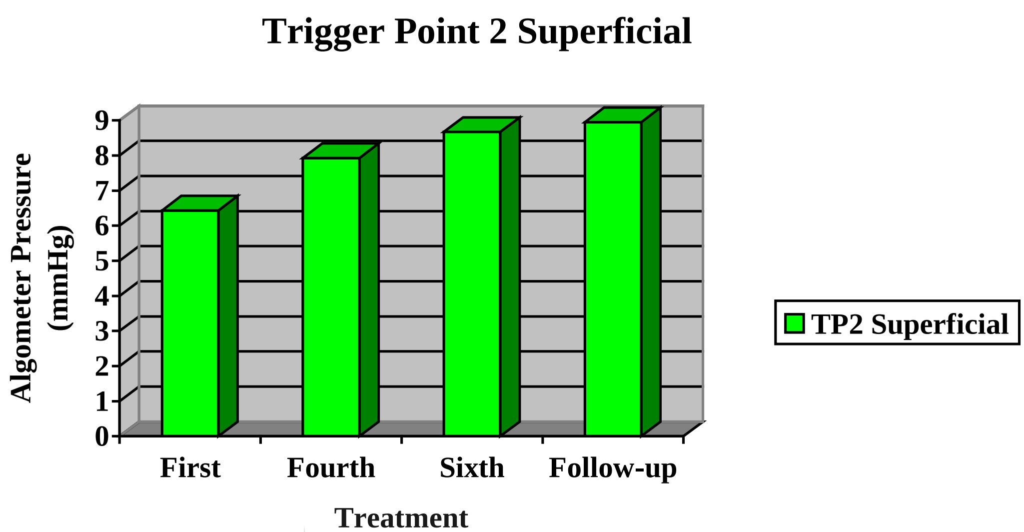
5.8.8 Interpretation of the data

There was a statistically significant increase in the pressure applied to this trigger point from the first to fourth, first to sixth and first to follow-up treatments. (see table 5.8.6 & 5.8.7).

Note: Statistically significant values in bold

5.8.9 Algometer readings - trigger point 2 superficial

Change in pressure applied to trigger point 2 superficial in Group 3.



5.8.10 Algometer readings for trigger point 2 superficial

Treatment	**Mean**	**Std Dev**	**95% conf.**	**Min**	**Max**	**Median**
First	6.43	2.61	2.41	3.25	10	6.8
Fourth	7.93	2.1	1.94	4.3	10	7.85
Sixth	8.67	2.11	1.94	4.7	10	9.95
Follow-up	8.95	2.04	1.89	4.8	10	10

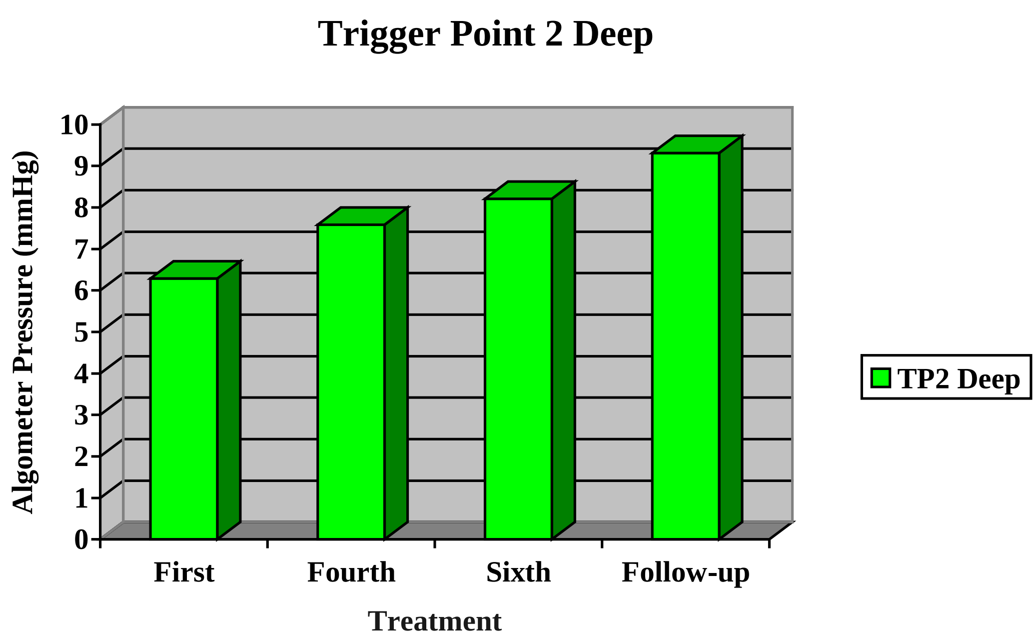
5.8.11 P-Values of the Wilcoxon signed rank test for trigger point 2 superficial

Trigger point 2 superficial	Treatment	Group 3
	First – Fourth	0.27
	First – Sixth	0.2
	First – Follow – up	0.15
	Fourth – Sixth	0.38
	Sixth – Follow-up	0.82

5.8.12 Interpretation of the data

There was an increase in the amount of pressure that could be applied to this trigger point throughout the treatment, but it was not statistically significant. (see table 5.8.10 & 5.8.11).

5.8.13 Algometer readings - trigger point 2 deep



5.8.14 Algometer readings for trigger point 2 deep

Treatment	Mean	Std Dev	95% conf.	Min	Max	Median
First	6.29	2.73	2.53	2.25	10	6.5
Fourth	7.58	2.11	1.95	4.5	10	7
Sixth	8.21	1.9	1.75	4.5	10	8.3
Follow-up	9.31	1.68	1.44	8.35	10	10

5.8.15 P-Values of the Wilcoxon signed rank test for trigger point 2 deep

Trigger point 2 deep	**Treatment**	**Group 3**
	First – Fourth	0.16
	First – Sixth	**0.05**
	First – Follow – up	**0.005**
	Fourth – Sixth	0.31
	Sixth – Follow-up	0.08

5.8.15 Interpretation of the data

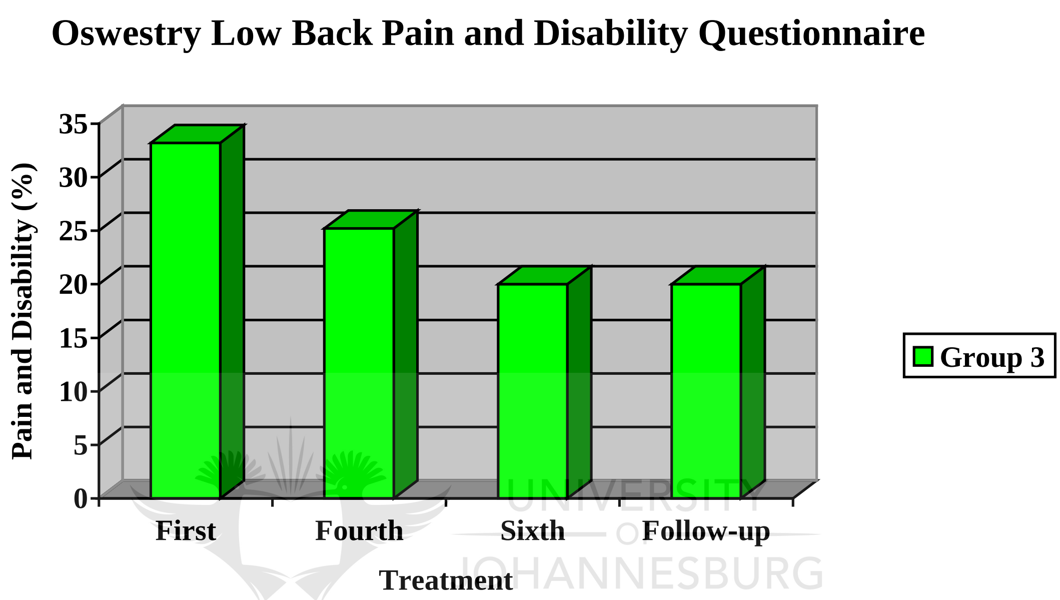
The increase in pressure applied to this trigger point was statistically significant from the first to the sixth treatment and the first to the follow-up treatment. (see table 5.8.13 & 5.8.14).

Note: Statistically significant values in bold

RESULTS OF THE SUBJECTIVE DATA

5.9 LOW BACK PAIN AND DISABILITY INDEX

5.9.1 Percentage pain readings of the Oswestry Low Back Pain Questionnaire



5.9.2 Percentage pain readings for the Oswestry Low Back Pain Questionnaire

Treatment	Mean	Std Dev	95% conf.	Min	Max	Median
First	33.2	17.29	10.72	16	78	30
Fourth	25.2	20.83	12.91	4	78	19
Sixth	20	19.8	12.27	2	72	15
Follow-up	20	15.52	9.62	0	56	21

5.9.3 P-Values of the Wilcoxon signed rank test for the Oswestry Low Back Pain Questionnaire

Oswestry low back pain questionnaire	**Treatment**	**Group 3**
	First – Fourth	**0.002**
	First – Sixth	**0.005**
	First – Follow – up	**0.0001**
	Fourth – Sixth	**0.004**
	Sixth – Follow-up	1

5.9.4 Interpretation of the data

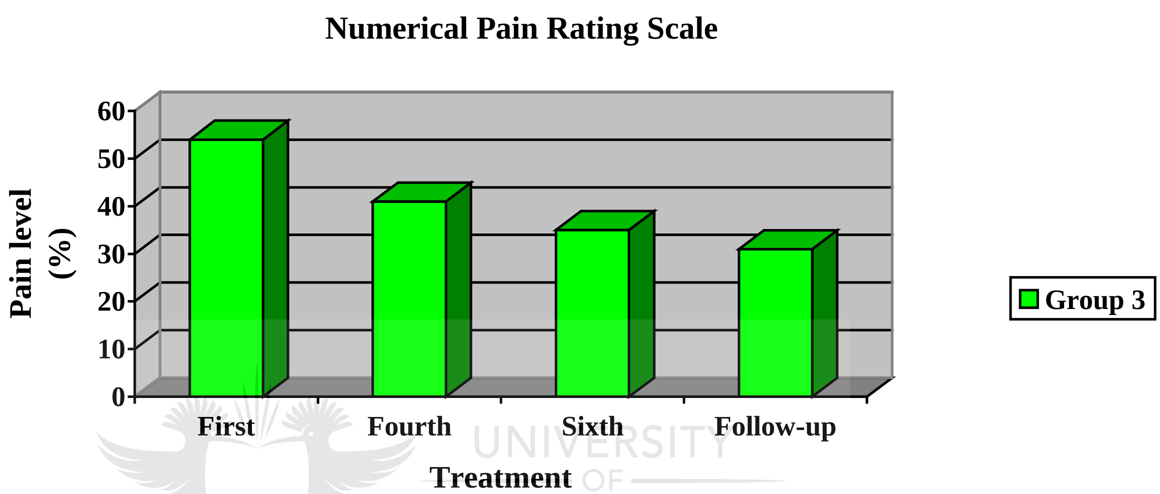
The decrease in percentage pain was statistically significant at all treatments, except from the sixth to the follow-up treatment. (see table 5.9.2 & 5.9.3).

Note: Statistically significant values in bold

5.10 NUMERICAL PAIN RATING SCALE

5.10.1 Numerical pain rating scale

Change in percentage pain and disability in Group 3.



5.10.2 Numerical pain rating scale in percentage pain

Treatment	Mean	Std Dev	95% conf.	Min	Max	Median
First	54	19.55	12.12	40	100	45
Fourth	41	23.31	14.45	20	100	35
Sixth	35	24.61	15.25	10	90	30
Follow-up	31	23.78	14.74	0	80	25

5.10.3 P-values of the Wilcoxon signed rank test on the numerical pain rating scale

Numerical pain rating scale	**Treatment**	**Group 3**
	First – Fourth	**0.002**
	First – Sixth	**0.001**
	First – Follow – up	**0.002**
	Fourth – Sixth	**0.051**
	Sixth – Follow-up	0.223

5.10.4 Interpretation of the data

The decrease in pain was statistically significant from the first to fourth, first to sixth and first to follow-up visits. (see table 5.10.2 & 5.10.3).

Note: Statistically significant values in bold

CHAPTER SIX

DISCUSSION OF OBJECTIVE AND SUBJECTIVE DATA

A DISCUSSION OF THE OBJECTIVE DATA

Back range of motion

Group 1 – In flexion and extension group 1 showed an increase in range of motion at the fourth and sixth treatment, but these ranges had decreased slightly by the follow-up visit. With right rotation the readings from group 1 showed an increase in range of motion by the fourth visit, this had decreased slightly by the sixth treatment but the range had increased again at the follow-up visit. The average range of left rotation of group 1 decreased from the first to the fourth treatment, it increased minimally by the sixth treatment and had then decreased slightly again by the follow-up visit. Left lateral flexion in group 1 showed a similar pattern to that of left rotation by decreasing, then increasing and then decreasing again. Group 1 right lateral flexion showed a slight increase between the first and fourth treatment, but then hardly any change occurred after that. In general, group 1 showed minimal changes in back range of motion as the treatment sessions progressed. (see graphs 4.1.1 – 4.6.1 and tables 4.1.2 – 4.6.4) Peters (2001) suggested, in an attempt to explain placebo, that psychological factors have an effect on voluntary muscles. Since the patients thought they were being treated it could be that their muscles relaxed and therefore their range of motion increased.

Group 2- The average ranges of motion for group 2 increased in most directions, with the exception of flexion and extension which both showed a slight decrease in range of motion at the follow-up treatments. The follow-up measurements were taken in an attempt to indicate how long, following chiropractic treatment, the patients would remain symptom free. These results show that some patients experienced a return of symptoms after 4 weeks without treatment; however the symptoms were not as severe as the patients' initial symptoms. This finding can be supported by a study by Meade et al

(1990 & 1995) which showed that patients with low back pain treated by chiropractic manipulative therapy derived more benefit and long-term satisfaction. In flexion, there was a statistically significant increase from the first to the follow-up treatment. With extension group 2 showed a statistically significant change between the first and the fourth treatment, although not statistically significant, this range increased again at the sixth treatment but then remained the same until the follow-up visit. Right rotation provided a statistically significant increase by the sixth treatment. At the follow up treatment left lateral flexion showed a statistically significant increase. (see graphs 4.1.1 – 4.6.1 and tables 4.1.3 – 4.6.4)

When testing Group 1 versus Group 2 for changes in degrees of range of motion only extension, right lateral flexion and right rotation prior to the follow-up treatment showed no statistically significant improvements, all the other ranges of motion were statistically significant. (see tables 4.1.5 – 4.6.5)

Group 3 – This group showed an increase in range of motion in all directions from the first to the sixth treatments. Flexion, left rotation and right and left lateral flexion showed a slight loss of motion from the sixth to the follow-up treatments. The patients had a 4 week break in treatment between the sixth and follow-up visits to determine if any symptoms would return. Flexion and right lateral flexion showed the most statistically significant increases in range of motion from the first to the follow-up visits. (see graphs 5.1.1 – 5.6.1 and tables 5.1.2 – 5.6.3)

These results can be supported by a study by Grice and Tschumi (1985) who observed that of 26 patients that received chiropractic manipulative therapy, 96% of the patients showed an increase in range of motion following treatment.

Koes, et al (1992:28) demonstrated that manipulation and or mobilization resulted in improved range of motion in 13 patients more that exercise, massage or physiotherapeutic modalities did after a 12 week follow-up.

Electromyograph

None of the electromyography readings provided any statistically significant differences when comparing treatment groups.

Group 1 demonstrated an increase in activity of the quadratus lumborum muscle between the first and fourth treatment, this activity then decreased by the sixth visit and had once again increased by the follow-up visit, although not to the levels of activity seen at the fourth reading. There are no explanations as to this pattern of muscle activity. (see graph 4.7.1 and tables 4.7.2 – 4.7.4)

Group 2 showed a similar pattern except the level of muscle activity decreased slightly more between the sixth and the follow-up treatments where group 1 had increased. (see graph 4.7.1 and tables 4.7.2 – 4.7.4)

Group 3 showed a steady increase in muscle activity from first to the sixth treatments and then a decrease in activity from the sixth to the follow-up treatment. (see graph 5.7.1 and tables 5.7.2 and 5.7.3)

No studies could be found discussing the decrease of electromyographic activity of the quadratus lumborum as a result of chiropractic treatment to the lumbar spine area in the treatment of lower back pain.

Algometer

Group 1 generally showed an increased tolerance to pressure applied to all trigger points with one exception being trigger point 1 deep from the first to the fourth treatment where pressure decreased. Group 2 showed a greater increase in tolerance in all instances than group 1 especially in trigger point 1 deep where group 1 showed no statistically significant changes at all. For the other trigger points, group 1 and 2 both had statistically significant changes. Group 1 was the placebo group and should therefore not have showed as significant changes as they did. Peters (2001) found that psychological factors could have an effect on the release of endorphins and endorphins function as excitatory substances that activate portions of the brain's analgesic system. This could be the reason for increased pain tolerance levels. (see graphs 4.8.1 and 4.8.2 and tables 4.8.3 – 4.8.5)

Group 3 – In all four trigger points measured with the algometer an increasing amount of pressure could be applied from the first to the follow-up treatment. Trigger point 1 superficial and deep showed statistically significant increases across the treatments Trigger point 2 superficial was not significant but trigger point 2 deep was statistically significant for the first to the sixth and first to the follow-up visits. (see graphs 5.8.1, 5.8.5, 5.8.9 and 5.8.13 and tables 5.8.2 – 5.8.15)

A DISCUSSION OF THE SUBJECTIVE DATA

Oswestry low back pain and disability index

Both group 1 and 2 showed a decrease in the pain and disability experienced over the trial period. Group 1's percentage decreased from the first to the fourth treatment and then again at the sixth treatment, both values were statistically significant. From the sixth to the follow-up treatment, there was a slight increase in the percentage pain and disability experienced by this group. The reasons for the decrease in pain and disability could again be because of the release of endorphins creating an analgesic effect as a result of psychological factors leading to their release. (see graph 4.9.1 and tables 4.9.2 - 4.9.4)

Group 3 showed a statistically significant decrease in pain and disability from the first to the follow-up visit. (see graph 5.9.1 and tables 5.9.2 and 5.9.3)

Numerical pain rating scale

Neither group 1 nor group 2 showed any statistically significant differences when testing the percentage pain and disability on the numerical pain rating scale. Group 1 showed a decrease in pain between the first, fourth and sixth treatment, but at the follow-up visit there was an increase in percentage pain and disability. Group 2 showed decreases in percentage pain and disability throughout the trial. When testing group 1 versus group 2 at both the sixth and the follow-up treatments there were statistically significant changes (see graph 4.10.1 and tables 4.10.2 – 4.10.4). The studies mentioned for the low back pain and disability questionnaire support the findings for the numerical pain rating scale in that the group receiving chiropractic manipulation showed a decrease in pain.

Group 3 showed statistically significant decreases in pain and disability from the first to the follow-up visit. (see graph 5.10.1 and tables 5.10.2 and 5.10.3)

CONCLUSION

The aim of this study was to investigate the effect of chiropractic manipulative therapy on quadratus lumborum muscle spasm and pain and mobility of the lumbar spine. It was hypothesized that chiropractic treatment would benefit patients of the experiment group in terms of decreased pain, increased range of motion, decreased sensitivity of quadratus lumborum trigger points and decreased hypertonicity of the quadratus lumborum muscle.

In the text of this research are the results of various studies that show that chiropractic manipulation is effective in restoring lost motion in an affected joint, increasing joint mobility and decreasing painful episodes. The candidates of the research groups (groups 2 and 3) reported episodes of decreased pain and improved ability to perform their daily tasks following chiropractic manipulative therapy. Measurements of back range of motion showed increase mobility of this group. During the four weeks after treatment, pain levels increased slightly and range of motion decreased slightly, but never reaching levels experienced prior to treatment. This indicates that chiropractic manipulation has long term effects after patients complete their treatment.

The electromyograph results of the quadtratus lumborum muscle indicated no significant changes or patterns in muscle activity over the two weeks of chiropractic treatment or the four weeks following treatment. Therefore, we conclude that chiropractic manipulative therapy had no effect on the hypertonic quadratus lumborum muscles of the subjects of this study in respect of changing their activity. However, there was a decrease in the quadratus lumborum trigger point sensitivity of the experiment group, and since trigger points are most commonly caused by muscle tonicity (Travell and Simons. 1983), we conclude that there was some change in the muscle tonicity of the quadratus lumborum muscle of the patients of the experiment group.

According to the results of the study, the control group showed slight improvements in some of the measurements as indicated by the results. However, since the patients did not receive chiropractic manipulative therapy these improvements must be attributed to other factors.

It can therefore be concluded from this study that chiropractic manipulation achieved decreased levels of pain, increased mobility of the lumbar spine and decreased sensitivity of trigger points of the quadratus lumborum muscle in candidates of the experiment group. This finding is useful to the chiropractic profession as it provides an effective method of treatment for chronic mechanical low back pain.

RECOMMENDATIONS

- It is advisable that future studies concerning a similar treatment regime use a larger sample size to achieve a greater representative group.

- Algometer and electromyograph readings should have been repeated directly after the treatment to determine the immediate benefits derived from the treatment on the trigger point.

- The algometer should have a pad to be placed on the trigger point of the patient. A large proportion of the pain elicited with the algometer was due to the sharp end of the algometer being pushed into the patient. The readings thus obtained during the study may be inaccurate.

- Biomechanical perpetuating factors of trigger points and spinal fixations were not taken into account in this study as it would have increased the number of variables. It is possible that due to individual differences in occupation, postural differences and structural biomechanical abnormalities some subjects trigger points or spinal fixations might have been perpetuated, while not that of others. The lumbar adjustments might therefore not have sufficiently cleared up these fixations because primary causative and perpetuating factors were not addressed. It would have been of benefit to the study if a screening process could have excluded persons with structural abnormalities (such as leg length discrepancies and pelvic asymmetries) and included people with the same occupation, unfortunately it would be impossible to standardise a human sample.

REFERENCES

Aprill, C., Bogduk, N. The Prevalence of Cervical Zygapophysial Joint Pain : A first approximation. *Spine.* 1992, (17), page 745.

Arroyo, P. Electromyography in the evaluation of reflex muscle spasm. *J Fla Med Assoc*. 1996, (53): page 29-32.

Awad, E.A. Interstitial Myofibritis : Hypothesis of the mechanism. *Arch Phys Med*. 1973, (54): page 440-453.

The Backpage. Life art image copyright. Lippincott, Williams & Wilkins. (2002). (www.thebackpage.net/facet_joint.GIF)

Bergmark, A. Stability of the Lumbar Spine. A Study in mechanical engineering. *Acta Ortopaedica Scandinavia.* 1989, (230), page 20.

Biedermann, H.J.; Shanks, G.L.; Forrest, W.J.; Inglis, J. Power spectrum analysis of electromyography activity discriminators in the differential assessment of patients with chronic low back pain. *Spine*. 1991, (16): page 1179-1185.

Bigos, S. and Battie, M. Acute Care to Prevent Back Disability: 10 years of progress, *Clin Orthop & Rel Res*. 1987, (221), page 121.

Bogduk, N., Twomey, L.T. Clinical Anatomy of the Lumbar Spine. 2nd Edition. Australia : Churchill Livingstone. 1991, pages 11, 13, 22.

Boureau, F.; Delorme, T.; Doubrere, J.F. Mechanisms of myofascial pain. *Rev Neurol* (Pairs). 2000, 156 (supple 4): page 4510-4514.

Broome, A. Health psychology: processes and applications. London: Chapman & Hall. 1989: page 35-56.

Calliet, R., MD. Low Back Pain Syndrome. 5th Edition. Philadelphia: FA David Company. 1995, pages 8,13.

Cholewicki, J. and McGill, S.M. Mechanical stability of the in vivo lumbar spine: implications for injury and low back pain. *Clinical Biomechanics.* 1996, (11), page 1.

Cooperstein. R., DC. ABS Fall Symposium : The Brave New World of Managed Care, Part I. *Dynamic Chiropractic.* February 1995.

Cox, J.M. Low Back Pain Mechanism, Diagnosis and Treatment. 5th Edition. Baltimore, Maryland : Williams & Wilkins. 1990, pages 4-484.

Cox, J.M. Low Back Pain Mechanism, Diagnosis and Treatment. 6th Edition. Baltimore, Maryland : Williams & Wilkins. 1998, pages 25-27.

Dashman, Robert, M.D. Back to Basics. Spine Anatomy. (www.espine.com/abnormal_anatomy.html)

Davidson, M. and Keating, J.L. A comparison of five low back pain questionnaires: reliability and responsiveness. *Phys Ther.* 2002, Jan 82 (1): pages 8-24.

De Franca, G.G and Levine, L.J. The Quadratus Lumborum and Low Back Pain. *Journal of Manipulative and Physiological Therapeutics*. 1991, Feb 14 (2), page 142.

Disability Data from the Labour Force Survey, Market trends. June 1998.

Dishman, R.W. Static and Dynamic components of the chiropractic subluxation complex: a literature review. *Journal of Manipulative and Physiological Therapeutics*. 1998, April 11 (2), page 98.

Fritz, J.M. and Irrgang, J.J. A comparison of a modified Oswestry low back pain and disability questionnaire and Quebec back pain and disability scale. *Phys Ther*. 2002, Feb 81 (2): page 775-778

Frymoyer, J.W., Ducker, T.B., Hadler, N.M., Kostuik, J.P., Weinstein, J.N., Whitecloud III, T.S. The Adult Spine Principles and Practice. Volume One. Raven Press, New York. 1991, pp 43-594.

Gatterman, M.I. Chiropractic Management of Spine Related Disorders. Baltimore, Maryland: Williams & Wilkins. 1990, pages 44-415.

Grice, A.S. and Tschumi, P.C. Pre and post-manipulative lateral bending radiographic study and relation to muscle function of the low back. *Ann Swiss Chiropractic Assoc.* 1985, vol. 8 page 149-165.

Guyton, A.C. Textbook of Medical Physiology. 6th Edition. Philadelphia : WB Saunders Company. 1981, page 136-640.

Haldeman, S. Principles and Practice of Chiropractic. 2nd Edition. Connecticut: Appleton and Lange. 1992, pages 218, 448, 450, 623, 627.

Hammer, W. Functional Soft Tissue Examination and Treatment by Manual Methods. 2nd Edition. *Aspen Publications Gaithersburg.* Maryland. 1999, page 416.

Hellems, H.K. and Keats, T.E. Measurement of the normal lumbosacral angle. *AJR*. 1971, (113), page 642.

Jackson, R.P. The facet syndrome, myth or reality? *Clin Orthop*. 1992, (279), page 110.

Janda, V. On the concept of postural muscles and posture in man. *Aust J Physiother*. 1983, (29), page 83.

Janda, V. Evaluation of muscular imbalance. Rehabilitation of the spine: a practitioners manual. Baltimore: Maryland, Williams and Wilkins. 1996, page 97-112.

Janda, V. Muscle spasm: a proposed procedure for differential diagnosis. *J Manual Med*. 1991:6 page 136-139.

Kahn, Joseph. Principles and Practice of Electrotherapy. 3rd Edition. New York : Churchill Livingston. 1994, page 39-74.

Kirk, C.R., Lawrence, D.J., Valvo, N.L. States Manual of Spinal, Pelvic and Extravertebral Technics. 2nd Edition. Baltimore. 1991, page 1, 93-104.

Kirkaldy – Willis; Cassidy, J.P. Spinal Manipulation in the Treatment of Low Back Pain. *Can Fam Physician.* 1985, (31) page 535-540.

Kitchen, Sheila and Bazin, Sarah. Clayton's Electrotherapy. 10th Edition. Philadelphia: WB Saunders. 1996, page 245.

Koes, B.W.; Bouter, L.M.; van Mameren, H. and Essers, A.H.M. The effectiveness of manual therapy, physiotherapy and treatment by the general practitioner for the non-specific back and neck complaints. A randomised clinical trial. *Spine*. 1992, vol. 17: page 28-35.

Korr, I.M. Neurochemical and Neurotrophic consequences of nerve deformation: Clinical implications in relation to spinal manipulation. *Jam Osteopath Assoc.* 1975 May 74 (9), page 878.

Lewit, K. The muscular and articular factor in movement restriction. *Manual Med 1*. 1996, page 83-85.

Liebenson, C. The quadratus lumborum and spinal stability. *Journal of Bodywork and Movement Therapies*. 2000 January, page 50.

Liebenson, C. Faulty Movement Patterns as a Cause of Articular Dysfunction. *Chiroweb*. 2002 April 11, page 1.

Magee, D.J. Orthopaedic Physical Assessment. 3rd Edition. Philadelphia: WB Saunders Company. 1997, pages 25, 26, 399.

Manga, P. (PhD); Angus, D. (M.A.), Papadopoulos, C. (M.H.A.); Swan, W. (B.A.). The Manga Study, Ontario. 1993.

Maniadakis, A. and Gray, A. The economic burden of back pain in the U.K. *Pain*. 2000, (84), page 95.

Marieb, E.N. Human Anatomy and Physiology. 2nd Edition – California: The Benjamin / Cummings Publishing Company, Inc. 1991, page 302.

Marras, W.S. and Mirka, G.A. Muscle activities during asymmetric trunk angular acceleration. *Journal of Orthopaedic Research*. 1990, (8), page 824.

McGill, S.M. Clinical Biomechanics of the Thoracolumbar Spine. *Clinical Biomechanics*. 2000, page 1-3.

McMorland, G. and Suter, E. Chiropractic management of mechanical neck and lower back pain: a retrospective outcome-based analysis. *Journal of Manipulative and Physiological Therapeutics*. 2000, Jan. 23 (5): page 307-311.

Mead, T.W.; Dyer, S.; Browne, W.; Townsend, J.; Fran, A.O. Randomized comparison of Chiropractic and Hospital Outpatient Management for Low Back Pain. *British Medical Journal*. 1990, (vol. 300), pages 1431-1437, and *British Medical Journal*. 1996, (vol. 311), pages 349-351.

The Merck Manual of Diagnosis and Therapy. 16th Edition. Merck Research Laboratories. Rahway, New Jersey, USA. 1992, pages 1362, 1363, 1369.

Moffet, P.; Moffet, S. and Schauf. C. Human Physiology. 2nd Edition. Mosby. St Louis, Missouri. 1983, page 332.

Nyiendo, J; Haas, M.; Goodwin, P. Patient characteristics, practice activities and one month outcomes for chronic, recurrent low back pain treated by chiropractors and family medicine physicians: a practice-based feasibility study. *Journal of Manipulative and Physiological Therapeutics*. 2000, (vol. 23), page 239.

Oxford Medical Dictionary, page 483, 591.

Palmer, K.T.; Walsh, K.; Bendall, H.; Cooper, C. and Coogan, D. Back pain in Britian: comparison of two prevalence surveys at an interval of 10 years. *British Medical Journal*. 2000, (vol.320), pages 1577-1578.

Panjabi, M.M. The stabilizing system of the spine, part 1. Function, Dysfunction, Adaption and Enhancement. *Journal of Spinal Disorders*. 1992, 5: page 383-389.

Peters, David. Understanding the Placebo Effect in Complementary Medicine – Theory, practice and research. London: Churchill, Livingstone. 2001: page 24, 115, 180.

Pongratz, D and Spath, M. What helps in back pain? Guidelines for symptomatic therapy. *MMW Fortschr Med.* 2001, May 3 143 (18): page 26.

Porterfield, J.S., De Rosa, C. Mechanical Low Back Pain – Perspectives in Functional Anatomy. 2nd Edition. Philadelphia: WB Saunders Company. 1991, pp 2,4.

Rachlin, E.S. Myofascial Pain and Fibromyalgia – Trigger Point Management. St Louis, Missouri : Mosby. 1994, pages 13-197, 480.

Richardson, C.; Jull, G.; Hodges, P. and Hides, J. Therapeutic exercise for spinal segmental stabilization in low back pain. Scientific basis and clinical approach. London: Churchill Livingstone. 1999, page 2, 30.

Rivner, M.H. The neurophysiology of myofascial pain syndrome. *Current Pain Headache Report*. 2001, Oct (5), page 432.

Robinson, A.J., Snyder-Mackler, L. Clinical electrophysiology – Electrotherapy and Electrophysiologic Testing. 2nd Edition. Baltimore, Maryland : Williams & Wilkins. 1985, page 282-407.

Sandoz, R.W. Some reflex phenomena associated with spinal derangement and adjustments. *Ann Swiss Chiro Assoc.* 1981, (7), page 60.

Schafer, C.C. and Faye, L.J. Motion palpation and chiropractic technic. 2nd Edition, USA, The Motion Palpation Institute. 1990, pages 7, 26, 98.

Shekelle, P.G.; Adams, A.H.; Chassin, M.R.; Hurwitz, E.I.; Phillips, R.B.; Brook, R.H. "The Appropriateness of Spinal Manipulation for Low Back Pain. Project Overview and Literature Review". Rand, Santa Monica, California. 1991.

Sola, A.E., Rodenberger, M.L., Gettys, B.B. Incidence of hypersensitive areas in posterior shoulder muscles. *AM J Phys Med 34*. 1955, (34), pages 585.

Sartlanyl, D.S. (M.D.) and Copeland, M.E. (M.S.; M.A.) Fibromyalgia and Chronic Myofascial Pain Syndrome – A Survival Manual. Oakland: New Harbinger Publications, Inc. 1996, page 17, 23, 123.

Travell, J.G. (M.D.) and Simons, D.G. (M.D.) Myofascial Pain and Dysfunction – The Trigger Point Manual. Vol 1 – Upper Extremities. Baltimore, Maryland : Williams & Wilkins. 1983, pages 3-86. Vol. 2 – Lower Extremities, pages 29, 30, 35.

Troyanovich, S.J., Harrison, D.D., and Harrison, D.E. Lower Back Pain and the Lumbar Intervertebral Discs: Clinical Considerations for the Doctor of Chiropractic. *Journal of Manipulative and Physiological Therapeutics*, March/April 2000, (vol 23, no. 3), page 155.

Wiesel, S.W., Weinstein, J.N., Herkkowitz, H., Dvorak. J., Bell. G. The Lumbar Spine. Vol 1. 2nd Edition. Philadelphia, Pennsylvania : WB Saunders Company. 1992, page 49.

APPENDIX 1

TECHNIKON WITWATERSRAND
CHIROPRACTIC DAY CLINIC

CASE HISTORY

Date: ____________

Patient ______________________________ File No; ____________

Age: ________ Sex: ________ Occupation: ______________________

Intern: ______________________________ Signature: ____________

FOR CLINICIAN'S USE ONLY

Initial visit clinician: __________________ Signature: ____________

Case History: ____

____

____

____

Examination:

Previous:	TWR Other	Current:	TWR Other

X-ray Studies:

Previous	TWR Other	Current:	TWR Other

Clinical path. lab:

Previous	TWR Other	Current:	TWR Other

Case status:

PTT: Conditional: Signed off: Final sign out:

Recommendations:

Intern's case history

1. Source of history:

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

3. Present illness:

Location

Onset

Duration

Frequency

Pain (character)

Progression

Aggravating factors

Relieving factors

Associated Sx's & Sg's

Previous occurrences

Past treatment and outcome

4. Other complaints:

5. Past history:

General health status

Childhood illnesses

Adult illnesses

Psychiatric illnesses

Accidents/injuries

Surgery

Hospitalisation

6. Current health status and lifestyle

Allergies

Immunizations

Screening tests

Environmental hazards

Safety measures

Exercise and leisure

Sleep patterns

Diet

Current medication

Tobacco

Alcohol

Social drugs

7. Family history:

Immediate family:

Cause of death
DM
Heart disease
TB
HBP
Stroke
Kidney disease
CA
Arthritis
Anaemia
Headaches
Thyroid disease
Epilepsy
Mental illness
Alcoholism
Drug addiction
Other

8. Psychosocial history:

Home situation

Daily life

Important experiences

Religious beliefs

9. Review of systems:

General

Skin

Head

Eyes

Ears

Nose/sinuses

Mouth/throat

Neck

Breasts

Respiratory

Cardiac

Gastro-intestinal

Urinary

Genital

Vascular

Musculoskeletal

Neurologic

Haematologic

Endocrine

Psychiatric

APPENDIX 2

Pertinent Physical

(Note: This form may only be used when you have completed 35 new patients)

Student Name------------------------- **Signature**-------------------------
Doctor name -------------------------- **Signature**--------------------------

Patient Information

Name—————————— **Occupation**——————————
Age—————————— **Sex**——————————

Vitals:

Height-------------------------- Weight-------------------------------

Pulse rate---------------------- Respiratory rate---------------------

Blood pressure---------------

	Inspection	**Palpation**	**Percussion**	**Auscultation**
Thorax				
Abdomen				

	Inspection	**Palpation**	**Percussion**	**Auscultaion**

	Cranial Nerves	**Motor System**	**Sensory system**	**Cerebellar signs**
Neurologic system				

APPENDIX 3

TECHNIKON WITWATERSRAND
CHIROPRACTIC DAY CLINIC

REGIONAL EXAMINATION
LUMBAR SPINE AND PELVIS

Date: ____________

Patient: ______________________________ File No: ____________

Clinician: ______________________________ Signature: ____________

Intern: ______________________________ Signature: ____________

A) STANDING

1. BODY TYPE
2. POSTURE
3. OBSERVATION:-

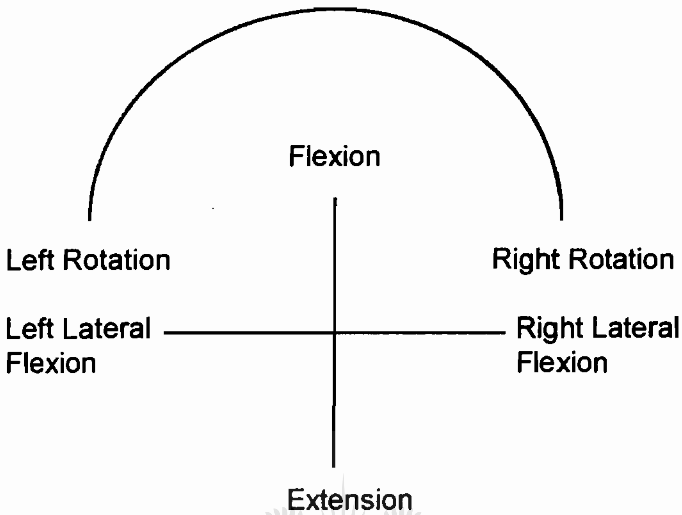
- Muscle Tone
- Bony + Soft Tissue Contours
- Skin
- Scars
- Discolouration
- Step deformity

4. SPECIAL TESTS

- Schober's Test
- Spinous Percussion
- Treadmill
- Minor's Sign
- Quick Test
- Trendelenburg Test

5. RANGE OF MOTION

Forward flexion	=	40 - 60 ° (15cm from floor)
Extension	=	20 - 35 °
L/R Rotation	=	3 - 18 °
L/R Lat Flexion	=	15 - 20 °



/ = Pain free limitation //= Painful limitation

6. GAIT

- Rhythm, pendulousness
- On Toes (S1)
- On Heels (L4 ,5)
- Half Squat on one leg (L2, 3, 4)
- Tandem Walking

7. MOTION PALPATION - sacroiliac joints

B. **SITTING**

1. SPECIAL TESTS

- Tripod Test
- Kemp's Test
- Valsalva Manoeuvre

2. MOTION PALPATION

Jt. play		Left						Right					Jt. play	
P/A	Lat	Fle	Ext	LF	AR	PR		Fle	Ext	LF	AR	PR	P/A	Lat
							T10							
							T11							
							T12							
							L1							
							L2							
							L3							
							L4							
							L5							
					U	L	SI	U	L					

C) **SUPINE**

1. OBSERVATION

- Hair, Skin, Nails
- Fasciculations

2. PULSES

- Femoral
- Popliteal
- Dorsalis Pedis
- Posterior Tibial

3. MUSCLE CIRCUMFERENCE

	LEFT	RIGHT
THIGH	cm	cm
CALF	cm	cm

4. LEG LENGTH

	LEFT	RIGHT
ACTUAL	cm	cm
APPARENT	cm	cm

5. ABDOMINAL EXAMINATION

- Observation
- Abdominal Reflexes
- Auscultation Abdomen and Groin
- Palpation Abdomen and Groin

Comments: ______________________________

____

____

____

NEUROLOGICAL EXAMINATION

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

7. SPECIAL TESTS

- SLR
- WLR
- Braggard's
- Bowstring
- Sciatic Notch Pressure
- Sign of the Buttock
- Bilateral SLR
- Patrick Faber
- Gaenslen's Test
- Gapping Test
- "Squish" Test
- Gluteus Maximus Stretch
- Thomas' Test
- Rectus Femoris Contracture Test
- Hip Medial Rotation
- Psoas Test

LATERAL RECUMBENT

- Sacroiliac Compression
- Ober's Test
- Femoral Nerve Stretch Test
- Myotomes: - Quadratus Lumborum Strength
  - Gluteus Medius Strength

PRONE

- Facet joint challenge
- Myofascial Trigger points;

  - Quadratus Lumborum
  - Gluteus Medius
  - Gluteus Maximus
  - Piriformis
  - Tensor Fascia Lata
  - Hamstrings

- Skin Rolling
- Erichsen's Test
- Sacroiliac Tenderness
- Pheasant's Test
- Gluteal Skyline
- Myotomes:
  - Gluteus Maximus strength

NON-ORGANIC SIGNS

- Pin-point pain
- Axial Compression
- Trunk Rotation
- Burn's Bench Test
- Flip Test
- Hoover's Test
- Ankle Dorsiflexion Test
- Pin-point pain

APPENDIX 4

TWR

PATIENT :	
FILE #	PAGE
DATE :	VISIT #
INTERN :	CLINICIAN : (PTT)

S :

A:

O :

P:

SPECIAL ATTENTION TO :

DATE :	VISIT #
INTERN :	CLINICIAN : (PTT)

S :

A:

O :

P:

SPECIAL ATTENTION TO :

APPENDIX 5

THE EFFECTIVENESS OF CHIROPRACTIC MANIPULATIVE THERAPY ON QUADRATUS LUMBORUM MUSCLE SPASM IN THE TREATMENT OF CHRONIC MECHANICAL LOWER BACK PAIN

Dear Participant

You are suffering from lower back pain. We are asking you to participate in a comparative research study whereby your lower back pain will be treated chiropractically using one of two different treatment methods.

The study will consist of two groups and the treatment you will receive will depend on which group you are placed in. Placement into groups will be done randomly. One group will receive chiropractic manipulative therapy to the lower back and the other group will receive ultra-sound therapy over the lower back area.

Before any treatment is carried out you will undergo a full medical examination and a case history will be taken. In addition a regional examination will be done. If indicated some participants may have to undergo x-ray examination of the lower back region to rule out any contra-indications to participate in the research.

If you agree to participate in this research study, you will be required to attend the Technikon Witwatersrand Health Clinic for a total of seven visits. The seven visits will be broken up into three treatments a week for two weeks and then a follow-up visit one month later. All treatment that you will receive will be free of charge, but transport to and from the clinic will be for the your own account. The initial consultation will be one hour long and subsequent visits will be twenty minutes each.

The potential benefits of positive results of this study for future patients will be a better understanding of the treatment of lower back pain.

It is essential to note that you are not obliged to complete the study and are allowed to leave the study at any time. However, the researcher has limited time allocation for the use of clinic facilities. In light of this fact, the researcher respectfully requests that if you are not fully committed to completing the full quota of consultations, or may be unable to attend booked sessions owing to circumstances within your control, that you not request to be in this project.

Thank you for the courtesy of your interest and assistance.

SONJA KNEPPERS
RESEARCHER

INFORMED CONSENT FROM

I have fully explained the procedures, identifying those, which are investigational, and have explained their purpose. I have asked whether any questions have arisen regarding the procedures and have answered these questions to the best of my ability.

Date:_______________________________ Researcher:________________________________

I have been fully informed as to the procedures to be followed, including those which are investigational and have been given a description of the attendant discomforts and risks, and benefits to be expected and the appropriate alternate procedures. In signing this consent form I agree to this method of treatment and I understand that I am free to withdraw my consent and discontinue my participation in this study at any time. I also understand that if I have any questions at any time, they will be answered.

Date:______________________________ Patient:____

APPENDIX 6

SAUNDERS DIGITAL INCLINOMETER

User's Guide

THE SAUNDERS GROUP INC.

By: H. Duane Saunders, MS PT

SAUNDERS DIGITAL INCLINOMETER

DESCRIPTION

The Saunders Digital Inclinometer is a portable, hand-held inclinometer designed to measure postu and mobility of the spine. The inclinometer has a liquid crystal screen that shows a digital display of i position. No calibration is required. The inclinometer may be zeroed in any position. A hold button ca "freeze" readings when it is difficult to read the digital display in a particular position. The inclinomete is powered by a standard 9 volt battery.

COMPONENTS (FIGURE 1)

1. **IMPACT RESISTANT CASING.** The inclinometer is housed in a factory sealed aluminum an impact resistant plastic case. The only entry into the case is to replace the battery. No user serviceabl parts are inside.
2. **LIQUID CRYSTAL DISPLAY.** The inclinometer has a liquid crystal screen that shows a digital display of its position. All readings are displayed in degrees.
3. **OPERATING CONTROLS.** There are three buttons on the face of the inclinometer: On/Off, Alternate Zero and Hold.
4. **ATTACHMENTS.** The inclinometer is packaged with two attachments: the Arch Attachment for measuring irregular surfaces such as the head and, the Ruler Attachment (not shown) for measuring the angle between bony landmarks farther apart than the width of the inclinometer's base.

For certain measurements, such as posture and flexion and extension of the lumbar and thoracic spine, we recommend using the short base of the inclinometer in direct contact with the subject, without any attachments.

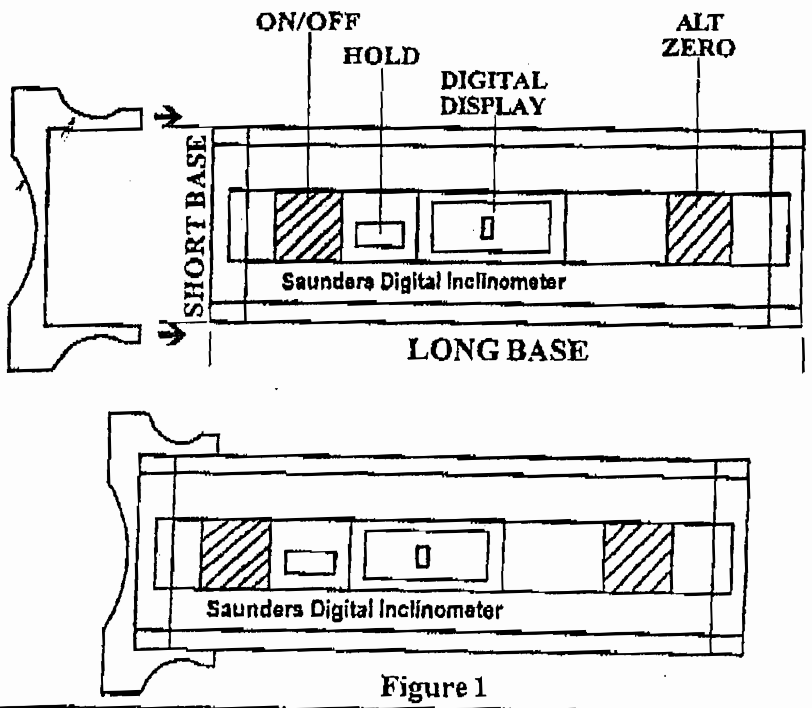


Figure 1

5. **ADDING THE ATTACHMENTS (FIGURE 1).** To add the arch attachment, slide it forward over the end of the short base. To remove the arch attachment, slightly flex and pull it away from the base. The ruler attachment is added and removed in the same manner. All operations (#1-4 above) may be performed with either attachment added to the inclinometer.

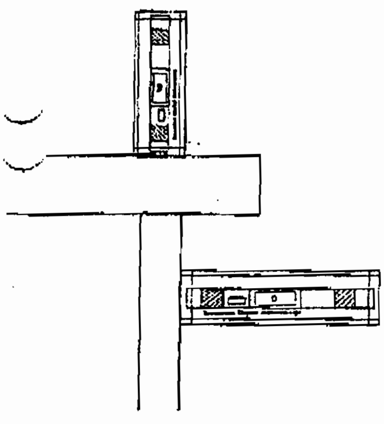


Figure 2

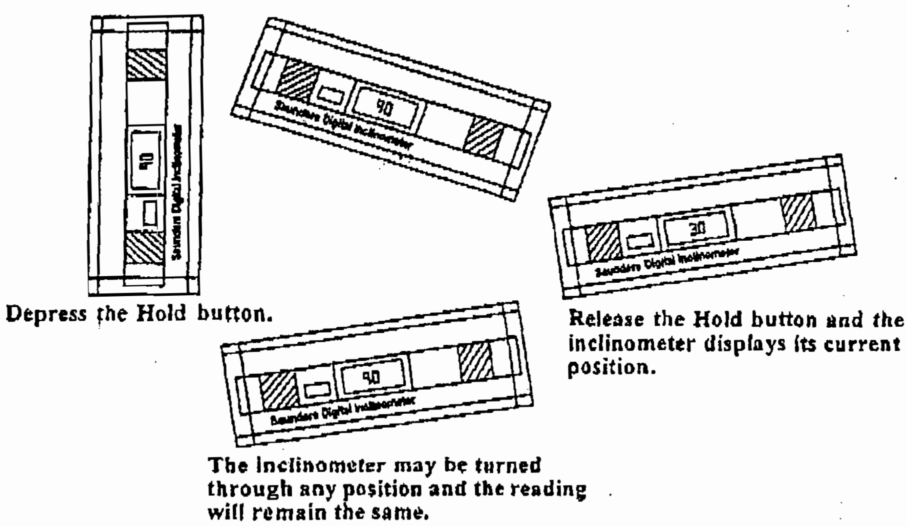


Figure 3

...ustomer service representative for instructions.

... in a cool, dry place. Keep it away from flame, heat, ultrasound, electr... ...g magnetic fields. Clean all surfaces of the inclinometer in accordance with standar... ...ean technique. Do not immerse in water. Do not apply soap or any other cleaner directly to th... inclinometer. Put cleaner on a sponge or soft cloth and wipe inclinometer gently, paying particul... attention to the base and to the attachments that came in direct contact with the patient.

2. **BATTERY REPLACEMENT.** The inclinometer is powered by a standard 9 volt battery. To repla... the battery, turn the inclinometer off. On the backside of the inclinometer is one screw holding th... battery case panel in place. Remove the screw and then remove the battery case panel. Remove th... old battery and insert the new battery. Be sure the battery connections are correct, and the battery i... fully seated in place. Replace the battery case panel and secure it by replacing the screw.

3. **TROUBLESHOOTING.** If the digital display does not show a reading when the inclinometer is turned on, please be sure to check the battery first. If replacing the battery has no effect, please call The Saunders Group, Inc. at 1-800-966-4308 and ask a customer service representative for instructions. Warning: no user serviceable parts are inside. Any attempt to tamper with the inclinometer may void any warranties that apply.

LIMITED WARRANTY

The Saunders Group, Inc., is proud of the high quality of our product and would like every customer to be completely satisfied. Therefore, we pledge to the original owner that should there be any defects in material or workmanship during the first year after purchase, we will at our discretion, repair it, replace it or refund your money.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER EXPRESSED OR IMPLIED WARRANTIES, AND NO PERSON (INCLUDING ANY AGENT, DEALER OR REPRESENTATIVE OF SAUNDERS PRODUCTS) IS AUTHORIZED TO MAKE ANY REPRESENTATION OR WARRANTY CONCERNING PRODUCTS, EXCEPT TO REFER PURCHASERS TO THIS WARRANTY. FURTHER, ANY IMPLIED WARRANTIES (INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE) ARE LIMITED TO THE DURATION OF THIS WRITTEN WARRANTY. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THIS LIMITATION MAY NOT APPLY TO YOU.

YOUR EXCLUSIVE REMEDY WITH RESPECT TO ANY AND ALL LOSSES OR DAMAGES RESULTING FROM ANY CAUSE WHATSOEVER SHALL BE AS SPECIFIED ABOVE. WE SHALL IN NO EVENT BE LIABLE FOR ANY CONSEQUENTIAL OR INCIDENTAL DAMAGES OF ANY KIND, HOWEVER OCCASIONED, WHETHER BY NEGLIGENCE OR OTHERWISE. NO SUIT OR ACTION MAY BE BROUGHT AGAINST THE SAUNDERS GROUP, INC., MORE THAN ONE (1) YEAR AFTER THE DATE OF THE OCCURRENCE OF ANY SPECIFIC INCIDENT. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THIS LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU.

THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.

LIMITS TO GOOD MEASUREMENT WITH THE INCLINOMETER

Before taking measurements with the inclinometer, please read about the following factors that limit good measurement.

1. Pain, fear, acute muscle spasm and neuromuscular inhibition may temporarily limit spinal movement. They should be distinguished from hypo- and hypermobility due to soft tissue or structural changes. If you suspect pain, fear, spasm or inhibition is causing the observed limitation, the measurement is invalid.
2. Less than optimal effort by the subject also affects measurement of mobility. Reproducibility of normal movement is a way to validate optimal effort. Be sure to perform at least three consecutive measurements, as recommended by the AMA Guides.
3. Measurements are considered reliable if they are consistent, that is, if all measurements fall within ±10% or 5° of each other (whichever is greater). If the consistency check fails for the first three measurements, take three more measurements. If the measurements are still not consistent, the test is considered unreliable. It may be performed later or be disqualified as a part of the evaluation. For additional suggestions on test validation, refer to "Method to Detect Consistency" on page 19.
4. Normal ranges of spinal mobility are presented throughout this manual to provide some broad, general guidelines. These are interpretations of the limited information available.[1-10] The curve angle method is described by Griffin and Troup.[4] Specific data regarding the curve angle method can be found in Griffin and Troup[4] and Troup, et al.[9] The AMA *Guides to the Evaluation of Permanent Impairment*[1] provides specific information about the AMA *Guides* method. Other information found in the additional references listed, as well as personal clinical experience, were considered when providing the normal ranges of spinal mobility in this manual.

EXAMPLE OF UNRELIABLE VS. RELIABLE MEASURMENTS

Curve angle at end range of lumbar flexion measurements were calculated from readings as follows:

Trial 1: 15° Kyphosis
Trial 2: 22° Kyphosis
Trial 3: 9° Kyphosis

Because the measurements did not fall within 5° of each other, they were considered unreliable. Perhaps the patient's pain, apprehension or muscle guarding did not enable an optimal effort and consistent measurement.

Curve angle at end range of lumbar flexion was reassessed one week later to try to obtain reliable measurements. Range of motion measurements were calculated from inclinometer readings as follows:

Trial 1: 20° Kyphosis
Trial 2: 22° Kyphosis
Trial 3: 17° Kyphosis

The measurements fell within 5° of each other and were therefore considered reliable.

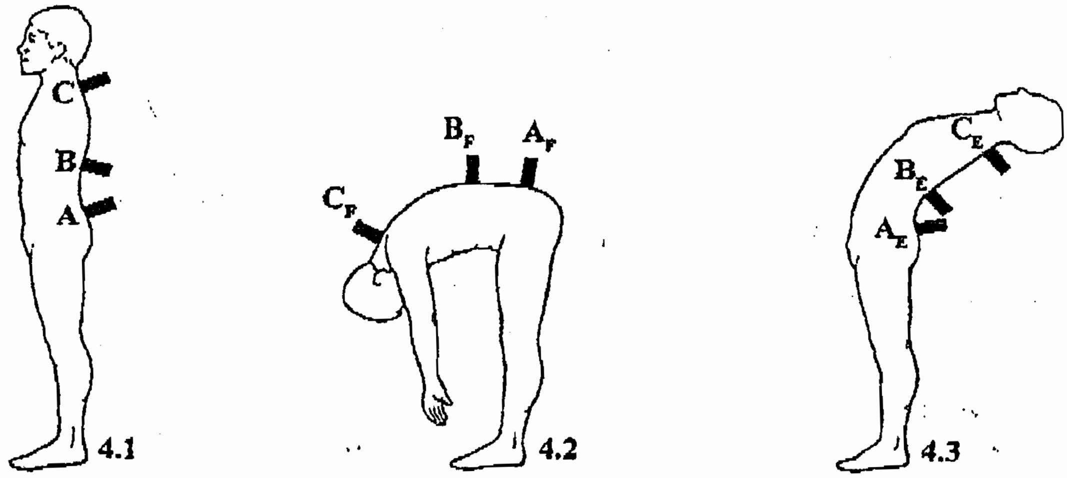


Figure 4

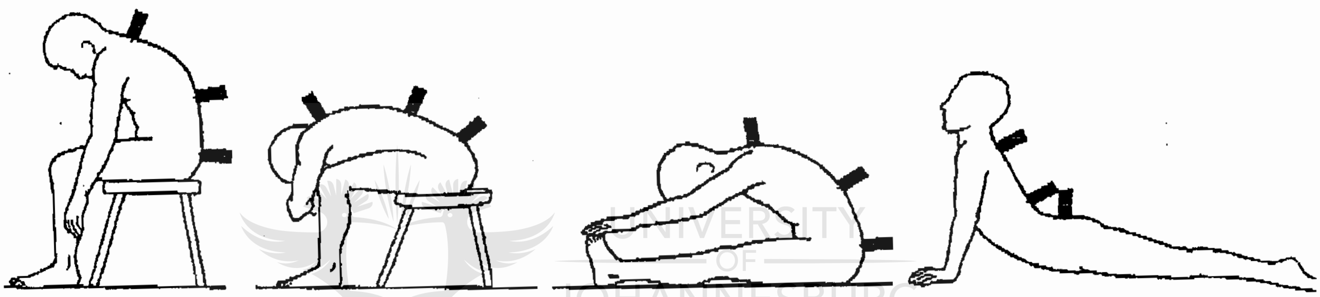
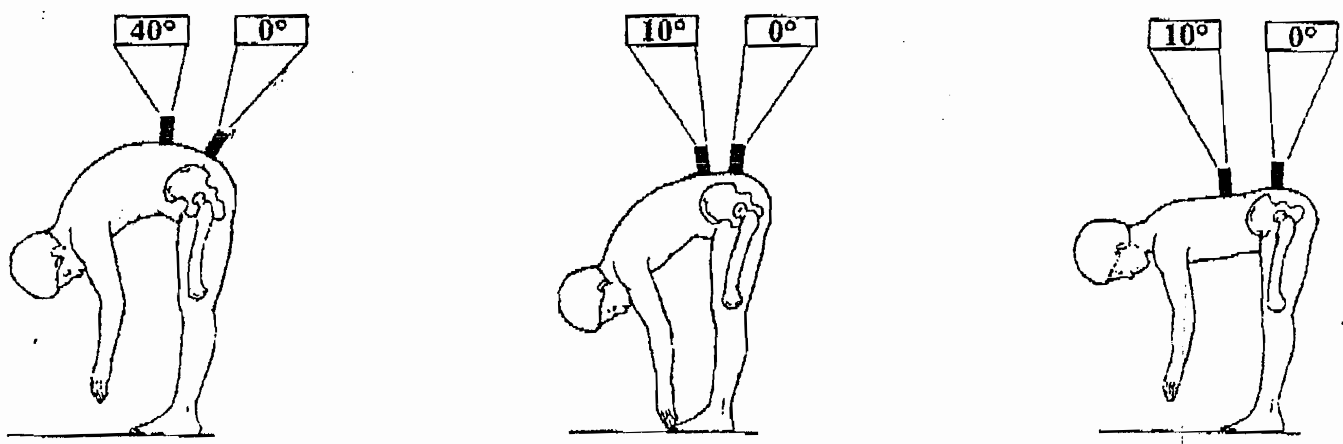


Figure 5



Curve angle at end range of lumbar flexion = 40° Kyphosis
Hyermobility
(30° or more of kyphosis)

Curve angle at end range of lumbar flexion = 10° Kyphosis
Normal Mobility
(0°-30° kyphosis)

Curve angle at end range of lumbar flexion = 10° Lordosis
Hypomobility
(any degree of lordosis)

Figure 6

D. FLEXION AND EXTENSION, AMA GUIDES METHOD (FIGURE 4)

1. With the subject standing in erect posture, locate and mark:
   A) the sacral midpoint
   B) the T12-L1 interspace (T-L joint)
   C) the C7-T1 interspace (C-T joint)
   (See A.1, page 5)
2. Zero the inclinometer at A (Figure 4.1).
3. Ask the subject to flex maximally (Figure 4.2).
4. Place the inclinometer at A_F and recond the reading. This measurement represents Standing Hip Flexion range of motion.
5. Ask the subject to return to erect posture. Zero the inclinometer at B (Fig 4.1).
6. Ask the subject to flex maximally.
7. Place the inclinometer at B_F and record the reading. This measurement represents Gross Lumbar Flexion range of motion.
8. Ask the subject to return to erect posture. Zero the inclinometer at C (Figure 4.1).
9. Ask the subject to flex maximally (Figure 4.2).
10. Place the inclinometer at C_F and record the reading. This measurement represents Gross Thoracic Flexion.
11. Ask the subject to return to erect posture. Repeat steps 2 - 10, asking subject to extend maximally, and record A_E, B_E and C_E (Figure 4.3).
12. Calculate the following measurements and compare to normal values:

Measurement	Method		Normal
Standing Hip Flexion	$= A_F$	= ______	45° to 65°
Standing Hip Extension	$= A_E$	= ______	20° to 30°
Gross Lumbar Flexion	$= B_E$	= ______	
Gross Lumbar Extension	$= B_E$	= ______	
Gross Thoracic Flexion	$= C_F$	= ______	
Gross Thoracic Extension	$= C_E$	= ______	
Lumbar Flexion	$= B_F - A_F$	= ______	≥60°
Thoracic Flexion	$= C_F - B_F$	= ______	20° to 30°
Lumbar Extension	$= B_E - A_E$	= ______	25°
Thoracic Extension	$= C_E - B_E$	= ______	20° to 35°

Note: All measurements in 1A, B and C are taken with the short base of the inclinometer in direct contact with the subject. No attachments are used.

APPENDIX 7

Low Back Pain and Disability Questionnaire (Revised Oswestry)

Patient Name: ______________________ **File #** __________ **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 the ONE box which applies to you. We realize you may consider that two of the statements in any one section relate to you, but please just mark the box which most closely describes your problem.

SECTION 1- PAIN INTENSITY

- ☐ The pain comes and goes and is very mild.
- ☐ The pain is mild and does not vary much.
- ☐ The pain comes and goes and is moderate.
- ☐ The pain is moderate and does not vary much.
- ☐ The pain comes and goes and is severe.
- ☐ The pain is severe and does not vary much.

SECTION 2 - PERSONAL CARE

- ☐ I would not have to change my way of washing or dressing in order to avoid pain.
- ☐ I do not normally change my way of washing or dressing even though it causes some pain.
- ☐ Washing and dressing increase the pain but I manage not to change my way of doing it.
- ☐ Washing and dressing increase the pain and I find it necessary to change my way of doing it.
- ☐ Because of the pain I am unable to do some washing and dressing without help.
- ☐ Because of the pain I am unable to do any washing and dressing without help.

SECTION 3 - LIFTING

- ☐ I can lift heavy weights without extra pain.
- ☐ I can lift heavy weights but it causes extra pain.
- ☐ Pain prevents me from lifting heavy weights off the floor.
- ☐ Pain prevents me from lifting heavy weights off the floor, but I manage if they are conveniently positioned (e.g. on a table).
- ☐ Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned.
- ☐ I can only lift very light weights at the most.

SECTION 4 - WALKING

- ☐ I have no pain on walking.
- ☐ I have some pain on walking but it does not increase with distance.
- ☐ I cannot walk more than one km. without increasing pain.
- ☐ I cannot walk more than 1/2 km. without increasing pain.
- ☐ I cannot walk more than 1/4 km. without increasing pain.
- ☐ I cannot walk at all without increasing pain.

SECTION 5 - SITTING

- ☐ I can sit in any chair as long as I like.
- ☐ I can only sit in my favorite chair as long as I like.
- ☐ Pain prevents me from sitting more than one hour.
- ☐ Pain prevents me from sitting more than half hour.
- ☐ Pain prevents me from sitting more than 10 minutes.
- ☐ I avoid sitting because it increases pain straight away.

SECTION 6 - STANDING

- ☐ I can stand as long as I want without pain.
- ☐ I have some pain on standing but it does not increase with time.
- ☐ I cannot stand for longer than one hour without increasing pain.
- ☐ I cannot stand for longer than 1/2 hour without increasing pain.
- ☐ I cannot stand for longer than 10 minutes without increasing pain.
- ☐ I avoid standing because it increases the pain straight away.

SECTION 7 - SLEEPING

- ☐ I get no pain in bed.
- ☐ I get pain in bed but it does not prevent me from sleeping well.
- ☐ Because of pain my normal night's sleep is reduced by less than 1/4.
- ☐ Because of pain my normal night's sleep is reduced by less than 1/2.
- ☐ Because of pain my normal night's sleep is reduced by less than 3/4.
- ☐ Pain prevents me from sleeping at all.

SECTION 8 - SOCIAL LIFE

- ☐ My social life is normal and gives me no pain.
- ☐ My social life is normal but increases the degree of pain.
- ☐ Pain has no significant effect on my social life apart from limiting my more energetic interests, e.g. dancing, etc.
- ☐ Pain has restricted my social life and I do not go out very often.
- ☐ Pain has restricted my social life to my home.
- ☐ I have hardly any social life because of the pain.

SECTION 9 - TRAVELLING

- ☐ I get no pain whilst travelling.
- ☐ I get some pain whilst travelling but none of my usual forms of travel make it any worse.
- ☐ I get extra pain whilst travelling but it does not compel me to seek alternative forms of travel.
- ☐ I get extra pain whilst travelling which compels me to seek alternative forms of travel.
- ☐ Pain restricts all forms of travel.
- ☐ Pain prevents all forms of travel except that done lying down.

SECTION 10 - CHANGING DEGREE OF PAIN

- ☐ My pain is rapidly getting better.
- ☐ My pain fluctuates but overall is definitely getting better.
- ☐ My pain seems to be getting better but improvement is slow at present.
- ☐ My pain is neither getting better nor worse.
- ☐ My pain is gradually worsening.
- ☐ My pain is rapidly worsening.

(NUMERICAL PAIN RATING SCALE (0)

Pain Severity Scale:

Rate the Severity of your pain by checking one box on the following scale

No pain	0	1	2	3	4	5	6	7	8	9	10	Excruciating Pain

APPENDIX 3

APPENDIX 4

APPENDIX 5

APPENDIX 6

APPENDIX 7