THE EFFECT OF FLEXION-DISTRACTION THERAPY OF THE SACROILIAC JOINTS ON QUADRICEPS FEMORIS MUSCLE STRENGTH

By

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DECLARATION

I, Bronwen Dael Eybers, hereby declare that this dissertation is my own work, both in conception and execution, except where otherwise indicated in the text.

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ABSTRACT

OBJECTIVE: This was an indirect study to determine the effect of a flexion distraction treatment protocol on the patient exhibiting pelvic malalignment. The purpose of this study was to determine possible neurophysiological effects of the flexion distraction procedure by demonstrating a post treatment change in the strength of the quadriceps femoris muscle.

DESIGN: Eighty subjects were grouped according to their gender and divided equally into male and female groups. Each research patient attended one thirty-minute consultation during which flexion distraction mobilisation of a motion restricted sacroiliac joint was performed. Quadriceps muscle strength, both ipsi-lateral and contra-lateral to the restriction, was tested.

MEASUREMENTS: Three pre-treatment measurements were recorded at one-minute intervals, followed by three post-treatment measurements also recorded at one-minute intervals. An isometric dynamometer provided the objective measurement.

CONCLUSIONS: Although bilateral measurements were recorded, only the right-sided measurements in the female group showed any statistically significant improvement in quadriceps muscle strength. Once combined the objective measurements of the male and female groups together showed no significant change, indicating that the flexion distraction procedure was ineffective in improving overall quadriceps femoris strength in the short-term. Therefore the application of flexion distraction therapy may be considered an ineffective procedure with regards to increasing short-term quadriceps femoris muscle strength. Although an increase in short-term quadriceps muscle strength, after a specific manipulative thrust to a motion restricted sacroiliac joint has previously been demonstrated, a flexion distraction procedure applied to a similarly restricted sacroiliac joint does not produce similar results.

DEDICATION

This work is dedicated to all those who live with Rheumatoid Arthritis.

Through the completion of this dissertation, I have made a stand against this disease. May you find the strength to do the same.

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CHAPTER ONE

INTRODUCTION

1.1 General Introduction

Manual therapy is defined as procedures by which the hands directly contact the body to treat the articulation and/or soft tissue. Massage, mobilization, traction, muscle energy techniques, adjustment and manipulation include some of the many forms in which manual therapy may be applied. The common characteristic of these methods is the application of external forces to affect the range of motion and pain-free function of the articulations and their contiguous tissues. (Bergman and Davis 1998:37)

Flexion distraction is an accepted form of treatment for mechanical low back pain in a chiropractic setting (Cox 1999:3). This low velocity, non-thrust mobilisation technique provides an effective alternative to the often contraindicated high velocity, low amplitude spinal manipulation techniques traditionally used by practicing Chiropractors (Dishman and Bulbulian 2000:2519-2525).

1.2 Problem Statement

A 1990 survey found that 14.4% of the population of the United States experiences chronic pain that is related to the joints and musculoskeletal system (Knutson 2000:564).

Chapman Smith (1996:1-6) defines rehabilitation as the restoration of normal form and function after injury or illness. Many back pain patients have no overt injury but a combination of subluxation/joint dysfunction, muscle weakness, muscle imbalance and poor posture. Management of these patients should therefore involve rehabilitation. Chapman Smith (1990:1-6) further includes exercise programs for muscle rehabilitation as one of the traditional elements of chiropractic management. He points out that pain relief following manipulation to correct spinal dysfunction and following stretching to relieve short tonic muscles, will be short lived if de-conditioned (weak) muscle groups, caused by long term pain and disuse, contribute to the problem.

Suter, McMorland, Herzog and Bray (1999:149-153) have found evidence that standard rehabilitation protocols fail to achieve full recovery of muscle strength and function after joint injury.

Jull and Richardson (1999:115) suggest that a key impairment in the muscle system is one of motor control rather than one of only strength. By re-establishing and enhancing muscle control, rehabilitation can protect and support the affected area from re-injury.

While the neural mechanism behind the flexion distraction technique remains relatively unexplored, the mechanical foundation of this technique, involving the reduction of intradiscal pressure and the resulting reduction of neural encroachment of herniated intervertebral disc material, is well documented (Bulbulian, Burke and Dishman 2002:526-532). The neural mechanisms behind spinal manipulative therapy have also been well investigated (Haldeman 2000:112-114). A comparison between the effectiveness of flexion distraction technique and spinal manipulative therapy has yet to be made. It is known that neural integrity is vital to muscle function (Pollard and Ward 1996:137-144), yet the relation of flexion distraction to muscle function has received little coverage.

Muscle weaknesses and imbalances are characteristic of many neuromusculoskeletal conditions. Deficits in strength may be due to many factors including aberrant neural involvement, fatigue, pain or disease atrophy (Pollard and Ward 1996:137-144). A recent study by Sher, Grobler and Yelverton (2002) found a correlation between spinal manipulative therapy of the sacroiliac joints and strength increases of the quadriceps femoris muscle group. No such correlation for sacroiliac mobilisations and strength changes are available.

1.3 Aim

The aim of this study was to discover whether a flexion distraction procedure of a restricted sacroiliac joint would provide results whereby strength change in the quadriceps femoris muscle group may be observed.

1.4 Possible Benefits

This study attempted to demonstrate that flexion distraction procedures might exhibit similar neurophysiological effects to that of spinal manipulative therapy. And in so doing, provide a stronger basis upon which non-force techniques may be more effectively used for patients in which high velocity, low amplitude type manipulation is contraindicated. It further attempted to show that a relationship between flexion distraction and an increase in muscle strength of weakened or inhibited muscles may possibly exist, and that this may subsequently have a role to play in rehabilitation protocols for lower back pain sufferers.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The purpose of this literature review is to bring together the information relating to the structure and biomechanics of the sacroiliac joints, the quadriceps femoris muscles, and the principles of application of the flexion distraction technique.

2.1.1 The Role of Flexion Distraction

Axial loads produce compression at all weight-bearing joints (Bergman & Davis 1998:29). Accordingly, this may have a major effect on the structural relationships and pathologic processes in the musculoskeletal system. This concept justifies the need for therapeutic procedures that are capable of producing distraction to unload the joints, relieving compressive pressure caused by weight bearing.

There is a long axis distraction movement of joint play possible at every synovial joint (Bergman *et al* 1998:39). Manual distractive techniques have been used for many years in the treatment of painful conditions of the extremities and less commonly of the spine. These techniques apply distractive forces through the long axis of the joint (y-axis), thereby stretching soft tissues and separating joint surfaces. Specific attention is given to the amount and form of applied traction force, using variations in the direction in which the body part being treated is placed - such as in flexion, extension or lateral flexion.

Although high-velocity, low-amplitude thrust techniques have been proven to be clinically effective, there is little evidence relating to patient tolerance for these procedures or what to do when they may be contraindicated. Alternative procedures, such as flexion distraction techniques, may be more easily tolerated by the patient while imposing less physical demand on the practitioner (Bergman *et al* 1998:xii).

2.1.2 The Role of Muscle Strength

Chapman-Smith (1990:1-6) states that muscle strength depends on the ability of the nervous system to activate the involved muscles and not solely on the condition of the muscles themselves. He describes a central role for the nervous system in developing muscle strength, claiming that increase in strength can be achieved without morphological change in muscle, but not without neural adaptation.

Pain originating in the locomotor system is most commonly caused by disturbance of function (Bergman & Davis 1998:37). According to Boyling and Palastanga (1994:223) muscle weakness is the result of deficient physiological function and that reduced quadriceps strength output may be directly or indirectly caused by disrupted joint biomechanics, local muscle inactivity (use of a knee brace) or by either anticipated or perceived pain. Pollard and Ward (1996:137-144) include aberrant neural involvement as a possible cause of muscle weakness. The integrity of each joint and its surrounding soft tissues determines the efficiency of the musculoskeletal mechanical unit. Manipulative therapy restores normal articular relationship and function, creating freedom of movement between contiguous joint surfaces, establishing functional balance of the surrounding soft tissues, and re-establishes neurologic integrity, which in turn influences physiologic processes (Bergman *et al* 1998:15).

Boyling and Palastanga (1994:212) define muscle strength as the ability of a muscle or group of muscles to generate a force or a moment of force about a joint or body axis. They recommend the need for more studies which relate optimal motor function requirements with isolated anatomical, mechanical and physiological capabilities. To learn the capabilities of specific muscles and ultimately the effect of treatment on their function, they suggests that it is necessary to study the ability of isolated muscle groups to generate force. These studies of the strength capabilities of separate muscle groups at several joints could then be incorporated into a larger interactive study of the strength factors required to carry out a variety of human tasks. When performing specific tasks, the weakest link in the kinetic chain will always be the limiting strength factor (Boyling *et al* 1994:212).

Lower limb muscle weakness and neurological deficit may be caused by dysfunction in the sacroiliac joint (Magee 1992:309).

According to Schamberger (2002:153) the quadriceps muscle ranks as the strongest muscle in most people. Strength of contraction may be affected by changes in muscle tension due to pelvic malalignment. An anterior innominate rotation will approximate the rectus femoris origin and insertion, inhibiting muscle spindle firing, decreasing the muscle tension and reducing the strength of the muscle contraction. Vastus medialis may be affected secondarily due to its invaginations with rectus femoris. Posterior rotation would have the opposite effect by increasing tension in the rectus femoris.

2.1.3 Comparison of Flexion Distraction Therapy and Spinal Manipulative Therapy

Herzog (2000:151) claims that there has been little effort to compare spinal high velocity low amplitude manipulation with mobilisation techniques, and that it remains to be proven which procedure is clinically more effective. He suggests that while manipulation procedures are more specific to local motion segment mechanics, mobilisation procedures have a more general biomechanical effect. Selection between manipulation and mobilisation techniques should be made based on the desired treatment outcome. Bergman *et al* (1998:xii), in agreement with Hertzog (2000:151), state that distractive techniques have seldom been compared with manipulation. They state the following factors as influencing the selection of manual therapy procedures: the age of the patient, the acuteness or chronicity of the problem, the patient's size and flexibility, the general physical condition of the patient, the clinician's size and ability, and/or the effectiveness of previous and/or present therapy. Ultimately, the therapy used must be appropriate for the structures on which it is to act (Bergman *et al* 1998:37).

2.2 The Sacroiliac Joint

According to Chapman-Smith (1990:1) the sacroiliac joint is important with regards to lower back pain, leg pain and general spinal dysfunction.

2.2.1 The Anatomy of the Sacroiliac Joint.

The articulation between the posterolateral aspect of the sacral ala and the anteromedial aspect of the ilium form the diarthrodial sacroiliac joint. The joint can be subdivided into two components, an anterior synovial portion which consists of the auricular surfaces of the sacrum and ileum, and a posterior syndesmotic portion which consists of the roughened sacral and ilial tuberosities (Cox 1999:209).

The articular surfaces of the sacroiliac joints are unique with respect to the type of cartilage that lines them. The sacral auricular surface is covered by hyaline cartilage, which is approximately three times thicker than the fibro-cartilage on the opposing iliac surface. Within the sacral auricular surface a central longitudinal groove roughly parallels the anterior and posterior borders of the joint and is complementary - without complete correspondence - to a bony articular ridge on the iliac auricular surface, thus providing an interlocking mechanism that stabilises the joint.

2.2.2 The Ligamentous System of the Sacroiliac Joints

The function of the ligamentous system is to limit every possible motion that may occur in the sacroiliac joints, maintaining the integrity of the low back and pelvis during transfer of energy from the spine to the lower extremities.

2.2.2.1 The Interosseous Sacroiliac Ligaments (Isl)

The superior, middle, and inferior sacral fossae on the sacral side and the iliac tuberosity on the iliac side form the more posterior syndesmotic portion of the sacroiliac joints and provide the bony attachments for the interosseous sacroiliac ligaments (ISL). The ISL consist of short fibers in the deepest part of the joint. These fibers become progressively longer the more posteriorly and superficially they are found. The longest and most superficial part of the ISL blends with the fibrous capsule of the sacroiliac joint. The ISL is considered to be the strongest ligament in the body. (By resisting posterosuperior gapping the ISL maintains the stability of the sacroiliac joint posteriorly.) It is classically considered to represent the axis of movement of the sacrum and is also known as the short axial ligament for this reason. (Cox 2000:214)

2.2.2.2 Intrinsic Ligaments of the Sacroiliac Joint

Intrinsic capsular ligaments strengthen the fibrous capsule of the sacroiliac joint anteriorly and posteriorly. The ventral or anterior sacroiliac ligament (VSL) strengthens the inferior half of the anterior capsule. Its fibers, which are thin superiorly and become progressively thickened inferiorly, attach horizontally across the joint. The strongest part of the VSL attaches anteriorly to the sacral ala at the level of the second sacral segment and crosses the most inferior part of the sacroiliac joint to attach to the subauricular sulcus on the ilium as far back as the posterior inferior iliac spine (PIIS). (Cox 2000:214)

The posterior or dorsal sacroiliac ligament (DSL) is divided into two components: short and long DSL. This ligament occupies the posterior recess between the sacrum and the ilium, called the "sacroiliac fissure." The short DSL attaches medially to the sacral tuberosity along the lateral sacral crest. Relative to the VSL, its fibers are thickened and course supero-laterally to attach to the anteromedial aspect of the PSIS of the ileum. This portion of the DSL may or may not be continuous with the interosseous sacroiliac ligament, which lies deep to it within the syndesmotic compartment of the sacroiliac joint. (Cox 2000:214)

The long DSL is more vertically oriented, and lies posterior to the attachment of the short DSL. Its dense fibers attach superiorly to the sacral ala above the first posterior sacral foramen and to the PSIS, along with the longest fibers of the sacrotuberous ligament. The fibers of the long DSL, which are thick and strong, course infero-medially to attach to the lateral sacral crest at the level of the third and fourth sacral segments and blend superficially with fibers of the sacrotuberous ligament. (Cox 2000:214)

Both the VSL and the DSL function to counteract gravitational forces and prevent distraction of the sacroiliac joint, particularly during upright posture and through the gait cycle. The DSL also serves to provide attachment for the deep fibers of the multifidus and gluteus maximus muscles. An additional ligament, "Illi's ligament" strengthens the sacroiliac joint capsule superiorly by attaching across the margins of the auricular surface. (Cox 2000:214)

2.2.2.3 Extrinsic Ligaments of the Sacroiliac Joint

The iliolumbar, sacrotuberous, and sacrospinous ligaments are extrinsic to the fibrous capsule of the sacroiliac joint. The iliolumbar ligament attaches superiorly to the transverse process and body of the fifth (and sometimes fourth) lumbar vertebra. Its fibers course laterally to attach along the superior border of the medial third of the iliac crest. This ligament may also have vertical fibers that blend anteriorly with the VSL and posteriorly with the long DSL. The iliolumbar ligament helps to prevent distraction of the sacroiliac joint superiorly. The sacrotuberous and sacrospinous ligaments, on the other hand, function to prevent posterior displacement of the sacral apex during nutation of the sacral promontory. The sacrotuberous ligament attaches medially to the lateral sacral crest from S3 to S5. Long fibers from this ligament also originate at the PSIS and join the lower fibers to course inferiorly, laterally, and anteriorly to attach to the medial aspect of the ischial tuberosity. Sacrospinous ligament fibers attach to the anterolateral border of the sacrum at the level of the third to fifth sacral segments and course laterally and anteriorly to reach the ischial spine. (Cox 2000:214)

The sacroiliac joint is considered a true synovial joint, with the surrounding ligaments and muscles making it uniquely stable (Harrison *et al* 1997:607-617).

2.2.3 Arterial Supply to the Sacroiliac Joint

The articular branches to these joints are derived from the superior gluteal, iliolumbar, and lateral sacral arteries. (Moore 1992:252)

2.2.4 Innervation of the Sacroiliac Joints

The ligaments and muscles surrounding the articulation are richly innervated. The articular capsule possesses both nociceptors and proprioceptors (Suter *et al* 1999:149-153).

Chapman-Smith (1993:1-2) states that independent branches of the posterior primary rami provide specific pathways to the joint capsule and overlying ligaments. Posteriorly the joint is innervated by the lateral branches of the posterior primary rami from L4 to S3. Anteriorly innervation is from the anterior primary divisions L2 to S2. According to Suter *et al* (1999:149-153) these project onto the main lower limb nerves, for example the femoral and tibial nerves. Non-specific branches coming from muscles overlying the joint are thought to have a unique feedback mechanism on those muscles, which receive the same innervation. This arthrokinetic reflex may exist because articular mechanoreceptors regulate muscle tone (Chapman-Smith 1993:1-6).

The sacro-iliac joint syndrome demonstrates a variable referred pain pattern due to the wide range of segmental innervation found from person to person, as well as differences between left and right sides (Chapman-Smith 1993:1-2).

2.2.5 Biomechanics of the Sacroiliac Joints

Asymmetry, both in the configuration and the amount of mobility possible on one side of the joint compared with the other, appears to be the rule (Schamberger 2002:12).

2.2.5.1 Normal Biomechanics of the Sacroiliac Joint

The mechanical behaviour of the sacrum is regulated and influenced by anatomical features that act to increase the stability of the pelvic ring and minimize all possible movements of the sacroiliac joints. These features include the structural configuration of the sacrum and pelvis, the size and shape of the sacroiliac joint surfaces, several large ligaments that surround the region, and the many muscles that act upon the region (Harrison, Harrison and Troyanovich 1997:607-617).

Schamberger (2002:6) states that the SI joint is surrounded by the largest and most powerful muscle groups in the body but none of these can be typically described as prime movers of that joint. He notes that 36 muscles have their insertion on each ilium, only 8 of which also cross the joint to attach to the sacrum. He further recognizes 22 muscles that influence SI joint movement either by establishing and maintaining the axes of movement or by stabilizing the joint.

Cox (1999:219) states that the synovial and syndesmotic parts of the sacro-iliac joint, and the interdigitating irregular articular joint surfaces, contribute to creating variable patterns of movement.

The sacrum moves when the spinal column changes position, and the ilium moves when the lower extremities change their position. The sacroiliac joint is surrounded by some of the body's most powerful muscles, which attach to various areas of the pelvis. The muscles that flex, extend, or rotate the vertebral column move the sacrum. The muscles that flex, extend, abduct, adduct, supinate, and pronate the thigh, move the ilium. The muscles that tilt the pelvis anteriorly and posteriorly move the sacrum, those that tilt right or left laterally, move the ilium. The sartorius muscles extend the ilium, while the hamstring muscles flex the ilium. The rectus abdominis muscles tilt the pelvic ring posteriorly and the erector spinae muscles tilt the pelvic ring anteriorly by moving the sacrum.

Movement of the joint is not only influenced by muscle action but also by many external forces, including gravity and ground reaction forces. According to Kapandji (1974:56) forces are transmitted from the vertebral column to the lower limbs along the alae of the sacrum, through the ischial tuberosities towards the acetabulum. Ground reaction forces are transmitted partly to the acetabulum via the femoral head and neck, and partly across the horizontal ramus of the pubic bone. These lines of force form a complete ring along the pelvic brim.

Traditionally, sacroiliac joint motion has been assessed by observing the movements of the sacral promontory (Cox 1999:219). Sacral promontory nodding (nutational motion) of about 5 to 6 mm occurs about an axis located 5 to 10 cm below the promontory - represented by the interosseous sacroiliac ligaments (ISL) or axial ligament. The sacrum rotates through an angle ranging from about four to twelve degrees (Cox 1999:219). The joints nutate whenever a position with lumbar lordosis is assumed such as when a weightlifter prepares to lift a large weight (Chapman-Smith 1993:2).

The promontory moves inferiorly and anteriorly while the apex of the sacrum and the tip of the coccyx move posteriorly. The iliac bones are approximated while the ischial tuberosities move apart. Nutation is limited by tension in the ventral sacroiliac ligament (VSL), and especially by the sacrotuberous and the sacrospinous ligaments, which stop the tip of the sacrum moving away from the ischial tuberosity. At the same time, the ground reaction forces applied via the femur to the hips, forms a rotatory couple with the body weight causing the iliac bone to tilt posteriorly. This backward tilt of the pelvis accentuates the movement of nutation occurring at the sacro-iliac joints (Kapandji 1974:64).

Counter nutation involves displacements in the opposite direction. Pivoting around the axial ligament, the sacrum rights itself so that the promontory moves superiorly and posteriorly, the apex of the sacrum and the tip of the coccyx move inferiorly and anteriorly. The anteroposterior diameter of the pelvic brim is increased while that of the pelvic outlet is reduced. The iliac bones now move apart and the ischial tuberosities move together. Counter nutation is limited by tension in both the ventral sacroiliac ligaments and the dorsal sacroiliac ligaments (Kapandji 1974:70).

2.2.5.2 Abnormal Biomechanics of the Sacroiliac Joints

With abnormal loading, a sacroiliac joint may be forced into a new position where the ridge and depression no longer compliment one another (Gatterman 1995:454). The resultant shift in the normal axis of rotation causes restriction of movement or aberrant motion which may be referred to as a sacroiliac subluxation. Gatterman (1995:454) describes this subluxation as ligamentous stretching sufficient enough to permit the ilium to slip on the sacrum so that an irregular prominence on one articular surface becomes wedged on another prominence of the other articular surface. She further notes that due to the fact that most sacroiliac joint motion occurs in the sagittal plane, the plane of blocked sacroiliac joint motion is generally flexion or extension with accompanying malposition in this plane.

Gatterman describes a PI (posteriorinferior) ilium as the ilium being fixed in a flexed position in relation to the sacrum, with the PSIS (posterior superior iliac spine) as reference. The AS (anteriorsuperior) ilium is fixed in an extended position. The pelvis may also become locked in a torqued position with one ilium in extension and the other in flexion (Gatterman 1995:462).

Schamberger (2002:1-3) refers to this assymetry of the pelvis and spine as Pelvic Malalignment which traditionally involves one of three presentations:

1. Rotational malalignment encompasses either an anterior or a posterior rotation of a pelvic innominate relative to the sacrum in the sagittal plane, using the upper part of the innominate; the iliac crest, ASIS or PSIS as reference. By far the most common presentation occurring in 80-85% of patients with pelvic assymetry.
2. Upslip of the sacroiliac joint refers to the upward translation of the innominate relative to the

sacrum, in the vertical plane. Occurs in just 5-10% of patients with pelvic assymetry.

3. Inflare/outflare or inward/outward movement of an innominate in the transverse plane that occurs in combination with one of the other presentations.

Rotational malalignment of one innominate is most likely to be seen in association with rotation of the contralateral innominate in the opposite direction and a dysfunction of movement of one or both sacroiliac joints. He observes the most common presentation of rotational malalignment is that of right anterior and left posterior innominate rotation with hypomobility of the right sacroiliac joint. On standing examination, the right anterior superior iliac spine would appear to have rotated downwards, while the right posterior superior iliac spine would appear to have rotated upwards, the reverse having occurred on the left side (Schamberger 2002: 28,29,405).

Anterior innominate rotation may occur through the action of iliacus, rectus femoris or the tensor fascia lata muscles. Rectus femoris, along with iliacus and tensor fascia lata, rotates the ilia forward relative to the base of the sacrum. In this way they influence counter nutation and may decrease pelvic stability (Schamberger 2002:18).

A rotational malalignment may result from any condition where a lower extremity exerts an asymmetrical force on a hip joint. The force is transmitted from the hip joint to the innominate, to the sacroiliac joint, and finally to the lumbosacral junction via the sacrum. Forces of this kind may result from a rotational force exerted on the innominate bone by a tight rectus femoris muscle by way of its origin from the anterior inferior iliac spine (Schamberger 2002:35).

Schamberger (2002:87) further states that pelvic malalignment never exists in isolation, but will always be associated with axial and appendicular skeleton changes as well as changes to tissue structures. Examples of these changes include assymetry of muscle tension and strength, asymmetry of muscle bulk and ligament tension, and asymmetry of lower extremity orientation. The malalignment of a specific bone or joint may result in either a facilitation (increase) or inhibition (decrease) of tension in specific pairs of muscles (Schamberger 2002:27).

Twenty to thirty percent of all lower back pain and referred pain comes from the SI joint and/or the surrounding muscles, ligaments and other soft tissues involved in the functioning of the joint

(Schamberger 2002:5). Pelvic malalignment may be considered to be one of the major causes of back pain and other musculoskeletal problems (Schamberger 2002:1).

2.3 The Quadriceps Femoris Muscle Group

2.3.1 Attachments of the Quadriceps Femoris

The quadriceps femoris is divided into four parts (Kendall, McReary and Provance 1993:212), namely the vastus medialis, vastus lateralis, rectus femoris, and vastus intermedius. All share a common insertion site into the proximal border of the patella and the tibial tuberosity via the patella ligament.

Covering the medial aspect of the thigh, the vastus medialis originates from the distal half of the intertrochanteric line, medial lip of linea aspera, proximal part of the medial supracondular line, the tendons of the adductor longus and magnus muscles, and the medial intermuscular septum (Kendall *et al* 1993:212).

Lying most lateral, the origin of the vastus lateralis muscle includes the proximal part of the intertrochanteric line, the anterior and inferior borders of the greater trochanter, the lateral lip of the gluteal tuberosity, the proximal half of the lateral lip of the linea aspera, and the lateral intermuscular septum (Kendall *et al* 1993:212).

The rectus femoris muscle covers the anterior aspect of the femur. It originates from the anterior superior iliac spine, and from a groove on the superior aspect of the acetabular rim (Kendall *et al* 1993:212).

The vastus intermedius muscle is located between the vastus medialis and vastus lateralis. Its origin includes the anterior and lateral surfaces of the proximal two thirds of the body of the femur, the distal half of the linea aspera, and the lateral intermuscular septum (Kendall *et al* 1993:212).

2.3.2 Innervation of the Quadriceps Femoris

This muscle group receives its innervation from the spinal segments L2, L3, L4 of the dorsal division of the lumbar plexus. The nerve roots from these segments form the femoral nerve (Pollard & Ward 1996:137-144).

2.3.3 Function of the Quadriceps Femoris

Travell and Simons (1999:257-258) describe the functions of the quadriceps femoris muscle group. When the leg and foot are free to move, the four heads of quadriceps femoris muscle act together as prime extensors of the leg at the knee. The rectus femoris either flexes the thigh at the hip, or flexes the pelvis on the thigh, depending on which segment is fixed. Participation of the rectus femoris in quadriceps contraction is dependant on the demands at the hip joint.

Balanced tension on the patella between the vastus medialis and vastus lateralis maintains normal positioning and tracking of the patella.

The quadriceps frequently undergo lengthening contractions to control or decelerate movement caused by body weight, functioning to control movements of bending backward, squatting, sitting down from a standing position, and descending stairs. The muscle is not active during quiet standing.

During walking, it is active immediately after heel-strike to control knee flexion, and at toe-off to stabilise the knee in extension. It is not active during the period that the knee is extending during stance phase.

The quadriceps femoris has a shortening function during rising from a seated position, and in ascending stairs.

2.4 Neurology – Joint Receptors and their Properties

2.4.1 Classification of Neurons

There are many different classifications of the types of nerves present in the human body. The basic delineation of nerve fibres into sensory or motor is not always possible and as a result nerve fibres are often differentiated by their conduction velocity or by whether or not they are myelinated. (McCarthy and Hill in Broome 2000:42)

The designation of A, B and C fibres does not directly relate to the motor or sensory nature of the fibre. A fibres are sensory and somatic motor. B fibres are preganglionic autonomic. C fibres are unmyelinated sensory and postganglionic autonomic motor. The A fibre group is divided into three subgroups. Aα-fibres represent the α-motorneurons for skeletal muscle, and some fast sensory fibres. Aβ-fibres represent the fast conducting sensory fibres. Aγ-fibres represent the γ-motorneurons to the intrafusal muscle fibres. Aδ-fibres represent the myelinated, yet slow conducting, sensory fibres. (McCarthy and Hill in Broome 2000:42)

Classification relating to the conduction velocity and receptor properties of sensory neurons takes its information from studies of muscle afferents. Wyke (1985:72-77) identifies four types of joint receptors. Type I fibres have a low threshold, responding to very small increments of tension in the superficial layers of the fibrous joint capsule in which they lie. Type I fibres may be divided into two subdivisions. Type Ia fibres are associated with the stretch receptors of the muscle spindle, while type Ib fibres are associated with the Golgi-tendon organs. Type II fibres are found in deeper layers of the fibrous joint capsule and intrafusal muscle fibres. They have a low threshold but are rapidly adjusting unlike the Type I fibres, which are slowly adapting. They are therefore inactive in immobile joints. Type III fibres need high threshold mechanical stimulation, have free nerve endings and are associated with the sensory Aδ-fibres. Type III fibres are found in most joint ligaments, barring the ligaments of the vertebral column. Type IV fibres are free unmyelinated nerve endings and are associated with noxious stimuli – most are nociceptors that only become active when irritated by abnormal mechanical or chemical changes.

When traction is applied axially through a joint, all receptors are stimulated simultaneously (Wyke 1985:72-77). Type I receptors discharge continuously in proportion to the applied traction force. They signal direction, amplitude and velocity of joint movement. Type II receptors only signal that a movement has been initiated. Type III receptors signal only when high traction forces are generated in the ligaments and/or capsule of the joint. Their discharge frequency continues for a prolonged period, proportionately to the magnitude of the tension that initially stimulated the receptors.

2.4.2 Physiology of Muscle Contraction – The Motor Response

According to McCarthy and Hill in Broome (2000:47) the Ia stretch receptor is found in all skeletal muscle, forming part of the intrafusal fibre system. These Ia receptors can be activated by a small overload of muscle during contraction, a sharp stretch of the muscle during rest (e.g. a tendon tap), or by the shortening of the contractile element of the intrafusal fibre (during pre-programmed movement). The impulses generated by the activated Ia stretch receptor are conducted rapidly along its Ia afferent fibres to the spinal cord, where they cause neurotransmitter release from their terminals.

The important synapses regarding this reflex are situated around dendrites of the homonymous alpha motorneurons in the ventral horn of the spinal cord. These motorneurons discharge action potentials which travel along the Aα axon to the extrafusal fibres of the homonymous muscle.

At the motorneuron terminals, the action potential releases acetylcholine. This neurotransmitter crosses the neuromuscular junction and initiates the production of an action potential in the cell membrane of the muscle fibre, resulting in contraction.

The number of motorneurons excited by the Ia afferent impulse and the number stimulated to produce an action potential are not the same. Each motorneuron innervates a different number of skeletal muscle fibres. The ratio of motorneurons to extrafusal muscle fibres varies from 1:300 in the dorsal interosseous muscle and 1:2000 for the gastrocnemius muscle.

Because motorneurons are large, fast-conducting and highly excitable neurons capable of discharging high frequency volleys of action potentials, there is a need for a strong modulating influence. This is the role of the inhibitory interneurons found in the ventral horn alongside the motorneuron pools. Direct input from upper motorneurons or muscle spindle receptors can lead to excitation of the required motorneurons and subsequent muscle contraction. The inhibitory interneuron acts as a focal point for indirect inputs such as from upper motorneurons, golgi-tendon organs, joint receptors, skin receptors and antagonist muscle stretch receptors. This indirect input leads to increased inhibition and subsequent suppression of muscle activity.

Wyke (1985:72-77) states that any degenerative, inflammatory or traumatic changes in joints result in loss of normal input from joint capsule mechanoreceptors which give rise to reflex disorders of posture and movement (including gait), impairment of postural and kinesthetic sensation and a decrease in pain threshold.

2.4.3 Reflexogenic Effects of Manipulation

According to neurophysiological models spinal manipulative therapy may stimulate or modulate the somatosensory system and thus subsequently evoke neuromuscular reflexes. Spinal manipulative therapy has been found to elicit significant neuromuscular reflexes in lower back pain patients. These mechanical and neurophysiologic studies suggest that joint manipulation may have both direct and indirect clinical benefits. Beneficial effects of spinal manipulation therapy have been thought to be associated with mechanosensitive afferent stimulation and presynaptic inhibition of nociceptive afferent transmission in the modulation of pain, inhibition of hypertonic muscles and improved functional ability. Mechanosensitive and nociceptive afferents have been found in the lumbar intervertebral discs, zygapophyseal joints, spinal ligaments and the paraspinal musculature. Joint stimulation has been found to be intimately related to reflexogenic muscular reactions. (Keller and Colloca 2000:592)

Wyke (1985:72-77) states that the afferent discharges from articular mechanoreceptors synapse not with alpha neurons, but rather with fusimotor neurons in the motorneuron pool within the central nervous system, thus exerting coordinated reflexogenic effects on muscle tone and on the excitability of stretch reflexes in all striated muscle. Collateral branches from these afferent nerve fibres allow manipulation of an individual joint to effect motor unit activity both in the muscle over the joint being manipulated, as well as in more remote muscles, including those on the opposite side of the body. This mechanism gives rise to the reflex changes of facilitation or inhibition in muscle tone with joint manipulation.

Haldeman (2000:112-114) describes a subluxation as an aberrant biomechanical relation within the spine that may stimulate receptors in muscles, ligaments and facets of spinal, paraspinal and sacroiliac tissues. Impulses generated by the stimulation of these structures are presumed to activate neural reflex centers within the central nervous system. These activated centers then cause somatovisceral responses in sympathetic and parasympathetic nerves, or somato-somatic responses resulting in muscle spasm. These responses may be stimulated by the application of a high velocity, low amplitude thrust to a specific spinal segment, i.e. spinal manipulative therapy.

Attenuation of the spinal reflex as a response to flexion distraction has been previously demonstrated by Bulbalian *et al* (2001:526-532).

2.5 Manipulation and Muscle Strength

According to Schamberger (2002:150-156) the presence of functional weakness of lower extremity muscles appears to correlate with the fact that malalignment of the pelvis is present. He acknowledges that while the endurance and the power of the involved quadriceps muscles can be reduced in the presence of malalignment, both can increase immediately following realignment.

Pollard and Ward (1996:137-144) proposed that the removal of motion restriction in an articulation reduced stresses in the joint, the joint capsule, ligaments, and surrounding musculature, thereby decreasing reactive proprioceptive, nociceptive and mechanical stimuli bombardment from these structures to the associated spinal segments. These aberrant biomechanical bombardments of the associated spinal segments have been implicated as contributing factors to the vertebral subluxation complex. The vertebral subluxation complex is a structural dysrelationship, typically between contiguous vertebrae, and is thought to affect reflex neural activity. If spinal cord excitability were the cause of altered physiological processes (muscle function and strength), then reducing or removing the hyperexcitability would reduce or correct the aberrant physiological processes.

Pollard and Ward (1996:137-144) found a relationship between the short-term effects of a manipulation and the modulation of muscle strength when they applied a manipulative procedure to the L3/4 motion segment of an asymptomatic student population. A short-term increase in quadriceps femoris muscle strength was observed. This demonstrated a link between spinal manipulation and the strength of a peripheral muscle supplied by the specific neuromere at the spinal level that received the manipulation.

Pollard *et al* (1996:137-144) proposed that the mechanism for this change in muscle strength could be due to alterations occurring within the spinal cord manifesting as changes in spinal excitability, suggesting that neural integrity is vital to muscle function and that manipulation promotes increased movement of fluid to the effected areas, normalising tissue chemistry. This would reduce afferent activity to the hyperexcitable spinal segment. A manipulation would diminish the effects of long-term sensitization, regulating muscle function and producing a change in muscle strength. Sensitisation is a brief increase in spinal excitability in response to a strong stimulus. When sensitisation occurs repeatedly, it may result in long-term sensitisation lasting up to a few hours. If manipulation reduces spinal cord excitability then the effects of manipulation would be to reduce or correct aberrant physiological processes, allowing muscle function to normalise.

Suter, McMorland, Herzog and Bray (1999:149-153) showed in a pilot study, motivated by clinical observations, that patients with lower extremity complaints typically showed sacroiliac joint and lumbar spine mechanical dysfunction. They observed that manipulation of the sacroiliac joint in patients with anterior knee pain demonstrated a subjective improvement in quadriceps muscle strength. Knee-joint pathologies were also found to be associated with muscle inhibition of the knee extensor muscles. They refer to muscle inhibition as the inability to recruit all motor units of a functional muscle group to their full extent during a maximal-effort voluntary contraction.

This study was followed by a randomised controlled clinical trial conducted by the same research team (Suter *et al* 2000:76-80), which concluded that sacroiliac joint manipulation reduces knee extensor muscle inhibition. Here, muscle inhibition would refer to strength deficits and reduced activation of the quadriceps femoris muscle. Both these studies suggest that spinal manipulation may be an effective treatment of muscle inhibition in the lower limb.

However, Dishman and Bulbulian (2000:2519-2525) report a paradox in the investigation of the neurophysiologic mechanism of spinal manipulation with certain investigators, such as Indahl, Kaigle, Reikerås and Holm (1997:2834-2840), reporting an inhibitory effect on the motoneuron pool as a consequence of spinal manipulation and others, such as Hertzog, Scheele and Conway (1999:149-152) reporting excitatory effects on the human motor system.

Hertzog *et al* (1999:149-152) had attributed excitatory reflexive discharge of paraspinal muscles after spinal manipulative therapy to a reflexive primary afferent discharge of various receptors, such as joint mechanoreceptors and muscle spindles.

Using a porcine model, Indahl *et al* (1997:2834-2840), through saline injection, distended the capsule of the zygapophyseal joints demonstrating a reduction of amplitude of motor unit action potentials from the paraspinal musculature. The attenuation of pain after spinal manipulation could therefore be due to an inhibitory stretch reflex response generated from the capsules of the zygapophyseal joints, or more specifically from cutaneous receptors, muscle spindles, mechanoreceptors, and free nerve endings in the zygapophyseal joint capsule and the ligaments of the spine. They proposed that the afferent discharges might then synapse on inhibitory interneurons that in turn inhibit alpha motoneuron pools of the paraspinal musculature.

In an attempt to resolve this paradox, Dishman and Bulbulian (2000:2519-2525) tested the effect of lumbosacral spinal manipulation with thrust, against spinal mobilisation without thrust on the excitability of the alpha motoneuronal pool in asymptomatic human subjects. The tibial nerve H-reflex response was measured to provide a neurophysiologic index of alpha motoneuron pool excitability - Ia afferents from the triceps surae muscle activate the alpha motoneuron pool of the lumbosacral spine. It was found that although the primary afferent discharges evoked by spinal manipulation and mobilizations were excitatory initially, less than 500 milliseconds after mechanical perturbation, the overall response was one of inhibition. Both spinal manipulations with thrust and spinal mobilisation without thrust produced a profound, but transient attenuation of alpha motoneuronal activity. The velocity and force of the manipulative thrust may therefore have little significance with respect to reflex inhibition of the motoneuron pool.

Dishman *et al* (2000:2519-2525) suggest that a possible physiologic explanation for this occurrence may be that the high density of muscle spindles in extremity and paraspinal muscles allow the potential muscle stretch stimulus (imposed by spinal manipulation or mobilisation procedures) to alter the mechanical state of muscle spindle receptors, leading to the reflex inhibition of motoneurons. These findings substantiate the theory that manual spinal therapy procedures may lead to short-term inhibitory effects on the human motor system.

2.6 Spinal Manipulation vs. Mobilisation

Boyling and Palastanga (1994:645) describes manipulation and mobilisation as distinct groupings of passive movement where manipulation involves a high velocity thrust of small amplitude performed at the limit of available movement, and mobilisation involves repetitive passive movement of varying amplitudes of low velocity applied at different parts of the range of motion depending on the effects required. Gatterman and Hansen in Bergman & Davis (1998:37) refer to mobilisation as movement applied singularly or repetitively, within or at the physiologic range of joint motion, without imparting a thrust or impulse, with the goal of restoring joint mobility. Manipulation, according to Gatterman *et al* (1998:37, is a manual procedure that involves a directed thrust to move a joint past the physiologic range of motion, without exceeding the anatomic limit.

Dishman and Bulbulian (2001:97-106) measured the magnitude and duration of motoneuron inhibition occurring both as a sequel to paraspinal and limb soft tissue massage and to spinal manipulation. Baseline tibial nerve H-reflex amplitudes were recorded both pre- and post-intervention. Spinal manipulation significantly attenuated alpha motoneuronal activity immediately post-therapy whereas paraspinal and limb massage did not. They concluded that spinal manipulation procedures lead to short-term inhibitory effects on motoneuron excitability to a greater magnitude than massage procedures do.

In addition to mechanical neural encroachment and joint capsule or muscle receptor inputs, ligamentous afferents may be involved in spinal reflexes as is evident in the feline lumbar spine. These reports suggest that cutaneous receptors, muscle spindles, and Golgi tendon organs that contribute to mediation of spinal reflex inhibition are not force and velocity dependent. (Dishman & Bulbulian 2001:97-106)

Bulbulian, Burke and Dishman (2002:526-532) report that paraspinal muscle reflex activation from spinal manipulation accompanied by an audible release does not differ from manipulation not accompanied by an audible release. They suggest that treatments not accompanied by an audible release represent spinal manipulations that do not overextend the joint through the full end range of passive motion into the so-called paraphysiological range. They have also reported spinal motoneuron pool inhibition both with lumbosacral high velocity, low amplitude spinal manipulative therapy and with low velocity spinal mobilisation. With the trunk positioned in flexion, compared with a neutral position, Bulbulian *et al* (2002:526-532) noted a decrease of 9% in alpha motoneuron pool excitability after a flexion distraction procedure of the lumbar spine. This suggests that cutaneous receptors, muscle spindle and Golgi tendon organs rather than velocity-dependent joint mechanoreceptors, contribute to inhibition of lumbar spinal reflex excitability during low velocity flexion distraction mobilisation. These tissues are neither force-dependant nor velocity-dependent. The findings of their investigation strengthen the theory that flexion distraction therapy mechanisms may be both mechanical and neurophysiological, and lay the foundation for further inquiry of the neurophysiologic mechanisms involved in this frequently used therapeutic procedure.

Sher, Grobler and Yelverton (2002) reported statistically significant increases in short-term quadriceps femoris muscle strength after a specific manipulative thrust to a motion-restricted sacroiliac joint.

2.7 The Role of Flexion Distraction in Rehabilitation

Suter, McMorland, Herzog and Bray (1999:149-153) have found evidence that standard rehabilitation protocols fail to achieve full recovery of muscle strength and function after joint injury.

Chapman-Smith (1990:1-6) states that management of lower back pain must restore normal function to both the joints and the muscles of the locomotor system. Many lower back pain patients have no specific injury, but a combination of joint dysfunction, muscle weakness, muscle imbalances and poor posture (Chapman-Smith 1996:1-6). Chronic pain results in long-term disuse and therefore deconditioned and weak musculature. There may be remarkable relief from long term pain following chiropractic procedures to correct spinal dysfunction and restore full range of motion in joints. However this encouraging result may be short-lived if a rehabilitation program that allows for strength, endurance and flexibility of the musculature is not included in the treatment protocol. It is important that both clinicians and patients therefore appreciate the need for muscle conditioning.

Efficient musculoskeletal function is dependent on the musculature and its nervous control. According to Bergman *et al* (1998:36) faulty neuromotor patterns are a frequent cause of joint dysfunction, and this disturbed function is the most frequent cause of pain.

Keller and Colloca (2000:585-595) state that in comparison with asymptomatic healthy individuals, lower back pain patients have been found to use a different motor control strategy. This may be a result of pain or damage to muscular, ligamentous, or nervous (mechanosensitive) tissues. They stress the role of rehabilitation programs in improving objective outcomes. They include increases in muscle strength, mobility, and functional capacity as well as improved motor control system function as important goals in patient care. Muscle output has been found to be closely correlated with muscle strength, therefore the potential ability of rehabilitation programs, and the role of spinal manipulation therapy in affecting the neuromuscular system, are of interest to both researchers and clinicians.

Experimental, clinical and current research literature has created a foundation and provided documentation for proposed mechanisms of action for low velocity manipulative treatment therapies in the management of acute or chronic low back pain. Proving that flexion distraction of the sacroiliac joints may have an effect on quadriceps muscle strength would expand on this hypothesis. Altered muscle function may be a potential short-term therapeutic effect of this type of clinical intervention.

2.8 Conclusion

According to Cox (1999:261) a 1993 survey conducted by the National Board of Chiropractic Examiners in the USA indicated that 52.7% of the Chiropractors surveyed routinely employ flexion distraction in the management of low back pain. Flexion distraction is described by Schafer and Faye (1990:233) as an effective, conservative low velocity treatment, providing an alternative to high velocity, low amplitude manipulation procedures. Although high-velocity, low-amplitude thrust techniques have been proven to be clinically effective, there is little evidence relating to patient tolerance for these procedures or what to do when they may be contraindicated. Alternative procedures, such as flexion distraction techniques, may be more easily tolerated by the patient while imposing less physical demand on the practitioner.

The sacroiliac joint is important with regards to lower back pain, leg pain and general spinal dysfunction. Lower limb muscle weakness and neurological deficit appears to correlate with the fact that pelvic dysfunction may be present.

The vertebral subluxation complex is described as a structural dysrelationship and is thought to affect reflex neural activity. If spinal cord excitability were the cause of altered physiological processes (muscle function and strength), then reducing or removing the hyperexcitability would reduce or correct the aberrant physiological processes. According to chiropractic literature the beneficial effects of spinal manipulation includes the reduction of spinal cord excitability. Therefore spinal manipulation should correct the aberrant physiological processes, and in so doing allow muscle function to normalise. A short-term increase in quadriceps muscle strength after lumbar spine manipulation has been observed, suggesting that neural integrity is vital to muscle function. Muscle strength therefore depends on the ability of the nervous system to activate the involved muscles and not solely on the condition of the muscles themselves.

There is evidence that standard rehabilitation protocols fail to achieve full recovery of muscle strength and function after joint injury.

Spinal manipulation accompanied by an audible release does not differ greatly from manipulation not accompanied by an audible release. High velocity, low amplitude spinal manipulative therapy and low velocity spinal mobilisation have both been shown to have an effect on spinal motoneuron pool inhibition. It may be the high density of muscle spindles in extremity and paraspinal muscles which allow the muscle stretch stimulus of spinal manipulation or mobilisation procedures to alter the mechanical state of the muscle spindle receptors and in turn lead to the reflex inhibition of motoneurons. Cutaneous receptors, muscle spindle and Golgi tendon organs rather than velocity-dependent joint mechanoreceptors may therefore contribute to inhibition of spinal reflex excitability during low velocity flexion distraction mobilisation. This strengthens the theory that flexion distraction therapy mechanisms may be both mechanical and neurophysiological.

These findings substantiate the theory that manual spinal therapy procedures may lead to short-term inhibitory effects on the human motor system, laying the foundation for further inquiry into the neurophysiologic mechanisms involved in the frequently used flexion distraction therapeutic procedure. Scientific knowledge of the effects of flexion distraction therapy on muscle strength is virtually unknown, resulting in its restricted application in especially rehabilitation.

CHAPTER THREE

METHODOLOGY

3.1 Methodology Introduction

This was an indirect study to determine the effect of a chiropractic treatment protocol in conjunction with a specific rehabilitation protocol for the chronic lower back pain sufferer exhibiting pelvic malalignment.

3.1.1 Patient Selection

Eighty patients were recruited by means of an advertisement poster placed throughout the Technikon Witwatersrand, Doornfontein Campus (refer to Appendix C). Subjects were given a detailed description of the study and they provided informed consent before participation (Appendix B). Participants ranged in age from 18 to 40 years of age and had no history of peripheral neuropathy or radiculopathy. A total of forty male and forty female subjects who may or may not have been symptomatic with regards to sacroiliac pain were selected. Subjects were required to express joint dysfunction at the sacroiliac joint. Each participant was required to attend a single thirty minute consultation during which flexion distraction of a motion restricted sacroiliac joint was performed.

3.1.2 Patient Screening

Selected subjects had no known contra-indications to flexion distraction therapy (Appendix D). A lumbar spine neurological examination (Appendix A) was conducted on every participant to ensure the absence of radicular presentations. The following nerve root tension tests were included (Appendix A); Straight Leg Raise, Well Leg Raising Test, Braggard's Test and Femoral Nerve Traction Test. Pheasant's test (Appendix A) was used to exclude the possibility of lumbar spine instability.

3.1.2.1 Straight Leg Raising Test

The patient lay supine, relaxed and comfortable. With the knee extended, the examiner passively flexed the patient's hip to the point of pain. A unilateral straight leg raise is full at 70° indicating that the nerve roots of the sciatic nerve are completely stretched at this point. The test was positive if pain extended from the posterior lower back and buttock region down the posterior thigh and calf in the sciatic nerve distribution. A comparison was made with the contralateral straight leg raise, and with what the examiner expected to be normal for that patient. Pain after 70° would indicate lumbar or sacroiliac joint pain. (Magee 1992:267)

3.1.2.2 Well Leg Raising Test

The reproduction of ipsilateral leg symptoms when the contralateral Straight Leg Raising Test is asymptomatic is called the Well Leg Raising Test. This test caused stretching of both the ipsilateral and contralateral nerve root as it pulled on the dural sac, indicating a possible space-occupying lesion such as an intervertebral disc protrusion. (Magee 1992:267)

3.1.2.3 Braggard's Test

When the point of pain in the Straight Leg Raising test had been reached, the examiner carefully lowered the leg until the pain was relieved. The patient's foot was slowly dorsiflexed by the examiner. Pain that increased with ankle dorsiflexion indicated increased tension in the tibial and sural branches of the sciatic nerve. Pain that did not increase with dorsiflexion may have been due to lesions in the lumbosacral or sacroiliac joints, or may have been due to shortened hamstring muscles. (Magee 1992:267)

3.1.2.4 Femoral Nerve Stretch Test

This test caused traction on the roots of the femoral nerve - nerve roots (L2 to L4). The patient lay on the asymptomatic side with that knee and hip slightly flexed. The patient's head was flexed, and back was straight. The symptomatic leg was extended approximately 15° at the hip and the knee was flexed, thereby increasing the tension on the femoral nerve. Pain radiating down the anterior thigh indicated a positive test. (Magee 1992:271)

3.1.2.5 Pheasant's Test

With the patient prone, the examiner applied gentle pressure over the posterior aspect of the lumbar spine. The patient's knees were passively flexed until the heels touched the buttocks. This increase in lumbar spine extension reproduced the patient's pain if there was an unstable spinal segment present. (Magee 1992:271)

3.1.3 Sacroiliac Joint Assessment

All subjects had to exhibit a sacroiliac joint dysfunction as detected by motion palpation, but were not necessarily symptomatic with regards to sacroiliac joint pain. Three orthopaedic tests were performed to determine whether sacroiliac joint related pain was present. Suter, McMorland, Herzog and Bray (2000:78) recommend the use of these tests in the diagnosis of sacroiliac joint syndrome. Magee (1997:443, 447, 473) describes the tests as follows:

3.1.3.1 Erichsen's Test

The patient lay prone. The examiner placed one hand above the knee under the thigh, on the affected side and extended that hip. Pain in that sacroiliac joint was a positive test. This indicated some form of sacroiliac joint pathology.

3.1.3.2 Sacral Compression Test

The patient lay prone on a firm surface, and the examiner applied downward pressure with the base of the hand at the apex of the patient's sacrum. Pain over the involved joint indicated a positive test for sacroiliac joint pain.

3.1.3.3 Patrick Faber Test

The patient lay supine, the test leg was flexed at the knee and hip, and the ankle of the test leg was placed on the opposite leg, on the thigh, above the knee. The examiner then externally rotated the hip and lowered the test leg in abduction, toward the examining table. A positive test occurred when the test leg remained above the opposite straight leg. A positive test, which may have included pain over the sacroiliac region, indicated possible sacroiliac joint pathology.

3.1.3.4 Motion Palpation of the Sacroiliac Joint

The Standing Flexed-Knee-Raising Test (Schafer and Faye 1990:260) was used to determine the motion restricted sacroiliac joint. The Standing Flexed-Knee-Raising test was conducted with the patient in the standing position. To screen iliac flexion and extension on the sacrum, the examiner's thumbs were placed on the patient's posterior superior iliac spines (PSISs), and the patient was asked to lift the right knee up. The right PSIS on the side of normal movement was felt to arc posteriorly and inferiorly, with the contralateral PSIS moving posteriorly and inferiorly at approximately 20^0 of leg raise. Any motion other than this indicated a sacroiliac joint motion restriction or fixation. The test was repeated using the left leg. To test specifically for a left sided flexion restriction, the examiner's left thumb was placed on the patient's left PSIS and the examiner's right thumb on the second sacral spinous process. If the movement was normal the examiner's left thumb moved inferiorly as the patient raised their left leg. When the joint was restricted the examiner's left thumb moved upward as the patient raised that leg. Keeping the same contact the patient's right knee was raised, and the examiner's thumbs should have approximated each other. If that did not occur a left-sided extension restriction was noted. Both of these tests were repeated for the right sacroiliac joint.

Fifteen studies have reported original data on the reliability of motion palpation of the spine and pelvis in which intra-examiner reliability of motion palpation has been verified (Gatterman 1995:61)

3.2 Patient Treatment

In selecting the proper flexion distraction technique for the management of sacroiliac joint syndrome, Cox (1999:229) used the anatomic position of the innominates as a guide. The movement of the innominates was determined by motion palpation as described above. The position of the innominates was determined by static palpation as described below.

Static palpation, according to Kirk, Lawrence and Valvo (1985:28), was used to compare the levels of the PSIS's. The test was performed standing. The examiner's thumbs were used to contact both posterior superior iliac spines. The levels of the thumbs were compared. The lower, more prominent posterior superior iliac spine was the side of sacroiliac joint fixation. This was considered to be the posterior innominate.

The therapy table used was a Spine-a-Line manufactured manual flexion distraction table (Figure 1). The therapy table motion was reproducible and did not vary among subjects.

The patient was positioned prone with the gap in the table in line with the patient's posterior superior iliac spine. Blocking procedures were determined by the position of the innominates. In order to assure correction of the malpositioned innominate a block in the form of a rolled up bath towel was placed under the innominates in such a way as to correct the malposition. This method is in accordance with the Cox method of sacroiliac joint correction (Cox 1999:229).

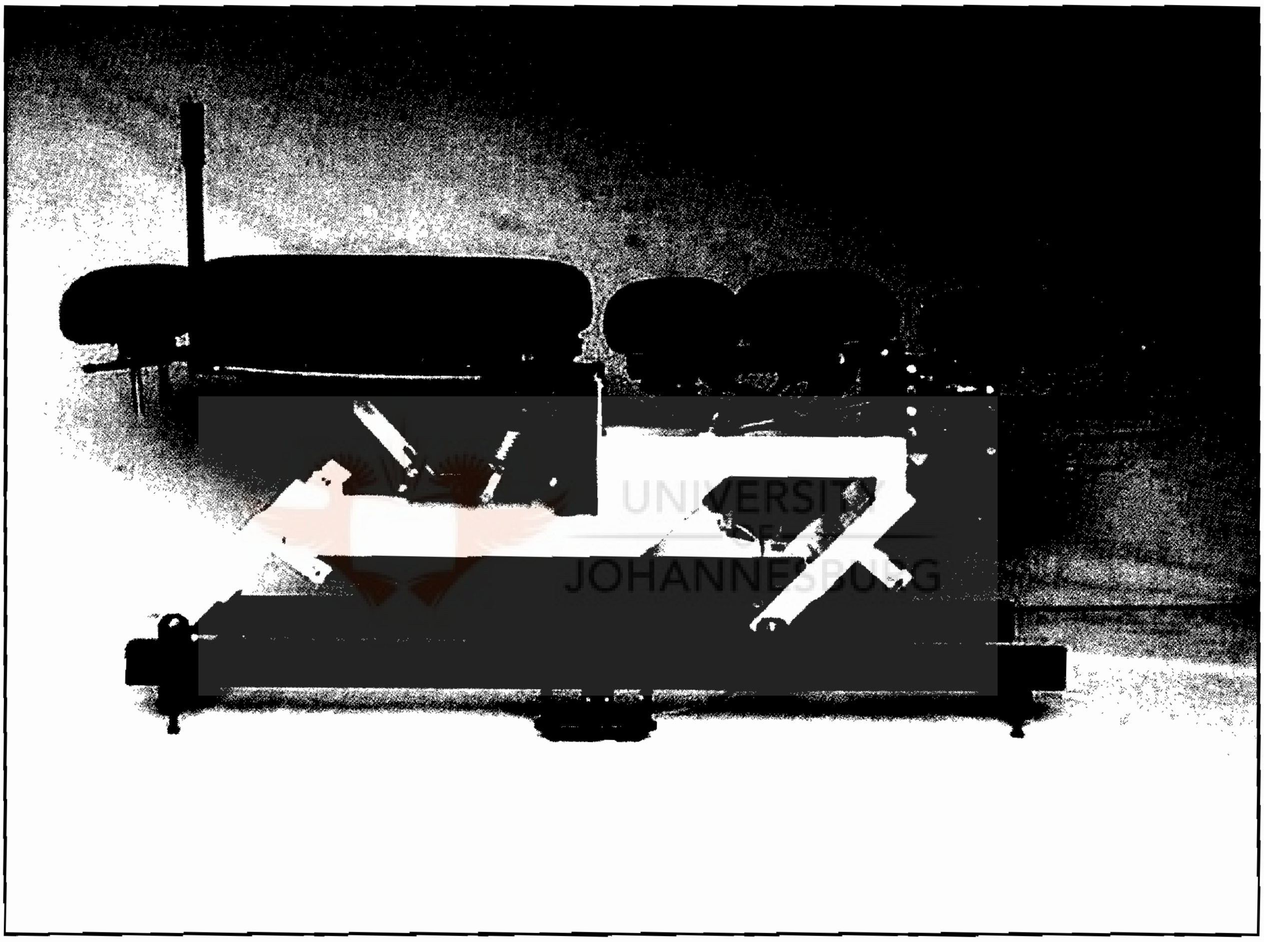


Figure 1

A Spine-a-line Manual Flexion Distraction Table Similar to the one used in this Study

3.2.1 The Anterior Innominate

In the case of an anterior innominate a block was placed under the involved ASIS and traction was applied to the corresponding innominate by placing a hand contact on the L5 spinous process in a cephalad direction. The contact was held for 20 seconds while the caudal section of the table was pumped up and down 2 inches. This 20-second distraction was repeated three times. A dutchman's role was placed under the ilia if both innominates were found to be anterior. In so doing both ilia were distracted simultaneously (Cox 1999:229).

3.2.2 The Posterior Innominate

In the case of the posterior innominate, a block was placed under the involved acetabulum and traction was applied to the corresponding innominate. A hand contact was placed on the L5 spinous process in a cephalad direction and held for 20 seconds while pumping the caudal section of the table up and down 2 inches. This 20-second distraction was repeated three times. This method remains in accordance with the Cox (1999:229) method.

In this way motion assisted manipulation was applied to the sacroiliac articulation in the prone position.

3.3 Objective Measurements

An isometric dynamometer reading of quadriceps strength, measured in kilograms, provided the objective measurement. Both intra- and inter-examiner reliability of the isometric dynamometer has been previously established by Dainty, Mior and Bereznick (1998:109-116). The intra-examiner reliability was evaluated using data collected by the same examiner evaluating ten subjects performing repeated trials over two days. Inter-examiner reliability was validated by two trained examiners who evaluated the same fifteen subjects in independent trials over a period of two days.

The dynamometer was fixed to the cross bar of the plinth, with the free end attached to the seated patient's ankle by a Velcro strap. The patient's leg was flexed at the knee and the Velcro strap was tightened to ensure a true isometric contraction was achieved. The patient was then instructed to grasp the table with the hands but not to pull down with the arms. This was done in order to prevent the tendency for the patients' body to rise up off the plinth while performing the quadriceps extension isometric contraction. Pulling down with the arms would affect the measurement recorded by the dynamometer.

Three pre-treatment measurements were recorded at one-minute intervals, followed by three post-treatment measurements also recorded at one-minute intervals. This method of testing is consistent with that used by Pollard and Ward (1996:137-144).

3.4 Statistical Analysis

Means and standard deviations of the difference of the observed measurements were recorded. The T-test for paired observations was then used to calculate the p-value, which was used to determine whether any differences were of statistical significance.

CHAPTER FOUR

RESULTS

4.1 Statistical Procedures

Objective data collected during the assessment period was statistically analysed by using a Two-sample T-test to differentiate between pre- and post-treatment quadriceps muscle strength. Three pre-treatment strength measurements and three post-treatment measurements were taken from each subject. This was accomplished using an isometric dynamometer marked in kilograms. The dynamometer has previously been found to be a reliable and accurate instrument by Dainty *et al* (1998:109-116).

The Two-Sample t-test was selected for this study as it statistically analyses results by comparing the mean values of two columns. In this study any statistically significant post-treatment changes would become evident by comparing the means of the pre-treatment and post-treatment readings, accurately analysing the data both before and after flexion distraction mobilisation was administered.

Two values were considered in analysing the Isometric Dynamometer readings. The P-value was used to determine the significance of the statistics, where $P < 0.05$ was considered statistically significant. The mean value was used to determine whether or not any change in quadriceps muscle strength occurred as a response to the treatment. An increase in quadriceps strength was indicated by a positive mean difference, thus demonstrating that the treatment had been beneficial. A negative value indicated that the treatment was ineffective in increasing quadriceps muscle strength. In this study, a 95% confidence interval was used to determine any statistical significance after conducting the Two-Sample t-test.

4.2 Quadriceps Femoris Strength Measurements

The statistically analysed means of the objective data were used to plot bar graphs indicating the objective changes in quadriceps muscle strength. Figures 1 and 2 show bar graphs representing comparisons of quadriceps femoris muscle strength (kg) before and after flexion distraction mobilisation for male and female subjects on both the left and the right.

Table 1

Comparison of pre- and post treatment measurements of quadriceps femoris muscle strength for **male** subjects on the left (L)

Group	n	Mean	Standard Deviation
Pre-treatment (L)	120	55.1	19.6
Post-treatment (L)	120	59.0	19.9

Table 1 shows pre- and post treatment quadriceps femoris muscle strength measurements of male subjects on the left side. The difference in the mean values of the two groups equals 3.9. This P value was not great enough to reject the possibility that the difference was due to random sampling variability, indicating insufficient increase in post treatment muscle increase. With P>0.05 there was no statistically significant difference between the input groups. (P=0.1311)

Table 2

Comparison of pre- and post treatment measurements of quadriceps femoris muscle strength for **male** subjects on the right (R)

Group	N	Mean	Standard Deviation
Pre-treatment (R)	120	60.1	20.3
Post-treatment (R)	120	64.1	19.9

Table 2 shows pre- and post treatment quadriceps femoris muscle strength measurements of male subjects on the right side. The difference in the mean values of the two groups equals 4.0. This P value was not great enough to reject the possibility that the difference was due to random sampling variability, indicating insufficient increase in post treatment muscle increase. With P>0.05 there was no statistically significant difference between the input groups. (P=0.1282)

In the male group (tables 1 and 2) the Two–Sample t-test demonstrated that the difference in the mean values before and after the flexion distraction mobilisation was applied was smaller than would be expected by chance, thus showing a statistically insignificant difference in quadriceps strength both on the left and on the right. (Graph 1)

Table 3

Comparison of pre- and post treatment measurements of quadriceps femoris muscle strength for **female** subjects on the left (L)

Group	**n**	**Mean**	**Standard Deviation**
Pre-treatment (L)	120	26.0	8.38
Post-treatment (L)	120	28.0	9.47

Table 3 shows pre- and post treatment quadriceps femoris muscle strength measurements of female subjects on the left side. The difference in the mean values of the two groups equals 2.0. This P value was not great enough to reject the possibility that the difference was due to random sampling variability, indicating insufficient increase in post treatment muscle increase. With P>0.05 no statistically significant difference between the input groups was demonstrated. (P=0.0820)

Table 4

Comparison of pre- and post treatment measurements of quadriceps femoris muscle strength for **female** subjects on the right (R)

Group	n	Mean	Standard Deviation
Pre-treatment (R)	120	27.4	8.56
Post-treatment (R)	120	30.1	10.20

Table 4 demonstrates a 2.7 difference in the mean values of the two groups. This post treatment improvement in quadriceps muscle strength was therefore greater than would be expected by chance, showing a statistically significant difference between the input groups with $P<0.05$. ($P=0.02$)

In the female group the Two–Sample t-test proved that the difference in the mean values before and after the flexion distraction mobilisation was applied to the left (table 3), was smaller than would be expected by chance, thus showing a statistically insignificant difference in quadriceps strength. However in the female group on the right side (table 4), the Two-Sample t-test proved that the difference in the mean value before and after the flexion distraction procedure, was greater than would be expected by chance, thus showing a statistically significant difference in quadriceps femoris muscle strength. (Graph 2)

Table 5			
Comparison of pre- and post treatment measurements of quadriceps femoris muscle strength for the **combined** subjects on the left (L)			
Group	**n**	**Mean**	**Standard Deviation**
Pre-treatment (L)	240	40.5	21.0
Post-treatment (L)	240	43.5	22.0

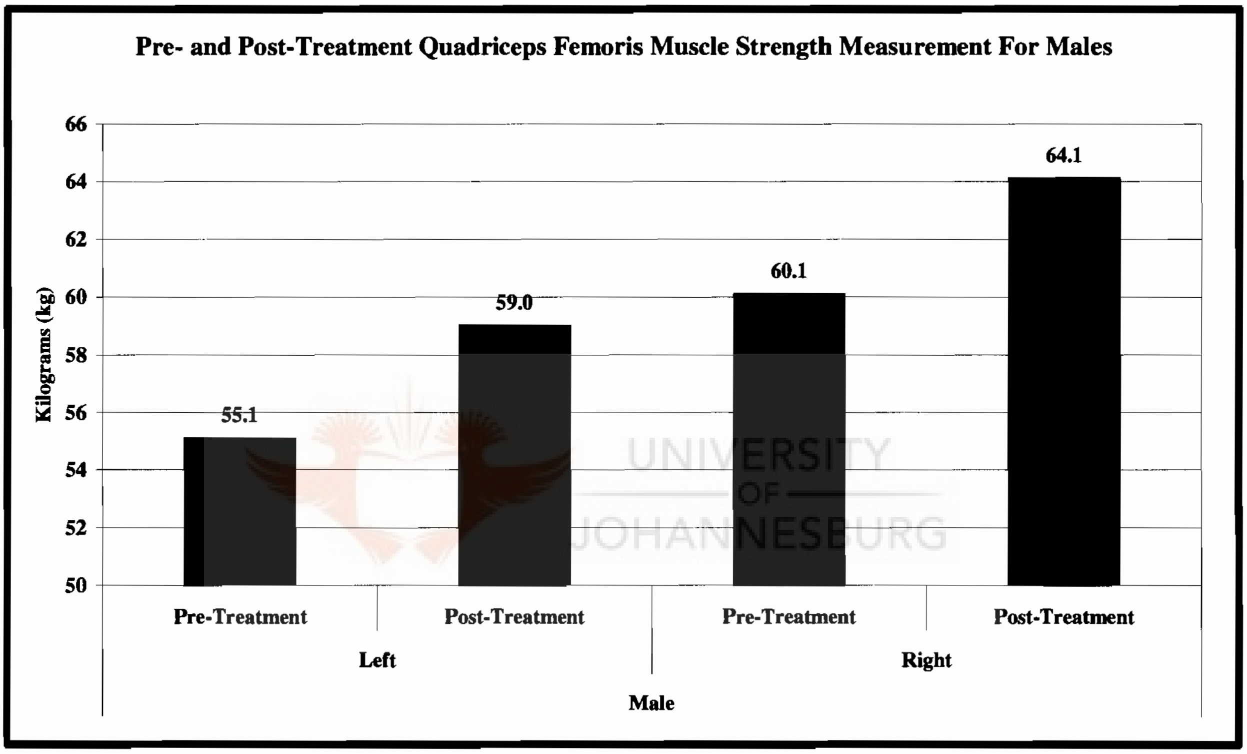
Table 5 shows a difference of 3.0 in the mean values of the two groups. P>0.05 and was therefore not great enough to reject the possibility that the difference was due to random sampling variability. There was no statistically significant difference between the input groups. (P=0.1344)

Table 6			
Comparison of pre- and post treatment measurements of quadriceps femoris muscle strength for the **combined** subjects on the right (R)			
Group	**n**	Mean	Standard Deviation
Pre-treatment (R)	240	43.8	22.6
Post-treatment (R)	240	47.1	23.2

Table 6 indicates a 3.3 difference in the mean values of the two groups. This is therefore not great enough to reject the possibility that the difference was due to random sampling variability (P>0.05).

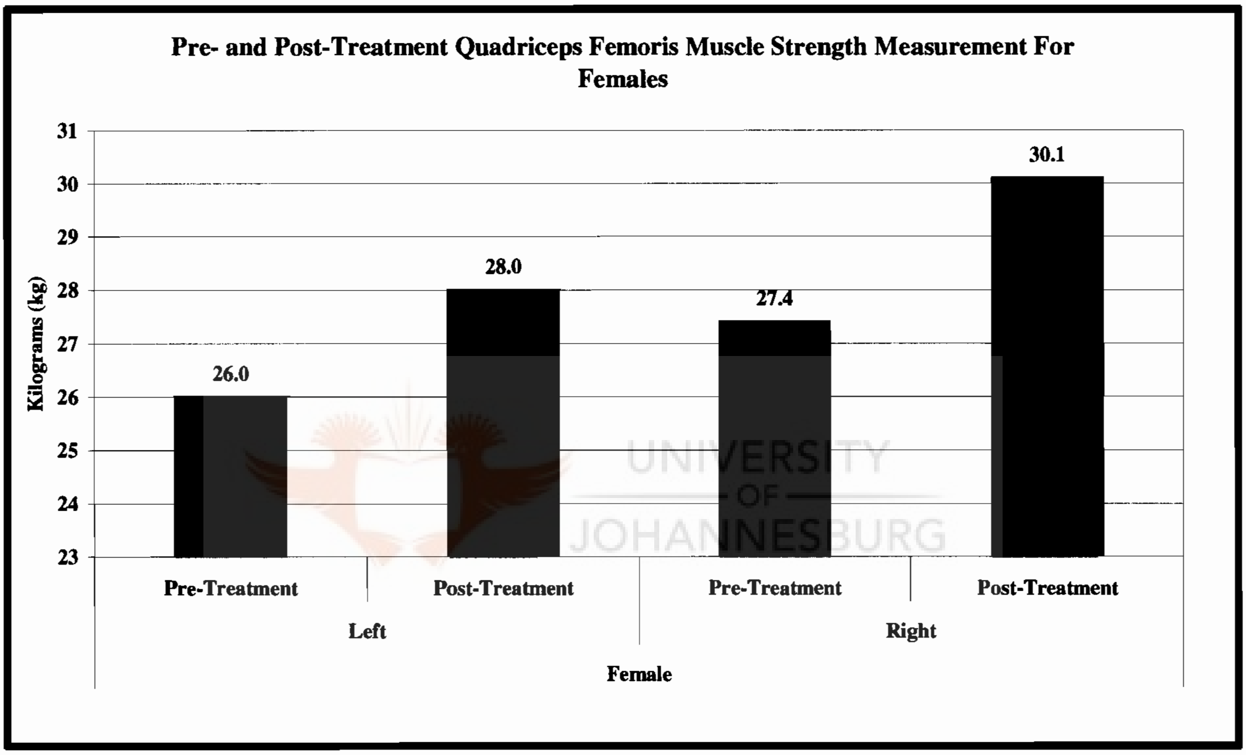
There was not a statistically significant difference between the input groups. (P=0.1120)

In Graph 3 an improvement in the quadriceps strength of both the male and female groups combined is shown. The Two–Sample t-test proved that the difference in the mean values for the combined group before and after flexion distraction mobilisation was smaller than would be expected by chance. A statistically insignificant difference in quadriceps strength both on the left and on the right is shown (tables 5 and 6).



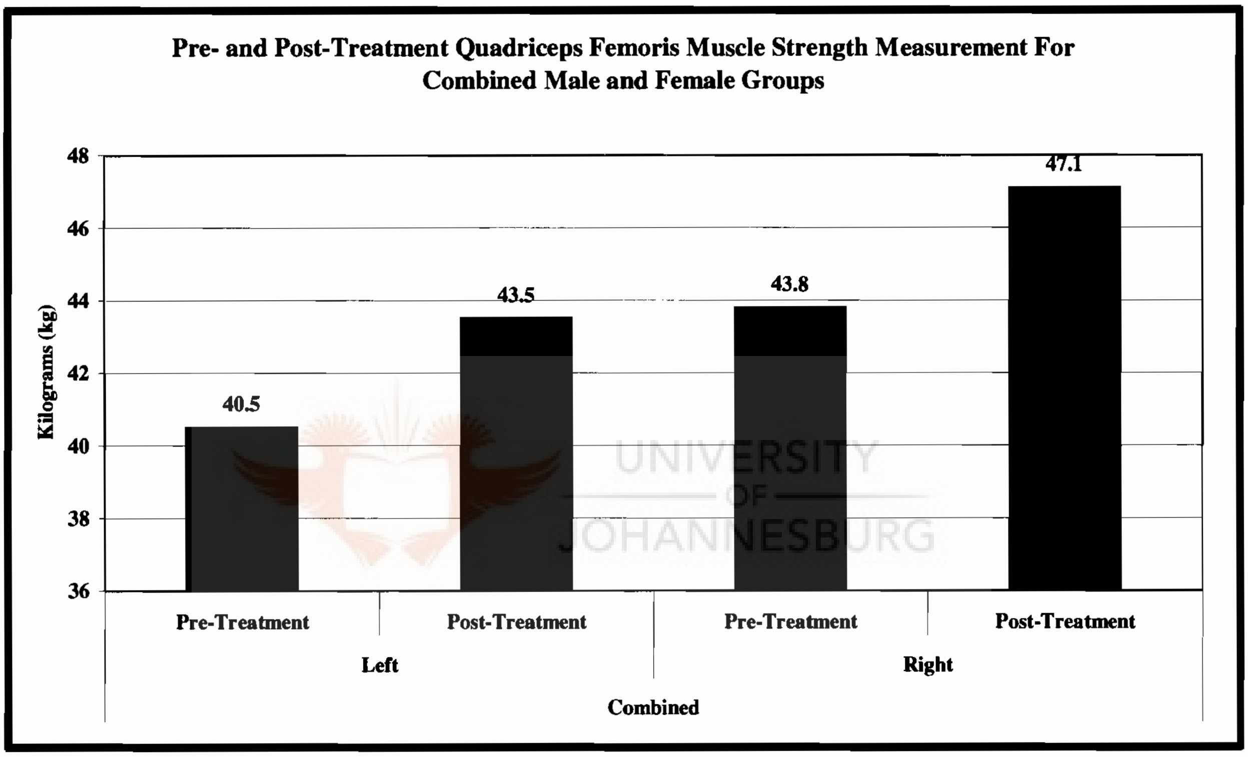
GRAPH 1

BAR GRAPH COMPARING PRE- AND POST-TREATMENT QUADRICEPS FEMORIS MUSCLE STRENGTH MEASUREMENTS (KG) FOR THE MALE GROUP ON THE LEFT AND ON THE RIGHT



GRAPH 2

BAR GRAPH COMPARING PRE- AND POST-TREATMENT QUADRICEPS FEMORIS MUSCLE STRENGTH MEASUREMENTS (KG) FOR THE FEMALE GROUP ON THE LEFT AND RIGHT



GRAPH 3

BAR GRAPH COMPARING PRE- AND POST-TREATMENT QUADRICEPS FEMORIS MUSCLE STRENGTH MEASUREMENTS (KG) FOR THE COMBINED GROUP ON THE LEFT AND RIGHT

CHAPTER FIVE

DISCUSSION

5.1 Introduction

All 80 subjects who participated in this study received a once-off flexion distraction mobilisation of their motion-restricted sacroiliac joint. Bilateral quadriceps muscle strength was measured, both pre- and post-treatment, in an attempt to determine the effect of flexion distraction on the strength of this muscle group. A previous study by Sher *et al* (2002) had demonstrated an increase in quadriceps muscle strength after spinal manipulative therapy was applied to the sacro-iliac joint. A comparison between the objective measurements of this study and the objective measurements of the Sher *et al* (2002) study was made.

5.2 Quadriceps Femoris Strength Measurements

This study failed to demonstrate a significant increase in quadriceps femoris muscle strength when a combined male and female group were statistically analysed. (Refer to tables 5 and 6)

When the male and female groups were considered separately a small but significant change in muscle strength was demonstrated in the female group, on the right side only. The mean difference between pre-and post-treatment measurements for this group was 2.70. This statistically significant increase suggests that the treatment may, in this instance, be considered effective.

Changes in the right side in particular may be explained by Schamberger (2002:150). He observes that the difference in strength between left and right sides of the same muscle group in the same person is often surprising. In adults the muscles that most consistently prove weak on the right side include the hip flexors (rectus femoris, iliopsoas and pectineus).

He notes that dynamometer studies have demonstrated an asymmetry in quadriceps strength on a side-to-side comparison with, in the presence of pelvic malalignment, the right being weaker than the left. Previously weak muscles will show an appreciable increase in strength on manual retesting immediately following realignment. In an attempt to explain the pattern of asymmetrical functional weakness seen in association with malalignment, Schamberger (2002:151) notes the following:

- The pattern cannot be attributed to laterality. Laterality may be defined as a tendency to use the organs (hand, foot, eye, ear) of the same side in voluntary motor acts. With laterality, any increase in asymmetrical strength is most likely to be observed on the dominant side.

- The pattern may reflect a lateralisation of motor dominance, as approximately 70% of the population are left and 15% are right motor cortex dominant. Asymmetry in motor control at the cortical level may result in the asymmetry in muscle strength.

- The pattern does not correspond to a nerve root or peripheral nerve lesion as the weakness consistently involves muscles supplied by different nerve roots and/or peripheral nerves

- The pattern may relate to impaired proprioception or kinaesthetic adaptation that has occurred as a result of the malalignment of the joints. This may cause inappropriate asymmetrical proprioceptive input from muscles and joints.

- The pattern may be a combination of some of the above.

In the Sher *et al* (2002) study the mean difference in the male group was 4.672 (left) and 5.162 (right), while the mean difference in the female group was 2.385 (left) and 2.888 (right).

In the present study the mean difference in the male group was 3.86 (left) and 3.96 (right), while the mean difference in the female group was 2.02 (left) and 2.70 (right).

In the Sher *et al* (2002) study the quadriceps strength increased greatly in the male group, and to a lesser degree in the female group.

According to Sher *et al* (2002) a possible biomechanical explanation for the statistically significant improvement in quadriceps strength after spinal manipulation, may be due to the lever system of the pelvis being returned to normal function. Sher *et al* (2002) postulated that restoring normal biomechanics of the pelvis may result in more efficient muscle contraction of any muscle acting about the pelvis. The relationship of the quadriceps muscle to the pelvis is by virtue of the superior attachment of the rectus femoris to the anterior inferior iliac spine.

Sher *et al* (2002) postulated a possible neurological basis for the statistically significant improvement in quadriceps strength, which is consistent with the findings of Pollard *et al* (1996). The quadriceps femoris is innervated by the femoral nerve (nerve root levels L2-L4). In their study, Pollard *et al* (1996) showed that manipulation applied to the L3/L4 motion segment resulted in a significant short-term increase in quadriceps strength. Suter *et al* (1999, 2000) reported that after manipulation, a decrease in quadriceps inhibition and an increase in knee extensor torques occurred. They reported a 7.5% increase in quadriceps strength in the 2000 study.

Attenuation of the spinal reflex as a response to flexion distraction was previously demonstrated by Bulbalian *et al* (2001:526-532). They showed a decrease in alpha motor neuron pool excitability with trunk flexion. They concluded that spinal flexion leads to motoneuron inhibition as a mechanism of reducing antagonistic action on the extensor muscles.

Although the flexion distraction subjects exhibited no significant increase in quadriceps muscle strength immediately following administration, the left and right muscles responded equally to the treatment in the short term as the strong side stayed strong and the weak side stayed weak.

Schamberger (2002:150) has found that strength changes attributable to the correction of the pelvic malalignment are not always apparent on initial post treatment testing. He explains that the time it takes for changes to materialise may relate, firstly, to the time it takes for the body to adapt fully to the correction and to the elimination of any residual asymmetries in muscle tension. Secondly, for the time it takes to achieve and maintain full pelvic and spinal alignment with the elimination of any change in tension attributable to facilitation and inhibition only.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The flexion distraction procedure is one of the most widely used techniques in the chiropractic profession, it is considered to be an effective and conservative low-velocity treatment in the management of lower back pain (Bulbalian *et al* 2001:526-532). The purpose of this study was to determine possible neurophysiological effects of the flexion distraction procedure by demonstrating a post treatment change in the strength of the quadriceps femoris muscle.

Both male and female groups received a flexion distraction procedure directed specifically at the motion restricted sacroiliac joint. Although bilateral measurements were recorded, only the right-sided measurements in the female group showed any statistically significant improvement in quadriceps muscle extension strength.

Once combined, the objective measurements of the male and female groups together showed no significant change, indicating that the flexion distraction procedure was ineffective in improving overall quadriceps femoris extension strength in the short-term.

It may therefore be proposed that, according to this study, the application of flexion distraction therapy may be considered an ineffective procedure with regards to increasing short-term quadriceps femoris muscle strength.

These findings indirectly validate the effectiveness of the Sher *et al* (2002) study, providing a comparison and re-affirming the significance of the results of that study. A manipulative thrust to the sacroiliac joint may be considered to be an effective treatment intervention, and may be administered prior to the muscle-strengthening component of a rehabilitation program, with the intention of improving the effectiveness of that program.

In conclusion, while short-term quadriceps strength may be increased with a specific manipulative thrust to the motion-restricted sacroiliac joint, a flexion distraction procedure applied to a similarly restricted sacroiliac joint does not demonstrate the same results.

6.2 Recommendations

Validation and improved accuracy of the results of the current study may be achieved through the following recommendations:

6.2.1 It should be noted that these data were collected from relatively healthy participants, often asymptomatic with regards sacroiliac joint pain, but all experiencing some form of sacroiliac joint dysfunction or abnormal biomechanical function, and should be interpreted with caution relative to the possible effects in patients who may also experience severe lower back pain. The response in such patients should be studied in future to determine whether a different result might be obtained.

6.2.2 The inclusion of a larger sample group or a more limited age group may determine the extent to which quadriceps strength may be affected in a specific population, increasing the significance of the statistical results.

6.2.3 Individuals involved in a specific sporting code often have a similar baseline level of strength and fitness. Recruitment of such subjects may increase the validity of the objective measurements.

6.2.4 A testing protocol extended over a number of weeks might provide an accurate comparison between short- and long-term effects of flexion distraction and spinal manipulative therapy with regards to quadriceps femoris muscle strength. This may demonstrate whether the treatment has a lasting effect and therefore possibly be of greater benefit to the patient during a rehabilitation program.

6.2.5 Treatment of the motion restricted articulations with flexion distraction and myofascial trigger point therapy may further improve muscle contraction. With restoration of full function the rehabilitation program may be more effective as myofascial pain and dysfunction plays a large role in joint dysfunction.

6.2.6 Utilising three groups, with the inclusion of a specific control group, may further validate the current study. The first group may receive spinal manipulative therapy, the second group flexion distraction therapy and the third group a placebo treatment. This could assist in determining whether a placebo effect plays a role in the change in muscle strength. A double blind, randomised process may then be utilised to recruit subjects and place them into groups.

6.2.7 The use of restraints to ensure correct patient positioning may increase the effectiveness of the flexion distraction procedure.

6.2.8 The isometric dynamometer readings may be replaced by EMG measurements thereby determining the electrical activity within the muscle during contraction.

6.2.9 The eccentric rather than the concentric contraction may be tested, as post-treatment strength increases have been shown to be greater when the eccentric contraction has been tested (Schamberger 2002:150).

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Appendix A: Physical Examination

Patient Name:	**Date:**

Neurological Examination of the Lumbar Spine								
Dermatomes	L	R	**Myotomes**	L	R	**Reflexes**	L	R
T12			Hip Flexion (L1,2)			Patellar (L3,4)		
L1			Knee Extension (L2,3,4)			Medial Hamstring (L5)		
L2			Knee Flexion (L5,S1)			Lateral Hamstring (S1)		
L3			Hip Int Rotation (L4,5)			Tibialis Posterior (L4,5)		
L4			Hip Ext Rotation (L5,S1)			Achilles (S1,2)		
L5			Hip Adduction (L2,3,4)			Plantar Reflex		
S1			Hip Abduction (L4,5)					
S2			Ankle Dorsiflexion (L4,5)					
S3			Hallux Extension (L5)					
			Ankle Plantar Flex (S1,2)					
			Eversion (S1)					
			Inversion (L4)					
			Hip Extension (L5,S1)					

Nerve Root Tension Tests	Left	Right	**Orthopaedic Examination**	Left	Right
Straight Leg Raise			Patrick FABER		
Well Leg Raise			Sacral Compression		
Braggard's			Erichsen's Test		
Femoral Nerve Stretch Test			Pheasant's Test		

Palpation of Sacroiliac Joints	Left	Right
Motion Palpation		
Static Palpation		

THE EFFECT OF A FLEXION-DISTRACTION MOBILISATION ON QUADRICEPS MUSCLE STRENGTH

Dear Participant,

The purpose of this study is to determine the effect of a flexion-distraction mobilisation of the sacroiliac joints on quadriceps muscle strength. The flexion-distraction procedure is a conservative mobilisation (non-thrust) technique used in the treatment of lower back pain. Using this technique to restore normal motion to your sacroiliac joints, more efficient muscle function may be achieved.

According to your gender you will be placed into one of two groups of forty.

You will be required to attend one, thirty-minute consultation.

Participation in this study is voluntary and you are free to withdraw your consent and discontinue participation at any time.

Any refusal to participate or withdrawal of consent, will not effect your regular treatments in any way. A signed copy of this consent form will be made available to you.

I, Bronwen Eybers, have fully explained the procedures involved in this investigative study, and have, to the best of my ability, answered any questions that may have arisen.

Researcher: ______________________ **Date:** ______________

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

Name: ______________________ **Date:** ______________

Signature: ______________________
(Patient/guardian/next of kin)

Would you like to participate in a **FREE** chiropractic research study?

The strength of the muscles at the front of your thigh will be tested before and after a flexion-distraction treatment during a once off consultation.
This is a traction / stretching modality used by Chiropractors in the treatment of lower back pain.

This study will take place between **May** and **August 2003**

All treatment is conducted by a chiropractic student intern at the
Technikon Witwatersrand Chiropractic Day Clinic

Are you interested?

Call BRONWEN EYBERS **073 316 8979**

0733168979 Bronwen Eybers	0733168979 Bronwen Eybers	0733168979 Bronwen Eybers	0733168979 Bronwen Eybers	0733168979 Bronwen Eybers	0733168979 Bronwen Eybers	0733168979 Bronwen Eybers	0733168979 Bronwen Eybers	0733168979 Bronwen Eybers	0733168979 Bronwen Eybers

Appendix D: Contraindications

Cox (1999) recommends that Flexion Distraction Techniques be limited to the treatment of conditions with probable mechanical cause only. Thereby eliminating the following:

1. Fracture
2. Dislocation
3. Neoplasm
4. Metastic disease
5. Infection
6. Diabetes Mellitus
7. Arthritides
8. Vascular disease
9. Systemic diseases
10. Cauda Equina syndrome or any hard or progressive neurological signs indicative of significant nerve root irritation