LUMBAR SPINE MANIPULATION, COMPARED TO COMBINED LUMBAR SPINE AND ANKLE MANIPULATION FOR THE TREATMENT OF CHRONIC MECHANICAL LOW BACK PAIN.

By:

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Dissertation submitted in partial compliance with the requirements for the Master's Degree in Technology: Chiropractic at the Durban University of Technology.

I, Lauren Hayley Forbes, do declare that this dissertation is representative of my own work in both conception and execution, except where specific assistance is sought and duly acknowledged.

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DEDICATION

It is with immense pleasure that I dedicate this dissertation to my parents, Colin and Ingrid, and my sister, Caryn. I thank you for providing me with strong foundations, upon which I base my morals. Your continued sacrifice, support and belief in me has made my dreams possible. Through your example, you have given me the inspiration and determination to reach my goals.

To my fiancé, Peter, thank you for your unwavering support and belief in me. Your constant motivation, as well as patience in me, during my studies, and this dissertation, has kept me going, and for that I am eternally grateful.

ACKNOWLEDGEMENTS

My sincere thanks go to the following people:

My supervisor, Dr. Brian Kruger, I am eternally grateful to you for your supervision. Your assistance, guidance and input in this dissertation are highly appreciated.

A special thank you to Pat, Linda and Mrs Ireland for always being so kind and helpful during my years at the clinic. It was a pleasure working with you.

To all the lecturers and teachers who have led me through my academic career.

To all the clinicians at DUT, I thank you for your encouragement and assistance throughout my time at the clinic and throughout the research process.

To Dr. Charmaine Korporaal, thank you for your constant support, your willingness to help and all the time you dedicate to the development and improvement of our profession.

To Mrs. T.M. Esterhuizen, Biostatistician, of Nelson R. Mandela School of Medicine for statistical support.

To Kershnee Pillay, thank you for your willingness to help and your cheerful ways.

To my class for their friendship, support and motivation throughout our years of study.

To all the patients that took the time to be in my study, and who, through their contribution, made this study possible.

ABSTRACT

The low back and the lower limb are generally viewed as two isolated regions, however, there are many authors who believe that these two regions are functionally related. This is due to the two regions being connected to each other through the kinematic chain of the lower extremity.

The lumbar spine is the link between the lower extremities and the trunk, and plays a significant role in the transfer of forces through the body via the kinematic chain. The physical link between the low back and the lower limb is supplied by the thoracolumbar fascia, which plays an important role in the transfer of forces between the spine, pelvis and legs.

Although a relationship between the lower extremity and low back pain is often assumed, little research has been published to demonstrate the association. Most of the evidence so far has been anecdotal, without scientific research to support it.

This study was designed to compare the relative effectiveness of lumbar spine manipulation, compared to combined lumbar spine and subtalar manipulation for the treatment of chronic mechanical low back pain, using subjective and objective measures, for the management of chronic mechanical low back pain.

The study design was a quantitative clinical trial, using purposive sampling. It consisted of forty voluntary participants with chronic mechanical low back pain. There were two groups of twenty participants each, each of whom received six treatments within a three week period. Group A received manipulation of the lumbar spine only, whilst Group B received manipulation of both the lumbar spine and subtalar joint.

The outcome measures included the response of the participants to the Numerical Pain Rating Scale-101 and the Quebec Low Back Pain and Disability Questionnaire. Objective data was obtained from three digital Algometer measures. Data was collected prior to the initial, third and sixth treatment.

Statistically both groups showed improvements, subjectively and objectively, with regards to chronic mechanical low back pain. Inter-group testing for NRS over time showed no significant effect for both treatment groups. There was a significant treatment effect for Algometer Average TP1 while the treatment effect for Algometer Average TP2 was not significant. However, inter-group testing for the Quebec LBP over time showed no significant effect for both treatment groups.

Inter-group analysis demonstrated no statistical significance between the two groups for subjective and objective measurements, thus suggesting that there is no additional benefit in treating the subtalar joint in the management of mechanical low back pain.

Further studies will also benefit greatly from the use of larger sample sizes to improve statistical relevance of data.

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DEFINITIONS

AFFERENT

The sensory function of neural elements (Redwood, 1997:333).

ANKLE

For the purpose of this study, the ankle will be referred to more specifically as the subtalar joint.

CHRONIC LOW BACK PAIN

Pain, ache or discomfort experienced in the lumbar region for greater than 12 weeks duration (Mouton, 1996).

CLOSED PACKED POSTITION

The joint is able to resist shear forces through maximum congruence of the articular surfaces and maximum tension of the major ligaments (Lee, 2004: 46).

GAIT CYCLE

A gait cycle is the time interval that occurs between two consecutive initial contacts (heel-strike) of the same foot (Magee, 2006:847).

INTERNEURONS

Small, highly excitable neural cells which innervate the anterior motor neurons (Guyton and Hall, 1997:441).

JOINT DYSFUNCTION

A joint dysfunction is a disturbance of function without structural change, thereby affecting quality and range of motion. It can present as a decrease in motion, increase in motion or an abnormal motion (Bergmann and Peterson, 2002:41).

JOINT RECEPTORS

Joint receptors are specialised cells or sub-cellular structures that change their properties in response to various stimuli (Hopkins and Ingersoll, 2000:135).

KINEMATIC CHAIN

The kinematic chain may be defined as a “combination of several successively arranged joints constituting a complex unit” (Peterson and Bergmann, 2002).

MANIPULATION

A passive therapeutic procedure in which specifically directed manual forces are applied to the vertebral and extra-vertebral articulations of the body, with the object of restoring mobility to the restricted areas (Gatterman, 1990:410).

MECHANICAL LOW BACK PAIN

Mechanical low back pain may be defined as low back pain of musculoskeletal origin (Borenstein, Wiesel and Boden, 1995:183). For the purpose of this study, mechanical low back pain was taken to include lumbar facet syndrome and sacroiliac syndrome (Kirkaldy-Willis, Burton and Cassidy, 1992:121).

MECHANORECEPTOR

A receptor that is excited by mechanical pressures or distortions such as sound, touch and movement (Redwood, 1997:339).

MOTORNEURON POOL

The complete innervation of one muscle group (Hopkins and Ingersoll, 2000).

NOCICEPTORS

Pain receptors which detect damage occurring within tissues due to physical, mechanical or chemical damage (Guyton and Hall, 1997:376).

PALPATION

Palpation is a procedure in which the hands are used to assess the mobility of the joints. It is the palpatory diagnosis that covers a collection of manual examination techniques used to assess tenderness, shape, size, consistency, position and inherent mobility of the structure beneath (Gatterman, 1990:63).

PRONATION

Pronation is made up of a combination of eversion, abduction, and dorsiflexion (Peterson and Bergmann, 2002:434).

SUPINATION

Supination is made up of a combination of inversion, adduction, and plantarflexion (Peterson and Bergmann, 2002:434).

CHAPTER ONE

INTRODUCTION

1.1 THE PROBLEM AND ITS SETTING

Low back pain is one of the most frequent and costly musculoskeletal pain syndromes, affecting 60-90% of the population at some point during their lifetime (Manga, Angus and Swan, 1993). The re-occurrence rate for low back pain is high and often develops into a chronic fluctuating problem with intermittent relapses. Thus, low back pain has become a significant public health problem and has a marked impact on quality of life and health care costs (Weiner and McCollach, 2000:450). Low back pain represents the most rapidly growing cause of any other form of disability (Waddell, 1998; Waddell, Aylward and Swaney, 2002) and has been identified as the most expensive healthcare problem in the 30-50 year old age group (Spengler, Bigos and Martin, 1986). Low back pain is the third most commonly reported symptom, the second most frequent cause of worker absenteeism (Guo, Tanaka, Halperin and Cameron, 1999:1029-1035) and the most costly ailment of working age adults in the United States of America (Hart, Deyo and Cherkin, 1998: 11-19 and Woodwall, 1999: 1-28).

Low back pain has a high recurrence rate (Andersson, 1999:583) therefore, making it a difficult entity to treat. In most cases, the exact cause of the pain is difficult to isolate, since there is often an emotional and psychological component involved (Weiner and McCollach, 2000:450). Low back pain is a self limiting disorder, with 60-70% of cases resolving within six weeks, and 80-90% within twelve weeks (Andersson, 1999:582). However, Burton, Tillotson, Main and Hollis (1995:727) and Croft, Macfarlan, Papageorgiou, Thomas and Silman (1998:1358) have found that a great percentage of individuals still experience some degree of discomfort after twelve months.

According to Magee, (2006:765), foot dysfunctions are also common, and affect at least 80% of the general population. Although the low back and feet are generally viewed as two isolated regions, there are many who believe that the two regions are functionally related (Cibulka, 1999:600; Dananberg and Guiliano, 1999:116; Voorn, 1998:442). This connection is due to the two regions being associated to one another through the kinematic chain of the lower extremity. The kinematic chain may be defined as a "combination of several successively arranged joints constituting a complex unit" (Bergmann and Peterson, 2002).

Although a relationship between the lower extremity and low back pain is often assumed, little research has been published to demonstrate the association (Cibulka, 1999:599). Most of the evidence so far has been anecdotal without scientific research to support it (Dananberg and Guiliano, 1999:109). Innes (2003) believes that it is essential to examine the lower extremity in the case of low back pain and states that by ignoring the effect of the lower extremity on the low back, the primary cause of a patients' pain may be missed, and unnecessary treatment provided to another area. Dananberg (1998) suggests that the repetitive nature of walking can result in a subtle stress to the lumbar spine and therefore it may easily be overlooked as a primary etiological factor.

According to Reiger-Krugh and Keysor (1996:166), problems in the lower extremity often transmit stresses directly into the pelvis and spine, resulting in compensatory biomechanical alterations such as an increased pelvic tilt or lumbar lordosis, rotation of the pelvis and altered knee flexion. Consequently, the structural and postural changes result in increased stress upon the musculature and other structures around the hip as well as the joints above and below (Reiger-Krugh and Keysor, 1996:166). Any sequencing malfunctions that occur during a specific task may be the result of many different factors of which injury is the most common. Consequently, the musculoskeletal system may not function optimally during the completion of a task when altered biomechanics exist (Downes, 2001).

1.2 AIMS AND OBJECTIVES OF THE STUDY

The aim of this investigation was to determine the relative effectiveness of lumbar spine manipulation, compared to combined lumbar and ankle manipulation for the treatment of chronic mechanical low back pain, using subjective and objective measures, in the management of chronic mechanical lower back pain.

1.2.1. OBJECTIVE ONE:

The first objective was to determine the relative effectiveness of lumbar spine manipulation, compared to combined lumbar and ankle manipulation, in terms of subjective clinical findings (pain and disability), in the management of chronic mechanical low back pain.

1.2.2 OBJECTIVE TWO

The second objective was to determine the relative effectiveness of lumbar spine manipulation compared to combined lumbar and ankle manipulation, in terms of objective clinical findings (pain pressure threshold), in the management of chronic mechanical low back pain.

1.3 PURPOSE AND BENEFITS OF THE STUDY

Due to the multiple unknown causes of low back pain, it is important to look at other areas of the body to see if these areas play a role in low back pain (Innes, 2003). If ankle joint dysfunctions are found to play a role in chronic mechanical low back pain, this knowledge would enable chiropractors to address this aspect. This would provide a more holistic approach to treating patients with low back pain.

If ankle joint dysfunctions are found to play a role in chronic mechanical low back pain, this knowledge would allow the chiropractor to be able to relieve the joint dysfunction, and thereby treat the possible cause of the condition, rather than only being able to provide treatment to the symptomatic area.

If an association can be made between chronic mechanical low back pain and ankle joint dysfunction, knowledge of this could lead to the condition being corrected, without unnecessary treatment to the back or even to other areas of the lower limb which may be affected along the kinematic chain.

1.4 CONCLUSION

This research aimed to contribute to the body of knowledge pertaining to the kinematic chain of the lower limb (subtalar joint) and its relationship to chronic mechanical low back pain. This research may provide a foundation for further studies related to the kinematic chain and its association with chronic mechanical low back pain or even other conditions.

In the remaining chapters, the researcher will review the pertinent literature pertaining to the topic (Chapter two); describe in detail the methodology of this study (Chapter three) and present the statistics (Chapter four); and the subsequent conclusions (Chapter five). Thereafter, recommendations will be made for suggested improvements (Chapter six).

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The intention of this chapter is to provide a detailed overview of the current literature that is pertinent to this study. An outline of the appropriate anatomy and biomechanics of the structures related to low back and ankle will be provided, as well as the current epidemiological data on low back pain. Finally, it will highlight the basic concepts and theories related to the lower limb and chronic mechanical low back pain and the potential relationship between the two.

2.2 MECHANICAL LOW BACK PAIN

Approximately 90% of low back pain cases are due to mechanical origin, with the remaining 10% being due to the manifestation of systemic illness (Diamond and Borenstein, 2006). Mechanical low back pain may be defined as low back pain of a musculoskeletal origin, either due to overuse of a normal anatomical structure (for example a muscle strain) or due to injury or deformity (for example a herniated intervertebral disc), (Borenstein, Wiesel and Boden,1995:183). Mechanical low back pain is the most common cause of disability in individuals that are younger than 45 years old and is the third most common cause of disability in individuals aged 45 and over (Manga *et al.,* 1993 and Hills, 2005). For the purpose of this study, mechanical low back pain was taken to include pain caused by posterior facet syndrome and sacroiliac joint syndrome (Schaefer and Faye, 1990).

2.3 INCIDENCE AND PREVALENCE

Low back pain is an omnipresent problem and there are many epidemiological and statistical studies documenting the high incidence and prevalence of low back pain (Manga *et al.,* 1993). In this respect, low back pain is estimated to affect between 60-90% of the world’s population sometime during their lives, while between 20-30% of people experience low back pain at any given time (Burton and Cassidy, 1992:3 and Waddell *et al*., 2002). South African epidemiological studies have revealed incidence rates of 57.6% among Black South Africans (Van der Meulen, 1997). The lifetime incidence of low back pain in Indian and Coloured communities in South Africa was found to be 78.2% and 76.6% respectively (Docrat, 1999). The prevalence of low back pain at the time of the respective studies was 53.1% in the Black community (Van der Meulen, 1997:99), 45% in the Indian community and 32.6% in the Coloured community (Docrat, 1999:157).

Whilst there is no evidence that the prevalence of back pain has increased, reported disability due to back pain, particularly work absence, has increased significantly in the last 30 years (Haslett, Chilvers, Boon and Colledge, 2002:981). This may be due to cultural changes that have influenced people's awareness of their symptoms and their willingness to report them (Palmer, Walsh, Bendall, Cooper and Coggon, 2000) and the attitudes and beliefs held by referring physicians (Buchbinder, Jolley and Wyatt, 2001). Although there is no mortality associated with mechanical low back pain, morbidity in terms of lost productivity and use of medical services results in exceedingly high societal costs (Waddell, 2004 and Hills, 2005).

The incidence of low back pain is higher in manual workers, particularly occupations that involve heavy lifting and twisting (e.g. construction, mining, agriculture, and nursing). However, there is evidence that the prevalence of low back pain is also high in sedentary workers (Linton, Hellsing and Hallden, 1998). Psychological factors (e.g. job dissatisfaction, perceived inadequacy of income, depression, anxiety, drug and alcohol abuse) have also been found to increase the transition of acute low back pain to chronic pain and disability (Haslett *et al.,* 2002; Manek and MacGregor, 2005 and Smith, Mihashi, Adachi, Koga and Ishitatake, 2006). According to Pope, Anderson, Frymoyer and Chaffin (1991) it is unknown as to whether some of these social factors are the cause or the result of low back pain. A study by Vieira, Kumar and Narayan (2005) concluded that smoking, a lack of exercise and being overweight increases the risk of having low back pain. Individual risk factors include increasing age (Bork, Cook, Rosecrance, Engelhardt, Thomason, Wauford and Worley, 1999), gender (Glover, McGregor, Sullivan and Hague, 2005), race (Docrat, 1999 and Vlok, 2005), anthropometric data such as height and weight (van der Meulen, 1997 and Vieira *et al.,* 2005) and structural abnormalities such as scoliosis and leg length inequalities are also significant factors (Tim, 1994 and Kovacs, Gestoso, Gil del real, Lopez, Mufraggi, and Mendez*,* 2003).

2.4 AETIOLOGY OF CHRONIC LOW BACK PAIN

Anatomical structures which may have the ability to cause low back pain include the lumbar vertebrae, muscles, thoracolumbar fascia, dura mater, epidural plexus, ligaments, sacroiliac joints, zygopohyseal joints, intevertabral discs (Bogduk, 1997:192-202) and vertebral end plates (Heggeness and Doherty, 1993:1050). These structures are able to cause pain because they are either innervated or have the ability to be mediators for nociceptive nerve endings (Paris, 1997:319).

Of the above structures, most are believed to be able to cause acute low pain, but are thought to be uncommon sources of chronic low back pain (Bogduk, 1997:212). Structures that have shown to 60% of the cause of chronic low back pain include the lumbar facet joints, sacroiliac joints and lumbar intervertebral discs (Bogduk, 1997:212).

According to Borestein *et al.* (1995), pain may arise from the lumbar facet joints and capsules because they are innervated. Furthermore, Cramer and Darby (1996:3) point out that pain may arise from the zygopophyseal joint folds (which are found in the joint space) as they may become entrapped between the two joint surfaces. According to Cramer and Darby (1996:3), this articular cartilage may degenerate resulting in the production of inflammatory agents which may stimulate nociceptors in these facet joints thus resulting in pain.

The sacroiliac joint has been found to be a significant source of chronic low back pain (Schwarzer, Aprill and Brogduk, 1995:31 and Sakamoto, Yamasitha, Takebayashi, Sekine and Ishii*,* 2001). The sacroiliac joint capsule and overlying ligaments have been shown to be innervated, making them possible causes of pain (Bernard, 1997:77-78). Although pain due to the sacroiliac joints is not common, it appears that the prevalence of pain arising from the sacroiliac joint may be between 13 and 30% or even higher than previously thought (Franke Jr. 2003:12). Similarly, Schwarzer *et al.* (1995) and Maigne, Aivalikis, and Pfefer (1996) were able to demonstrate via formal studies using intra-articular sacroiliac joint anaesthetic blocks, that 15-21% of individuals with low back pain had a contribution from the sacroiliac joint. Sacroiliac pain therefore appears to play an important role in the aetiology of chronic mechanical low back pain.

In order to achieve a greater understanding of mechanical syndromes, it is essential to understand the basic anatomy and pathomechanics of the low back region. In this respect, the anatomy of the low back will now be presented.

2.5 ANATOMY

The lumbrosacral spine is comprised of five lumbar vertebrae, the sacrum and the coccyx. It is an intricate structure comprising of bony elements, linked by ligaments and joint capsules which are governed by layers of muscles (Kirkaldy-Willis and Burton, 1992).

2.5.1 BONY ANATOMY

2.5.1.1 THE LUMBAR SPINE

Moore and Dalley (1999) state that the five lumbar vertebrae can be identified by their large kidney shaped bodies, sturdy laminae and absent costal facets. The vertebrae increase in size from L1 to L5 as the load that they support increases towards the inferior end of the vertebral column (Moore and Dalley, 1999).

The vertebral arch is horseshoe-shaped structure formed by laminae and pedicles. There are seven processes that project from this arch. These are the paired superior and inferior articular processes, the spinous process and two transverse processes (Kirkaldy-Willis and Burton, 1992). The thick and broad spinous processes are hatchet shaped and point posteriorly. The transverse processes originating from the laminae-pedicle junction are slender, long and flattened on the anterior and posterior surfaces (Moore and Dalley, 1999). The transverse processes, together with the spinous processes serve as a site for muscles and ligaments to attach (Kirkaldy-Willis and Burton, 1992). The articular processes, which are also large, thick and strong, facilitate flexion, extension and lateral bending of the spine, whilst prohibiting rotation (Moore and Dalley, 1999).

2.5.1.2 THE SACRUM

The sacrum is said to be the foundation of the spine (Lee, 2004). The sacrum is a large triangular shape bone that is situated at the base of the spine and articulates laterally with the ilium. The sacrum is a fusion of the five sacral segments that results in a triangular wedge-shaped bone (Moore and Dalley, 1999 and Lee, 2004). The sacral base is formed by the superior surface of S1 and has two superior facets that articulate with L5 (Moore and Dalley, 1999). The sacral base points inferiorly and articulates with the coccyx by means of a disc. The sacral tubercles are located in the midline and correlate with the spinous processes of the fused vertebrae, whereas the tubercles on the posterolateral aspect correlate with the transverse processes. The sacrum is provides strength and stability to the pelvis and transmits the weight of the body to the pelvis. The sacrum provides support for the vertebral column and forms the posterior part of the pelvis (Moore and Dalley, 1999).

2.5.2 THE LUMBAR ZYGOPOPHYSEAL JOINT (LUMBAR FACET JOINT)

2.5.2.1 ANATOMY

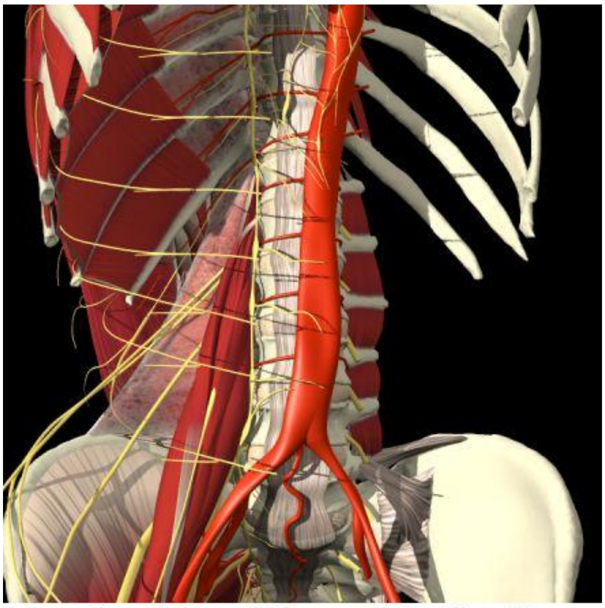
There are five pairs of facet joints, which are located in the vertebral arches of the lumbar spine (Magee, 2006:467). The lumbar facet joints are classified as synovial planar joints and are formed by the articulation between the superior articular process of the vertebral body below and the inferior articular process of the vertebral body above. (Moore and Dalley, 1999). The superior facets face medially and backward and in general are concave, whilst the inferior facets face laterally and forward and are convex (Magee, 2006:467). Each joint is surrounded by a thick and fibrous articular capsule posterolaterally and ligamentum flavum covers the anterior and medial aspects of the joint. The accessory ligaments help to stabilize the joint by uniting the laminae, transverse process and spinous process (Moore and Dalley, 1999). The synovial membrane lines the articular capsule and ligamentum flavum whilst the synovial joint folds supply the joint surface with synovial fluid (Giles and Singer, 1997).

2.5.2.2 FUNCTION

The function of the lumbar facet joints is to stabilize the motion between the two adjacent vertebrae, resist torsion and translation, whilst facilitate sagittal plane flexion and extension (Borenstein *et al.,* 1995:3 and Giles and Singer, 1997). The facet joints carry 20% to 25 % of the axial load, sharing this function with the intervertebral discs (McCullach and Transfeldt, 1997:81; Moore and Dalley, 1999:455 and Magee, 2006:467).

2.5.2.3 INNERVATION

The medial branch of the dorsal rami of the spinal nerves supplies the lumbar zygopophyseal joints. The dorsal ramus arises from the spinal nerve outside the intervertabral foramen and divides into medial and lateral branches. Each articular branch innervates two adjacent joints, thereby supplying each joint with two nerves (Moore and Dalley, 1999).



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2.5.3 BIOMECHANICS OF THE LUMBAR SPINE AND PELVIS

The spine is a multifarious structure, having to provide support for the upper body and transmit the weight of the upper body into the pelvis and lower limbs (Magee, 2006:467), whilst providing a protective passage for the spinal cord, at the same time allowing enough mobility and flexibility to execute a variety of tasks (McCullach and Transfeldt, 1997:75). The basic functional unit of the spine is known as a functional motion unit, and it consists of two adjacent vertebral bodies with the intervertebral disc between them (Andersson, 1992:27 and Magee, 2006:469). The functional motion units enable the spine to bend forward (flexion), backward (extension), twist (axial rotation) and bend to the side (lateral flexion), as well as combinations of the above movements (Andersson, 1992:27).

The various components of the spine all play their own role in the function of the spine. The intervertebral discs are interposed between the bodies of two adjacent vertebrae (Moore and Dalley, 1999:451). The intervertebral discs are the main load bearing units of the spine for axial compression, flexion and lateral and posterior shear (McCullach and Transfeldt, 1997:81). They act as a shock absorber for the spine, distributing and absorbing some of the load applied to the spine (Magee, 2006:469). They also separate the vertebrae, allowing far more mobility to the spine than if the vertebrae were in direct contact with each other (Borenstein *et al.,* 1995:7) and allowing the nerve roots to pass freely from the spinal cord through the intervertebral foramina (Magee, 2006:469). The intervertebral disks vary in shape, thus producing the secondary curvatures of the vertebral column (Moore and Dalley, 1999:450).

According to Bogduk (1997:58), the lumbar spine normally has a lordotic curve, which protects it to a large extent from compressive forces due to body weight because if the lumbar spine was straight, forces would be transmitted through the vertebral bodies and intervertebral discs, with the shock absorption of the intervertebral discs being the only protection of the vertebrae. However, the curves of the vertebral column reduce these downward forces significantly, by helping to reduce the transmission of the forces (Moore and Dalley, 1999).

The pelvis, with its articulations and ligaments, is often classified as being part of the lower limbs, however the pelvis forms an essential connection between the spine and the lower extremity (Vleeming, Snijders, Stoeckart and Mens, 1997:53-54). The sacroiliac joints, together with the pubic symphysis help translate the weight from the spine to the lower limbs and provide elasticity to the pelvic ring. At the same time they also act as a buffer in an attempt to reduce the force of bumps and jars, caused by contact of the feet on the ground, to the spine and upper body (Lee, 1999).

The sacroiliac joints have no muscles that control their movements directly; however, they are influenced by the action of the muscles that move the lumbar spine and hip because many of the muscles attach to the sacrum and the pelvis (Magee, 2006: 567). The sacroiliac joints are supported by several strong ligaments. The long posterior sacroiliac ligaments limit anterior pelvic rotation, whilst the short posterior sacroiliac ligaments limit all pelvic or sacral movement (Moore and Dalley, 1999). The posterior interosseous ligament forms a part of the sacroiliac articulation, and the anterior sacroiliac ligaments. The sacrotuberous ligament and sacrospinous ligaments limit nutation, whilst the iliolumbar ligament stabilizes the L5 vertebra on the ilium (Jackson, 1998).

It is important to look at the pelvis, and especially the sacroiliac joints and the hip joints, when examining the lumbar spine (Magee, 2006:567). The sacroiliac joints and symphysis pubis is influenced by the action of the muscles moving the lumbar spine and hip as many of these muscles attach to the sacrum and hip, thus actively stabilizing the pelvic joints and contributing significantly to load transfer during gait and pelvic rotational activities (Lee, 1999). This connection between the spine and lower extremity will be revisited later, when we take a look at the link between the lower limbs and the low back.

2.5.4 FUNCTIONAL ANATOMY AND BIOMECHANICS

2.5.4.1 TALOCRURAL JOINT

The ankle, also known as the talocrural joint, is a uniplanar, modified hinge type synovial joint which is located between the talus, medial malleolus of the tibia, and the lateral malleolus of the fibula (Magee, 2006:765). The functional biomechanics of the ankle joint allow for flexible locomotion and the ability to bear weight (Bergmann and Peterson, 2002:434).

The primary movements of talocrural joints are 20 to 30 degrees of dorsiflexion and 30 to 50 degrees of plantar flexion. However, only 10 degrees of dorsiflexion and 20 degrees of plantar flexion are required for the normal gait pattern to occur (Edmond, 1993:161; Bergmann and Peterson, 2002 and Magee, 2006). The closed-packed position of the ankle joint is full dorsiflexion (Magee, 2006:765). The talocrural joint is designed for stability, and is the most stable in the dorsiflexed position (Anderson, 2002 and Magee, 2006:765,766). During dorsiflexion the anterior talus is wedged between the malleoli and therefore allows for little or no inversion or eversion of the ankle joint (Magee, 2006:765). During plantar flexion, the talocrural joint is relatively unstable, because the talus is narrower posteriorly and therefore lies relatively loosely in the mortice, allowing for more mobility (Moore and Dalley, 1999; Anderson, 2002 and Magee, 2006:765). The loose packed position of the talocrural joint is 10 degrees of plantar flexion, midway between maximum inversion and eversion (Magee, 2006:766).

2.5.4.2 SUBTALAR JOINT

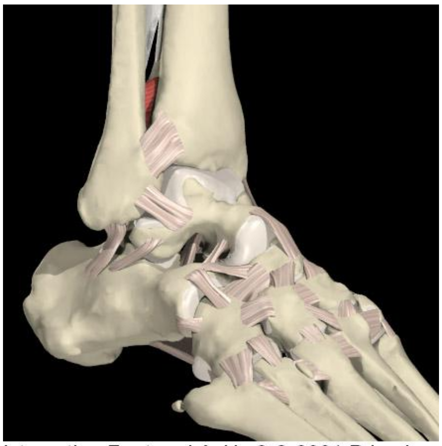
The subtalar joint, also known as talocalcaneal joint, is a plain synovial joint formed by the articulation of the superior surface of the calcaneous and the inferior surface of the talus (Edmond, 1993:161 and Bergmann and Peterson, 2002:432). The function of the subtalar joint is to absorb shock during heel strike (initial contact with the ground) and to rotate the lower extremity in the transverse plane during the stance phase (when the foot is weight bearing) of gait (Bergmann and Peterson, 2002:435). The axis of movement passes through all three cardinal planes of movement, thus allowing for movement in all three planes, which includes supination and pronation of the calcaneus under the talus (Bergmann and Peterson, 2002:434). Supination is composed of inversion, adduction and plantar flexion, while pronation is composed of eversion, abduction and dorsiflexion (Hunt, Smith, Torode and Keenan, 2001; Abboud, 2002 and Bergmann and Peterson, 2002:434). During the gait cycle, joints, muscles and other anatomical structures function differently in open chain (non weightbearing) and closed chain (weight bearing) positions. The subtalar joint is responsible for any compensation that may occur during the gait cycle (Root, Orien and Weed, 1977 and Perry, 1983). The motion in which the foot moves to adjust to irregularities of the supporting terrain or deviations in any part of the trunk or lower extremity is known as compensation. This compensation can either be normal or abnormal. Therefore, the subtalar joint has the potential to affect and be affected by more proximal joints such as the knee, hip or spine and more distal structures such as all the joints and structures of the foot (Lattanza, Gray and Kantner, 1988). Pain in the subtalar joint is primarily located posteriorly between the malleoli and is particularly aggravated by walking on uneven surfaces that require inversion and eversion on the foot (Haslett *et al.,* 2002:980).

2.5.4.3 LIGAMENTS

The stability of the complex series of joints that comprise of the foot and ankle is primarily maintained by the expansive network of ligaments. The articular fibrous capsule attaches superiorly to the borders of the tibia and malleoli and inferiorly to the talus. The capsule is thin anteriorly and posteriorly, but is supported laterally and medially by collateral ligaments (Moore and Dalley, 1999:633-635).

The lateral ankle ligaments are responsible for resistance against inversion and internal rotational stresses. The lateral ankle ligaments are composed of three ligaments, namely the anterior talotibular ligament, the calcaneofibular ligament and the posterior talofibular ligament (Moore and Dalley, 1999:633-635 and Magee, 2006:767).

The medial supporting ligaments (deltoid ligaments) resist eversion and external rotational stresses. The deltoid ligament consists of four separate ligaments: tibionavicular ligament, anterior tibiotalar ligament, posterior tibiotalar ligament and the tibiocalcaneal ligament (Moore and Dalley, 1999:633-635 and Magee, 2006:767).



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2.6 MOTOR CONTROL

Motor control pertains to the timing of specific muscle activation and inactivation. Coordinated muscle action results in efficient movement, such that the stability is maintained while motion is controlled and not restricted (Hodges, Cressell and Thorstensson*,* 2001 and Hodges, 2003a).

With respect to the lumbopelvic region, coordinated action between the local and global muscle systems ensures stability of posture, without rigidity and episodes of collapse (Richardson, Jull, Hodges and Hides*,* 1999 and Lee, 2001a, 2003).

2.6.1 THE ROLE OF THE LOCAL MUSCLE SYSTEM

Research conducted by Hodges and Richardson (1996, 1997c) focused on the role of the transverses abdominis in healthy individuals and the response of this muscle in patients with low back pain. Hodges and Richardson were able to conclude that the transversus abdominis is an anticipatory muscle for stabilization of the low back and is recruited prior to the initiation of any movement of the upper or lower extremity. However, the anticipatory recruitment of the transversus abdominus was shown to be absent or delayed in patients with low back pain.

Moseley, Hodges and Gandevia (2002) were able to demonstrate that the deep fibres of the multifidus muscle are recruited prior to the initiation of any movement of the upper extremity when the timing of the load is predictable. However, the superficial and lateral fibres of the multifidus muscle were shown to be direction-dependant.

The “roof and floor” of the local muscle system is provided by the musculature of the pelvic floor and respiratory diaphragm (Lee, 2004). Sapsford, Hodges, Richardson, Cooper, Markwell and Jull (2001) found that the pelvic floor can be facilitated by the co-activation of the abdominals and vice versa.

The diaphragm which is better known as a respiratory muscle is a modified half-dome which separates the thorax from the abdominal cavity (Lee, 2004). Hodges *et al.* (1997a,b), Hodges and Gandevia (2000a,b) and Hodges (2003a) investigated the role of the diaphragm of the trunk during perturbation studies. The findings supported the classification of the diaphragm as a local stabilizer of the trunk in addition to its respiratory responsibilities.

In summary, when the local muscle system is functioning optimally, it provides anticipatory inter-segmental stiffness of the joints in the lumbar spine (Hodges, Kaigle-Holm and Holm, 2003b) and pelvis which helps to prevent excessive shearing during loading (Richardson, Snijders, Hides, Damen, Pas, and Storm, 2002). Prior to the onset of any movement the low back and pelvis stiffen to prepare for any additional loading from the global system. Simultaneously, the diaphragm maintains respiration while the pelvic floor maintains the position of the pelvic organs as the load is transferred though the pelvis (Lee, 2004).

2.6.2 THE ROLE OF THE GLOBAL MUSCLE SYSTEM

There are four slings of muscle systems which stabilize the pelvis between the thorax and the lower limb (Snijders, Vleeming and Stoeckart, 1993; Vleeming, Pool-Goudzwaard, Stoeckart, Van Wingerden and Snijders, 1995a and Vleeming, Snijders, Stoeckart and Mens, 1995b). It is important to understand the role of the individual muscles in regional stabilization as well as their role in mobility and how they connect and function together.

The four slings are composed of:

1) The posterior oblique sling is composed of the connections between the latissimus dorsi and gluteus maximus through the thoracodorsal fascia (Lee, 2004:52).

2) The anterior oblique sling is made up of connections between the external oblique, the anterior abdominal fascia, the contra-lateral internal oblique abdominal muscle and adductors of the thigh (Lee, 2004:52).

3) The longitudinal sling connects the peroneii, biceps femoris, sacrotuberous ligament, the deep lamina of the thoracodorsal fascia and the erector spinae (Lee, 2004:52).

4) And lastly, the lateral sling is composed of the gluteus medius, gluteus minimus, tensor fascia latae and the lateral stabilizers of the thoracopelvic region which form the primary stabilizers of the hip joint. (Lee, 2004:52).

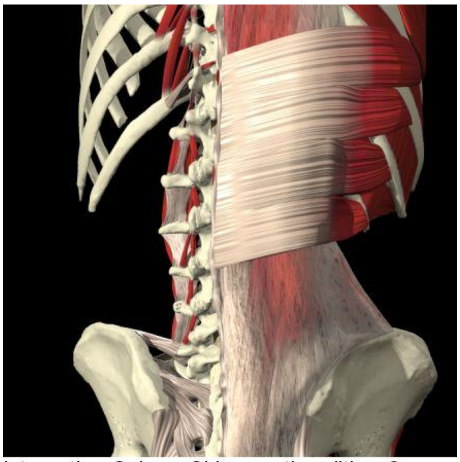
The anatomical integration is imperative to understand when restoring global muscle stability and mobility between the pelvis and the lower limb, as the close relationship elucidate why some components of the sling may be rigid or lacking in support (Lee, 2004:53).

2.7 THE PHYSICAL LINK

2.7.1 THORACOLUMBAR FASCIA

In detailed anatomic dissections, Vleeming *et al.* (1995a) have shown previously unrecorded anatomical interactions of various postural and lower extremity segments. The physical link between the low back and the lower limb is provided by the thoracolumbar fascia, which plays an important role in the transfer of forces between the spine, pelvis and legs (Vleeming *et al.,* 1995a:775). There are several muscles that are important in providing stability to the pelvic girdle. They attach to the thoracolumbar fascia and can affect tension within it. The muscles that provide stability to the pelvic girdle include the transversus abdominis, internal oblique, gluteus maximus, latissimus dorsi, erector spinae, multifidus and biceps femoris (Lee, 2004).

The thoracolumbar fascia is made up of three layers, the anterior, middle and posterior layers. The posterior layer of the thoracolumbar fascia extends from the sacral area all the way up into the thoracic region, and is continuous with the latissimus dorsi muscle and partly with the trapezius muscle superiorly and with the gluteus maximus muscle inferiorly (Vleeming *et al.,* 1995a:754-755). This forms the link between the lumbar spine and the pelvis. From here some of the forces from the upper half of the body are transferred downwards into the rest of the lower limb through the iliotibial band, which extends down from the gluteus maximus muscle (Vleeming *et al.,* 1997:68) down to the lateral condyle of the tibia (Snell, 2000:513).



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2.7.2 THE FASCIA OF THE LEG

The fascia of the lower extremity attaches to the pelvic girdle and envelopes the muscles of the lower limb. Thus the fascia is able to influence the function of the pelvic girdle and subsequently become symptomatic in dysfunction (Lee, 2004).

The fascia of the lower limb surrounds the pelvic girdle by attaching to the sacrum, coccyx, iliac crest, inguinal ligament, superior pubic ramus, inferior pubic ramus, ischial ramus, ischial tuberosity, and sacrotuberous ligament (Moore and Dalley, 1999:522 and Lee, 2004:36). The fascia blends superiorly with the thoracolumbar and abdominal fascia of the trunk and descends inferiorly from the iliac crest over before splitting into two bands to surround the gluteus maximus muscle. The two bands insert into the iliotibial tract at the inferior border of the gluteus maximus (Lee, 2004). The iliotibial tract attaches distally to the condyles of the femur and the tibia, and to the head of the fibula, merging with aponeurosis quadriceps muscle (Moore and Dalley, 1999 and Lee, 2004). The tenor fascia lata is enclosed between two layers of fascia and inserts into the iliotibial tract (Moore and Dalley, 1999:531) anterior to the attachment of the gluteus maximus muscle (Lee, 2004).

The fascia is a continuous sheet of tissue that surrounds and connects the neuromuscular skeletal system, therefore the slightest change in tension in one region, stimulates receptors in the adjoining regions. The proprioceptors provide a vital and uninterrupted continuum of sensory input from which the central nervous system provides a coordinated efferent response, optimizing locomotion along the kinetic chains (Swinkels and Dolan, 1998: 590-597).

2.8 ARTHROGENIC MUSCLE INHIBITION

Arthrogenic muscle inhibition is the failure of a functional muscle group to recruit all motor units during maximal voluntary effort (Suter, McMorland, Herzog, and Bray, 2000). Clinical arthrogenic muscle inhibition manifests itself as a decrease in strength of the affected muscle group (Suter *et al.,* 2000).

Arthrogenic muscle inhibition is a joints natural and protective response to distension, damage or pain. As this recurring response takes place, reflex inhibition of the muscles surrounding the joint takes place in order to protect the joint (Hopkins and Ingersoll, 2000).

Individual risk factors such as increasing age, manual labour, sedentary lifestyle, poor health, joint degeneration, exposure to vibration, smoking, physiological and postural problems can lead to changes in the biomechanics (Kirkaldy-Willis and Burton, 1992). These changes in biomechanics often result in inflammation, due to pain and joint irritation, or muscle spasm. This pain and/or discomfort has been associated with the patient being unable to recruit all muscle fibres within muscles that cross the joint, thereby creating a perceived or actual weakness within the muscle (Suter *et al.,* 2000 and Kirkaldy-Willis and Burton, 1992). The compromise of the muscles' functional ability perpetuates the presence of low back pain and results in a negative pathomechanical spiral with regards to the patients' low back pain (Kirkaldy-Willis and Burton, 1992).

Arthrogenic muscle inhibition is caused by the stimulation of joint receptors as a result of pain, capsule compression, ligament stretching, or effusion and irritation due to injury within the joint (Spencer, Hayes and Alexander, 1984). Stimulation of the joint receptors results in excitation of the interneurons (Hopkins and Ingersoll, 2000), which transmit excitatory or inhibitory impulses (Crossman and Neary, 1995).

Joint receptors appear to stimulate inhibitory interneurons causing inhibition of the joints motorneuron pool, resulting in the reduction of motorneuron recruitment (Hopkins and Ingersoll, 2000). The reduction in motorneuron recruitment is seen clinically as a reduction in strength in the affected muscle group (Suter, McMorland, Herzog and Bray, 1999). The decrease in strength caused by muscle inhibition delays the rehabilitation of the affected joints as active exercise forms a vital role in rehabilitation process (Hopkins and Ingersoll, 2000 and Suter *et al.* 1999). Changes in proprioceptive and motor control systems will alter movement patterns and strategies of load transfer, resulting in inefficient movement, suboptimal function and a higher risk of pain and re-injury (Hides, Richardson and Jull, 2001). Altered joint forces may also result in earlier degenerative changes and pain (Lee, 2004).

Suter *et al.* (1999, 2000) proposed that sacroiliac manipulation reduced arthrogenic muscle inhibition. Manipulation is believed to cause excitation of the joint receptors, which are known as the Wyke receptors (Leach, 1994:63). Stimulation of these joint receptors causes an alteration in the afferent input to the motorneuron pool resulting in a reduction of arthrogenic muscle inhibition (Suter *et al.,* 2000).

The sacroiliac joint is richly innervated with nociceptive mechanoreceptors making it plausible that this joint is a significant cause of low back pain (Sakamoto *et al.,* 2001). A symptomatic sacroiliac joint will cause stimulation of the nociceptors that are in and associated with the joint (Sakamoto *et al.,* 2001). Therefore, sacroiliac syndrome could lead to the development of arthrogenic muscle inhibition. Arthrogenic muscle inhibition arising from sacroiliac syndrome would lead to the inhibition of the muscles that fall within the motorneuron pool of the sacroiliac joint.

The role of a high velocity, low amplitude manipulation lies in reinstating the balance between joint kinematics and associated muscle function, which subsequently normalises the arthrogenic reflex and breaks the pain cycle. Active stimulation and stretch of the large pelvic muscle structures creates a reflex myofascial relaxation and pain inhibition, thus overriding nociception stimulation (Bernard and Cassidy, 1991 and Tullberg, Blomberg, Branth and Johnsson*,* 1998).

2.9 THE KINEMATIC CHAIN

According to Andersson (1999) and Magee (2006), foot dysfunctions are also common, and affect at least 80% of the general population at some point during their lifetime. Although the lower back and feet are generally viewed as two isolated regions, there are many who believe that the two regions are functionally related (Voorn, 1998:442; Cibulka, 1999:600 and Dananberg and Guiliano, 1999:116). This connection is due to the two regions being connected to each other through the kinematic chain of the lower extremity.

Similarly, Akuthota and Nadler (2004), suggest that the lumbar spine is the link between the lower extremities and the trunk, and plays a significant role in the transfer of forces through the body via the kinematic chain. In 1875 Reuleux introduced the term “kinematic chain” in reference to a mechanical system of links. The kinematic chain is defined as a “combination of several successively arranged joints constituting a complex unit” (Bergmann and Peterson*,* 2002). The human body is made up of numerous kinematic chains (Huson, 1997:130) which are composed of individual body segments and joints that are collectively called links, and these segments and joints must be moved in specific sequences in order to allow for efficient accomplishment of the required task (Brukner and Khan, 2002:28). The kinematic chain of the pelvis and lower extremity is a closed kinematic chain when the feet are weight-bearing (Huson, 1997:128). For this reason, all the links in the system are interdependent (DeFranca and Levine, 1996:58) resulting in any changes in one link or joint of the chain having immediate effects on the kinematics of other joints in the chain (Huson, 1997:130).

The bony structure of the feet provides the foundation for the kinematic chain that extends from the occiput to the soles of the feet (Schaefer and Faye, 1990 and Abboud, 2002). Thus the articulations of the foot and ankle provide an important role in holistic biomechanical integrity (Schaefer and Faye, 1990). The foot and ankle combine a complex series of joints and controlling forces and integrate them to meet the demands of static and dynamic situations (Schaefer and Faye, 1990). The foot and ankle must be flexible enough (free from restrictions) to accommodate different surfaces, yet be rigid enough to provide the required torque for locomotion. Any disruption of the mechanics of the kinematic chain can lead to pathologic function (Schaefer and Faye, 1990; DeFranca and Levine, 1996 and Huson, 1997).

However, the muscular “corset’’ formed by the trunk musculature is said to be the foundation of all limb movements, and is the centre of the functional kinematic chain (Akuthota and Nadler, 2004). A high degree of lumbopelvic stability may contribute to efficient transmission of force generated by the lower limbs through the trunk to the upper body (Mills, Traunton, and Mills*,* 2005). Similarly, Hendrick (2000) suggests that all movements of the body either originate in or are coupled through the trunk, and this coupling action is created by a strong trunk region. The forces that occur on impact of heel strike are transferred up the kinematic chain to the lumbar spine, and the related supporting structures of the trunk.

Although a relationship between the lower extremity and low back pain is often assumed, little research has been published to demonstrate the association (Cibulka, 1999:599). Most of the evidence so far has been anecdotal (Dananberg and Guiliano, 1999:109), without scientific research to support it. Innes (2003) believes that it is essential to examine the lower extremity in the case of low back pain and states that by ignoring the effect of the lower extremity on the low back, the primary cause of a patients' pain may be missed, and unnecessary treatment provided to another area. Dananberg (1998) suggests that the repetitive nature of walking can result in a subtle stress to the lumbar spine therefore it may easily be overlooked as a primary etiological factor. Dananberg (1997) believes that joint dysfunctions in the feet can adversely affect the low back.

A motion restriction refers to a limitation of the normal range of motion of a joint (Everett, 1997:133). The process of motion palpation is used to detect joint pain and mobility suggesting that restricted joint and accessory joint motion may be indicative of joint dysfunction and sufficient evidence for joint manipulation (Bergmann and Peterson, 1993:96). This restricted movement is believed to cause changes in gait, leading to repetitive injury to the lumbar spine and resultant low back pain (Dananberg and Guiliano, 1999:113). These joint dysfunctions however rarely cause any symptoms in the foot or ankle, so an association between the foot and the low back is seldom made (Dananberg, 1997:253). Shaefer and Faye (1989) believe that the feet are the functional base of the spine and many recurring joint dysfunctions in the spine can be traced to a mobility restriction in the feet. Studies conducted by Gillet (1984) have shown a distinct relationship between talus dysfunctions and L5 dysfunctions and demonstrate that the foot is a common site of single or multiple dysfunctions that can frequently be linked to spinal dysfunctions. Root *et al.* (1977) found that the subtalar joint and its motion affects the function and position in all joints of the foot as well as the lower extremity during the weightbearing phase of gait. Therefore, it is important that patients who present with lower extremity and/or low back dysfunction be evaluated in both non-weightbearing and weightbearing positions.

In theory, this implies that stresses that are applied to the chain can be spread among the components of the kinematic chain, linking them in function as well as dysfunction (DeFranca and Levine, 1996:58).

Research conducted by Gilbert, Brantingham, Shaik and Globe (2006) indicated a significantly reduced amount of dorsiflexion in individuals with chronic mechanical low back pain in comparison to individuals without low back pain. Individuals with chronic mechanical low back pain also exhibited significantly less ankle dorsiflexion in the right foot than in the left foot and individuals without low back pain exhibited significantly less hallux dorsiflexion in the left foot as opposed to the right. The study also found that individuals with chronic mechanical low back pain had a significantly smaller difference in navicular height between the resting and neutral standing postures in comparison to individuals without low back pain. This indicates that they pronate less than individuals without low back pain. Thus indicating that sagittal plane blockage (decreased dorsiflexion) may be a factor in chronic mechanical low back pain.

2.10 THE GAIT THEORY

The gait cycle is defined as "the time interval or sequence of motions occurring between two consecutive initial contacts of the same foot" (Magee, 2006:867). The foot and the ankle play a major role in gait as the various joints allow the foot to accommodate to the ground. During normal gait, the joints in the foot and ankle work independently. During heel-strike (when the foot first initially the ground), the lower limb becomes a closed kinematic chain, and movements are absorbed by the structures in the lower limb (Magee, 2006:859). During stance phase the foot becomes the stable segment, with alterations occurring from the foot up. The joints of the foot adapt first, followed by those of the ankle, knee, hip, pelvis, spine and finally the upper limb, which acts as a counterbalance to the movement of the lower limb (Krebs, Wong, Jevesar and Hodge, 1992).

Dananberg and Guiliano (1999) found that a large proportion of low back pain symptoms are related more to the abnormal stresses that occur during the gait cycle than to a specific abnormality of the spine itself. A gait-related perspective of chronic low back pain provides a model that is highly consistent with the natural history and frequent symptom recurrence that is typical of low back pain. The iliopsoas muscle is the primary hip flexor during the single swing phase and attaches to the lumbar spine, discs, vertebral septa and iliac crest (Moore and

Dalley, 1999 and Bergmann and Peterson, 2002). Dananberg and Guiliano (1999) found that failure of proper extension during the single support phase results in overuse of the iliopsoas muscle, which could become a major etiological factor in low back pain.

Correct gait mechanics is permitted by the pivotal activity of the sagittal plane. Any restriction of the sagittal plane motion during the single phase support (i.e. sagittal plane blockage) will result in a primary gait abnormality and will inhibit proper timing sequence of extension of the proximal joints (Dananberg, 1986). The natural tendency to extend the hip is progressively lost, resulting in a compromised position about which preswing, toe-off, and, finally the swing phase itself is initiated. Failure of the of the limb to undergo proper acceleration during prewsing phase results in impeded initiation of the swing phase, which results in lateral trunk bend towards the contralateral side during of toe-off. (Dananberg, 1997). The contalateral quadrates lumborum and hip extensors “drag” the trailing side into motion (Dananberg and Guiliano, 1999). Patients often present with low back symptoms, particularly at the sacroiliac joint, on the same side of the sagittal plane blockage, and greater trochanter bursitis, often with iliotibial band syndrome, on the opposite side. Dananberg and Guiliano (1999) report that chronic tightness of the quadrates lumborum and gluteal muscles may also be found. These findings are consistent with the clinical findings of patients that present with chronic low back pain.

Constant overuse and rotational stress to the L5 vertebra could be caused by the quadrates lumborums’ insertion into the iliac crest and iliolumbar ligament, (Moore and Dalley, 1999). If gait-style is not addressed as cause of low back pain, it could become a perpetuating factor and create a chronically unstable lumbar spine, in spite of standard treatment that focuses on the site of pain but does not alter the application of stress to the spine. This could explain the high recurrence rate of symptoms in patients with low back pain.

2.11 THE PELVIC LIST MODEL

Pronation of the subtalar joint has two important effects on the biomechanics of the foot. a) It acts as a directional torque transmitter, absorbing the axial rotation of the leg to prevent it from entering the foot and b) unlocks and prepares the forefoot for heel strike which results in deviation of the axes at the midtarsal joint (Bergmann and Peterson, 2002). However, structural weaknesses in the foot can result in excessive subtalar pronation, resulting in the foot not following the pronation pattern generated by the pelvis (Rothbart and Estabrook, 1988). Which may lead to symptoms within the ankle, knee, hip and low back (Root *et al.,* 1977; Rothbart and Estabrook, 1988; DeFranca and Levine 1996 and Dananberg and Guiliano 1999).

Rothbart and Estabrook (1988) found that asymmetrical pronation is the primary biomechanical factor leading to a static (stable) pelvic list. Excessive pronation functionally shortens the leg by dropping the inner longitudinal arch. Gravity and altered biomechanics then results in a vertical and rotational (forward and downwards) displacement of the sacroiliac joint towards the functionally short leg (Rothbart and Estabrook, 1988; Dananberg, 1997 and Dananberg and Guiliano, 1999). Thus, resulting in an increased lordosis of the lumbar spine and in turn generates mechanical stress to the lumbar facets and sacroiliac joint, causing irritation of the nerve complex (Rothbart and Estabrook, 1988). Rothbart and Estabrook (1988) went on to explain that if excessive pronation is chronic and asymmetrical, a pelvic list will occur. This places traction on the afferent nerves and, in time, pathagnomonic inflammatory changes that are seen in chronic low back pain can be seen. It was shown that the pelvic tilt has a high statistical correlation to asymmetrical pronation patterns and is one of the primary causes of leg length discrepancy syndrome. Treatment is based on limiting excessive limb pronation, thus improving the prognosis and maintaining sacroiliac alignment (Rothbart and Estabrook, 1988). Thus, the articulations of the foot and ankle play an important role in holistic biomechanical integrity (Schaefer and Faye, 1990).

This in concurs with a study conducted by Cibulka, Sinacore, Cromer and Delitto (1998), who reported that patients who presented with sacroiliac joint regional pain had hip asymmetry whilst patients who presented with low pain but without evidence of sacroiliac joint dysfunction had significantly greater hip external rotation than internal rotation bilaterally, whereas those with evidence of sacroiliac joint dysfunction had significantly more external hip rotation than internal rotation unilaterally.

However, Lee (2004) stated that postural asymmetry is not necessarily indicative of pelvic girdle dysfunction; however, pelvic girdle dysfunction is often reflected via postural asymmetry.

2.12 LEG LENGTH INEQUALITY

The evaluation of leg length inequality incorporates the consideration of both anatomical and functional discrepancies. Anatomic inequality results primarily from osseous asymmetry. Whilst functional leg length inequality implies that the legs are anatomically equal in length but appear unequal as a result of compensation that may have occurred because of positioning rather than structure (Bergmann and Peterson, 2002 and Magee, 2006). Functional leg length inequality is considered an important sign of spinal or pelvic dysfunction (Cooperstein, 1991 and Magee, 2006). It has been hypothesized that spinal joint dysfunctions potentially impact leg length by inducing reflex alterations in spinal muscle balance resulting in asymmetry of the pelvis and legs (Mannello, 1992). Disturbances in sacroiliac function and pelvic alignment can result in torsion, thus affecting leg length by creating positional changes in the femoral heads or imbalances in the hip flexor and extensor muscle tone (Cooperstein, 1991).

According to Subotnick (1999), the shorter leg is often externally rotated in individuals with leg length discrepancies in order to provide increased stability. When the foot and ankle are in externally rotated, instead of being in neutral during heelstrike it will result in prolonged pronation and decreased ankle dorsiflexion (Voorn, 1998). This may explain why decreased ankle dorsiflexion range of motion has been implicated in some cases of sacroiliac joint pain (Dananberg, 1999).

In cases of suspected sacroiliac dysfunction and associated functional leg length inequality, the patients' leg length should be evaluated in the supine and seated positions (Bergmann and Peterson, 2002 and Magee, 2006). Functional leg length inequality that is secondary to sacroiliac dysfunction may reverse from the supine to seated position, whereas anatomic leg length inequality secondary to dysfunction at other sites is not likely to change (Bergmann and Peterson, 2002). An iliac crest that appears low in the standing position, but high in the prone position may indicate the presence of sacroiliac dysfunction and a functional short leg (Bergmann and Peterson, 2002). However, an identification of altered alignment is not confirmation of dysfunction and like all physical procedures, is prone to examiner error.

Leg length inequality has been the focus of few studies and therefore the literature has been inconsistent with regards to being a possible determinant for chronic low back pain. With regards to a leg length inequality of 2.5cm or more, there are few studies that suggested an association (Rowe, 1971; and Giles, 1981) and there are many that suggest there is not (Bering-Sorensen, 1984; Fairbank, Pynsent, and Van Poortvliet*,* 1984; Soukka, Alatanta, and Tallroth*,* 1991 and Magnusson, Pope, and Wilder*,* 1996).

2.13 PAIN THEORY

Pain disability is a type of pain behaviour which is constantly influenced by social and psychological conditions (Vlaeyen, Kole-Snjiders, Heuts and Van Eek*,* 1997 and Butler, 2000). The perception of pain can be influenced by previous experiences, anxiety, culture, drugs such as barbiturates, as well as caffeine, alcohol and psychological factors, all of which increase the experience of pain (Butler, 2000; Butler and Moseley, 2003). The presence of pain and the fear of pain are known to have an effect on motor control (Hodges and Mosely, 2003c). Several studies have demonstrated that pain and pathology result in changes in muscle fibre type, muscle bulk and recruitment patterns (Uhlig, Weber, Grob and Muntener*,* 1995; Hides *et al.,* 1996 and Hodges and Richardson, 1996). When emotional states are sustained over a period of time, they are physically expressed through muscle action, thus resulting in a change in muscle tone and patterning (Holstege, Bandler and Saper, 1996). When the pelvic muscles become hypertonic, this will result in the increased compression of the sacroiliac joints (Van Wingerden, Vleeming, Buyruk, and Raissadat, 2001 and Richardson *et al.,* 2002). Thus, bringing to light the importance of understanding the patient's emotional state since the motor pattern can often only be changed by making positive changes to the emotional state of the patient. Sometimes it can be as simple as restoring hope through patient education and awareness of the underlying mechanical problem (Butler and Mosely, 2003 and Hodges and Mosely, 2003c).

2.14 SPINAL MANIPULATIVE THERAPY

Spinal manipulation which involves the movement of a joint beyond the end range of motion, but not beyond its anatomic range of motion (Bergmann and Peterson, 2002). Randomized clinical trials indicate that the use of manipulation is one of the most effective approaches in the treatment of low back pain (Di Fabio, 1992). According to Gatterman (1995), the treatment of choice for sacroiliac syndrome is specific manipulative therapy directed at the sacroiliac articulations. Clinical studies support this statement, and have shown a successful response to manipulation in more than 90% of cases (Gatterman, 1995 and van Tulder, Furnan and Gagnier, 2005). There is clear evidence to justify the use of manipulative therapy in the treatment of patients with lumbar facet syndrome and/or sacroiliac syndrome (Di Fabio, 1992).

Kirkaldy-Willis (1992:129) established that along with myofascial pain syndrome, posterior facet syndrome and sacroiliac joint syndrome accounted for 50% of cases of low back pain. The majority of these cases had been treated with the use of spinal manipulation, where the emphasis is placed on restoring joint mobility. This approach to treatment has been shown to be one of the most effective approaches in the management of low back pain that is of a mechanical origin (Di Fabio, 1992, and Haldeman, 1992:415). It has been reported that the side lying posture method is the most effective method for treating sacroiliac dysfunction (Cassidy and Mierau, 1992; Bernard and Kirkaldy-Willis, 1987).

Meade *et al.* (1990) concluded that chiropractic manipulative management was highly successful in the long term management of chronic and severe forms of low back pain compared with outpatient hospital care. Koes, Bouter and van Mameren (1992) went on to demonstrate the long term benefits of manipulative therapy compared to medical treatment and physiotherapy for chronic non-specific neck and back pain over a 12 month period.

The potential hypothesis for the working mechanism of spinal manipulation lies in restoring the balance between joint kinematics and associated muscle function, which subsequently normalises the arthrokinetic reflex and breaks the pain cycle; whilst actively stimulating and stretching the muscles which results in reflex myofascial relaxation and pain inhibition (Bernard and Cassidy, 1991 and van Tulder *et al.,* 2005).

2.15 CONCLUSION

The social impact of low back pain has been described as enormous and extremely costly in terms of treatment and lost productivity (Burton and Cassidy, 1992 and Waddell *et al.,* 2002). There is little doubt that low back pain affects the quality of life for a substantial number of people worldwide (Waddell *et al.,* 2002). Modern societies are currently facing an epidemic of low back pain disability that until recently was rising exponentially (Waddell, 1998).

Although a link between altered mechanics of the foot and low back is often presumed, there is insufficient evidence of the possible link. There is a growing base of research that supports the idea that an important relationship exists between the lower limb and the low back, however more research is needed in this field.

Therefore, this research aims to investigate whether lumbar spine manipulation versus lumbar spine and ankle manipulation shows statistical and clinical evidence of improvement with regards to recovery time.

CHAPTER THREE

METHODOLOGY AND MATERIALS

3.1 INTRODUCTION

This chapter will include a detailed description of the study design, participants selected to participate in the study and the methods of evaluation used in the study. The measurements obtained and the statistical procedures used in the analysis of the data will also be discussed.

3.2 THE STUDY DESIGN

This study was designed as a clinical trial in which purposive sampling was utilized. This study was conducted in order to determine whether a relationship between chronic mechanical low back pain and subtalar dysfunction exists.

This study received approval from the Institutional Review Board (FRC) of the Durban University of Technology (Appendix K) and was compliant with the ethical standards of the Helsinki Declaration of 1975, in the format that it was executed and is presented here.

3.3 METHOD

3.3.1 ADVERTISING

Participants were recruited by placing flyers at the Durban University of Technology, local sports clubs, gyms and health shops (Appendix J).

3.3.2 SAMPLE

The sample group for this study consisted of forty participants. The number of participants was based on similar, yet unpublished research that has previously been conducted on comparable or related subjects (Russell, 1996; Matkovich, 2004 and Campbell, 2007). The participants were purposively divided into two groups of twenty each (N =20). For statistical purposes, the groups were named

Group A and B. Group A had no subtalar fixations and received treatment in the form of spinal manipulative therapy to the lumbar spine only, whilst Group B received spinal manipulative therapy to the lumbar spine and subtalar joint respectively. All participants that were allocated to group B had subtalar fixations. However, all forty participants had chronic mechanical low back pain.

3.3.2.1 SAMPLE SIZE

Forty participants were selected as per the inclusive and exclusion criteria. Two groups each consisting of twenty participants.

3.3.2.2 SAMPLE ALLOCATION

The participants' response was based on a purposive sampling method (Mouton, 1996). After the participants were assessed and found eligible for the study, they were allocated into group A or B. All participants in Group A had chronic mechanical low back pain with no subtalar fixations, whilst all participants in Group B had chronic mechanical low back pain with subtalar fixations present.

3.3.2.3 SAMPLE CHARACTERISTICS

The participant evaluation and selection process began with all possible participants undergoing a cursory interview with the researcher in order to exclude participants that did not fit the criteria for the study. All participants successfully complying with the interview were evaluated at the initial consultation. During the first consultation, all participants received and signed a Letter of Information and Consent (Appendix A) explaining the study and allowing the participant to withdraw from the study at any time without any repercussions. A diagnosis was made based on a case history (Appendix B), physical examination (Appendix C), relevant lumbar spine regional examination (Appendix D), foot and ankle regional examination (Appendix E) and SOAPE note (Appendix F). The participants had to meet the following inclusion and exclusion criteria:

3.3.2.3.1 INCLUSION CRITERIA

- Participants had to be between 18 and 45 years of age. Participants over the age of 18 were used to avoid parent/guardian consent, whilst participants that were 45 years and younger were used to avoid and reduce the chance of sacroiliac and/ or spinal ankylosis (Kirkaldy-Willis, 1992:418).
- All participants had to have been suffering from untreated low back pain for more than 3 months (Mouton, 1996) or recurrent mechanical low back pain (Andersson, 1999:581).
- The participants' pain rating scale on the Numerical Pain Rating Scale (NRS 101) had to be greater than 4 and less than 8. This improves the sample homogeneity (Mouton, 1996 and Fejer, Jordan and Hartvigsen, 2005).
- All participants signed a Letter of Information and Consent to ensure that they undertook the study in full awareness of all that it entailed, and that they were given the opportunity to make any enquiries pertaining to the study. Signing this form also indicated that they understood that they were free to withdraw from the research at any time without any repercussions (Appendix A).
- Participants suffering from mechanical low back pain that included both posterior facet syndrome in the lumbar spine (Kirkaldy-Willis and Burton, 1992:203) and/or sacroiliac syndrome (Cox, 1998) were included in the study.

For the purpose of this study, research participants had to present with at least three of the five symptoms stated below:

Signs and symptoms of posterior facet syndrome include:

- The pain of lumbar facet syndrome is usually in the midline, presenting with an 'achy' or sometimes sharp sensation (Bergmann and Peterson, 2002).
- The pain improves in the morning or after rest and becomes worse in the evening after prolonged weight bearing (Schaefer and Faye,

1990; Schwarzer, Aprill, Derby, Fortin, Kine and Bogduk, 1994 and Bergmann and Peterson, 2002).

- The pain is aggravated by any manoeuvre causing extension of the lumbar spine, such as Kemp's test, and often relieved by forward flexion (Cassidy and Mierau, 1992).
- Associated referred pain can refer to the ipsilateral iliac crest, buttock, groin, scrotum, labium or leg (usually above the knee).
- There are no conclusive neurologic signs and no pain on coughing or sneezing associated with this syndrome (Schaefer and Faye, 1989 and Bergmann and Peterson, 2002).

Signs of and symptoms of sacroiliac syndrome (McCullach and Transfeldt, 1997) include:

- Pain over the sacroiliac joint
- Local tenderness to palpation over the sacroiliac joint
- Referred pain to the buttocks, posterior thigh, groin and occasionally the lateral aspect of the calf and ankle.
- Pain is aggravated by pain provocation tests (Gaenslen's, Patrick Faber, posterior shear test, and extension tests (Laslett and Williams, 1994; McCullach and Transfeldt, 1997: 180-181; Reider, 1999:195 and Riggien, 2003).
- That there is no other apparent cause for the participants' sacroiliac joint pain.
- That there are no nerve root tension signs, reflex or motor sensory deficits. This helps to distinguish sacroiliac syndromes from nerve root entrapment syndromes.

For the purpose of this study, participants presented with at least four of the eight symptoms mentioned above.

3.3.2.3.1 EXCLUSION CRITERIA

- Participants were excluded from the study according to the following contra-indications to spinal manipulative treatment (SMT) (Bergmann and Peterson, 2002)
    - Marked osteoporosis that was previously diagnosed.
    - Ankylosing Spondylitis.
    - The presence of fever, tumours, tuberculosis or any infectious diseases.
    - Local inflammation, thrombosis, metal implants or hip prosthesis.
    - Spinal fusion or spinal surgery.
    - Acute disc herniation.
    - Abdominal aortic aneurysm.
- Participants who presented with hard neurological signs and symptoms such as (Kirkaldy-Willis and Burton, 1992 and Plaugher, 1993:216-217):
    - Presence of parathesias.
    - Presence of neurological deficit.
    - Presence of root tension signs.
- Participants who had foot pain, other lower limb pain or foot surgery.
- Participants who received medical intervention within 48 hours prior to the onset of the study had to comply with a 3-day washout period as proposed by Poul, West, Buchannan and Grahame (1993).
- Participants may not have participated in any research trials at the Durban University of Technology Chiropractic Day Clinic within the past 3 months to ensure memory decay with respect to research outcome tools (Mouton, 1996), as well as to avoid long term effects of previous research in the outcome of the study.
- Participants who required further clinical testing to confirm the diagnosis (e.g. X-rays, blood tests) were excluded and referred to appropriate specialists.
- Participants who are unable to present to the Durban University of Technology Chiropractic Day Clinic for the prescribed appointments were excluded from the study.

3.4 CLINICAL PROCEDURE

3.4.1. PARTICIPANT ASSESSMENT

The initial consultation took place in the Chiropractic Day Clinic at the Durban University of Technology campus. This included participant screening and establishments of their suitability for the study.

Physical testing involved the use of provocation tests to stress the joint's structure in an attempt to reproduce the participants' pain (Laslett and Williams, 1994). Orthopaedic tests used in isolation were not considered as part of the diagnostic criteria for posterior facet syndrome and sacroiliac syndrome. However, it was possible that used as a group or set, the tests may have revealed a greater likelihood of a particular diagnosis being made, thus ensuring the validity of the diagnosis (Quon, Bernard, Burton and Kirkaldy-Willis*,* 1999:122-152).

For the purpose of the study, participants had to have three out of the four tests listed below as being positive in order to diagnose posterior facet syndrome (Kirkaldy-Willis and Burton, 1992 and Quon *et al.,* 1999:122-152).

A) **Kemp's Test:**

   This involves a combination of lateral flexion and extension over the facet joints whilst the participant was seated (Magee, 2006). The practitioner reached around the shoulders from behind and laterally flexed, rotated and extended the participant to the right and then the left, whilst applying and axial force (Gatterman, 1995). A positive test is indicated by the presence of symptoms (Magee, 2006).

B) **Facet joint challenge:**

   The participant was placed in the prone position. "Springing" the spinous process discerned the status of the facet joints. The practitioner placed one thumb on the spinous process above and the other on the spinous process below. Forces were applied in a horizontal direction, each towards the centre in opposite directions to each other. A positive test would be indicated if the participant perceived pain in the area of palpation (Gatterman, 1995).

C) Palpatory tenderness:

The participant was placed in the prone position. The practitioner palpated a point in the midline, over the L4-L5 interspace moving cephald. The interpaces and spinous processes of the remaining lumbar vertebrae were also palpated. The practitioner looked for areas of tenderness, muscle spasm and other signs of muscle pathology. In order to palpate the lumbar facet joints, the practitioner needed to move 2-3cm laterally from the spinous processes (Magee, 2006).

D) Spinous percussion:

Spinal percussion may be applied with the use a reflex hammer. A gentle percussive force was applied to the spinous processes. A marked, or persistent, painful response to the percussion indicated an underlying fracture or non-mechanical pathology whereas a mild pain response indicated local irritation and dysfunction (Bergmann and Peterson, 2002).

For the purpose of this study, participants had to have three out of the four tests described below being positive, in order to diagnose sacroiliac syndrome (Kirkaldy-Willis and Burton, 1992 and Quon *et al.,* 1999:122-152). A systematic literature review conducted by Wurff, Hagmeijer and Meyne (2000) demonstrated the reliability for both pain provocation and mobility tests for the sacroiliac joint and concluded that there is no reliability for any test that is conducted individually. They suggest that a multi-test score would be a more reliable and valid method for detecting sacroiliac joint pain and dysfunction.

A) Gaenslen's test/Pelvic torsion test:

The participant lay in the supine position. The hip and knee on the suspected side of dysfunction was flexed, whilst the hip on the opposite side was extended simultaneously. The practitioner applied overpressure on the thigh, causing the joint to be stressed at its end range of motion. This position causes the illium on the affected side to rotate posteriorly on the sacrum. The other leg was tested similarly. A positive test was indicated by pain in the sacroiliac joint(s) being tested (Magee, 2006).

B) Patrick Faber test

The participant lay in the supine position, whilst the hip on the side of the sacroiliac joint that was being tested was placed in a flexed, abducted and externally rotated position. The practitioner pushes down on the medial aspect of the knee on the side being tested whilst stabilizing the opposite hemi-pelvis with the other hand. A positive test was indicated by a decrease in abduction as well as pain in the ipsilateral sacroiliac joint (Magee, 2006). This test was found to be highly sensitive (77%) and specific (100%) for the detection of sacroiliac syndrome (Broadhurst and Bond,1998: 341-345).

C) Erichsen's test/Yeoman's test

The participant lay in the prone position. The practitioner placed one hand under the thigh above the knee, on the same side of the suspected sacroiliac syndrome, whilst the participants' knee was flexed to 90 degrees. The other hand was placed on the crest of the ilium. The practitioner causes extension of the hip, by pulling up with the hand on the thigh and applying a downward pressure with the hand on the iliac crest. A positive test was indicated by pain in the sacro -iliac joint (Magee, 2006). In a study conducted by Kirkaldy Willis and Burton (1992) Erichsen's test was found to be a specific and reliable test for the diagnosis of sacroiliac syndrome.

D) Lateral recumbent sacroiliac compression test

The participant lay in the side lying position. The practitioner's hands were placed over the upper part of the iliac crest, applying pressure towards the floor. A positive test was indicated by pain and / or an increased feeling of pressure in the sacroiliac joints (Magee, 2006).

In both Groups A and B, joint dysfunction/s were identified by motion palpation of the lumbar, sacroiliac and ankle joints (Schaefer and Faye, 1990), and in which plane in the manipulation would be given, in order to ensure the least amount of discomfort and to restore maximum joint play (Schaefer and Faye, 1990).

A diagnosis was based on three of the four tests being positive as well as the presence of a dysfunction, to diagnose posterior facet syndrome and / or sacroiliac syndrome. Three or more positive sacroiliac stress tests are significant only when the clinical history and other physical findings rule out other causes of low back pain and support the diagnosis of sacroiliac involvement (Quon *et al.,* 1999:122-152). The participants were then approved and signed for by a clinician at the Chiropractic Day Clinic.

3.4.2 INTERVENTION

- **Group A** – the participants received Treatment A (manipulation) on the fixated lumbar segment(s), and / or sacroiliac joint(s), twice a week for three weeks.
- **Group B** – the participants received Treatment B (manipulation) on the fixated lumbar segment(s), and / or sacroiliac joint(s) as well as the subtalar joint, twice a week for three weeks.

3.5 INTERVENTION FREQUENCY

Participants had six visits over a period of three weeks (Kirkaldy-Willis and Burton, 1988).

3.6 MEASUREMENT TOOLS

3.6.1 SUBJECTIVE DATA

Subjective data was obtained from the following:

1. <u>The Quebec Low Back Pain Disability Index (Appendix H)</u>
   The Quebec Back Pain Disability Index Questionnaire (Kopec, Esdaile, Abrahamomicz, Abenheim, Wood-Dauphine, Lamping and William, 1995) is a 20-item self-administered instrument designed to assess the level of functional disability in individuals with low back pain. It adopts a

generally accepted conceptual definition of disability as a restriction of ability to perform daily activities.

The scale contains 20 items and covers six empirically derived sub-domains of disability in back pain. All items contribute to the assessment of global disability and are relevant and acceptable to the participants. The items are scored 0 to 5 and the scale provides an overall disability score, ranging from 0 to 100, by simple summation of the scores for each item.

The scale is brief and easy to self-administer. Comparisons with the Roland and Oswestry scales suggest that the Quebec scale may be more reliable and is as sensitive to change as the best available measures (Kopec *et al.,* 1995).

2. The Numerical Pain Rating Scale (NRS 101) (Appendix G)

The Numerical Pain Rating Scale is a reliable and effective tool to evaluate whether pain is reduced with treatment and to what degree (Bolton and Wilkinson, 1998).

This questionnaire is used to determine the subjective pain intensity experienced by the participant. The participants were asked to pick a number between 1 and 10, which best described their pain that they were experiencing at that time, 1 being the least pain and 10 being the most. The number noted represents the participant's level of pain intensity (Jensen, Karoly and Braves, 1986).

The Numerical Pain Rating Scale (NRS-101) has been shown to be simple, effective and the recommended choice in a study comparing six methods of measuring clinical pain intensity (Jensen *et al.,* 1986).

3.6.1 OBJECTIVE FEEDBACK

Objective feedback was obtained through the use of:

The force dial algometer was used to assess the tenderness of affected joints and to quantify the response to treatment, thus providing a means of measuring the participant's outcome to the treatment (Fischer, 1986). According to Livingstone, Bernadi, and Caroll (1998), the algometer is designed to quantify and document levels of tenderness via pressure threshold measurement and pain sensitivity by means of a pain tolerance measurement. In a study conducted by Fischer (1987), the algometer was shown to have excellent reliability and reproducibility with pressure threshold measurement. Thus algometery can be used for objective medico-legal documentation of pain intensity Livingstone *et al.* (1998).

The procedure and use of the algometer was demonstrated and explained to the participant. The algometer was reset before taking the reading. The area that was measured was localized by palpation. The rubber tip stylus was then placed over the tender area with the dial perpendicular to the skin surface. Steady, gentle pressure was then applied at the rate of one kilogram per square centimetre per second until the participant first perceives pain and responds by saying so. The stylus was then removed and the recorded value was noted (Fischer, 1986). Pain threshold was determined by the amount of force per square centimetre for a person to first perceive pain (Fischer, 1986).

3.7 MEASUREMENT FREQUENCY

All readings and testing were done prior to the interventions at consultations 1, 3 and 6 to assess for any changes.

3.8 SUMMARY OF MEASUREMENT/TREATEMNT FREQUENCY

Week	Visit	Group A	Group B
1	1	Case history Physical Lumbar regional Foot and ankle regional Clinical evaluation First readings Quebec Low Back Pain and Disability Index questionnaire Treatment A	Case history Physical Lumbar regional Foot and ankle regional Clinical evaluation First readings Quebec Low Back Pain and Disability Index questionnaire Treatment B
	2	Treatment A	Treatment B
2	3	Second reading Treatment A	Second reading Treatment B
	4	Treatment A	Treatment B
3	5	Treatment A	Treatment B
	6	Third reading Quebec Low Back Pain and Disability Index questionnaire Treatment A	Third reading Quebec Low Back Pain and Disability Index questionnaire Treatment B

Readings = Algometer and NRS
Treatment A = Lumbar spine and /or sacroiliac joint manipulation
Treatment B = Lumbar spine and /or sacroiliac and subtalar joint manipulation

3.9 MANIPULATION PROCEDURES FOR LUMBAR SPINE AND SACROILIAC JOINTS

3.9.1 SIDE LYING POSTURE

Participant position:

The participant was instructed to lie on his/her side facing the practitioner with the participants' head resting on the headpiece to support the thoracic and cervical spine. The participant was instructed to fold his/her arms across his/her chest. The practitioner then positioned the participants' legs by flexing the upper leg (same side as the joint restriction) at the hip and placing the dorsum of the foot into the popliteal fossa of the bottom leg. This placed the hip at a 90 degree flexion. The dorsum of the foot was placed in this posture to ensure enough hip flexion for joint tension in the lumbopelvic region (Byfield, 2005).

Practitioner position:

The practitioner faced the participants directly, 90 degrees to the table and placed her cephalad hand over the participants' hand on the shoulder, keeping her arm relatively straight, whilst applying minimal downward and cephalad pressure to hold the participant on the table in order to maintain participant position and to control the participants upper body weight. Simultaneously, the practitioner slowly pushes the participants top leg down a few inches, whilst remaining upright with the practitioners sternum positioned over the lumbar spine to allow for maximum use of the practitioners own body weight during the manipulation procedure. The practitioners' caudal hand was then placed over the restricted joint and a body drop thrust was applied when the elastic barrier was met. The manipulation consisted of high velocity, low amplitude thrust. The line of drive was in an inferior direction (Byfield, 2005).

3.10 MANIPULATION PROCEDURE FOR THE SUBTALAR JOINT

3.10.1 LONG AXIS SUBTALAR JOINT DISTRACTION

Participant position:

Accessory joint movements of the foot and ankle articulations were assessed by means of motion palpation to determine the presence of any joint dysfunctions (Bergmann and Peterson, 2002:437). The participant was instructed to lie prone on the examination table, with the dorsum of the foot resting on the edge of the table, whilst maintaining the ankle in plantar flexion. The participant was instructed to hold onto the sides of the bed (Bergmann and Peterson, 2002).

Practitioner position:

Whilst the practitioner stood at the foot end of the table, facing cephalically, grasping the calcaneus with interlaced the fingers whilst the participants' foot rested on the practitioners' abdomen whilst a manipulative force was applied. The line of drive was in an inferior direction (Bergmann and Peterson, 2002).

3.11 STATISTICAL METHODOLOGY

SPSS version 15.0 (SPSS Inc., Chicago, Illinois, USA) was used to analyze the data. A p value <0.05 was considered as statistically significant. Normal distribution testing was completed using the One-Sample Kolmogorov-Smirnov Test. This was done to justify the use of parametric testing. Frequency tables were computed in the case of the demographic variables. Demographics were compared between the two treatment groups using t-tests for quantitative normally distributed variables and Pearson's chi square tests for categorical nominal or ordinal variables. Baseline (pre-manipulation) quantitative outcomes were compared between the two groups using t-tests. To determine the effect of the lumbar spine manipulation alone, compared to combined lumbar spine and subtalar manipulations, intra-group comparisons of outcomes over time were achieved using repeated measured ANOVA generalized linear models. The time points were compared using simple contrasts. To compare the effect of the lumbar spine manipulation alone and combined lumbar spine and subtalar manipulation, repeated measures ANOVA generalized linear models were used with inter-group comparisons. A significant time*group interaction effect indicated a statistically significant differential treatment effect. Profile plots were generated to compare the trends visually.

CHAPTER FOUR
RESULTS

4.1 INTRODUCTION

The statistical findings and results obtained from the data will be presented and discussed in this chapter. The first part of this chapter contains the statistical analysis of the subjective and objective data. The participants in Group A received spinal manipulation only, and the participants in Group B received spinal and subtalar manipulations.

The results have been tabulated and, where appropriate, shown in the form of a graph. The demographic data has been divided into two groups (Group A having lumbar spine manipulations, and Group B having lumbar spine and a subtalar manipulation).

The following abbreviations have been used in this chapter:

Sample size	N
Mean value	MEAN
Standard deviation	S.D.
Level of significance	P
t-value for independent samples t-test	t
Algometer Average 1	Initial mean algometer reading
Algometer Average 2	Second mean algometer reading
TP 1	Trigger point 1
TP 2	Trigger point 2
NRS	Numerical Pain Rating Scale-101
Quebec LBP Questionnaire 1	Initial Quebec Low Back Pain Disability Scale score
Quebec LBP Questionnaire 2	Final Quebec Low Back Pain Disability Scale score

The following units were used in the tables:

Age	Years
Algometer	Kg/cm^2

4.2 CRITERIA GOVERNING THE ADMISSIBILITY OF THE STUDY

Only data that met all the criteria of the study was used. Objective measurements were taken by the researcher and from information obtained in the respective participants' files after the consultations with the chiropractic intern. All algometer readings were taken three times and the mean of the three measurements was used in order to obtain a more reliable average of readings.

4.3 DEMOGRAPHICS

4.3.1 AGE, GENDER AND RACE

Table 1: Distribution of sample according to demographic characteristics

		Count	%
Group	Lumbar spine manipulation	20	50.0%
	Lumbar spine and subtalar manipulation	20	50.0%
Age Group	<21	4	10.0%
	21-25	11	27.5%
	26-30	9	22.5%
	31-35	5	12.5%
	36-40	6	15.0%
	41-45	5	12.5%
Gender	Male	26	65.0%
	Female	14	35.0%
Race	White	20	50.0%
	Black	6	15.0%
	Indian	13	32.5%
	Coloured	1	2.5%

4.4 BASELINE READINGS

Table 2: One-Sample Kolmogorov-Smirnov Test

The data in Table 2 reflects that the baseline NRS, Algometer data and the Quebec LBP Questionnaire data follow an approximately normal distribution.

	N	Kolmogorov-Smirnov Z	p
NRS 1	40	1.083	.191
Quebec LBP Questionnaire 1	40	.897	.397
Quebec LBP Questionnaire 2	40	1.050	.220
Algometer Average 1 TP1	40	.782	.573
Algometer Average 1 TP2	40	.748	.630

a Test distribution is Normal.

b Calculated from data.

4.5 AGE, GENDER, RACE AND OCCUPATION

Table 3: Comparison between treatment groups and Age

The demographics and baseline (pre-manipulation) outcomes were checked for consistency between the two groups to ensure that the two groups were equivalent at the beginning of the study. Thus any changes found at the endpoints would reflect the intervention's effect only and not indicate chance or coincidence.

Table 3 reflects that there were no statistical differences in terms of Age between the treatment groups (p=0.377).

		Age Group						Total
		<21	**21-25**	**26-30**	**31-35**	**36-40**	**41-45**	
Lumbar spine manipulation (Group A)	Count	4	4	5	2	3	2	**20**
	%	**10.0%**	**10.0%**	**12.5%**	**5.0%**	**7.5%**	**5.0%**	**50.0%**
Lumbar spine and subtalar manipulation (Group B)	Count	0	7	4	3	3	3	**20**
	%	**.0%**	**17.5%**	**10.0%**	**7.5%**	**7.5%**	**7.5%**	**50.0%**
Total	Count	**4**	**11**	**9**	**5**	**6**	**5**	**40**
	%	**10.0%**	**27.5%**	**22.5%**	**12.5%**	**15.0%**	**12.5%**	**100.0%**
Pearson Chi-Square = 5.329, df=5, p=0.377								

Table 4: Comparison between treatment groups and Gender

Table 4 reflects that there were no statistical differences in terms of Gender between the treatment groups (p=0.185).

		Gender		**Total**
		Male	**Female**	
Lumbar spine manipulation (Group A)	Count	15	5	**20**
	%	**37.5%**	**12.5%**	**50.0%**
Lumbar spine and subtalar manipulation (Group B)	Count	11	9	**20**
	%	**27.5%**	**22.5%**	**50.0%**
Total	Count	**26**	**14**	**40**
	%	**65.0%**	**35.0%**	**100.0%**
Pearson Chi-Square=1.758, df=1, p=0.185				

Table 5: Comparison between treatment groups and Race

Table 5 reflects that there were no statistical differences in terms of Race between the treatment groups (p=0.783).

		Race				**Total**
		White	**Black**	**Indian**	**Coloured**	
Lumbar spine manipulation (Group A)	Count	10	3	6	1	**20**
	%	**25.0%**	**7.5%**	**15.0%**	**2.5%**	**50.0%**
Lumbar spine and subtalar manipulation (Group B)	Count	10	3	7	0	**20**
	%	**25.0%**	**7.5%**	**17.5%**	**.0%**	**50.0%**
Total	Count	**20**	**6**	**13**	**1**	**40**
	%	**50.0%**	**15.0%**	**32.5%**	**2.5%**	**100.0%**
Pearson Chi-Square=1.077, df=3, p=0.783						

Table 6: Comparison of between treatment groups and Occupation

	Lumbar spine manipulation (Group A)		Lumbar spine and subtalar manipulation (Group B)		**Total**	
	N	**%**	N	**%**	N	**%**
Managerial and Professional	3	**7.5%**	2	**5.0%**	**5**	**12.5%**
Sales and Marketing	6	**15.0%**	6	**15.0%**	**12**	**30.0%**
Medical and Paramedical	1	**2.5%**	5	**12.5%**	**6**	**15.0%**
Operator and Manual labourer	1	**2.5%**	1	**2.5%**	**2**	**5.0%**
Student	8	**20.0%**	3	**7.5%**	**11**	**27.5%**
Sports	0	**.0%**	1	**2.5%**	**1**	**2.5%**
Office worker	1	**2.5%**	1	**2.5%**	**2**	**5.0%**
Unemployed	0	**.0%**	1	**2.5%**	**1**	**2.5%**
Total	**20**	**50.0%**	**20**	**50.0%**	**40**	**100.0%**

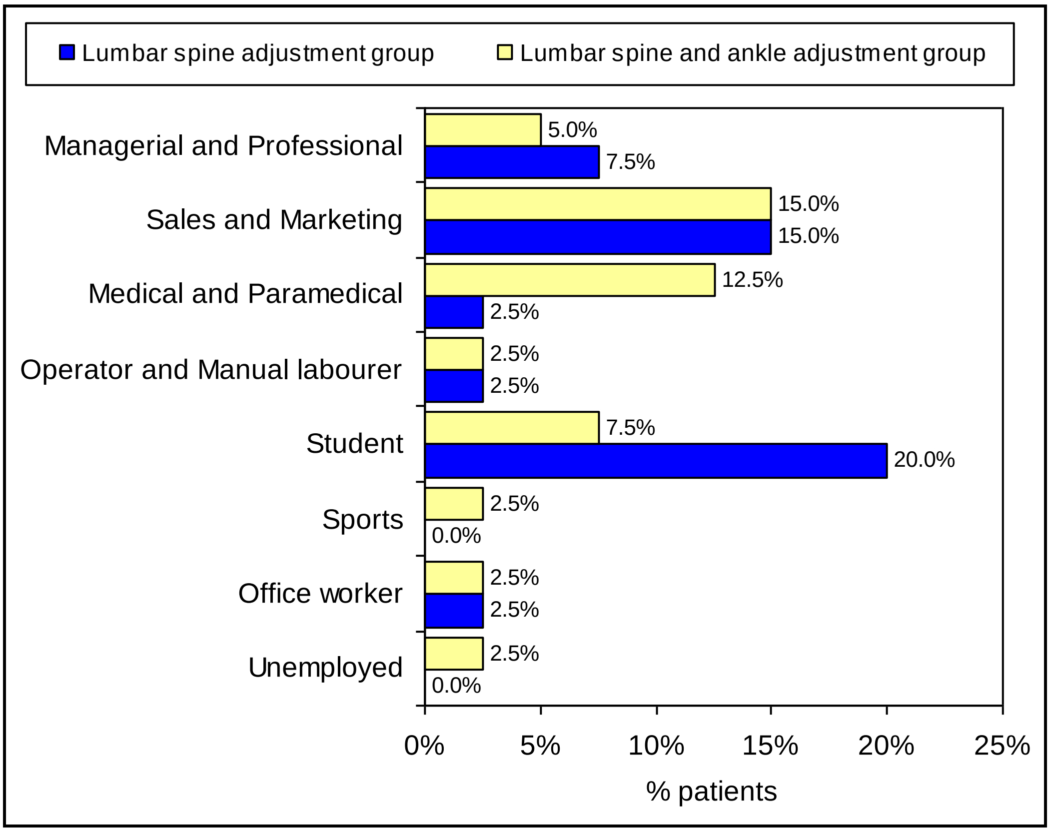

Figure 1: Occupation in total sample by group

4.6 COMPARISON OF BASELINE OUTCOMES BETWEEN TREATMENT GROUPS

Table 7: Comparison of pre-manipulation readings between the treatment groups

The results in Table 7 reflect that the pre-manipulation readings were not significantly different between treatment groups (p>0.05)

	Group	N	Mean	Std. Deviation	t	p
NRS 1	Lumbar spine manipulation group	20	5.75	1.410	.229	.820
	Lumbar spine and subtalar manipulation group	20	5.65	1.348		
Quebec LBP Questionnaire1	Lumbar spine manipulation group	20	33.75	19.145	.945	.351
	Lumbar spine and subtalar manipulation group	20	27.85	20.332		
Algometer Average 1 TP1	Lumbar spine manipulation group	20	4.8750	1.29528	.258	.798
	Lumbar spine and subtalar manipulation group	20	4.7750	1.15251		
Algometer Average 1 TP2	Lumbar spine manipulation group	20	4.8050	1.16686	-.207	.837
	Lumbar spine and subtalar manipulation group	20	4.8800	1.12746		

4.7 ASSESSMENT OF THE TREATMENT EFFECT

4.7.1 INTRA-GROUP RESULTS

4.7.1.1 SUBJECTIVE OUTCOMES

NUMERICAL PAIN RATING SCALE

Table 8: Intra-group comparison of the effect of lumbar spine manipulation on NRS

Table 8 reflects a significant change over time (p<0.05) with regards to NRS within the lumbar spine manipulation group

Effect		Value	f	p
NRS	Wilks' Lambda	0.053	161.028	0.000

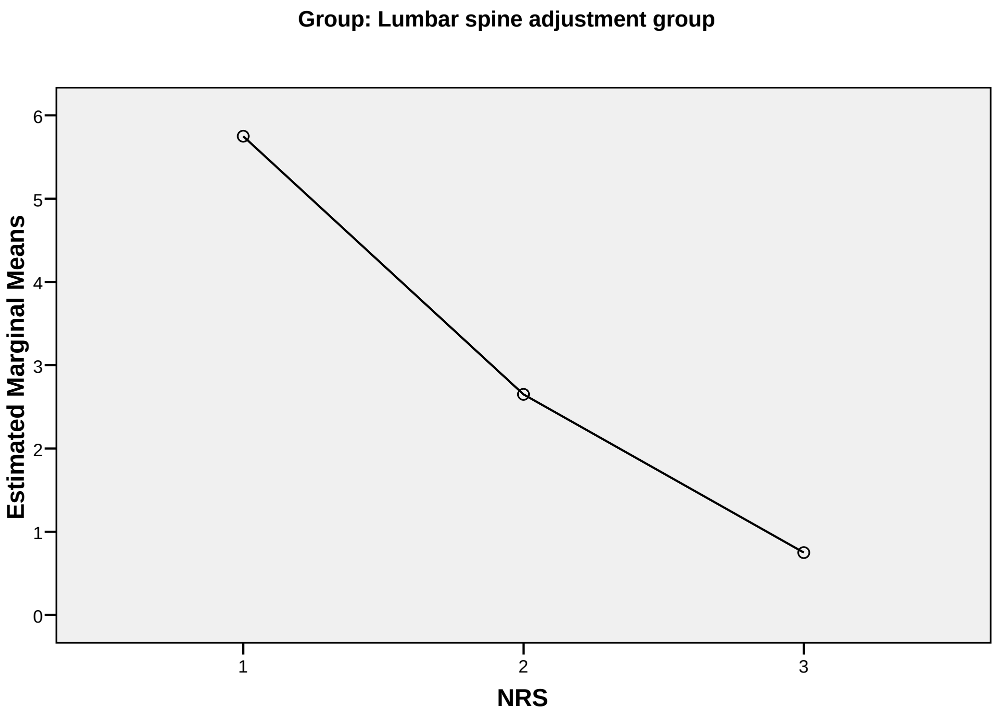

Figure 2: Mean NRS by time in the lumbar spine manipulation group

Table 9: Intra-group comparison of the effect of lumbar spine and subtalar manipulation on NRS

Table 9 reflects a significant change over time ($p<0.05$) with regards to NRS within the lumbar spine and subtalar manipulation group

Effect		Value	f	p
NRS	Wilks' Lambda	0.080	103.207	0.000

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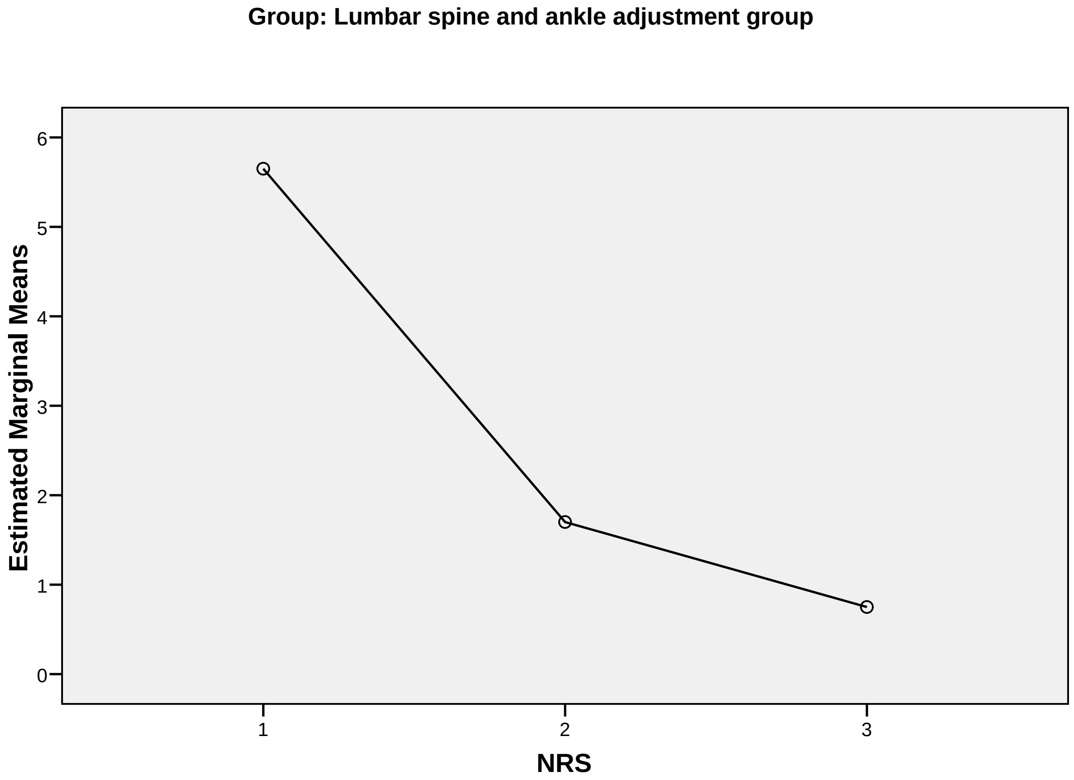


Figure 3: Mean NRS by time in the lumbar spine and subtalar manipulation group

THE QUEBEC LOW BACK PAIN DISABILITY SCALE

Table 10: Intra-group comparison of the Quebec LBP Pre and Post readings

Within the lumbar spine manipulation group, there is a significant change between pre and post mean scores. The mean changed from 33.75 in the pre test to 11.20 in the post test. The change is statistically significant ($p<0.05$).

Within the lumbar spine and subtalar manipulation group, the mean changed from 27.85 in the pre test to 7.00 in the post test. The change is statistically significant ($p<0.05$).

		Mean	N	Std. Deviation	Std. Error Mean	t	p
Lumbar spine manipulation (Group A)	Quebec LBP Questionnaire1	33.75	20	19.145	4.281	6.701	.000
	Quebec LBP Questionnaire2	11.20	20	8.383	1.874		
Lumbar spine and subtalar manipulation (Group B)	Quebec LBP Questionnaire1	27.85	20	20.332	4.546	5.194	.000
	Quebec LBP Questionnaire2	7.00	20	5.262	1.177		

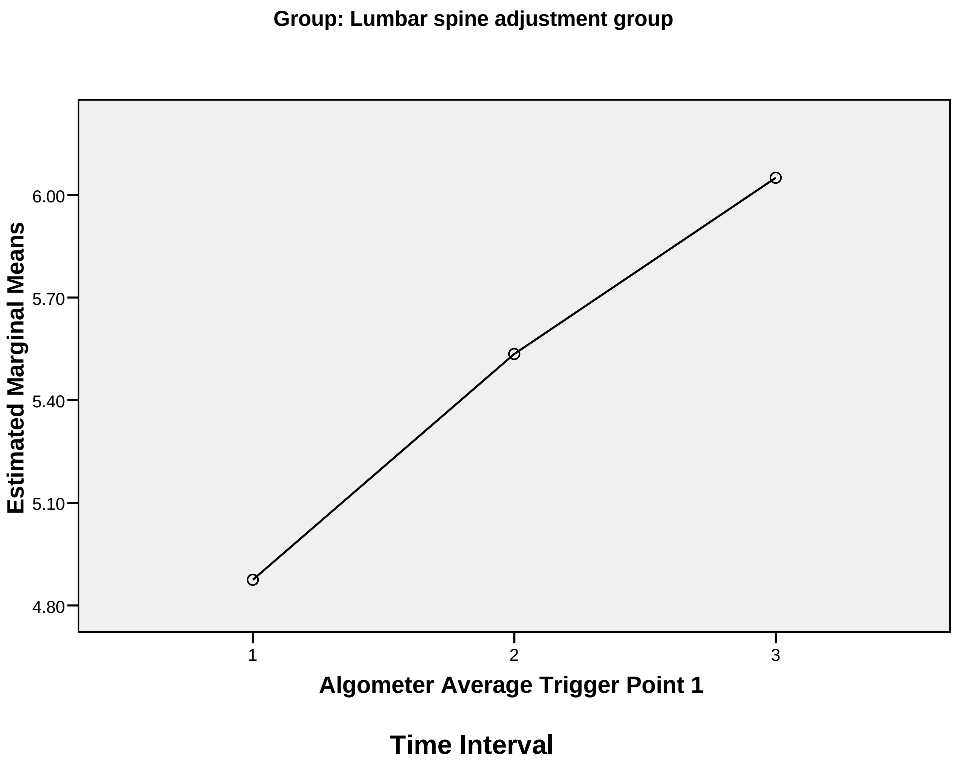
4.7.1.2 OBJECTIVE OUTCOMES

ALGOMETER READINGS

<u>Table 11: Intra-group comparison of the effect of lumbar spine manipulation on Algometer Average TP1</u>

Table 11 reflects a significant change over time ($p<0.05$) with regards to the Algometer Average TP1 within the lumbar spine manipulation group.

Effect		**Value**	**F**	**p**
Algometer Average TP1	Wilks' Lambda	0.327	18.538	0.000



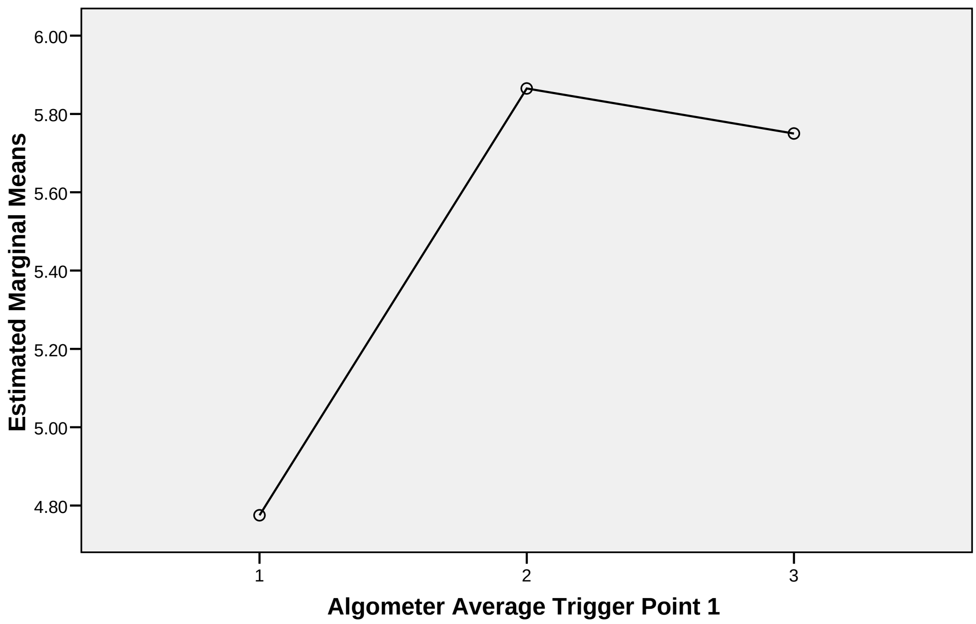
<u>Figure 4: Mean Algometer Average TP1 by time in the lumbar spine manipulation group</u>

<u>Table 12: Intra-group comparison of the effect of lumbar spine and subtalar manipulation on Algometer Average TP1</u>

Table 12 reflects a significant change over time ($p<0.05$) with regards to the Algometer Average TP1 within the lumbar spine and subtalar manipulation group. Figure 5 shows that there was a decrease between the 2nd and 3rd time points.

Effect		**Value**	**f**	**P**
Algometer Average TP1	Wilks' Lambda	0.211	33.569	0.000

Group: Lumbar spine and ankle adjustment group



Time Interval

<u>Figure 5: Mean Algometer Average TP1 by time in the lumbar spine and subtalar manipulation group</u>

Table 13: Intra-group comparison of the effect of lumbar spine manipulation on Algometer Average TP2

Table 13 reflects a significant change over time ($p<0.05$) with regards to the Algometer Average TP2 within the lumbar spine manipulation group.

Effect		Value	f	p
Algometer Average TP2	Wilks' Lambda	0.232	29.835	0.000

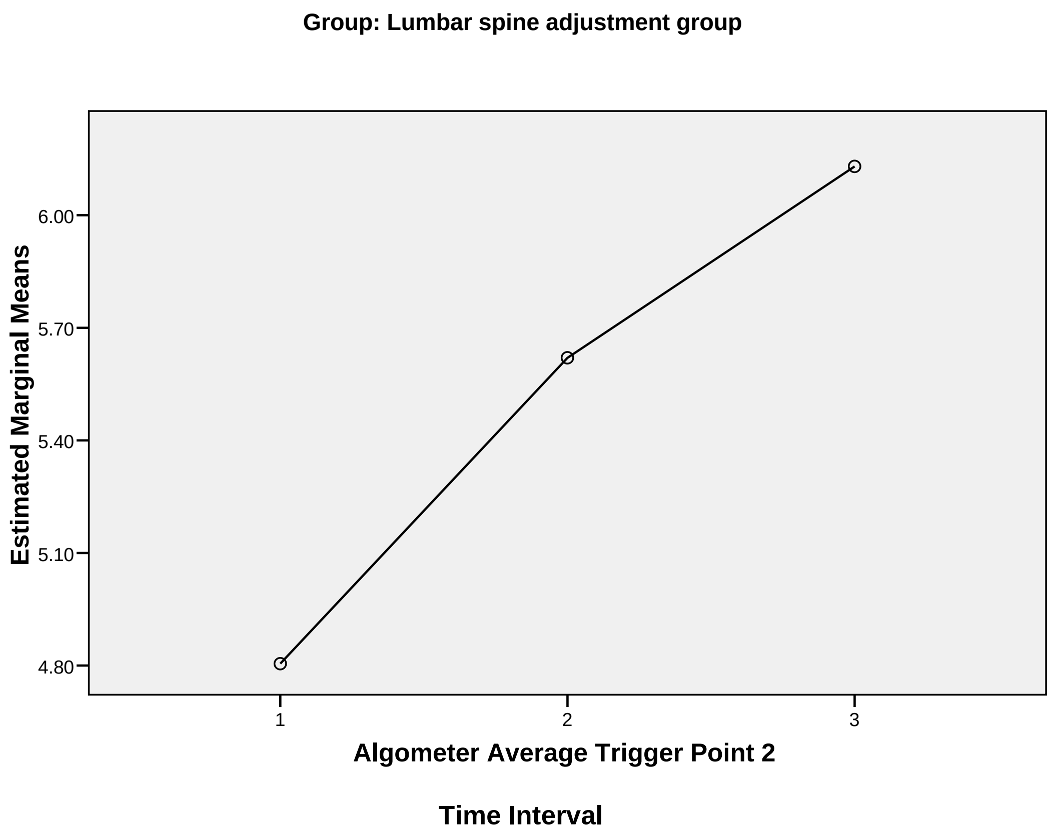


Figure 6: Mean Algometer Average TP2 by time in the lumbar spine manipulation group

Table 14: Intra-group comparison of the effect of lumbar spine and subtalar manipulation on Algometer Average TP2

Table 14 reflects a significant change over time ($p<0.05$) with regards to the Algometer Average TP2 within the lumbar spine and subtalar manipulation group. Figure 7 shows that there was a small decrease between the 2nd and 3rd time points.

Effect		Value	f	P
Algometer Average TP2	Wilks' Lambda	0.219	32.151	0.000

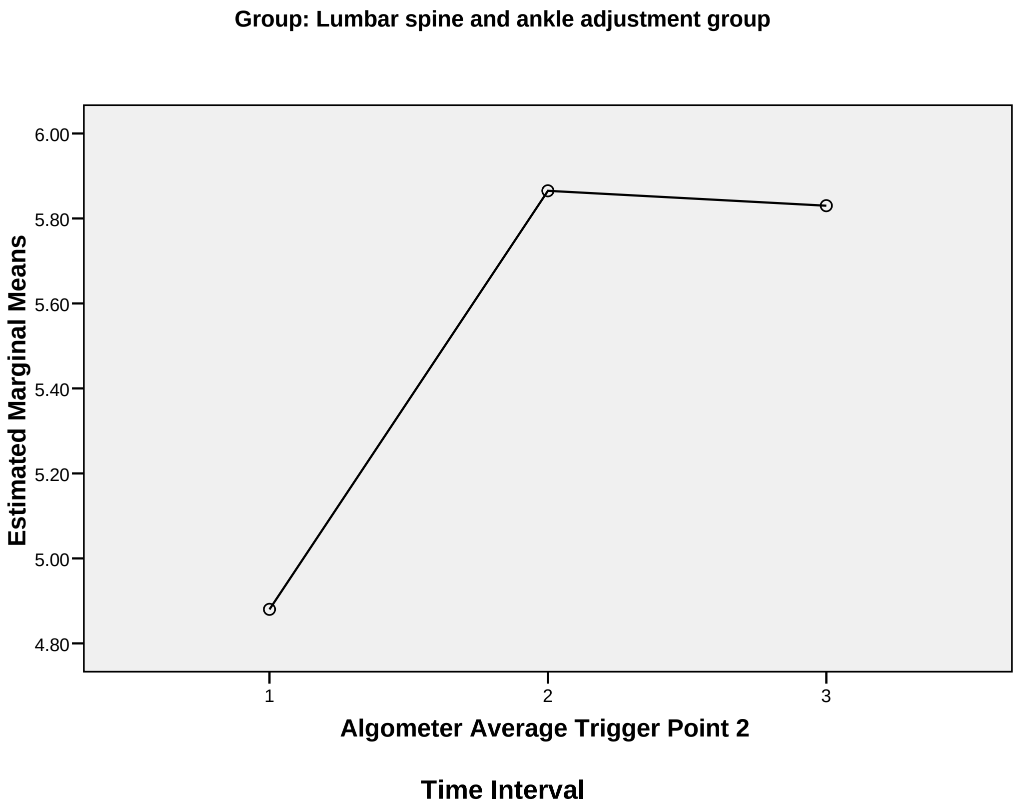


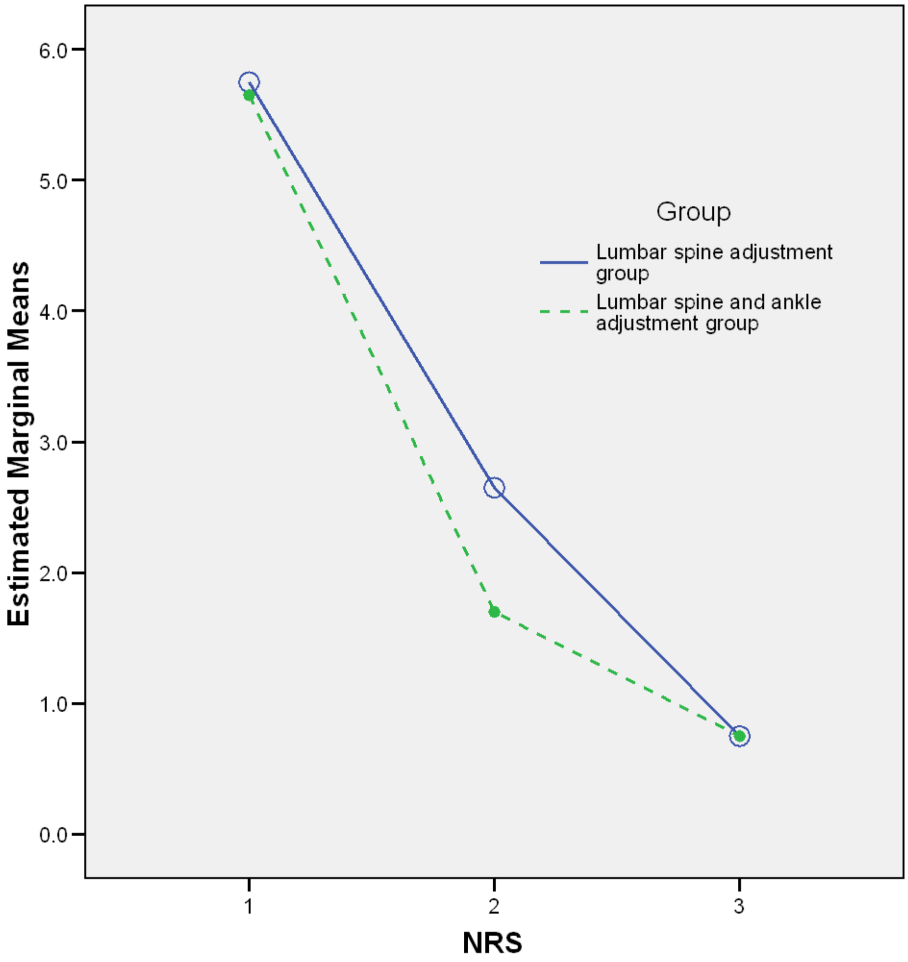
Figure 7: Mean Algometer Average TP2 by time in the lumbar spine and subtalar manipulation group

4.7.2 INTER-GROUP RESULTS

4.7.2.1 SUBJECTIVE OUTCOMES

Table 15: Inter-group comparison of time effects for NRS

Effect (NRS)		**Value**	**f**	**p**
Time	Wilks' Lambda	0.071	240.530	0.000
Time*Group	Wilks' Lambda	0.943	1.109	0.340
Group			0.895	0.350



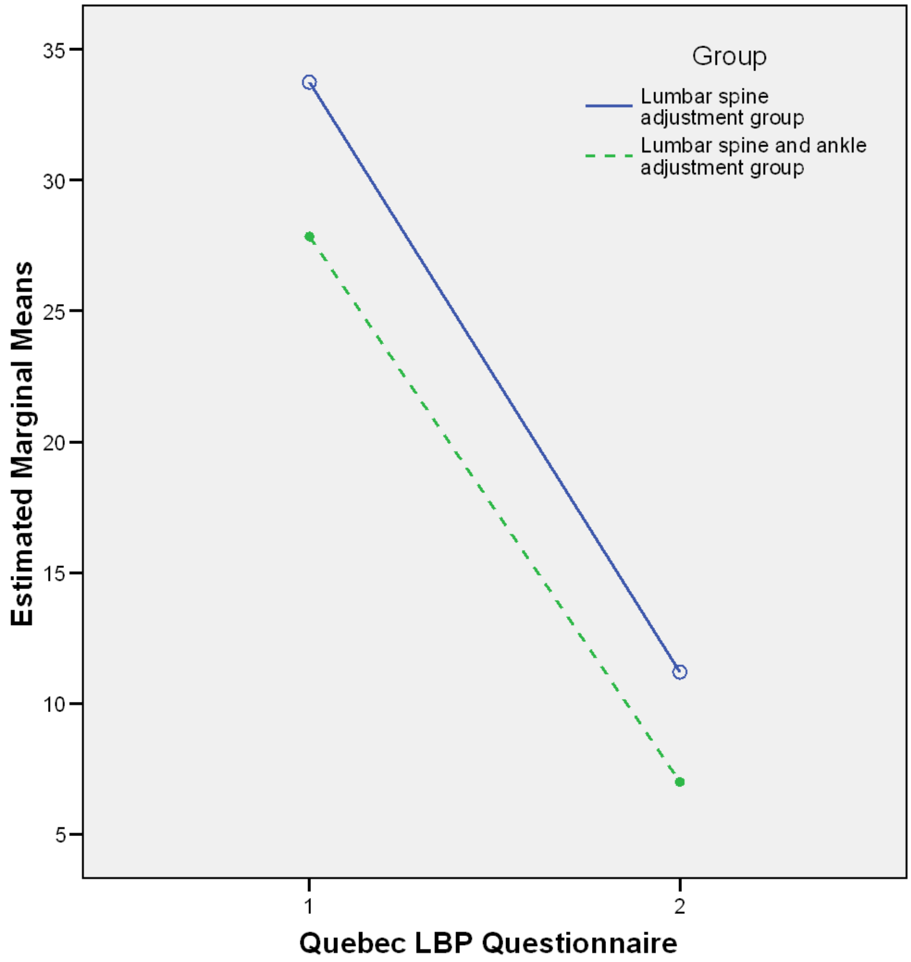
Time Interval

Figure 8: Mean NRS by time

For NRS, there was no evidence of a differential treatment effect in the two groups (p=0.340). Figure 8 shows that the profiles of both treatments groups are similar. Both groups show a significant change over time.

Table 16: Inter-group comparison of time effects for Quebec LBP

Effect (Quebec LBP)		Value	F	p
Time	Wilks' Lambda	0.356	68.641	0.000
Time*Group	Wilks' Lambda0.997	0.997	0.105	0.747
Group			1.690	0.201



Time Interval

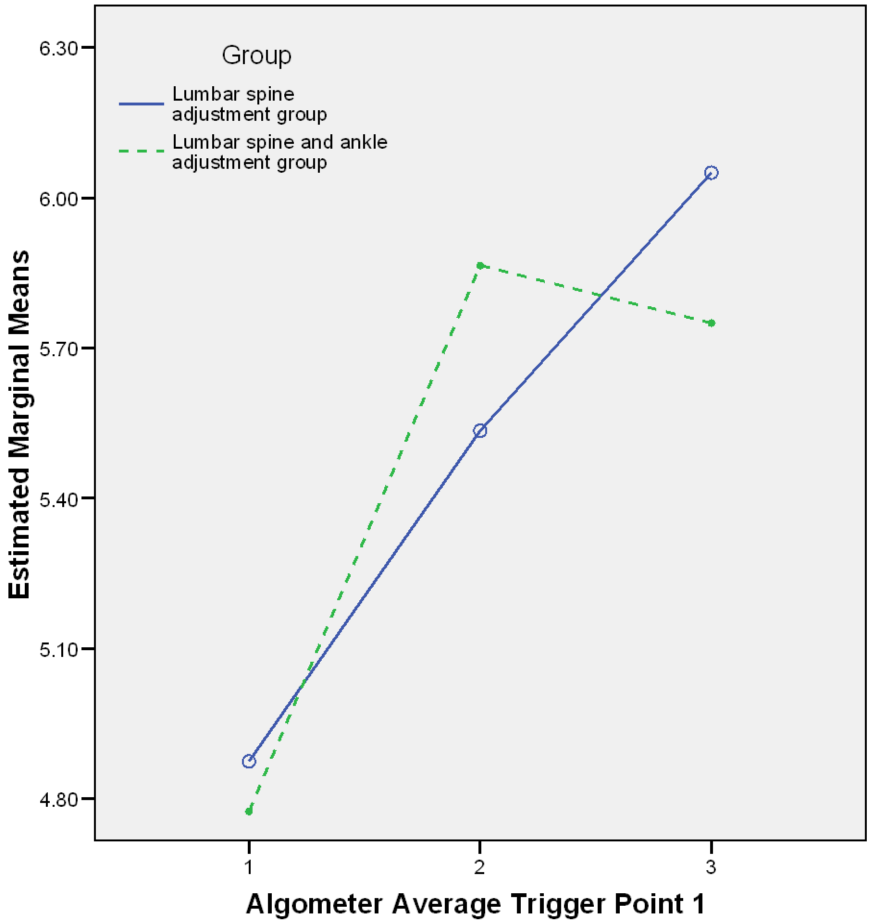
Figure 9: Mean Quebec LBP Questionnaire scores by time

For the Quebec LBP, there was no evidence of a differential treatment effect in the two groups (p=0.747). Figure 9 shows that the profiles of the two groups are similar. Both groups reflect a change over time. The scores for lumbar spine and subtalar manipulation are lower than the lumbar spine group.

4.7.2.2 OBJECTIVE OUTCOMES

Table 17: Inter-group comparison of time effects for Algometer Average TP1

Effect (Algometer Average TP1)		Value	F	p
Time	Wilks' Lambda	0.314	40.454	0.000
Time*Group	Wilks' Lambda	0.845	3.393	0.044
Group			0.004	0.950



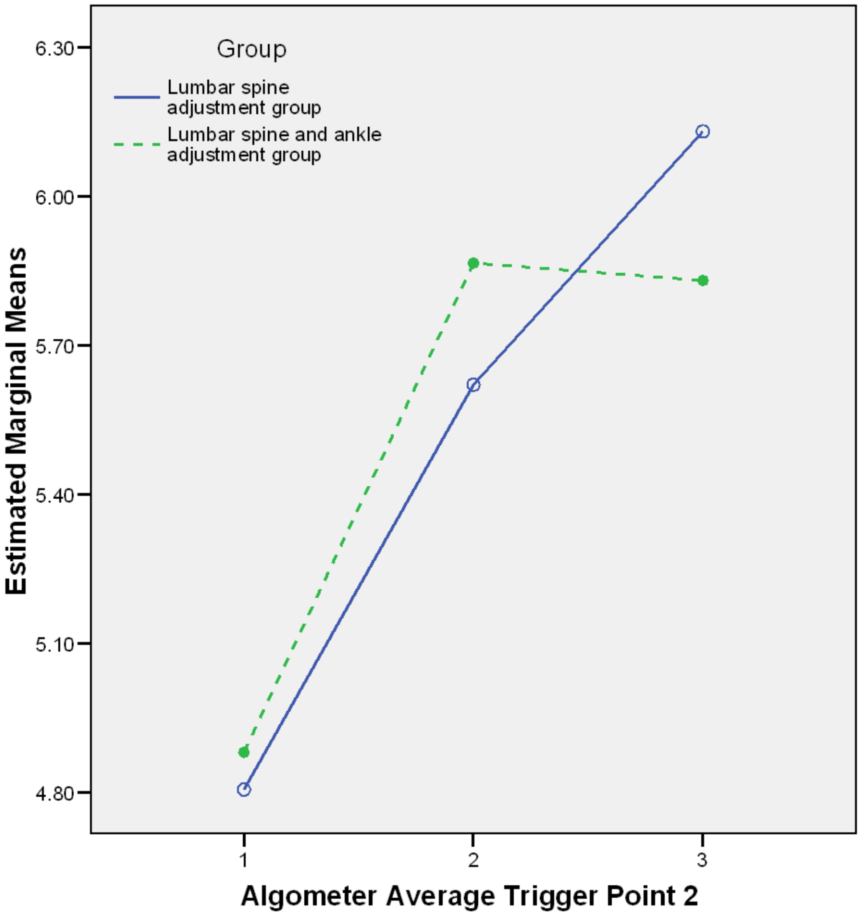
Time Interval

Figure 10: Mean Algometer Average TP1 by time

For Algometer Average TP1, there was significant evidence of a differential treatment effect in the two groups (p=0.044). Figure 10 shows that the profiles of both groups differ significantly for TP1. The mean score for Algometer Average TP1 decreases between the 2nd and 3rd time point in the lumbar spine and subtalar manipulation group.

Table 18: Inter-group comparison of time effects for Algometer Average TP2

Effect (Algometer Average TP2)		Value	F	P
Time	Wilks' Lambda	0.253	54.494	0.000
Time*Group	Wilks' Lambda	0.892	2.249	0.120
Group			0.000	0.985



Time Interval

Figure 11: Mean Algometer Average TP2 by time

For Algometer Average TP2, there was no evidence of a differential treatment effect in the two groups (p=0.120). Figure 11 shows that the profiles of the two groups differ at time 3 but the difference is not significant.

Table 19: Means for variable by treatment group

Table 19 reflects the means for each variable.

	Lumbar spine manipulation (Group A)	Lumbar spine and subtalar manipulation (Group B)	Total
NRS1	5.75	5.65	5.70
NRS2	2.65	1.70	2.18
NRS3	0.75	0.75	0.75
Quebec LBP Questionnaire 1	33.75	27.85	30.80
Quebec LBP Questionnaire 2	11.20	7.00	9.10
AlgometerAverage1 Tp1	4.8750	4.7750	4.8250
AlgometerAverage2 Tp1	5.5350	5.8650	5.7000
AlgometerAverage3 Tp1	6.0500	5.7500	5.9000
AlgometerAverage1 Tp2	4.8050	4.8800	4.8425
AlgometerAverage2 Tp2	5.6200	5.8650	5.7425
AlgometerAverage3 Tp2	6.1300	5.8300	5.9800

4.8 CORRELATIONS BETWEEN CHANGES IN OUTCOME OVER TIME

4.8.1 LUMBAR SPINE MANIPULATION GROUP

Table 20: Pearson's correlation between the changes in outcomes

The r value for the lumbar spine manipulation group is 0.895 ($p<0.05$). This indicates a significant linear relationship between change in TP1 and change in TP2 (TP1 changes as TP2 changes) in the lumbar spine manipulation group.

		Algometer Average TP1 post-pre lumbar spine manipulation	Algometer Average TP2 post-pre lumbar spine manipulation	Quebec post-pre lumbar spine manipulation	NRS post-pre lumbar spine manipulation
Algometer Average TP1 post-pre lumbar spine manipulation	Pearson Correlation	1	.895*	-.001	-.030
	P		.000	.998	.900
	N	20	20	20	20
Algometer Average TP2 post-pre lumbar spine manipulation	Pearson Correlation	.895*	1	-.084	.052
	P	.000		.725	.829
	N	20	20	20	20
Quebec post-pre lumbar spine manipulation	Pearson Correlation	-.001	-.084	1	.121
	P	.998	.725		.611
	N	20	20	20	20
NRS post-pre spine manipulation	Pearson Correlation	-.030	.052	.121	1
	P	.900	.829	.611	
	N	20	20	20	20

* Correlation is significant at the 0.05 level (2-tailed).

4.8.2 LUMBAR SPINE AND SUBTALAR MANIPULATION GROUP

Table 21: Pearson's correlation between the changes in outcome

The r value for the lumbar spine and subtalar manipulation group is 0.892 ($p<0.05$). This indicates a significant linear relationship between change in TP1 and change in TP2 (TP1 changes as TP2 changes) in the lumbar spine and subtalar manipulation group.

		Algometer Average TP1 post-pre lumbar spine and subtalar manipulation	Algometer Average TP2 post-pre lumbar spine and subtalar manipulation	Quebec post-pre lumbar spine and subtalar manipulation	NRS post-pre lumbar spine and subtalar manipulation
Algometer Average TP1 post-pre lumbar spine and subtalar manipulation	Pearson Correlation	1	.892*	.417	.226
	p		.000	.067	.338
	N	20	20	20	20
Algometer Average TP2 post-pre lumbar spine and subtalar manipulation	Pearson Correlation	.892*	1	.354	.100
	p	.000		.126	.673
	N	20	20	20	20
Quebec post-pre lumbar spine and subtalar manipulation	Pearson Correlation	.417	.354	1	-.095
	p	.067	.126		.691
	N	20	20	20	20
NRS post-pre lumbar spine and subtalar manipulation	Pearson Correlation	.226	.100	-.095	1
	p	.338	.673	.691	
	N	20	20	20	20

* Correlation is significant at the 0.05 level (2-tailed).

Table 20 and Table 21 reflect the inter-correlations for the both groups. The post-pre value for the Algometer Average and NRS is the difference between the 3rd reading (post) and the 1st reading (pre). The significant correlations were between TP1 and TP2 for both groups A and B. None of the other outcomes are correlated ($p>0.05$).

Table 22: Difference in means: Post test (3rd reading) – Pre test (1st reading)

The data in Table 22 reflects the mean difference between the post and pre readings.

	N	Mean Difference	Std. Deviation
Algometer Average TP1 post-pre lumbar spine and subtalar manipulation	20	.98	.64
Algometer Average TP1 post-pre lumbar spine manipulation	20	1.18	.86
Algometer Average TP2 post-pre lumbar spine and subtalar manipulation	20	.95	.68
Algometer Average TP2 post-pre lumbar spine manipulation	20	1.33	.75
Quebec post-pre lumbar spine and subtalar manipulation	20	-20.85	17.95
Quebec post-pre lumbar spine manipulation	20	-22.55	15.05
NRS post-pre lumbar spine and subtalar manipulation	20	-4.90	1.62
NRS post-pre lumbar spine manipulation	20	-5.00	1.21

4.9 SUMMARY AND CONCLUSION

Comparison between pre-manipulation scores between the two treatment groups did not indicate significant differences. The groups were not different in terms of age, race, and gender. Further, the baseline outcomes for NRS, Quebec LBP and Algometer Average at TP1 and TP2 were not different between the groups.

Intra-group testing showed that there was a significant difference over time with regards to NRS, Algometer Average TP1 and Algometer Average TP2 within both groups.

NRS reflects a significant decrease over time within both groups.

Within the lumbar spine manipulation group, the mean scores for Algometer Average TP1 and Algometer Average TP2 reflect an increase over time.

Within the lumbar spine and subtalar manipulation group, the mean scores for Algometer Average TP1 and Algometer Average TP2, reflect a decrease between the 2nd and 3rd time points.

Inter-group testing for NRS over time showed no significant effect for both treatment groups.

There was a significant treatment effect for Algometer Average TP1 while the treatment effect for Algometer Average TP2 was not significant within both groups.

Inter-group testing for the Quebec LBP over time showed no significant effect for both treatment groups.

CHAPTER 5

DISCUSSION

5. 1 INTRODUCTION

This chapter consists of a discussion of the results that were presented in chapter four. Firstly the demographics will be presented, followed by the discussion of the subjective and objective data. The results of this study will be compared with the available literature on this subject, in order to determine how the results of this study compare to those of other studies.

5.2 DEMOGRAPHIC DATA

Forty participants were divided into two equal treatment groups using purposive sampling. The first group included 20 subjects who had received lumbar spine manipulation only. The second group included 20 subjects who had combined lumbar spine and subtalar joint manipulation.

5.2.1 AGE

The data in Table 1 reflects that 27.5% of the subjects were between 21 and 25 years of age while 22.5% were between 26 and 30 years of age. A total of 10% were under 21 years and 12.5% were between 41 and 45 years.

Table 3 demonstrates the age distribution of the participants who took part in the study. The results showed a relatively even age spread, with a slight majority in Group A being found in the 22-25 year age range and 26-30 year age range in Group B respectively. The age distribution of Group A was 18 to 45 years of age, with an average age of 28.85. The age distribution for Group B was from 21 to 45 years of age, with an average age of 30.55. Although the age range was 18 to 45, the average age was low.

Dissimilar to the results in this study, literature has indicated that the prevalence of low back pain rises with increasing age up to the age of 65 (Andersson, 1999:584). However it was also noted by Kirkaldy-Willis and Burton (1992) that symptomatic low back pain usually starts in the second decade and becomes progressively more recurrent as the patient passes through the phases of dysfunction and stabilisation before the low back pain stabilises and in some instances decreases. Thus it is possible to state that the participants in this study seemed to represent a snap shot of possible patients primarily in the dysfunctional phase who had the ability and time to dedicate to the study.

The recruitment was thus influenced by a number of possible factors including:

- time (as above);
- the study was conducted at a higher education institution where students would have been readily available to participate (Appendix K);
- According to Durban Metro (1999), the 1991 and 1998 census estimates state that the majority (61.5%) of the Durban Metropolitan Area is composed of working age individuals. The majority of working age patients that could have participated in the study may have been prohibited by work commitments (e.g. the 25 – 45 year age group).

Therefore it is noted that the study results, although representative of patients with low back pain should be read with caution, as the results may only be applicable to patients with a dysfunctional low back pain pattern as described by Kirkaldy-Willis and Burton (1992) and not to those who have further progressed in their pathophysiology to stages beyond the dysfunctional phase (Kirkaldy-Willis and Burton, 1992).

Notwithstanding the limitation as outlined above, it was noted that both groups have similar limitations with regards to age as the p-value was not statistically significant ($p=0.377$); indicating that in this respect they were homogenous (Mouton, 1996), thus the influence of age on the outcomes was negligible.

5.2.2 GENDER

With regards to gender, Table 1 demonstrates that there were more males than females overall (65% males and 35% females). However, if one looks at the two groups separately in Table 4, Group A had majority of the males, with (75%) males and (25%) females, and Group B had (55%) male and (45%) females.

The results of the gender distribution achieved in this study tended to be consistent with the literature which states that low back pain has a slight male predominance (Roncarti and McMullen, 1998:160 and Burton, Tillotson, Main and Hollis, 1995:724). However, it was also noted that other studies indicated that low back pain was equally prevalent between the genders (Andersson, 1999:582).

5.2.3 RACE

Table 1 also demonstrates the race distribution of the participants who took part in the study. The majority of the participants who took part in the study were White (50%) with (32.5%) Indians, (15%) Black and (2.5%) were Coloured.

Table 5 demonstrates that the participants were relatively evenly distributed between the two groups. There were (25%) of White participants in each group. The Indian participants, which consisted of (32.5%) of the study, were also relatively evenly distributed between the two groups with (15%) of Indians in Group A and (17.5%) of Indians in Group B respectively. This was followed by the Black population which consisted (15%) of the study, which was also evenly distributed between the two groups with (7.5%) each. The smallest population group was the Coloured population representing (2.5%) of the study. The higher proportion of Indian participants, compared to Black participants is supported by literature in terms of patients experiencing low back pain (Docrat, 1999:157). The Durban Metropolitan area is racially diverse. According the Durban Metro (1999), the estimates of the 1991 census state that the majority of residents are Black (56%), with a large Indian community representing (27%), and a minority White community (14%), with only (3%) of Durban's population being coloured.

The small number of Black and Coloured participants may also be due to the study being carried out at the Chiropractic Clinic, since treatment is relatively new within the respective populations in South Africa and not yet greatly recognised within the population groups.

5.2.4 OCCUPATION

The sample had a diverse occupational profile (Table 6). The majority of the participants were in the sales and marketing sector (30%), followed closely by students (27%). The medical and paramedical sector consisted of (15%), whilst the managerial and professional sector constituted (12%).

Figure 1 is a graphical representation of the occupational profile of all the participants and demonstrates that both Group A and B had an even distribution of participants in the sales and marketing sector (15%). Group A consisted of (20%) of students, whilst Group B had (7.5%) respectively. The medical and paramedical sector was represented with (2.5%) in Group A, whilst Group B had (12.5%). The managerial and professional sector had a relatively even distribution of participants with (7.5%) in Group A and (5%) in Group B. It is noted that most of the participants were employed in a relatively sedentary working environment as opposed to manual labour. According to Linton, Hellsing and Hallden (1998), low back pain is most prevalent amongst occupations that are more physically demanding. However, there is evidence that the prevalence of low back pain is also high in sedentary workers.

5.3 COMPARISON OF BASELINE OUTCOME MEASUREMENTS

Table 7 reflects that all participants in Group A and B started at the same baseline from which the objective and subjective clinical findings were obtained. Therefore any changes would be less likely to be caused by the demographics and more likely due to intervention (Mouton, 1996).

5.4 DISCUSSION OF TREATMENT EFFECT

5.4.1 INTRA-GROUP RESULTS

5.4.1.1 SUBJECTIVE OUTCOMES

NRS

Table 8 demonstrates that there was a significant change over time ($p<0.05$) with regards to NRS within the lumbar spine manipulation group (Group A). Figure 2 demonstrates the decrease in the NRS reading in the lumbar spine manipulation group from the initial treatment to the final treatment.

Table 9 demonstrates that there was a significant change over time ($p<0.05$) with regards to NRS within the lumbar spine and subtalar manipulation group (Group B). Figure 3 demonstrates the drop in NRS reading from the initial treatment to the final treatment in the subtalar and lumbar spine manipulation group.

Both Groups A and B experienced low back pain/dysfunction. In both groups the dysfunction was addressed directly in the form of manipulation that could have resulted in the restoration of mechanical mobility (Gatterman, 1995 and Bergmann and Peterson, 2002). Manipulation is believed to cause excitation of the joint receptors (Leach, 1994:63), which subsequently normalises the arthrogenic reflex and breaks the pain cycle (Bernard and Cassidy, 1991; Tullberg, Blomberg, Branth and Johnsson, 1998).

QUEBEC LOW BACK PAIN DISABILITY SCALE

Table 10 demonstrates that both groups showed a statistically significant improvement ($p<0.05$) from the initial to the final treatment. This indicates that the participants experienced a decrease in functional disability on a day to day living basis. The mean scores for Group A changed from 33.75 pre-treatment 11.20 the post treatment, and the mean score for Group B changed from 27.85 to 7.00 at the end of the treatment period.

From the literature reviewed, it was clear that the lumbar spine manipulation would be effective in the treatment of mechanical low back pain (Meade *et al.,* 1990, Di Fabio, 1992, Haldeman, 1992, Kirkaldy-Willis and Burton, 1992, Gatterman, 1995 and Van Tulder, Furnan, and Gagnier*,* 2005). Subjectively therefore, the participants all reported having improvements in their lumbar spine as all the participants received lumbar spine manipulations.

Larger sample sizes may contribute to capturing statistical data of greater significance and avoiding the possibility of a Type II error. The inclusion of questionnaires enquiring about any changes in the foot and ankle joint may have also helped to add to the pool of knowledge with regards to possible changes in those regions as a result of the manipulations they have received.

5.4.1.2 OBJECTIVE OUTCOMES

ALGOMETER

On intra group analysis both groups improved significantly over time ($P<0.05$) for this outcome. Table 11 reflects a significant change over time ($p<0.05$) with regards to the Algometer Average TP1 within the lumbar spine manipulation group. Table 12 reflects a significant change over time ($p<0.05$) with regards to the Algometer Average TP1 within the lumbar spine and subtalar manipulation group. Figure 5 shows that there was a decrease between the 2nd and 3rd time points.

Table 13 reflects a significant change over time ($p<0.05$) with regards to the Algometer Average TP2 within the lumbar spine manipulation group and Table 14 reflects a significant change over time ($p<0.05$) with regards to the Algometer Average TP2 within the lumbar spine and subtalar manipulation group. Figure 7 shows that there was a small decrease between the 2nd and 3rd time points.

These results show a reduction in the level of tenderness experienced by both groups over the treatment period (Fischer, 1986). This is supported by Bergmann and Peterson (2002).

5.5 INTER-GROUP RESULTS

5.5.1 SUBJECTIVE OUTCOMES

NRS

Table 15 reflects that there was no evidence of a differential treatment effect in the two groups (p=0.340) with regards to the NRS readings. Figure 8 shows that the profiles of both treatments groups are similar. Both groups demonstrated a significant change over time.

Thus the NRS shows combining the treatment does not enhance the outcome and it does not reduce the patients' perception of pain more than manipulation of the lumbar spine alone.

QUEBEC LOW BACK PAIN DISABILITY SCALE

The Quebec LBP disability scale demonstrated that there was no evidence of a differential treatment effect between the two groups (p=0.747). Figure 9 demonstrates that the profiles of the two groups were similar. There was a slightly greater total decrease in the mean scores of Group A, however, Group B had a slightly lower post treatment mean score (7.00). The statistical evaluation consequently did not reveal any significant differences between the two groups, thus indicating that the patients who received the combined treatment did not experience any greater reduction statistically with regards to disability.

5.5.2 OBJECTIVE OUTCOMES

ALGOMETER

Table 17 demonstrates that there was significant evidence of a differential treatment effect in the two groups (p=0.044) for Algometer Average TP1. Figure 10 shows that the profiles of both groups differ significantly for TP1. The mean score for Algometer Average TP1 decreases between the 2nd and 3rd time point in the lumbar spine and subtalar manipulation group.

Table 18 demonstrates that there was no evidence of a differential treatment effect in the two groups (p=0.120) for Algometer Average TP2. Figure 11 shows that the profiles of the two groups differ at time 3 but the difference is not significant.

5.6 DISCUSSION

Both subjective and objective results corroborated the final outcome with neither indicating any additional benefit by combing subtalar joint manipulation to lumbar spine manipulation. The consistency of the data in this paper supports other research stating that spinal manipulative effect is effective in the treatment of mechanical low back pain (Schaefer and Faye, 1990:16; Haldeman, 1992:415 and Kirkaldy-Willis and Burton, 1992:283).

As a result of the two treatment approaches being so similar in many respects there were only minor statistical differences between the two treatment protocols. It is postulated that with the use of larger sample sizes, there would be more conclusive variation in the statistical data.

Unfortunately, no definite conclusions could be made with regard to the hypothesis testing, other than to support the hypothesis that both treatment group would respond favourably to spinal manipulation, which they did, thus adding to the pool of knowledge that manipulation is a treatment of choice in the treatment of mechanical low back pain.

In this study the manipulations were performed on two treatment groups, both of which received lumbar spine manipulations. The fact that lumbar spine manipulation is effective in the treatment of low back pain has been demonstrated and is undisputed. Therefore, it would seem logical that both treatment groups would respond favourably. However, it is anticipated that by including manipulations of the subtalar joint to those of the lumbar spine, the results rendered would be of far greater significance in light of Gatterman's findings (1990:48) of the reflexogenic effects of spinal fixations. This paper was not able to directly contribute to substantiate these findings, but it did emphasise that further research is needed in this field.

This study cannot be compared to other studies, as to date there have been no other clinically orientated studies conducted in which manipulations were administered to the lower limb when attempting to treat mechanical low back pain. Research conducted by Russell (1996) demonstrated the effects of adjusting the thoracic and cervical spine for the treatment of mechanical low back pain, versus adjusting the lumbar spine alone, but concluded that both treatments were as effective as the other, although similar recommendations were put forward, such as a larger sample size to determine if there was a discernible benefit between the two treatment protocols.

5.8 CONCLUSION

Both groups showed a significant improvement regarding pain reduction as well as a decrease in disability. From the statistical evidence gathered it was concluded that there was no discernible benefit from the combination of lumbar and subtalar manipulations over lumbar spine manipulations alone. Both treatments were as effective as each other.

This research paper was unable to demonstrate that the combination of lumbar spine and subtalar manipulation is more effective than lumbar spine manipulation alone.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The study showed that there was a significant improvement in both treatment groups and the rate of improvement was similar. The study illustrates a direct reduction of low back pain, as a result of manipulation.

From the results produced in the statistical evaluation of this research dissertation the outcome was twofold. Firstly, it was confirmed that spinal manipulation is therapeutically effective in reducing pain and disability in the management of chronic mechanical low back pain. This serves to support authors such as Schaefer and Faye (1990:16), Haldeman (1992:437) and Kirkaldy-Willis and Burton (1992:294) in stating that, there is mounting research evidence that manipulation is most effective form of therapy in the treatment of mechanical low back disorders.

Secondly the research paper was unable to demonstrate that the combination of lumbar spine and subtalar manipulation is more effective than lumbar spine manipulation alone. Therefore, this research paper thoroughly supports authors who advocate spinal manipulation in the treatment of mechanical low back pain (Schaefer and Faye, 1990:16, Haldeman, 1992:437 and Kirkaldy-Willis and Burton, 1992:294).

It should be noted that prior to drawing any strong conclusions, all outcome data gathered may have some degree of measurement error as both subjective and objective data are open to criticism and that they rely, to a greater or lesser extent, on patient interpretation (Bolton, 1994).

6.2 RECOMMENDATIONS

No long term follow up evaluation was done which would help to address the cost-effectiveness and general efficacy of the treatment protocols utilized. A long term follow-up study is necessary in order to illustrate which treatment approach is more effective in recurring spinal fixations. The author of this paper encourages further research into this field and suggests a longer treatment follow-up period be utilized. Follow-up consultations are recommended at one month, and even six month interval, to evaluate the intermediate and long term effects of the treatment protocols.

Further studies will also benefit greatly from the use of larger sample sizes to improve statistical relevance of data and to avoid the possibility of a Type II error.

Objective measurements were obtained with the use of a digital algometer. Unless the exact point of where the algometer was placed, is permanently marked, it is impossible to get repeated measurements on exactly the same area. This brings into doubt the validity of this instrument as an objective measure.

It would be recommended to add a third group into the study that receives a subtalar joint manipulation only to determine if this would have any effectiveness in the management of chronic mechanical low back pain.

To conclude, this research paper has shown that manipulation is effective in the management of mechanical low back pain. It has however failed to produce any conclusive evidence to substantiate the use of subtalar manipulations in conjunction with low back manipulation and it is suggested that further research be concluded and retrospective research be analysed in order to establish the efficacy for adopting this approach in the treatment of chronic mechanical low back pain.

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APPENDIX A:

DURBAN UNIVERSITY of TECHNOLOGY

LETTER OF INFORMATION AND CONSENT:

Dear Participant, welcome to my research project.

Title of Research Study:
Lumbar spine manipulation, compared to combined lumbar spine and ankle manipulation for the treatment of chronic mechanical low back pain.

Principal Investigator:
Lauren Hayley Forbes Contact number (031-3732205 /0822696102)

Co-Investigator:
Dr. Brian Kruger Contact number (031) 5649091
[M.Tech-Chiropractic, CCSP]

Introduction and Purpose of Study:
You have been selected to take part in a study investigating the effect of lumbar spine manipulation, compared to combined lumbar spine and ankle manipulation for the treatment of chronic mechanical low back pain. Forty people will be required to complete this study. All participants will be split into two equal groups. Each group will receive a standard clinical treatment for the purpose of this study.

Outline of Procedures:
At the first consultation you will be screened for suitability as a participant using a case history, physical examination and lumbar spine and ankle regional examination. All patients are requested to attend 2 consultations a week for a three week period at the Durban University of Technology Chiropractic Day Clinic.

If you are taking any medication, a 3-day washout period is required before taking part in the study. This is because medications may have an effect on the symptoms, and you may be excluded from the study. If you are undergoing any other form of treatment for your back pain you may be excluded from the study.

Please try not to alter your normal lifestyle or daily activities in any way as this could interfere with the results of the study. Those taking part in the study must be between the ages of 18 and 45.

All patients that are contraindicated to spinal manipulative therapy or that have had ankle/foot surgery will be excluded from this study. Patients who are found to be dishonest in the history provided by them, that require further clinical testing for diagnosis and all patients that fail to comply with the informed consent form would be excluded from the study.

Risks and Discomfort:
The treatment is safe and is unlikely to cause any adverse side effects. All treatments will be performed under the supervision of a qualified chiropractor.

Benefits of the study:
Your full co-operation will assist the Chiropractic profession in expanding its knowledge of this condition and thus making future treatment of patients suffering from chronic mechanical low back pain more effective.

Implications for Withdrawal from the Study:
You are free to withdraw at any stage with no negative repercussions to your health care.

Remuneration:
Patients taking part in the study will not be offered any other form of remuneration for taking part in the study.

Costs of Study:
Treatment for the duration of the research process will be free of charge. Upon completion of the research process, the normal cost of consultations will be charged for those patients wanting further treatment.

Confidentiality:
All patient information is confidential and the results of the study will be made available in the Durban University of Technology library in the form of a mini-dissertation. All patient information will be kept confidential and will be stored in the Chiropractic Day Clinic for 5yrs, after which it will be shredded.

Persons to Contact in the Event of Any Problems or Queries:
Please do not hesitate to ask questions with regards to any aspect of this study. Should you wish you may contact my research supervisor, **Dr. Brian Kruger (031) 5649091**, or alternatively you could contact **Dr. Charmaine Korporaal (031) 3732094** Head of Department (Chiropractic).

Statement of Agreement to participate in the Research Study:

I, __________________________________ (full name), ID number_____________________________,

have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by _______________________________ to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in this study.

Name___________________________________ Signature_________________ Date______________

Researcher's name_________________________ Signature_________________ Date_____________

Witness name_____________________________ Signature_________________ Date _____________

Supervisor's name_________________________ Signature_________________ Date______________

APPENDIX B:

DURBAN UNIVERSITY of TECHNOLOGY

DURBAN INSTITUTE OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: .... Date: ....

File # : .... Age : ....

Sex : .... Occupation: ....

Intern : ....Signature: ....

FOR CLINICIANS USE ONLY:
Initial visit
Clinician: Signature :

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

Case Status:

PTT:	Signature:	Date:

CONDITIONAL: Reason for Conditional:	
Signature:	Date:

Conditions met in Visit No:	Signed into PTT:	Date:

Signed off:	Date:

Intern's Case History:

1. **Source of History:**
2. **Chief Complaint : (patient's own words):**
3. **Present Illness:**

	Complaint 1	**Complaint 2**
► Location		
► Onset : Initial:		
Recent:		
► Cause:		
► Duration		
► Frequency		
► Pain (Character)		
► Progression		
► Aggravating Factors		
► Relieving Factors		
► Associated S & S		
► Previous Occurrences		
► Past Treatment		
► **Outcome:**		

4. **Other Complaints:**

5. **Past Medical History:**

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

6. **Current health status and life-style:**

- Allergies
- Immunizations
- Screening Tests incl. xrays
- Environmental Hazards (Home, School, Work)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication
  Analgesics/week:
- Tobacco
- Alcohol
- Social Drugs

7. **Immediate Family Medical History:**

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

8. **Psychosocial history:**

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

9. Review of Systems:

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

APPENDIX C:

Durban University of Technology
PHYSICAL EXAMINATION: SENIOR

Patient Name : **File no :** **Date :**
Student : **Signature :**

VITALS:					
Pulse rate:			Respiratory rate:		
Blood pressure:	R	L	Medication if hypertensive:		
Temperature:			Height:		
Weight:	Any recent change? Y / N		If Yes: How much gain/loss	Over what period	

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

SYSTEM SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION

NEUROLOGICAL EXAMINATION

COMMENTS

Clinician: **Signature :**

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APPENDIX D:

REGIONAL EXAMINATION - LUMBAR SPINE AND PELVIS

Patient:______________________________ File#:______Date:_________
Intern\Resident:______________________________ Clinician:_______________

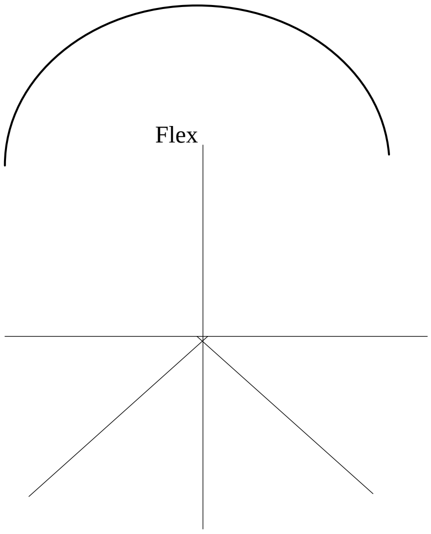
STANDING:

Posture– scoliosis, antalgia, kyphosis
Body Type
Skin
Scars
Discolouration

Minor's Sign
Muscle tone
Spinous Percussion
Scober's Test (6cm)
Bony and Soft Tissue Contours

GAIT:

Normal walking
Toe walking
Heel Walking
Half squat



ROM:

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

Which movt. reproduces the pain or is the worst?

- Location of pain
- Supported Adams: Relief? (SI)
  Aggravates? (disc, muscle strain)

SUPINE:

Observe abdomen (hair, skin, nails)
Palpate abdomen\groin
Pulses - abdominal
- lower extremity
Abdominal reflexes

		Degree	LBP?	Location	Leg pain	Buttock	Thigh	Calf	Heel	Foot	Braggard
S L R											

	L	R
Bowstring		
Sciatic notch		
Circumference (thigh and calf)		
Leg length: actual -		
apparent -		
Patrick FABERE: pos\neg – location of pain?		
Gaenslen's Test		
Gluteus max stretch		
Piriformis test (hypertonicity?)		
Thomas test: hip \ psoas? \ rectus femoris?		
Psoas Test		

SITTING:

Spinous Percussion
Valsalva
Lhermitte

TRIPOD Sl, +, ++		Degree	LBP?	Location	Leg pain	Buttock	Thigh	Calf	Heel	Foot	Braggard

Slump 7 test											

LATERAL RECUMBENT:

	L	R
Ober's		
Femoral n. Stretch		
SI Compression		

PRONE:

	L	R
Gluteal skyline		
Skin rolling		
Iliac crest compression		
Facet joint challenge		
SI tenderness		
SI compression		
Erichson's		
Pheasant's		

MF tp's	Latent	Active	Radiation
QL			
Paraspinal			
Glut Max			
Glut Med			
Glut Min			
Piriformis			
Hamstring			
TFL			
Iliopsoas			
Rectus Abdominis			
Ext/Int Oblique muscles			

NON ORGANIC SIGNS:

Pin point pain
Burn's Bench test
Hoover's test
Repeat Pin point test

Axial compressionTrunk rotation
Flip Test
Ankle dorsiflexion test

NEUROLOGICAL EXAMINATION

Fasciculations

Plantar reflex

Level	Tender?	Dermatomes		DTR		
		L	R		L	R
T12				Patellar		
L1				Achilles		
L2						
L3				Proproception		
L4						
L5						
S1						
S2						
S3						

MYOTOMES

Action	Muscles	Levels	L	R	
Lateral Flexion spine	Muscle QL	T12-L4			
Hip flexion	Psoas, Rectus femoris	L1,2,3,4			5+ Full strength
Hip extension	Hamstring, glutes	L4,5;S1.2			4+ Weakness
Hip internal rotat	Glutmed, min;TFL, adductors				3+ Weak against grav
Hip external rotat	Gluteus max, Piriformis				2+ Weak w\o gravity
Hip abduction	TFL, Glut med and minimus				1+ Fascic w\o gross movt
Hip adduction	Adductors				0 No movement
Knee flexion	Hamstring,	L4,5:S1			
Knee extension	Quad	L2,3,4			W – wasting
Ankle plantarflex	Gastroc, soleus	S1,2			
Ankle dorsiflexion	Tibialis anterior	L4,5			
Inversion	Tibialis anterior	S1			
Eversion	Peroneus longus	L4			
Great toe extens	EHL	L5			

BASIC THORACIC EXAM

History
Passive ROM
Orthopedic

BASIC HIP EXAM

History
ROM: Active
Passive : Medial rotation :
A) Supine (neutral) If reduced - hard \ soft end feel
B) Supine (hip flexed): - Trochanteric bursa

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<u>APPENDIX E:</u>

<u>FOOT AND ANKLE REGIONAL EXAMINATION</u>

Patient:____________________
File no: _________________________________Date: ____________

Intern / Resident__________________________Signature:___________
Clinician:________________________________Signature:___________

Observation
Gait analysis (antalgic limp,toe off, arch, foot alignment, tibial alignment).

____

____

Swelling____
Heloma dura / molle____
Skin____
Nails____
Shoes____
Contours (achilles tendon, bony prominences)_____________________________________

Active movements

Weight bearing:	**R**	**L**	***Non weight bearing:***	**R**	**L**
Plantar flexion			50°		
Dorsiflexion			20°		
Supination					
Pronation					
Toe dorsiflexion			40°(mtp)		
Toe plantar flexion			40° (mtp)		
			Big toe dorsiflexion (mtp) (65-70°)		
			Big toe plantar flexion (mtp) 45°		
			Toe abduction + adduction		
			5° first ray dorsiflexion		
			5° first ray plantar flexion		

Passive movement motion palpation (Passive ROM quality, ROM overpressure, joint play)

Ankle joint: *Plantarflexion*			Subtalar joint: *Varus*		
Dorsiflexion			*Valgus*		
Talocrural: *Long axis distraction*			Midtarsal:*A-P glide*		
First ray: *Dorsiflexion*			*P-A glide*		
Plantarflexion			*Rotation*		
Circumduction of forefoot on fixed rearfoot			Intermetatarsal glide		
			Tarso metatarsal joints: *A-P*		
Interphalangeal joints: *L /A dist*			Metatarsophalangeal dorsiflexion (with associated plantar flexion of each toe		
A-P glide					
lat and med glide					
rotation					

Resisted Isometric movements

	R	L		R	
Knee flexion			Pronation (eversion)		
Plantar flexion			Toe extension (dorsiflexion)		
Dorsiflexion			Toe flexion (plantar flexion)		
Supination (inversion)					

Neurological

	R	
Dermatomes		
Myotomes		
Reflexes		
Balance/proprioception		

Special Tests

	R	
Anterior drawer test		
Talar tilt		
Thompson test		
Homan sign		
Tinel’s sign		
Test for rigid/flexible flatfoot		
Kleiger test (med. deltoid)		

Alignment

	R	
Heel to ground		
Feiss line		
Tibial torsion		
Heel to leg (subtalar neutral)		
Subtalar neutral position:		
Forefoot to heel (subtalar & Midtarsal neutral)		
First ray alignment		
Digital deformities		
Digital deformity flexible		

Palpation *Anteriorly*

	R	
Medial maleoli		
Med tarsal bones, tibial (post) artery		
Lat.malleolous, calcaneus, sinus tarsi, and cuboid bones		
Inferior tib/fib joint, tibia, mm of leg		
Anterior tibia, neck of talus, dorsalis pedis artery		

Posteriorly

Calcaneus, Achilles tendon, Musculotendinous junction		

Plantarily

Plantar muscles and fascia		
Sesamoids		

APPENDIX F:

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Patient Name: ***File #:*** ***Page:***	
Date: ***Visit:*** ***Intern:*** ***Attending Clinician:*** ***Signature:***	
S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***Least*** ***0 1 2 3 4 5 6 7 8 9 10*** ***Worst*** ***0:*** ***E:*** ***Special attention to:***	***A:*** ***P:*** ***Next appointment:***
Date: ***Visit:*** ***Intern:*** ***Attending Clinician:*** ***Signature:***	
S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***Least*** ***0 1 2 3 4 5 6 7 8 9 10*** ***Worst*** ***O:*** ***E:*** ***Special attention to:***	***A:*** ***P:*** ***Next appointment:***
Date: ***Visit:*** ***Intern:*** ***Attending Clinician:*** ***Signature***	

APPENDIX G:

DURBAN UNIVERSITY of TECHNOLOGY

NUMERICAL PAIN RATING SCALE - 101 QUESTIONNNAIRE

Date:________________ File no: ____________ Visit no: ______________

Patient name: ____

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience **when it's at its worst**. A zero (0) would mean " no pain at all", and one hundred (100) would mean " pain as bad as it could be".

Please mark on the line where would best describe your pain

0 ____ 100

APPENDIX H:

THE QUEBEC BACK PAIN DISABILITY SCALE

Name: ____________________________ Age:______ Date: ________ Score:________

This questionnaire is about the way your back pain is affecting your life. People with back problems may find it difficult to perform some of their daily activities. We would like to know if you find it difficult to perform any of the activities listed below, because of your back. For each activity there is a scale of 0 to 5 (0 = normal; 5 = severe). Please choose one response option for each activity (do not skip any activities) and check the corresponding box.

Today, do you find it difficult to perform the following activities because of your back?	0	1	2	3	4	5
1. Get out of bed.						
2. Sleep through the night (sleep at least 6 hours).						
3. Turn over in bed.						
4. Ride in a car (travel 1 hour in a car).						
5. Stand up for 20 – 30 minutes.						
6. Sit for 4 hours in a chair.						
7. Climb one flight of stairs.						
8. Walk a few blocks (300 – 400 m).						
9. Walk several miles.						
10. Reach up to high shelves.						
11. Throw a ball.						
12. Run two blocks (about 200 m).						
13. Take food out of the refrigerator.						
14. Make your bed.						
15. Put on socks (panty hose).						
16. Bend over a sink for 10 minutes.						
17. Move a chair.						
18. Pull or push heavy doors.						
19. Carry two bags of groceries.						
20. Lift and carry a heavy suitcase (or 40 pounds).						
SUB-TOTAL						
TOTAL SCORE						

Scored by: ____ SCORE:___________ DATE: _________

From Kopec JA, Esdaile JM, Abrahamowicz M, Abenhaim L, Wood-Dauphinee S, Lamping DL. The Quebec Back Pain Disability Scale: Measurement properties. Spine 1995; 20:341 – 352.

APPENDIX I:

ALGOMETER READINGS:

Patient Name: ____

File number: _________

		Trigger point 1				Trigger point 2			
Visit	Date	1	2	3	Mean	1	2	3	Mean
Before 1st									
Before 3rd									
@ final follow up									

APPENDIX J:

Are you between the ages of **18** and **45** and suffering from:

Low Back Pain

Research is currently being carried out at the Durban University of Technology Chiropractic Day Clinic

Free Treatment

Available to those who qualify to take part in this study.

Contact **Lauren Forbes** on
031 3732205/ 082 2696 102
for more information.

APPENDIX K:

DURBAN UNIVERSITY of TECHNOLOGY

Faculty of Health Sciences

ETHICS CLEARANCE CERTIFICATE

Student Name	**Lauren Hayley Forbes**	**Student No**	**20200717**
Ethics Reference Number	FHSEC	**Date of FRC Approval**	
Research Title:	**Lumbar spine manipulation, compared to combined lumbar spine and ankle manipulation for the treatment of chronic mechanical low back pain.**		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with Institutional requirements and confirms the following ethical obligations:

1. The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the DUT 186 and agrees to comply with them.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. ***The following section must be completed if the research involves human participants:***

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	X		
❖ Potential psychological and physical risks have been considered and minimised	X		
❖ Provision has been made to avoid undue intrusion with regard to participants and community	X		
❖ Rights of participants will be safe-guarded in relation to: - Measures for the protection of anonymity and the maintenance of Confidentiality.	X		
- Access to research information and findings.	X		
- Termination of involvement without compromise	X		
- Misleading promises regarding benefits of the research	X		

SIGNATURE OF STUDENT/RESEARCHER　　　　DATE

SIGNATURE OF SUPERVISOR/S　　　　DATE

SIGNATURE OF HEAD OF DEPARTMENT　　　　DATE

SIGNATURE: CHAIRPERSON OF RESEARCH ETHICS COMMITTEE　　　　DATE