The effect of sacroiliac joint manipulation compared to manipulation and static stretching of the posterior oblique sling group of muscles in participants with chronic sacroiliac joint syndrome

By

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I, Shaylene Swanepoel, do declare that this dissertation is representative of my own work in both conception and execution and that the use of work by others has been duly acknowledged in the text.

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DEDICATION

I dedicate this thesis to my parents, my grandmother and my boyfriend. Edward and Ruth Swanepoel, Granny and Bradley Rorke, this one is for you!

Thank you for making me the person I am today, through all your sacrifices, support and endless encouragement over the years. Words cannot express how grateful I am to you.
Thank you for helping me achieve my dreams.

To my Heavenly Father, thank you for guidance on every step of this journey. Without your Grace and guidance I would have been lost.

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ABSTRACT

Sacroiliac joint syndrome is diagnosed in patients who complain of various painful symptoms associated to their lower back, for example: hip and groin pain, sciatica pain, and / or a need to frequently urinate. They further report that their pain is further intensified when standing from sitting, stair walking, bending forward or from sitting or standing too long. Sacroiliac joint syndrome has been widely accepted by health professions as a contributor to low back pain. Spinal manipulation has shown to be an effective method for pain relief of this condition. Studies have been done using physical therapy in conjunction with manipulation in treating sacroiliac joint syndrome. However, little research has been done on the effects of static stretching and manipulation combined.

The posterior oblique sling group of muscles is created by the biceps femoris, gluteus maximus, erector spinae and latissimus dorsi muscles. The sacroiliac joint can be affected by the functional relationship of the posterior oblique sling muscles. These muscles are involved in forces across the sacroiliac joint. Tightness of muscles can affect the sacroiliac joint.

Flexibility is an essential element of normal biomechanical functioning. Flexibility of muscles, tendons and ligaments can influence a joints range of motion. There is evidence that suggests that stretching could increase a joint's range of motion which was evident one or more days after the stretching protocol in people without clinically significant contractures. Upon review of the related literature, it appears that there is insufficient literature assessing the clinical effectiveness of static stretching of the posterior oblique muscle sling group with respect to sacroiliac joint syndrome. Therefore this study is aimed at providing insight into the role of the posterior oblique muscle sling group in participants with and chronic sacroiliac joint syndrome. It is hypothesized that effective treatment of these muscles will allow for a more effective outcome of symptoms.

The study design chosen was a randomised, clinical trial consisting of thirty voluntary participants' between the ages 18 to 45 years suffering from chronic sacroiliac joint syndrome. There were two groups of fifteen participants, who received four treatment consultations within a two week period. Participants placed into Group One received sacroiliac joint manipulation only, while participants in Group Two received static stretching of the posterior oblique muscle sling and sacroiliac joint manipulation. Subjective and objective readings were taken at the first, third and fourth (final) consultations. The Numerical Pain Rating Scale (NRS) and the Oswestry Low Back Pain Disability Index (OSW) questionnaires were used to assess the

subjective findings whilst the objective measurements were collected from results of algometer and inclinometer readings.

The intra-group analysis revealed there was a statistically significant improvement within both groups for NRS, OSW, and inclinometer results. It appeared that Group Two fared better in terms of the algometer (pressure) results. The inter-group analysis revealed that all comparisons apart from the algometer readings had no statistically significant improvement between the two groups. From the intra-group comparisons of the objective data, participants in both groups experienced a statistically significant improvement. However, Group Two fared better in terms of the algometric pressure readings ($p = 0.001$).

This study confirms that both treatment protocols were effective in reducing the signs and symptoms associated with sacroiliac joint syndrome. Although the readings were not statistically significant, there is evidence that Group Two responded better than Group One in terms of the algometer readings (Figure 4.13). There is insufficient literature on studies related to the posterior oblique sling muscles, and therefore, comparisons are needed with respect to the posterior oblique muscle sling group and its effects on the sacroiliac joint. This study concludes that overall there was no statistically significant difference between the two groups and recommends that further studies be undertaken with a greater number of participants to gauge if a more significant result can be achieved.

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DEFINITIONS

- **Articulation –** place of union or junction between two or more bones of the skeleton (Gatterman 1990: 406)
- **Biomechanics –** the study and knowledge of biological function obtained from an application of mechanical principles (Gatterman 1990: 406)
- **Chronic –** Low back pain that persists continuously or intermittently for longer than three months is considered to be chronic (Maughan and Lewis, 2010).
- **Erector spinae –** the erector spinae muscle group is an intermediate layer of intrinsic back muscles which consists of the iliocostalis, longissimus and spinalis (Moore and Dalley, 2006). Their function bilaterally is to extend the vertebral column, and unilaterally to laterally flex the vertebral column (Moore and Dalley, 2006).
- **Force closure –** both a lateral force and friction are needed to bear a vertical load (Vleeming *et al*., 1997). Compression produced by muscles and ligaments that can be adapted to the specific loading situation prevents shearing in the sacroiliac joint (Vleeming *et al*., 1997).
- **Form closure –** "a stable situation with closely fitting joint surfaces, in which no extra forces is needed to maintain the state of the system, given the actual load situation" (Vleeming *et al*., 1997). In the sacroiliac joint, shear is prevented by a combination by specific anatomic features (Vleeming *et al*., 1997).
- **Kinematics** – is concerned with the movements of parts of the body that produce motion by displacement. Velocity and acceleration are taken into account as forces that produce motion (Bergmann and Peterson, 2011).
- **Posterior oblique sling -** The posterior oblique sling muscle group is created by the biceps femoris, gluteus maximus, erector spinae and latissimus dorsi muscles (Page *et al*., 2010).
- **Sacroiliac joint syndrome -** a collection of signs and symptoms that result from mechanical irritation of the sacroiliac joint, which results in low back and buttock pain that can be referred to the groin and posterior thigh (Haldeman, 1992).
- **Spinal manipulative therapy -** is the application of a high velocity low-amplitude thrust to target the biomechanical normalisation of joint function and related local or remote symptoms (Haldeman, 2005).
- **Zygapophyseal Joint -** Also known as facet joints, that occurs between the articular processes of two adjacent spinal vertebrae (Moore and Dalley, 2006).

LIST OF ABBREVIATIONS

ANOVA: Analysis of variance

NRS - Numerical Pain Rating Scale

OSW - Oswestry Low Back Pain Questionnaire

POS - Posterior Oblique Sling

SIJ - Sacroiliac joint

Chapter One

1.1 INTRODUCTION

It has been found that the sacroiliac joint (SIJ) is a cause of low back pain (Murata *et al*., 2001). Sakamoto *et al.,* (2001) stated that the SIJ is responsible for 22.6% of low back pain cases, which is in accordance with another study that has estimated the prevalence of SIJ syndrome, and hence low back pain in the population to be between 19.3% and 47.9% (Toussaint *et al.,* 1999). Low back pain is a common condition and commonly affects 70% of individuals at some point their lives (McIntosh and Hall, 2007). The most common disability is low back pain in people younger than 45 years of age (Hills, 2006). In a systematic review performed by Louw *et al*., (2007), it was recorded among African adolescents, the average low back pain prevalence was 12% and among the adults 32% (which ranged from 10% to 59%).

The SIJ is situated below the lumbar spine, and above the coccyx. It connects the sacrum with the pelvis iliac crest (Moore and Dalley, 2006).
The joint typically has the following characteristics:

- Small and strong in structure as it is reinforced by surrounding strong ligaments
- Limited motion
- Transfers all the forces of the upper body to the pelvis (hips) and legs
- Acts as a shock-absorbing structure (Gatterman and Panzer, 2005)

A change in the normal joint motion may be the cause that contributes to SIJ pain. SIJ pain can be caused by either:

- Too much movement (hypermobility): Lower back and/or hip pain can be experienced that may also refer into the groin area (Gatterman and Panzer, 2005).

- Too little movement (hypomobility): Pain is usually felt on one side of the low back or buttocks that can refer down the leg. The pain can spread to the foot at times, however it usually remains above the knee (Gatterman and Panzer, 2005; Bergmann and Peterson, 2011).

Altered biomechanics that is a result of injury or pain may create weakness leading to further dysfunction of the lower back as the joints are not correctly supported (Cholewick and McGills, 1992). This can result in the pelvis or lower extremities over-compensating, which therefore increases the susceptibility to chronic pain (Cholewick and McGills, 1992).

In order for the pelvis to function normally, the SIJ needs to be stable, and act as a shock absorber between the lower limbs and spine, and a proprioceptive feedback mechanism for coordination and control of movement between the trunk and lower limbs (Tucker, 2011).

The SIJ achieves stability via form and force closure (Vleeming and Stoeckart, 2007) described as follows:
In form closure, stability of the SIJ is achieved by the shape, structure and congruency of the SIJ bones and associated sacral ligaments (i.e. two block pieces that are fitted together) (Tucker, 2011). In force closure, compression and stabilization of the SIJs is caused by the external forces exerted by muscle systems, through their attachment into the ligaments and fascia (Vleeming and Stoeckart, 2007). Sufficient force closure is essential for a person to enable them to walk, transfer from a chair to the standing position, climbing stairs, bending and walking (Tucker, 2011).

The “self-locking mechanism” is known as the combination of form and force closure of the SIJ (Vleeming and Stoeckart, 2007). If a person has minimal form closure, they will require more stability from muscles that assist in force closure allowing form and force closure to be balanced. Myofascial slings, such as the posterior oblique sling (POS) provide force closure of the SIJ (Tucker, 2011).

The POS group of muscles is created by the biceps femoris, gluteus maximus, erector spinae and latissimus dorsi muscles (Page *et al*., 2010). While Liebenson (2004) suggests that the POS be made up of the biceps femoris, gluteus maximus and contralateral latissimus dorsi muscles. However, for the purpose of this study, the erector spinae will be included as part of the POS (refer to Figure 1.1).

Vleeming *et al*., (1997) revealed that the SIJ can be affected by the dysfunctional relationship connecting the erector spinae, biceps femoris, gluteus maximus, and latissimus dorsi muscles. These muscles are involved in generating forces across the SIJ (Vleeming *et al*., 1997). Bogduk *et al*., (1998), noted that the latissimus dorsi muscle, through its attachment to the thoracolumbar fascia, has been identified as having an effect on the SIJ. The gluteus maximus has also been shown to be hypertonic during SIJ dysfunction (Gitelman, 1980). It was found that the coupled functioning of the gluteus maximus and contralateral latissimus dorsi creates a force across the SIJ, when extreme contraction of these muscles results in increased compression of the SIJ (Vleeming and Stoeckart, 2007). Increased activity of the ipsilateral gluteus maximus can cause the pelvis to tilt posteriorly which provides a neutral position, the contralateral latissimus dorsis' muscle activity increases to counterbalance the effect (Kim *et al*., 2014). The hamstrings are an important contributor to lumbo-pelvic pain as they are attached to the pelvis at the ischial tuberosity, and control the amount of rotation of the pelvis over the hip joints when bending forward and in the standing position (van Wingerden, 1997). Shear force on the SIJ can be increased by the contraction of the biceps femoris, which increases the tension of the sacrotuberous ligament and results in the sacrum being pulled against the ilium (Porterfield and De Rosa, 1998).

The erector spinae has a double function where it pulls the sacrum forward that will induce nutation of the SIJ, which in turn tenses the sacrotuberous, interosseous and sacrospinal ligaments (Vleeming *et al*., 1997). Its iliac connection pulls the posterior sides of the iliac bones closer to each other which limits nutation (Vleeming *et al*., 1997). Therefore, during nutation, and the action of the erector spinae, the cephalad side of the SIJ becomes compressed while the caudal side widens (Vleeming *et al*., 1997).

According to Kirkaldy-Willis and Bernard (1999) a patient with SIJ syndrome, nearly always has reduced movement and associated SIJ pain. Spinal manipulative therapy (SMT) has the ability to restore joint movement and in doing so relieve pain (Kirkaldy-Willis and Bernard, 1999). SMT is designed to induce joint motion through either mobilization, traction, muscle energy techniques or thrust manipulative techniques (Bergmann, 2005). SMT is a technique that carries the spinal joints beyond its passive range of motion by the application of either high-velocity, low-amplitude (HVLA) manual thrusts and/ or mobilization (Bergmann and Peterson, 2011; Dagenais and Haldeman, 2012).

The therapeutic effects of SMT includes:

- A change in joint alignment and dysfunctional joint movement,
- A reduction in pain,
- A change in tone and strength of supporting muscles (restoring of normal force couple force relationships among antagonists, agonists, neutralizers and stabilizers),
- Improves circulation (Bergmann, 2005)

SMT has been described as an effective treatment for patients with chronic SIJ syndrome (Gatterman, 2005; Haldeman, 2005).

Stretch interventions that apply tension to soft tissues are widely supported as a means of producing an increase in the extensibility of soft tissues crossing the joints (Harvey *et al*., 2002). Many studies have been done on manipulation of chronic SIJ syndrome suggesting its efficacy (Shearer, 2003; Matkovich, 2004). However, to the researcher's knowledge, no studies have assessed the combined effect of static stretching of the POS and SIJ in the treatment of chronic SIJ syndrome.

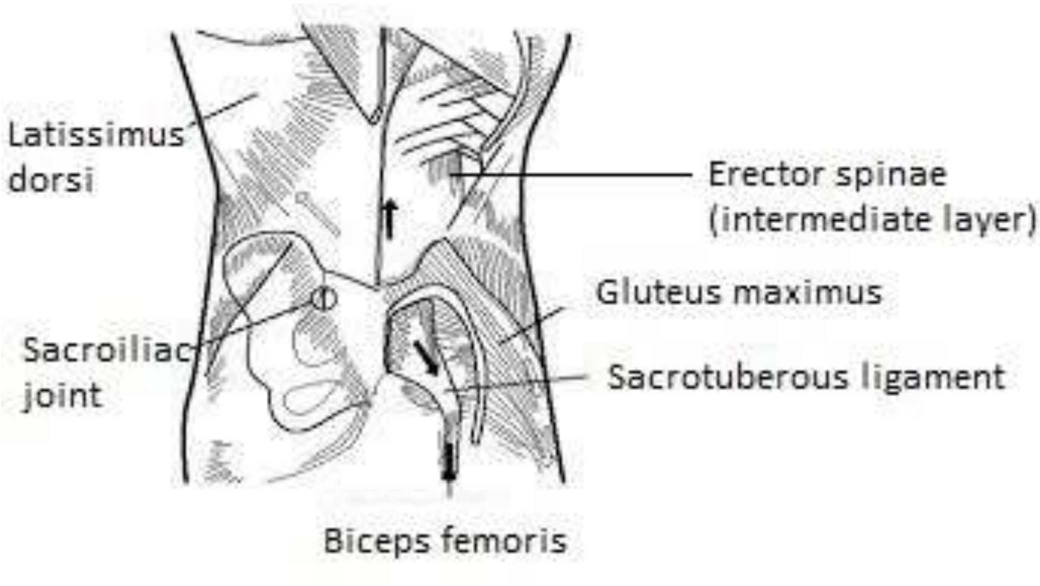


Figure 1.1: Posterior oblique sling muscles

http://ericasuter.com/wp-content/uploads/2016/01/images.jpeg

1.2 AIM AND OBJECTIVES

The aim of this study was to determine the effect of static stretching the POS muscles in conjunction with SIJ manipulation, compared to SIJ manipulation only in the treatment of chronic SIJ syndrome.

Objectives:

1. To determine the effect of SIJ manipulation in terms of subjective and objective outcome measures in participants with chronic SIJ syndrome.

2. To determine the effect of manipulation and static stretching of the POS of muscles in terms of subjective and objective outcome measures in participants with chronic SIJ syndrome.

3. To compare the outcomes of the Objective 1 and 2.

1.3 HYPOTHESIS

Null Hypothesis: The null hypothesis indicated that there would be no difference when comparing readings between the two groups.

Alternate Hypothesis: It was hypothesized that Group Two would have a more favourable response to treatment when comparing the two groups.

1.4 RATIONALE

Vleeming *et al.,* (1997), revealed there to be a functional relationship between the POS and the SIJ stability. Tightness of muscles can affect the SIJ (Vleeming *et al*., 1997). The erector spinae, gluteus maximus, latissimus dorsi and biceps femoris muscles are important in the involvement of force closure of the SIJ (Vleeming and Stoeckart, 2007). Force closure is created by a lateral force and friction that are required to tolerate a vertical load (Vleeming *et al*., 1997). Tension forces can be generated in the gluteal muscles on one side of the body, which can then be transmitted diagonally across the back to the contralateral latissimus dorsi by means of the lumbodorsal fascia (Adams *et al*., 2007). These forces can press the SIJ surfaces closer together, which in turn can increase their stability by force closure (Adams *et al*., 2007).

Chronic SIJ syndrome is a common problem for which manipulation is effective (Haldeman, 2005). Stretch interventions that apply tension to soft tissues produce an increase in the extensibility of soft tissues that cross the joints (Harvey *et al*., 2002). This may be useful when treating chronic SIJ pain. Many studies have been done on manipulation of chronic SIJ syndrome suggesting its efficacy (Shearer, 2003; Matkovich, 2004). No studies have been done to assess if static stretching of the POS and SIJ manipulation combined is effective in the treatment of chronic SIJ syndrome.

1.5 POTENTIAL BENEFITS OF THE STUDY

This research attempted to evaluate if stretching the POS group of muscles in conjunction with SIJ manipulation had an effect on chronic SIJ pain when compared to manipulation only in patients with chronic SIJ syndrome.

1.6 OUTLINE OF CHAPTERS

In Chapter Two the research will review the literature on chronic SIJ syndrome and POS muscle dysfunction. Chapter Three will explain the research methodology of this study. Chapter Four will present the results of this study, and Chapter Five will discuss these results. In Chapter Six, the research will be concluded after recommendations are made for future studies looking at static stretching of the POS muscles and its effect on the SIJ.

Chapter Two

2.1 INTRODUCTION

SIJ syndrome is a common cause of low back pain (Murata *et al*., 2001). Low back pain has been described as pain felt between the 12th rib and the inferior gluteal folds, with or without leg pain, which includes the SIJ (Krismer and van Tulder, 2007). Chronic low back pain has a duration of more than three months, which can occur episodically within a six month period (Krismer and van Tulder, 2007). SIJ pain is a source of low back pain that affects between 15 and 30% of people with chronic pain (Cohen *et al*., 2013).

2.1.1 Prevalence and Incidence of sacroiliac joint syndrome and low back pain

There is a minimal literature regarding the prevalence of SIJ dysfunctions in the general population. A prospective, observational study performed by van der Wurff *et al*., (2006), found that 38% of the 60 patients displayed a prevalence of pain originating from the SIJ. SIJ disorders have been associated as a contributing factor in 50-70% of adults that present with low back pain (Morris, 2006). According to Kirkaldy-Willis and Burton (1992), and Morris (2006), SIJ syndrome is a prevalent causative agent of low back pain in a large percentage of the population.

In a systematic review performed by Louw *et al*., (2007), it was recorded among African adolescents, the average low back pain prevalence was 12% and among the adults 32% (which ranged from 10% to 59%). Van der Meulen (1997) found that in Chesterville, Durban, South Africa, (an informal black settlement) - the prevalence of low back pain was 53.1%, while the lifetime incidence was 57.6%. Docrat (1999) found the prevalence for low back pain in parts of South Africa in the Indian and coloured populations to be between 26.6 to 78.2%.

Louw *et al*., (2007) conducted a systematic review of 27 studies on the prevalence of low back pain in Africa and South Africa. This review indicated that there was little difference in the prevalence of low back pain among Africans compared to the prevalence of low back pain in developed countries (Louw *et al.*, 2007). Of the epidemiological studies, 37% were conducted in parts of South Africa and 26% in Nigeria, of which the most common population group that participated were workers (48%), and students (15%). The average prevalence of low back pain among the adolescents was 12% and the adults was 32% (Louw *et al.*, 2007). The average one year prevalence of low back pain among adolescents was 33% and among adults was 50% (Louw *et al.*, 2007). The average lifetime prevalence of low back pain among the adolescents was 36% and among adults was 62% (Louw *et al.*, 2007).

2.1.2 Intervention of low back pain relating to sacroiliac joint syndrome

There are many treatment plans for reducing pain stemming from the low back. Pharmacological treatment can be used to reduce symptoms and help to reduce pain, and so the use of analgesics and muscle relaxants has been recommended (Krismer and van Tulder, 2007). Other than pain relieving medicines, a variety of interventions have been recommended for patients, such as: rehabilitative interventions that include joint mobilization, traction, manipulative therapy, transcutaneous electrical nerve stimulation (TENS), relaxation techniques, massage and acupuncture (Krismer and van Tulder, 2007). Exercise and behavioural therapy that includes pain management, or a combination of both are effective treatments for sub-acute and chronic low back pain (Krismer and van Tulder, 2007).

Multidisciplinary programmes should be provided for low back pain if there is no improvement with exercise or behavioural therapy (Krismer and Van Tulder, 2007). Exercise therapy includes stretch regimes such as static stretching (Page, 2012). Since the POS is a group of muscles that can affect the SIJ (Vleeming and Stoeckart, 2007), these muscles are of interest in the intervention of chronic SIJ syndrome. As this study attempts to look at the effect of stretching the posterior oblique muscle sling in chronic SIJ syndrome, a detailed discussion of all the components of the SIJ will be addressed with further emphasis on the POS.

2.2 SACROILIAC JOINT SYNDROME

SIJ syndrome is a common but poorly recognised cause of low back pain because of the way it often mimics other recognised sources of low back pain (Laslett, 2008). The SIJs are an important source of pain and may limit function (Liebenson, 2004). The International Association for the Study of Pain recognises that SIJ pain is a spinal condition and refers pain to the lower limb (Dreyfuss *et al*., 1996; Morris, 2006).

2.2.1 Clinical presentation of sacroiliac joint syndrome

SIJ syndrome is a collection of signs and symptoms that result from irritation of the SIJ, which results in low back and buttock pain and can refer pain to the groin and posterior thigh (Haldeman, 1992).

Kirkaldy-Willis *et al*., (1992) described SIJ syndrome as pain over the SIJ that is located in the area of the posterior superior iliac spine (PSIS), with the possibility of referral to the buttock, groin, posterior and anterior thigh. The pain that is associated with SIJ syndrome is usually unilateral and dull in nature (Kirkaldy-Willis *et al*., 1992). The SIJ receives numerous innervations from a wide range of spinal levels; therefore, referred pain to and from this joint can cause some diagnostic confusion (Haldeman, 1992). Harrison *et al*., (1997) suggested that most patients with SIJ syndrome seem to present with increased pain and inflammation and spasticity of the surrounding muscles. Hendler *et al*., (1995) stated that the ligaments of the SIJ become tense, and this results in a reflex muscle spasm and pain can be severe and constant.

The symptoms may be aggravated by movements such as bending, sitting and rising form a seated position, lifting, and engaging in quick forceful movements (Mior *et al.*, 2011).

2.2.2 Causes of sacroiliac joint syndrome

The SIJ is exposed to many factors from trauma to infection that may have an impact on the patients' symptoms (Mior *et al*., 2011).
Risk factors include socio-demographic factors, such as:

- Biological,
- age
- gender,
- ethnicity,
- levels of education,
- levels of activity,
- employment status,
- nutritional status (such as smoking/tobacco use) (Morris, 2006; Dagenais and Haldeman, 2012).

Other factors that are considered when dealing with low back pain patient are health factors that include levels of physical activity, body weight, genetics, the presence of possible systemic disease, physical and psychological factors that could all relate to the low back pain (Dagenais and Haldeman, 2012).

2.2.3 Diagnosis of sacroiliac joint syndrome

- Clinical tests for SIJ dysfunction based on manoeuvres intended to stress the SIJ and provoke familiar pain are seen to be reliable (Laslett, 2008; Magee, 2007).

- According to McCulloch and Transfeldt (1997), and Van der Wurff *et al.,* (2006), patients who present with sacroiliac joint syndrome generally present with pain and palpable tenderness over the SIJ. The pain is aggravated by provocation tests, these are:

  - Patrick Fabers,
  - Erichsons,
  - Compression,
  - Gaenslens and,
  - Sacral thrust tests (Magee, 2002, and Laslett *et al*., 2003).

Magee (2002) and Laslett (2008) state that three or more tests out of the five have to test positive in order to reach a definitive diagnosis of SIJ syndrome. A study performed by Laslett *et al.*, (2003) provides evidence for a clinician to differentiate a symptomatic and asymptomatic SIJ by provocation tests for the SIJ.

- According to Mior *et al.,* (2011), the distribution of pain in SIJ syndrome can be complicated by an overlap of different pain patterns that are created by other surrounding structures. They also found that the facet, disc, or muscle related conditions can have a similar presentation to that of SIJ pain.

2.2.4 Treatment of Sacroiliac Joint Syndrome

SIJ pain of a non-pathological nature can be managed by conservative measures which are directed at:

- relieving the pain,
- restoring joint movement,
- correcting imbalances in length and strength of muscles of the lower limbs, pelvis and torso,
- and the use of rehabilitation protocols (Mior *et al.,* 2011).

Relief may be noted with standing, rest, or keeping active by walking (Mior *et al.*, 2011). Non-conservative measures such as injections into the SIJs are also an option for patients with SIJ syndrome (Morris, 2006).

Non-Steroidal Anti-Inflammatory Drugs (NSAID's) and opioids have been suggested in patients with chronic low back pain disorders for temporary pain relief (Kuijpers *et al*., 2011). It was noted that possible adverse effects such as abdominal pain, nausea and vomiting should be considered before deciding which medication to prescribe (Kuijpers *et a*l., 2011).

Manipulation has been suggested to be the preferred treatment for restricted SIJs (Paris and Viti, 2007; Bergmann and Peterson, 2011).

Chiropractic treatments are commonly used to remedy SIJ syndrome and includes:

- side-posture spinal manipulation,
- drop piece manipulation,
- blocking technique, and
- instrument guided method (Yeomans, 2010).

For chronic SIJ syndrome, many studies have been done locally (Thompson, 2002; Moodley, 2002; Bisset, 2003; Shearar, 2003; Morgan, 2005; Matkovich, 2004) with sample sizes of 30, 40, and 60, respectively. They found spinal manipulation to have statistically significant results, indicating the effectiveness of spinal manipulative therapy.

2.3 ANATOMY OF THE SACROILIAC JOINT

2.3.1 Anatomical development of the sacroiliac joint

At birth, the SIJ surfaces are smooth and flat, and is orientated vertically, and after puberty the joint develops a more articular shape (Mior *et al*., 2011; Beal, 1982). During infancy and childhood, the flat surface allows for freedom of movement in all directions, with stability of the joint being dependent on its supporting ligaments (Beal, 1982).

During the second decade of life, joint stability is improved by the sacral articular sulcus and an iliac articular cartilaginous ridge. This is as a result of secondary ossification centres that appear near the cartilage after 12 years of age, and is known as the remodelling process (Mior *et al.*, 2011).

The sacral and iliac tuberosity become enlarged, and fibrosis of the interosseous sacroiliac ligament strengthens the joint posteriorly during the third decade of life (Mior *et al.*, 2011). During the fourth and fifth decades, the bony margins of the articular surface ossify and can result in minimal osteophytes that may appear (Mior *et al.*, 2011).

2.3.2 Functional Anatomy

The two SIJs are posteriorly located bilaterally, and is formed by the articulation of the sacrum with the ilium at the base of the spine (Mior *et al*., 2011). The joints have limited movement, which contributes to strength (Mior *et al*., 2011). This strength is necessary as each joint transmits weight from the vertebral column to the lower limb respectively (Hendler *et al.*, 1995).

The SIJs structure is determined by its two functions. Firstly, a load is transferred from the axial skeleton to the pelvis and legs, and secondly it absorbs twisting forces placed upon the pelvis during walking/standing movements (Bergmann and Peterson, 2011). Adams *et al*., (2013) proposed that the SIJ is designed to act as a stress-relieving joint in the pelvic girdle. The SIJ is paired with the pubic symphysis within the pelvic ring, and here the role of the SIJ is to absorb the torsional stresses placed upon the pelvis by the gait cycle (Bergmann and Peterson, 2011). Strong ligaments that surround and support the SIJ help provide the joint with the ability to absorb and relieve stress (Bogduk, 2005; Moore and Dalley, 2006). Forces travel upward the spine and anteriorly towards the pubic symphysis from the lower extremities, and downward forces of gravity on the spine divide to both sides (Bergmann and Peterson, 2011).

The posterior SIJs are true synovial joints as they have a joint cavity which contains synovial fluid and are enclosed by a joint capsule (Bergmann and Peterson, 2011). The SIJs articular surface is described as a letter C shape lying on its side (Bergmann and Peterson, 2011). The articular surfaces have different contours that develop into interlocking elevations and depressions. This configuration produces a “key-stone effect” of the sacrum, which means that the axial compressive forces through the pelvic mechanism are distributed (Bergmann and Peterson, 2011).

The SIJ is a synovial joint between the articular surfaces of the sacrum and the ilium (Adams *et al.*, 2013). A depression is seen on the articular surface of the sacrum opposite the second sacral segment (S2), and prominences opposite the first (S1) and third (S3) sacral segments (Adams *et al.*, 2013). The sacrum locks between the two ilia of the pelvic girdle by the up-and-down motions that articulate with common surfaces on the ilium (Adams *et al.*, 2013). As long as the ilia are kept compressed against the sacrum, the sacrum is prevented from being driven downwards by the weight of the trunk or from rotating forwards due to its locking mechanism (Adams *et al.*, 2013).

The lumbosacral joints and the pubic symphysis are closely associated with the sacroiliac joints (Moore and Dalley, 2006). The lumbosacral joints consist of an intervertebral disc between the L5 vertebral body and the sacral base (S1), and two posterior zygapophyseal (facet) joints between the articular processes of the vertebral bodies (Moore and Dalley, 2006). The facets face posteromedially on the S1 vertebra, which interlocks the anterolaterally facing inferior articular facets of the L5 vertebra (Moore and Dalley, 2006). This prevents anterior sliding of the lumbar vertebra down the side of the sacrum. The pubic symphysis lies between the bodies of the pubic bones and is a secondary cartilaginous joint that consists of a fibro-cartilaginous disc and surrounding ligaments (Moore and Dalley, 2006).

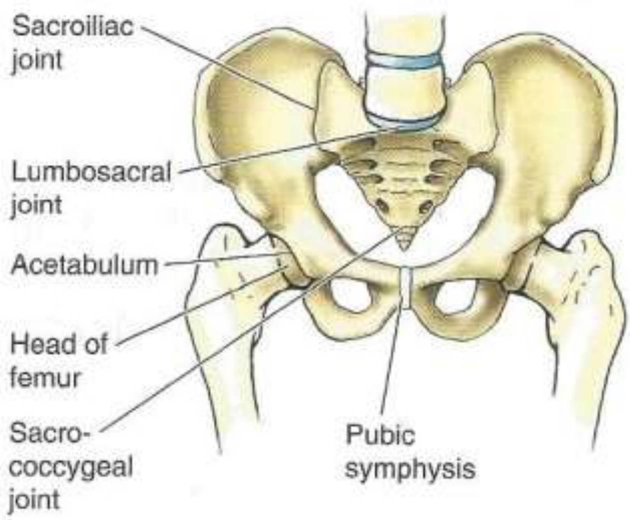


Figure 2.1: Anterior view of the joints of the adult pelvic girdle

Adapted from Moore and Dalley (2006)

2.3.3 Sacroiliac joint Ligaments

2.3.3.1 Intrinsic ligaments

The fibrous capsule of the SIJ is strengthened by the intrinsic capsular ligaments which are the anterior and posterior intrinsic ligaments (Mior *et al*., 2011). The anterior sacroiliac ligament and the posterior sacroiliac ligament make up the intrinsic ligaments of the SIJ (Mior *et al*., 2011). The anterior sacroiliac ligament strengthens the inferior half of the capsule as its fibres are thin superiorly and become gradually thickened inferiorly as it attaches horizontally across the joint (Mior *et al.,* 2011). The anterior sacroiliac ligaments strongest part is attached anteriorly to the sacral ala level to the second sacral segment (S2) which then crosses the most inferior part of the SIJ to attach to the subauricular sulcus on the ilium as far back as the posterior inferior iliac spine (PIIS) (Mior *et al.*, 2011).

The posterior sacroiliac ligament is divided into short and long parts (Mior *et al*., 2011). The short posterior sacroiliac ligament attaches to the sacral tuberosity medially along the lateral sacral crest in which its fibres pass laterally and superiorly to attach to the posterior superior iliac spine (PSIS) of the ilium anteromedially (Mior *et al.*, 2011). The long posterior sacroiliac ligament attaches above the first sacral foramen and the posterior superior iliac spine (PSIS) superiorly to the sacral ala and posterior to the attachment of the short sacroiliac ligament along with the longest fibres of the sacrotuberous ligament.

The anterior and posterior sacroiliac ligaments both prevent disturbance of the SIJ by counteracting gravitational forces, which takes place during the gait cycle and when in the upright posture (Mior *et al.*, 2011).

2.3.3.2 Extrinsic ligaments

The extrinsic ligaments of the SIJ are made up as follows:

- Iliolumbar,
- Scarotuberous and
- Sacrospinous ligaments (Mior *et al*., 2011)

These ligaments help to support the anterior and posterior sacroiliac ligaments (Mior *et al*, 2011).

The iliolumbar ligament attaches superiorly to the transverse process of the fifth lumbar vertebral body, and passes laterally to attach along the superior border of the medial third iliac crest (Mior *et al.*, 2011). This ligament helps to prevent superior distraction of the SIJ (Mior *et al.*, 2011).

The sacrotuberous ligament attaches medially to the lateral sacral crest from S3 to S5 sacral segments (Mior *et al.*, 2011). The long fibres originate from the PSIS which course to meet the lower fibers inferiorly, laterally and anteriorly to attach at the medial aspect of the ischial tuberosity (Mior *et al*., 2011).

The sacrospinous ligament attaches to the anterolateral border at S3 to S5 sacral segments of the sacrum which course laterally and anteriorly to the ischial spine (Mior *et al*, 2011). Both the sacrotuberous and sacrospinous ligaments share the function to prevent posterior movement of the sacral apex during nutation of the sacral promontory (Mior *et al.*, 2011).

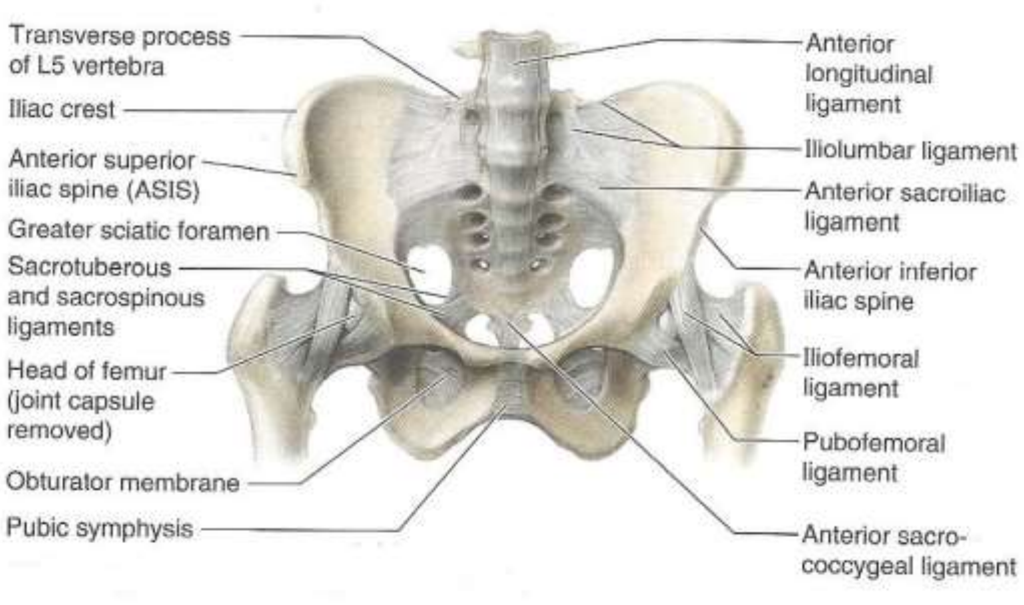


Figure 2.2: Anterior ligaments of the pelvis

Adapted from Moore and Dalley (2006)

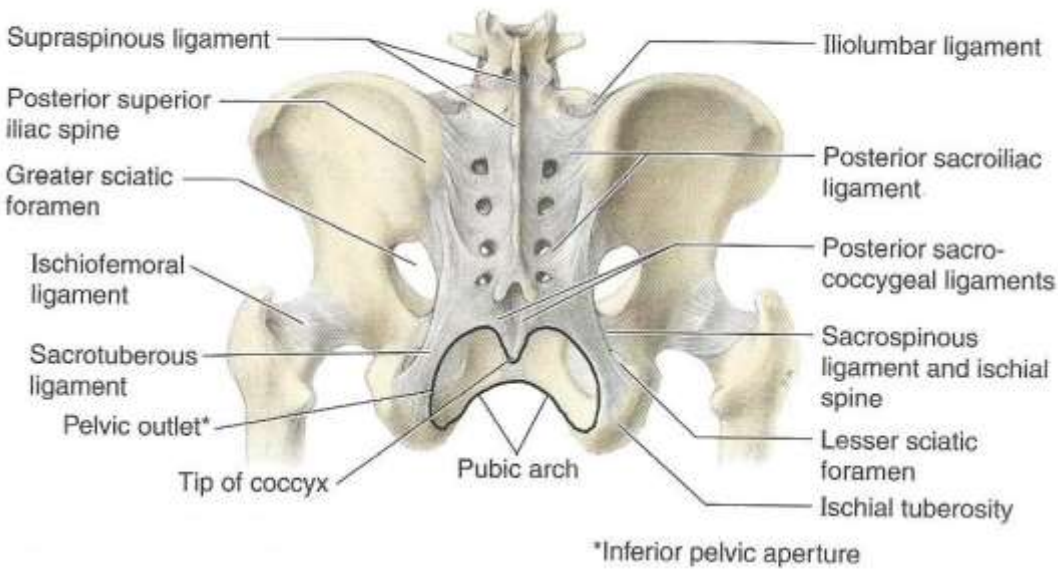


Figure 2.3: Posterior ligaments of the pelvis

Adapted from Moore and Dalley (2006)

2.3.4 Innervation at the sacroiliac joint

Nerves from L2 to S4 are found in the SIJ (Mior *et al.*, 2011). The nerves run posteriorly between the superficial layer of interosseous sacroiliac ligaments and dorsal sacroiliac ligaments. The anterior primary rami of S1 and S2 supply the anterior surface of the joint (Mior *et al.*, 2011: 194). The SIJ is innervated by pain receptors (nociceptors), movement and sensory receptors (proprioceptors) (Otter, (1985) and Beal, (1982)).
The innervation of the SIJ can vary from right to left sides in some individuals (Cramer and Darby, 2013) and due to this, a wide range of pain referral patterns may occur. This explains why the symptoms of patients with SIJ syndrome may be slightly different (Bernard and Cassidy, 1993; Souza, 2009). This is supported by Cramer and Darby, (2013); Evans, (2001); Giles, (2003), who suggested that different pain referral patterns stemming from the SIJ can make the diagnosis difficult.

2.3.5 Biomechanics

The SIJ is located centrally in the pelvic girdle. Its function is to stabilise and transmit forces during the gait cycle (Mior *et al.*, 2001:185). During the gait cycle, the pelvic girdle is exposed to twisting forces similar to that of a figure of eight to which stresses are applied (Adams *et al.,* 2013). The SIJ allows small movements between the sacrum and pelvis.

SIJ stability can be increased by muscle action (Adams *et al.,* 2013). Tension can be generated in the gluteal muscles on one side of the body, which can then be transmitted diagonally across the back to the contralateral latissimus dorsi by means of the lumbodorsal fascia (Adams *et al.*, 2013). These forces can press the SIJ surfaces closer together, which in turn can increase their stability by force closure (Adams *et al.*, 2013).

2.3.5.1 Kinematics

SIJ motion can be described as upward, downward, forward, backward and rotational movement about a transverse axis, as the sacrum 'floats' within the pelvic ring (Schafer and Faye, 1990).

The main movements in the SIJs are the posterior-anterior and anterior-posterior rotatory movements of the ilia relative to the sacrum (nutation), - forward tilting of the sacrum relative to the ilia and backward tilting (counter-nutation) (Vleeming and Stoeckart, 2007). Nutation is whereby the sacral promontory moves in an anterior-inferior direction while the posterior superior iliac spine moves in a posterior-inferior direction, and is increased during loaded situations such as standing or sitting. Counter-nutation is the posterior-superior movement of the sacral promontory and anterio-superior movement of the PSIS, and occurs during lying supine and as the lumbar lordotic curve is decreased (Schafer and Faye, 1990; Bergmann and Peterson, 2011).

2.3.5.2 Self-locking Mechanism

There are two functional mechanisms that work together to lock the SIJ (Vleeming and Stoeckart, 2007). This is known as form closure and force closure (Vleeming and Stoeckart, 2007).

Form closure is a stable position where the joint is locked without the aid of outside forces (Vleeming and Stoeckart, 2007). The close-fitting, common irregular surfaces of the SIJ come closer to each other and reduce movement (Vleeming and Stoeckart, 2007). The degree of form closure is determined by the amount of axial loading. They only come closer together, as opposed to fitting perfectly because if the sacroiliac joint became flush with the form closure, then overall mobility would be lost (Vleeming and Stoeckart, 2007). The reason being that tight fitting structures do not allow fluidity of movement (Vleeming and Stoeckart, 2007).

Force closure involves the use of extra outside forces provided by various ligamentous and muscular structures (Vleeming and Stoeckart, 2007). These structures compress the joint surfaces and increase stability and decrease shear (Vleeming and Stoeckart, 2007). Nutation is vital in force closure of the sacroiliac joints during self-locking, as it places the interosseous and short posterior sacroiliac ligaments under tension and this increases compression of the SIJ (Vleeming and Stoeckart, 2007).

In the self-locking mechanism of the SIJ, the sacrotuberous and long posterior sacroiliac ligaments both play a vital role (Vleeming and Stoeckart, 2007). The sacrotuberous ligaments role is to restrict nutation by connecting the sacrum to the ischial tuberosity (Vleeming and Stoeckart, 2007). Tension of the long posterior sacroiliac ligaments could restrict counter-nutation as the ligament joins the posterior superior iliac spine to the sacrum and its lateral fibres are continuous with the sacrotuberous ligament (Vleeming and Stoeckart, 2007).

The biceps femoris tendon attachment to the sacrotuberous ligament means that increased tension in the hamstring muscles can, in turn, load the sacrotuberous ligament and effectively cause counter-nutation (Vleeming and Stoeckart, 2007). Other musculature such as the thoracolumbar fascia, latissimus dorsi, erector spinae and gluteus maximus on the long posterior sacroiliac ligament can be involved in the self-locking mechanism of the SIJ (Vleeming and Stoeckart, 2007). The erector spinae brings about nutation of the SIJ by loading and extending the spine and pelvis, by tensing the interosseous, sacrotuberous, and sacrospinal ligaments (Vleeming and Stoeckart, 2007). Nutation becomes restricted when the erector spinae pulls together the posterior sides of the iliac bones, and allows compression on the cranial side of the SIJ (Vleeming and Stoeckart, 2007). The gluteus maximus causes compression of the SIJ both directly, through its perpendicular position, and indirectly through its attachment to the sacrotuberous ligament (Vleeming and Stoeckart, 2007). The latissimus dorsi contracts in conjunction with the gluteus maximus to compress the SIJ via the thoracolumbar fascia (Vleeming and Stoeckart, 2007).

In conclusion, based on the above, it is evident the muscle activity affects the SIJ mechanics. Vleeming and Stoeckart, (2007) highlights the biceps femoris, gluteus maximus, latissimus dorsi and erector spinae muscles, while other authors (Liebenson, 2004; Page, *et al*., 2010) specifically refer to these muscles as the POS.

2.4 THE POSTERIOR OBLIQUE SLING

2.4.1 Definition

The POS muscle group is created by the biceps femoris, gluteus maximus, erector spinae and latissimus dorsi muscles (Figure 2.1) (Page *et al.,* 2010).

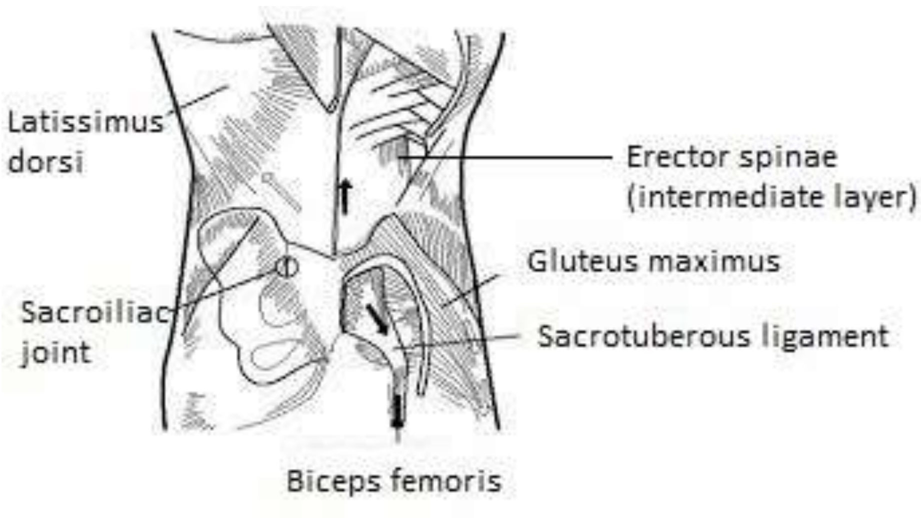


Figure 2.1: The posterior oblique sling muscle group

http://ericasuter.com/wp-content/uploads/2016/01/images.jpeg

2.4.2 Anatomy of each posterior oblique sling muscles:

Table 2.1

Muscle	Origin	Insertion	Innervation	Function
Biceps Femoris				
Long head:	Ischial tuberosity	Lateral side of the head of the fibula	Tibial division of the sciatic nerve (L5, S2, S2)	Extends thigh
Short head:	Linea aspera and lateral supracondylar line of femur		Common fibular division of the sciatic nerve (L5, S1, S2)	Flexes leg and laterally rotates it when the knee is flexed

Adapted from Moore and Dalley, (2006):

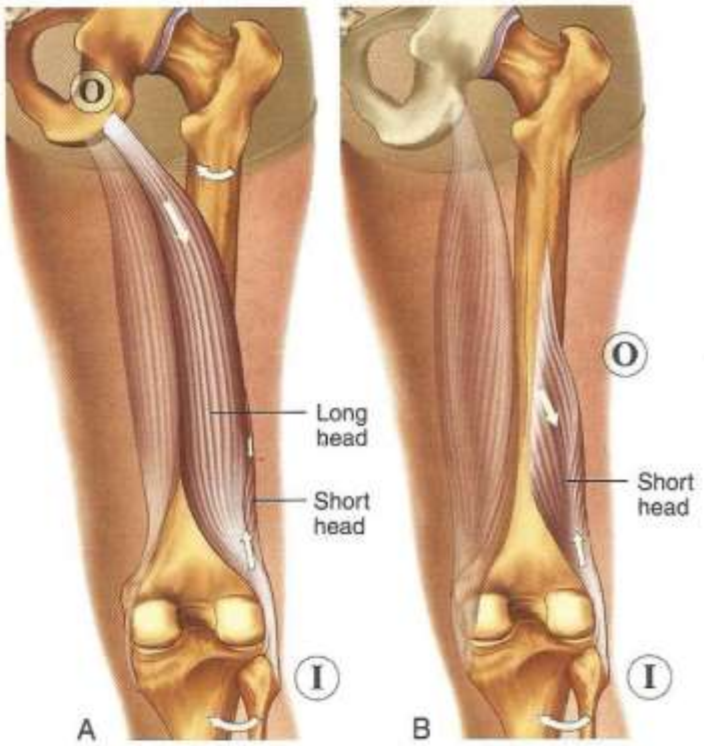


Figure 2.4: A: long and short heads of the biceps femoris muscle. B: The short head of the biceps femoris.

O: origin; I: insertion

Adapted from Muscolino, (2012)

Table 2.2:

Muscle	**Origin**	**Insertion**	**Innervation**	**Function**
Gluteus Maximus	Ilium posterior to the posterior gluteal line; posterior surface of the sacrum and coccyx; sacrotuberous ligament	Iliotibial tract which inserts into the lateral condyle of the tibia. And some fibers insert on the gluteal tuberosity	Inferior gluteal nerve (L5, S1, S2)	Extends thigh, and assists lateral rotation

Adapted from Moore and Dalley, (2006)

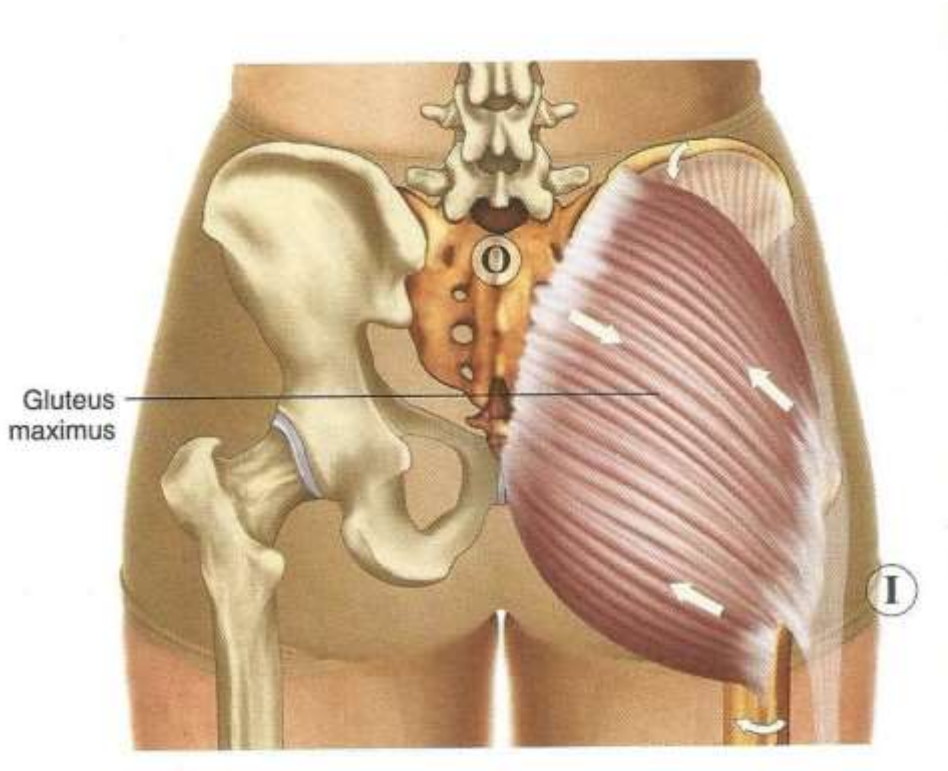


Figure 2.5: Gluteus maximus muscle.

O: origin; I: insertion

Adapted from Muscolino, (2012)

Table 2.3:

Muscle	**Origin**	**Insertion**	**Innervation**	**Function**
Erector Spinae **illiocostalis** **longissimus** **spinalis**	Arise by a broad tendon from the posterior iliac crest, posterior surface of the sacrum, sacroiliac ligaments, sacral and inferior lumbar spinous process, and supraspinous ligament	Iliocostalis: angles of lower ribs and cervical transverse processes. Longissimus: mastoid process of temporal bone, thoracic and cervical transverse processes, and ribs. Spinalis: Spinous processes of upper thoracic vertebrae, and cranium	Posterior rami of spinal nerves	When acting bilaterally, they extend vertebral column. When acting unilaterally, they laterally flex vertebral column

Adapted from Moore and Dalley, (2006)

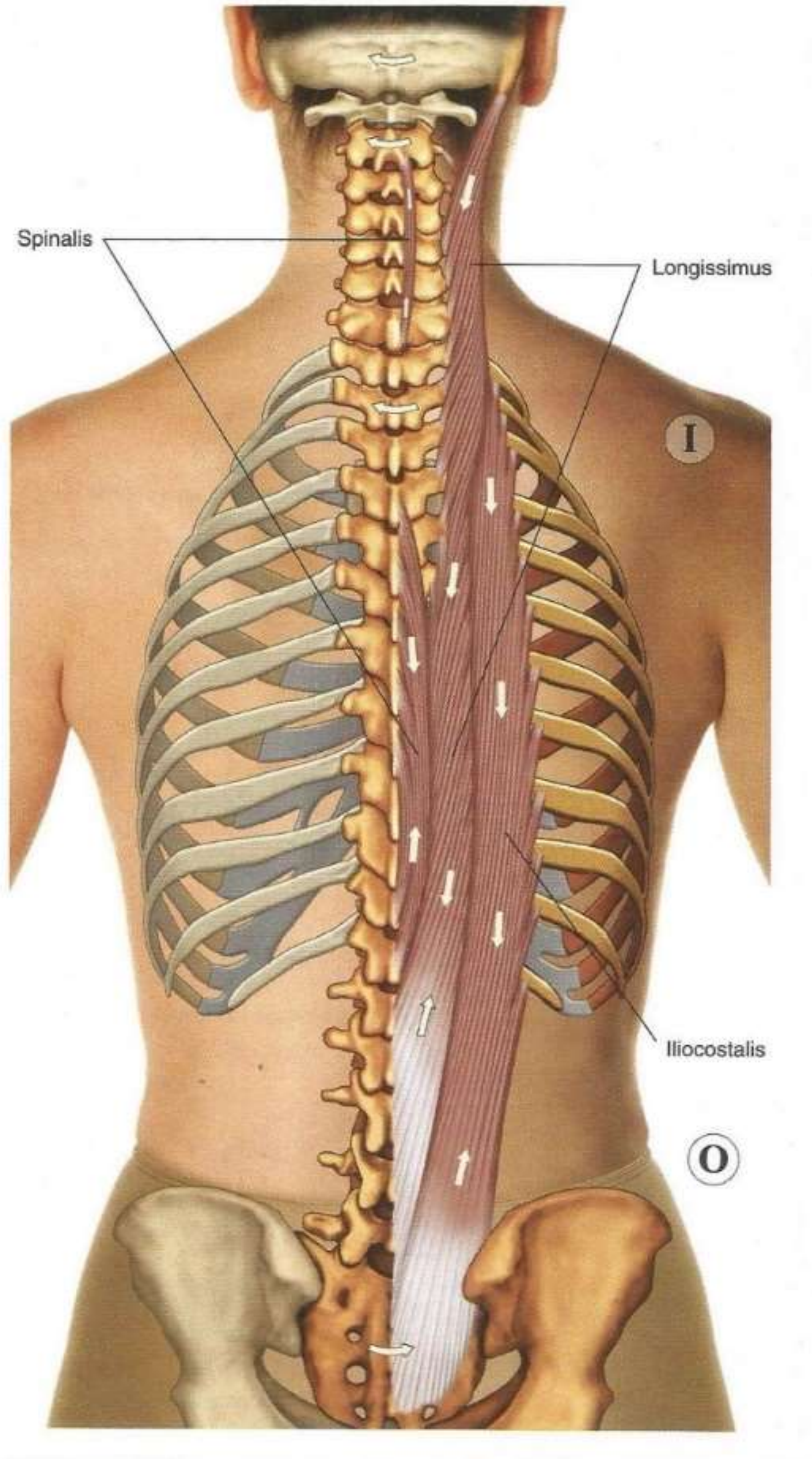


Figure 2.6: Erector spinae muscle group.

O: origin; I: insertion

Adapted from Muscolino, (2012)

Table 2.4:

Muscle	Origin	Insertion	Innervation	Function
Laitissimus dorsi	Spinous processes of inferior six thoracic vertebrae, thoracolumbar fascia, iliac crest, and inferior three ribs	Floor of intertubercular groove of humerus	Thoracodorsal nerve (C6, C7, C8)	Extends, adducts, and medially rotates the humerus

Adapted from Moore and Dalley, (2006)

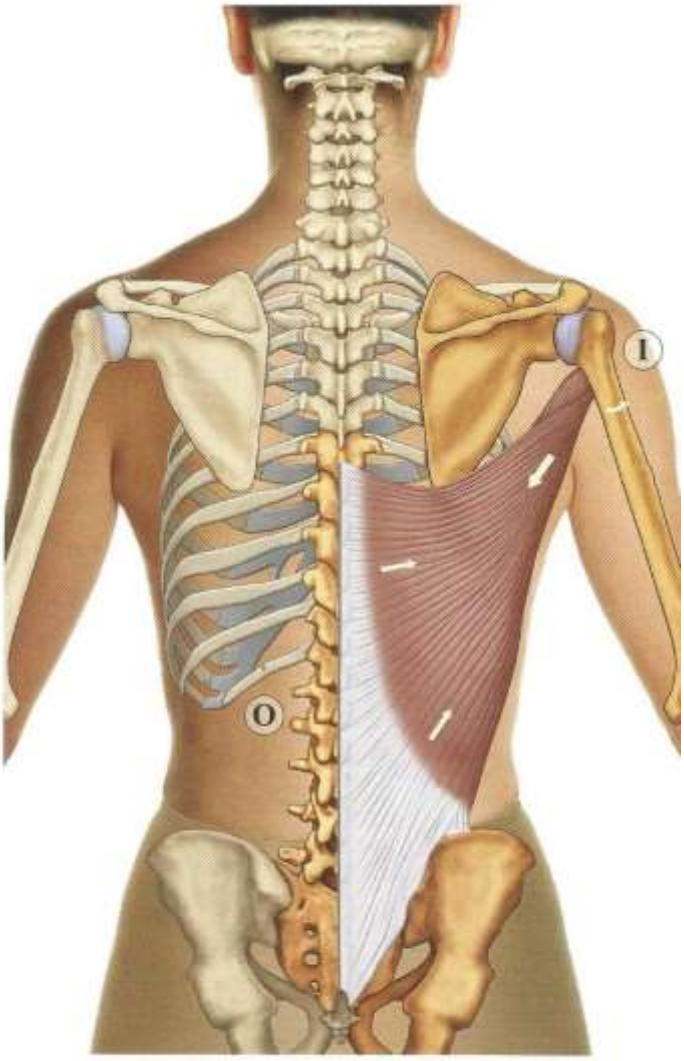


Figure 2.7: Latissimus dorsi muscle.

O: origin; I: insertion

Adapted from Muscolino, (2012)

2.4.3 The posterior oblique sling muscles with respect to function of the sacroiliac joint

Vleeming *et al.,* (2007) revealed that the SIJ can be affected by the functional relationship of the POS muscles, such as the erector spinae, biceps femoris, gluteus maximus, and latissimus dorsi muscles.

A force is created across the SIJ by the coupled functioning of the gluteus maximus and contralateral latissimus dorsi (Vleeming *et al*., 2007). This relationship between the contralateral latissimus dorsi and the ipsilateral gluteus maximus has an impact on the SIJ, and increases the compression between the joint surfaces (Porterfield and De Rosa, 1998). Simultaneous extreme contraction of these muscles can create a series of force directions resulting in increased compression of the SIJ (Porterfield, 1998). Bogduk *et al.,* (1998), identified that the latissimus dorsi muscle as having a possible effect on the SIJ by its attachment to the posterior layer of the thoracolumbar fascia. The gluteus maximus has also been shown to be hypertonic during SIJ dysfunction (Gitelman, 1980). Increased activity of the ipsilateral gluteus maximus can cause the pelvis to tilt posteriorly to provide a neutral position, the contralateral latissimus dorsis' muscle activity increases to counterbalance the effect (Kim *et al*., 2014). This result is consistent with other studies that involve SIJ pain (Carvalhais *et al*., 2013).

The hamstrings are an important contributor to lumbo-pelvic pain as they are attached to the pelvis at the ischial tuberosity, and control the amount of rotation of the pelvis over the hip joints when bending forward and in the standing position (van Wingerden, 1997). Shear force on the SIJ can be increased by the contraction of the biceps femoris, which increases the tension of the sacrotuberous ligament and results in the sacrum being pulled against the ilium (Porterfield and De Rosa, 1998). The erector spinae has a double function where it pulls the sacrum forward that will induce nutation of the SIJ, and will therefore tense the sacrotuberous, interosseous and sacrospinal ligaments (Vleeming *et al*., 2007). Nutation is limited by the pull of the posterior sides of the iliac bones closer to each other (Vleeming *et al*., 2007). Therefore, during nutation, and the action of the erector spinae, the cephalad side of the SIJ becomes compressed while the caudal side widens (Vleeming *et al*., 1997).

2.5 INTERVENTIONS

2.5.1 Spinal Manipulative Therapy

Manipulation is effective in the treatment of chronic SIJ syndrome (Hendler *et al*., 1995; Haldeman, 2005), and the primary goal of treatment for SIJ dysfunction is the restoration of normal lumbopelvic mechanics. Manipulation is thought to restore joint play of dysfunctional joints, and it has been proposed by Shekelle (1994) and Bergmann and Peterson, (2011), that manipulation restores normal joint movement by causing the following to occur:

- Disruption within, relating to or occurring around a joints adhesions,
- Relaxation of contracted muscle by sudden stretching,
- Release of caught synovial folds,
- Unbuckling of motion segments that have undergone unequal dislodgement.

Paris and Viti (2007) prescribe manipulation as the preferred treatment for restricted SIJs and Cibulka (1992) describes the use of SIJ manipulation to be successful in the treatment of low back pain. Chronic SIJ syndrome may be effectively treated by SMT (Haldeman, 2005). Gatterman (2005) supports SMT as a treatment of choice for patients suffering from chronic SIJ syndrome.

Laslett (2008) reported that there are few randomised trials that investigate different treatment protocols for patients with pain that confirmed as arising from the SIJs. A number of studies have shown that SIJ manipulation has been found to be effective in the treatment of SIJ syndrome (Hendler *et al.*, 1995; Cooperstein *et al.*, 2001; Haldeman, 2005). Shearer *et al.,* (2005), found that chiropractic adjustments reduced pain and disability in patients with SIJ syndrome. Their trial consisted of 4 visits of MFMA (mechanical-force, manually assisted) or HVLA (high velocity low amplitude) chiropractic adjustments, and neither of the two were found to more effective than the other (Shearer et al., 2005).

It was suggested that there is a restoration of normal muscle tone surrounding the joint through a reflex action with a SIJ manipulation (Bernard and Cassidy, 1991). This is supported by Plaugher (1993). Thus a reflex action is thought to reduce muscle spasm and can lead to a return of motion (Plaugher, 1993).

2.5.2 Static Stretching

Stretching is frequently used in physical therapy for the management of back, shoulder and knee pain (Page, 2012). Static stretching has been defined as the lengthening of a muscle to its acceptance and maintaining that position for a period of time (Bandy and Irion, 1994). Page (2012) found that static stretching often resulted in increased joint range of motion. The stretch should be held for a duration of thirty seconds once daily (Bandy *et al*., 1997). According to Harvey *et al*., (2002), restricted joint range of motion is caused from the loss of extensibility in the soft tissues covering joints. Stretch interventions are supported as a means of producing an increase in the extensibility of soft tissues by applying tension to soft tissues that cross the joints (Harvey *et al.*, 2002). According to Bandy *et al.,* (1998), the benefits of a slower stretch technique to improve muscle discomfort prevents the muscle from having to absorb great amounts of energy, as the stretch will not provoke a powerful reflex contraction, therefore allowing this technique. Tightness of muscles can affect the sacroiliac joint (Vleeming *et al*., 1997).

Flexibility is an important factor necessary for all physical movements (Ylinen, 2008). This helps prevent injury to the muscles, tendons, joints and improves functional performance (Ylinen, 2008). Changed flexibility of the muscle can cause biomechanical problems such as restrict joint range of motion. This results in less efficient movement patterns, and may lead to stress, or inflammation and pain (Ylinen, 2008).

Decreased mobility can be caused by factors, such as:

- degenerative changes with age,
- neurological disease,
- inactivity,
- and repetitive stress injuries or trauma to an area of the body (Ylinen, 2008).

The purpose of stretching is to increase the elasticity of muscles, tendons, joint ligaments, and increase joint mobility (Ylinen, 2008). Bandy *et al*., (1997) found that static stretching could increase a joints range of motion. This is supported by Harvey *et al*., (2002), who found there to be evidence of one or more days after the stretching protocol, that stretching increases a joint’s range of motion in people without clinically significant contractures. They further stated that studies are required to determine the effects of stretching on participants with functionally significant contractures along with the effects of longer periods of stretching.

Static stretching involves movement of the joint to the point where there is resistance from muscle tension, and from this point the stretch is maintained until there is reduction of tension (Ylinen, 2008). The joint is then returned to allow the stretch to release (Ylinen, 2008). Each stretch can be repeated three times and held for 30 seconds, as according to Page (2012), it was recommended the stretch be repeated two to four times and at least two to three times per week.

A randomised, clinical trial performed by Mould (2003), consisted of sixty participants suffering with unilateral SIJ syndrome of which were divided among four groups. One group received SIJ manipulation alone; the second group received SIJ manipulation and static stretching of the ipsilateral gluteus maximus; group three received SIJ manipulation combined with static stretching of the contralateral latissimus dorsi; and the fourth group received combined SIJ manipulation and static stretching of the unilateral gluteus maximus and contralateral latissimus dorsi muscle. Mould (2003) concluded that manipulation combined with static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi is effective at restoring the over activity of the muscle and under activity of the contralateral latissimus dorsi muscle in patients who suffer with unilateral SIJ syndrome. It was found that 95% of patients who suffered with unilateral SIJ syndrome, presented with over activity of the ipsilateral gluteus maximus and under activity of the opposite latissimus dorsi (Mould, 2003). According to Snijders (1993), the ipsilateral gluteus maximus over activity on the side of the restricted SIJ, was due to a compensatory method that protects the SIJ by further shear stresses placed over the joint.

The literature suggests static stretching the POS have an effect on the SIJs, however no studies have investigated the effect of static stretching of the POS for individuals with chronic SIJ syndrome. Therefore, this study will attempt to determine if static stretching of the musculature of the POS has any value in the treatment of SIJ syndrome, compared to SIJ manipulation only.

Chapter Three

3.1 INTRODUCTION

This chapter will detail the procedures that were involved in carrying out this study, including study design, participant recruitment, data collection and analysis, and the interventions used.

3.2 STUDY DESIGN

This study was a prospective, randomised clinical trial in a quantitative paradigm. The study population consisted of individuals residing in the greater Durban area of Kwa-Zulu Natal area who met the inclusion criteria.

3.3 SAMPLE ALLOCATION

This was a randomised clinical trial that consisted of 30 subjects aged between 18 to 45 years old with chronic SIJ syndrome. Participants were randomly allocated to one of the two groups of 15 each by the use of a number drawn by an independent party. Participants in Group One received SIJ manipulation only and the participants in Group Two received SIJ manipulation combined with static stretching. Each group received four treatment sessions over two weeks (two sessions per week with an interval of two to four days).

3.4 RECRUITMENT

The use of advertisements (Appendix A) was placed on the notice boards at the Durban University of Technology (DUT), Chiropractic Day Clinic, Super Markets (the free advertisement boards), sports clubs, and gyms after permission had been given by the relevant authorities. Permission was given by the Institutional Research and Ethics Committee (IREC) chair to use social media such as Facebook was used as an addition to the advertising mentioned, Potential participants were requested to contact the researcher telephonically for further information (Appendix B).

All participants who contacted the researcher were informed that this would be the introductory selection and that further inclusion/exclusion criteria would be applied after the first consultation. The participants were then asked the following questions (Appendix B):

Questions	Answers required
“Would you mind answering a few questions to gauge your eligibility to participate in the study?”	No
“How old are you?”	Any age between 18 to 45
“For how long have you had the pain?”	More than three months
“Where is your pain?”	They could use their own words to describe: Pain over the sacroiliac joint in the region of the posterior superior iliac spine, with the possibility of referral to the buttock, groin, and posterior and anterior thigh (Haldeman, 1992).
“Do you have a recent history of trauma?”	No
“Are you currently taking any anti-inflammatory medication?”	No

3.5 SAMPLE CHARACTERISTICS

3.5.1 Inclusion Criteria

Subjects were only accepted if they:

- Male and female participants between the ages of 18 and 45 years
- Had given Informed Consent (Appendix C) and completed a Numerical Pain Rating Scale (Appendix K) (Jenson, *et al.* 1986).
- Had an understanding of the English language so they could understand and comprehend instructions.
- Presented with chronic SIJ syndrome based on the history and orthopaedic examinations.

- Tested positive for 3 out of the 5 SIJ tests such as: Gaenslen's, Patrick Faber, Erichson's (Magee 2002: 588-620), and the Sacral thrust and Compression test (Laslett *et al*., 2003) (Appendix G).

- Were diagnosed with unilateral SIJ syndrome.

Orthopaedic tests:

1. **Gaenslen's Test** (Magee, 2002)

The participant was asked to lie on their back on the table with their hips and knees bent to their chest. On the suspected side of dysfunction, the knee and hip were bent, whilst the hip on the opposite side extended at the same time. The clinician applied an overpressure on the thigh which caused the joint to be stressed at its end of range of motion. This position caused the ilium on the affected side to rotate posteriorly on the sacrum. The participant was asked to call out if pain was felt and if they did so, the pain in the SIJ indicated the test to be positive.

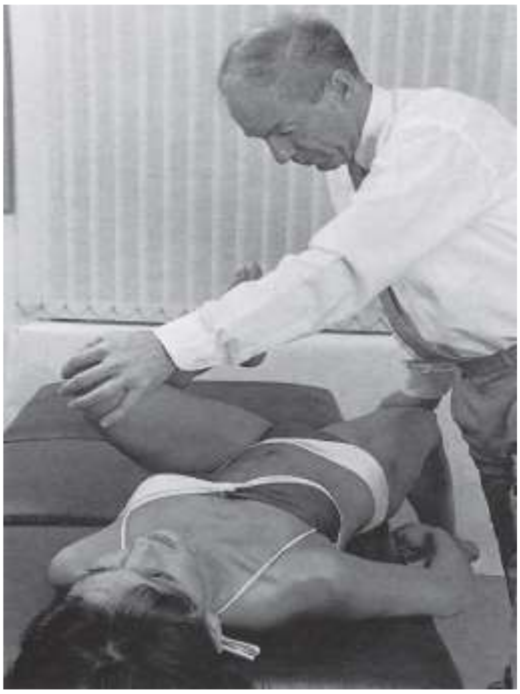


Figure 3.1: Gaenslens Test

Adapted from Ombregt, (2013)

2. **Patrick Faber Test** (Magee, 2002)

The participant was asked to lie on their back on the table with the hip on the side of the tested SIJ was flexed, abducted and externally rotated and placed on top of the opposite knee. The clinician lowered the test leg closer toward the table by placing pressure with one hand over the opposite iliac crest, and the other hand on the medial aspect of the knee of the side being tested. The participant was asked to call out if this position caused pain over the SIJ that was being tested and if the test leg remained above the opposite straight leg. This would indicate a positive test.

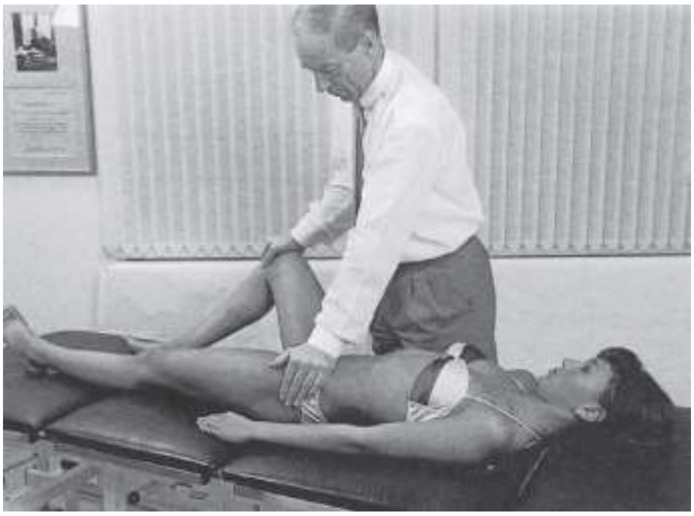


Figure 3.2: Patrick Faber Test
Adapted from Ombregt, (2013)

3. **Erichsons's Test** (Magee, 2002)

The participant was asked to lie on their stomach. The clinician bent the participant's knee by placing one hand under the thigh to 90°, while the other hand was placed over the iliac crest (hip bone). The clinician stressed the joint by extending the hip, by pulling up with the hand on the thigh and having a downward pressure applied with the hand on the iliac crest. The participant was asked to call out if this position reproduced and localized the pain to the sacroiliac joints over the joint that was tested. This would indicate the test to be positive.

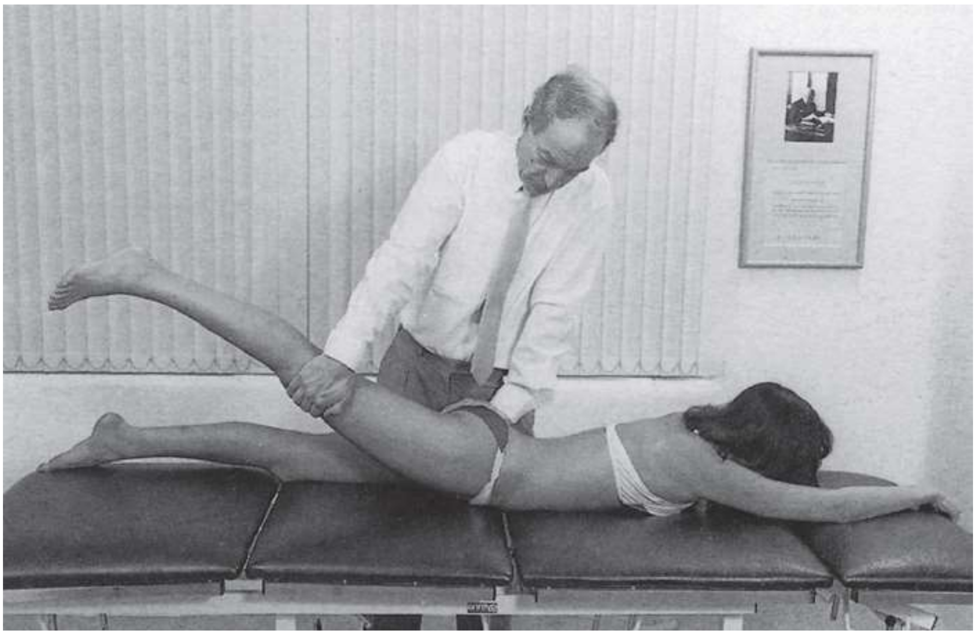


Figure 3.3: Erichson's Test

Adapted from Ombregt, (2013)

4. **Sacral Thrust Test** (Laslett *et al*., 2003)

The participant was asked to lie on their stomach on the table with the clinicians hands placed over the posterior iliac crest where a downward directed thrust was applied and was performed one side at a time. This caused a shearing force across the SIJ. The participant was asked to call out if this position caused pain that was reproduced over the sacroiliac joint with the shearing test. This would indicate the test to be positive.

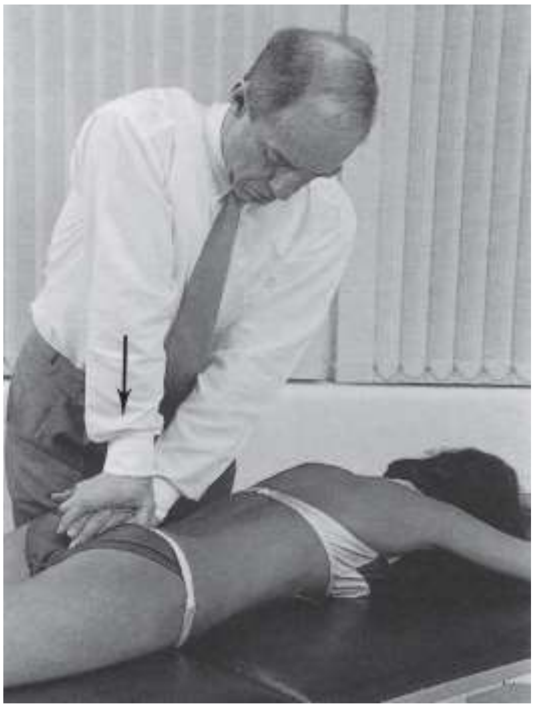


Figure 3.4: Sacral Thrust Test
Adapted from Ombregt, (2013)

5. **Compression Test** (Laslett *et al*., 2003)

The participant was positioned on their side to lie in the lateral recumbent position with their hips and knees bent at a right angle (90º). The clinician knelt on the table and applied a vertically downward force over the iliac crest. This caused a compression force to both sacroiliac joints. The participant was asked to call out if pain was felt and if they did so, the pain in the SIJ indicated the test to be positive.

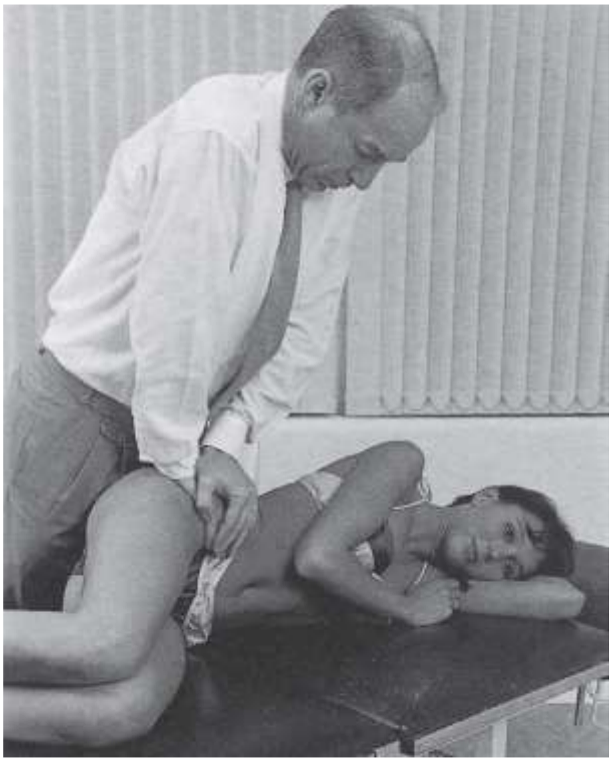


Figure 3.5: Compression Test

Adapted from Ombregt, (2003)

3.5.2 Exclusion Criteria

Subjects were excluded from the study if:

- They were younger than 18 years of age to avoid parental consent legalities.
- They were older than 45 years of age so as to exclude significant degenerative changes that occur in the SIJ's (Kirkaldy-Willis *et al*., 1992 and Brand, 2002).
- Were diagnosed with bilateral SIJ syndrome.
- They had received any other manual therapy for SIJ syndrome during the study period.
- They had taken pain killers or anti-inflammatories during the study.

- Were suspected of having contraindications to spinal manipulations, such as TB, osteopenia, fractures, disc herniation's, and abdominal aortic aneurysm, cancer, systemic viral or bacterial infections (Gatterman, 1990).

- Had open wounds located at or around the testing area (i.e. the POS muscle group and the SIJ).

- Did not test positive for three out of the five orthopaedic tests. The orthopaedic tests were conducted by the Clinician on duty to ensure a more positive diagnosis of SIJ syndrome.

- They didn't or wouldn't comply with the home stretching program.

3.6 METHOD

Before the participants were included in the study, they were given a Letter of Information (Appendix C), which detailed the description and aim of the study as well as what was required for their involvement in the study. Participants were told that they could withdraw from the study at any time without giving a reason for their withdrawal and without experiencing any repercussions for future treatment.

All consultations were conducted at the Durban University of Technology Chiropractic Day Clinic. To assess the interested participant for involvement into the study, the participant was asked to complete the informed consent form (Appendix C). A case history (Appendix D), physical examination (Appendix E), SOAPE note (Appendix F), orthopaedic examination (Appendix G) and Lumbar regional (APPENDIX H) were completed to assess the participant. If the participants did not have three out of the five orthopaedic tests positive when performed by a clinician, they were excluded.

As detailed above, consenting participants who complied with the research requirements were accepted at the initial consultation. Prior to recording measurements, the appointed research assistant was trained in how to operate the measurement equipment. The research assistant was tasked with undertaking subjective and objective measurements. After the readings were recorded, the senior researcher then proceeded with the treatment according to their treatment group allocated by a number drawn randomly by an independent party.

The treatment and data collection for both Group One and Two were performed over a total of four consultations. Consultations were scheduled twice weekly, two sessions per week with an interval of two to four days, for two consecutive weeks. All four consultations were to be completed within a timeframe of no longer than fourteen days from the initial visit. The data collected occurred at consultations one, three and four.

3.7 INTERVENTION

3.7.1 Sacroiliac Joint Manipulation

Participants had their sacroiliac joints motion palpated to test the joint for restrictions. According to Magee (2002:499), sacral fixation is tested through the use of Gillet's Test. The participant was asked to stand with their weight equally distributed over to both legs. The researcher then palpated their posterior superior iliac spine (PSIS) on one side with one thumb and one on the sacral planes with the other thumb (S2) (Magee, 2002). The researcher then placed their right thumb on the participants' ischial tuberosity and their left thumb on the participants' sacral apex. The participant was then told to flex their hip on the test side. Normal movement would indicate that the thumb on the ischial tuberosity would move laterally. A fixated joint would indicate by pushing the thumb up (Magee, 2002). The opposite side was then tested. Participants that were in Group Two then were to receive manipulation of the SIJ according to the restriction that was palpated.

The participant was then asked to lie on the table with their legs placed in the lateral recumbent (side lying) position with the restricted side facing up. A hypothenar contact was placed over the affected SIJ and a body drop thrust was applied (Schafer and Faye, 1990). The SIJ was then reassessed. Both groups received SIJ manipulation on the side of fixation. It was assumed that there was a joint restriction on the side of pain/complaint. Therefore, all participants received SIJ manipulation to test for joint restrictions.

3.7.2 Static Stretching

Research done by Harvey *et al*., (2002), suggested that stretching increased a joint's range of motion one or more days after a stretching protocol was conducted on people who were free of clinically significant contractures. Bandy *et al*., (1997) found that static stretching could increase a joints range of motion. The POS sling was stretched according to the side of SIJ fixation (i.e. SIJ fixated on the right, therefore, the gluteus maximus and biceps femoris on the right was stretched while the latissimus dorsi was stretched on the contralateral side. Mould (2003) reported that 95% of patients who suffered with unilateral SIJ syndrome, presented with over activity of the ipsilateral gluteus maximus and under activity of the opposite latissimus dorsi. The erector spinae pulls the posterior sides of the iliac bones towards each other, which result in restricting nutation and allowing the cranial side of the SIJ to be compressed (Vleeming and Stoeckart, 2007). According to Snijders (1993), the over activity of the gluteus maximus on the ipsilateral side of the restricted SIJ, was due to a compensatory method that protects the SIJ by further shear stresses placed over the joint.

Participants who were in Group Two received manipulation and stretching of the erector spinae, gluteus maximus and biceps femoris muscles on the side of their restriction, as well as their latissimus dorsi on their opposite side for 30 seconds (Bandy and Irion, 1997). Each stretch was repeated three times, as per Page's (2012) recommendation that a stretch be repeated two to four times and at least two to three times per week (Appendix M).
The participants were given a set of stretches that they could individually do at home (Appendix M) and to ensure participant compliance, participants were given a mild stretching regime in the form of a home diary (appendix N) which was to be completed by the participant on the assumption that they would be honest with the home stretching. Stretches were expected to be done three times a day at home on the days they did not receive treatment at the DUT Chiropractic Day Clinic. If the participant didn't comply with the home stretches, this led to the participant being excluded from the research.

The following stretch techniques on the respective muscles were undertaken (Ylinen, 2008):

- **<u>Latissimus dorsi</u>** (Ylinen, 2008: 138) – the researcher placed the participant in the side lying position with the shoulder joint abducted 135º and elbow flexed at approximately 90º. The researcher pressed against the body of the muscle with the thenar part of their hand, while pulling on the elbow with the cephalad hand down and toward external rotation with the other hand.

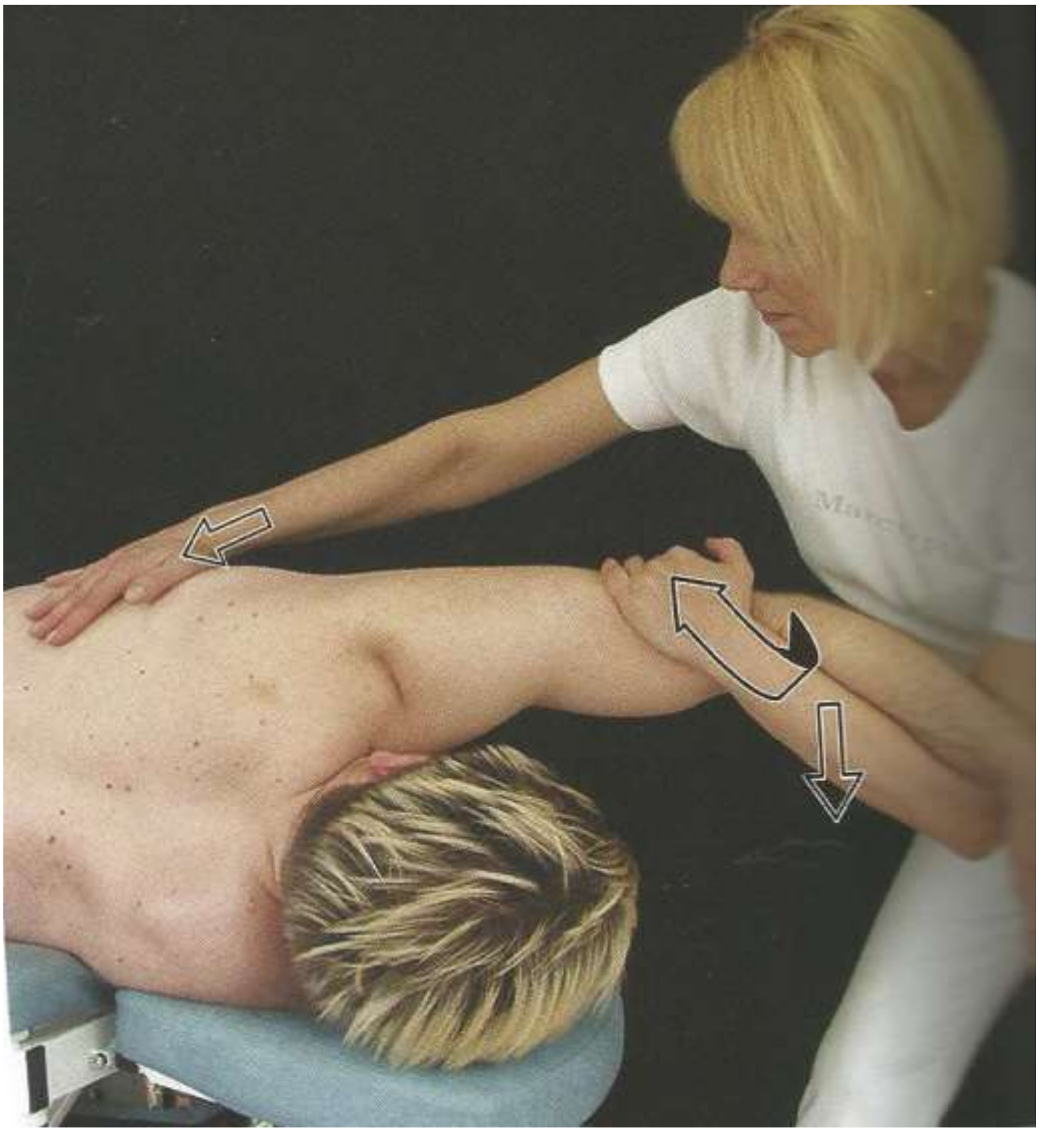


Figure 3.6: Latissimus dorsi muscle stretch

<u>Adapted from Ylinen, (2008)</u>

- **<u>Erector Spinae Muscles</u>** :

- **Longissimus** (Ylinen, 2008: 196) – the participant was asked to lie in their stomach with a pillow under their abdomen to flex the spine. The participant’s arm was raised above their head and their thoracic spine was bent to side away from the muscle. The participant’s legs were bent to the same side to stretch the lumbar section. The researcher placed the thenar part of their hand next to the transverse processes of the thoracic vertebrae on the convex side and applied a downward pressure with the hypothenar of the opposite hand that was placed over the sacrum. The researcher’s arms were crossed to achieve the necessary pressure required.

- **Iliocostalis** (Ylinen, 2008:195) – the participant was asked to lie on their stomach with a pillow under their abdomen to flex the spine. The participants arm was raised above their head and their thoracic spine was bent to side away from the muscle. The participant’s legs were bent to the same side to stretch the lumbar section. The researcher placed the hypothenar aspect of their hand on the convex side of ribs 6 to 12, and applied a diagonal stretch toward the head, while the other hand, with the thenar aspect, a diagonal downward pressure toward the iliac crest.

- **Spinalis** (Ylinen, 2008:193) – the participant was asked to lie on their stomach with their head lowered to create flexion of the thoracic spine. With the researchers arms crossed, the hypothenar aspect placed pressure over the facet joints (T2-8) toward the head diagonally, and the thenar contact of the other hand applied a diagonal downward pressure simultaneously at the level T10 to L3.

Figure 3.7: Erector spinae muscle group stretch

Adapted from Ylinen, (2008)

- **<u>Gluteus maximus</u>** (Ylinen, 2008: 215) – the participant was positioned lying supine with the affected sides hip and knee flexed. The researcher placed pressure over the participant's knee with the other hand using the thenar aspect to stretch the muscle fibers away from the gluteal tuberosity. The patient should try to keep the ipsilateral pelvis on the table to maximize the stretch.

Figure 3.8: Gluteus maximus muscle stretch

<u>Adapted from Ylinen, (2008)</u>

- **<u>Biceps femoris</u>** (Ylinen, 2008: 239) – the participant was asked to lie on their back on the table with one leg fully extended on the table. The researcher lifted the affected leg (fully extended) by flexing and abducting at the hip. The ipsilateral knee is extended to enhance the stretch.

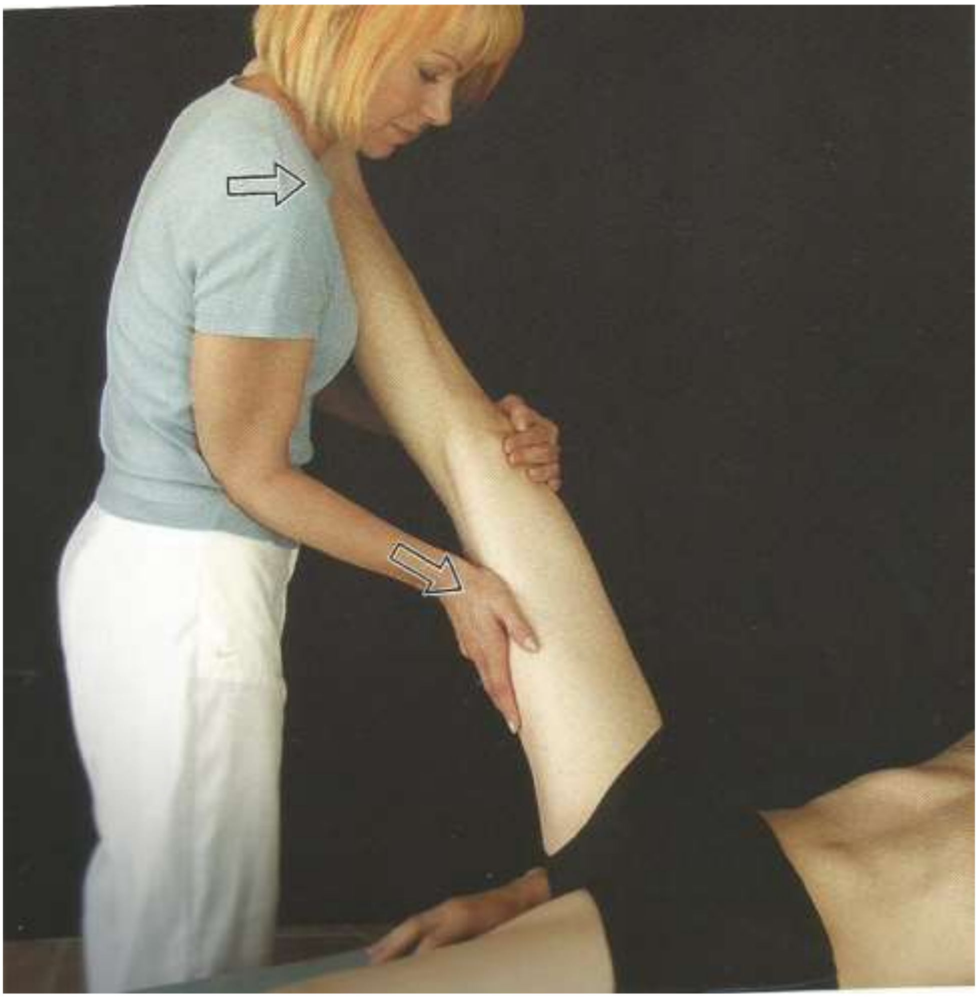


Figure 3.9: Biceps femoris muscle stretch

<u>Adapted from Ylinen, (2008)</u>

Participants were requested to stretch their muscles at home on the days they did not come to the clinic and diarises the time and frequency (Appendix N):

Each of the stretches was to be held for 30 seconds and repeated three times on the sides instructed by the researcher.

These muscles involved the: Latissimus dorsi, Erector spinae, Gluteus maximus, and Biceps femoris.

- **Latissimus dorsi** – the participant was to stand with their feet shoulder width apart, pulling their affected side (e.g. the right) with the left hand pulling the right arm up and over the participants head (refer to Figure 3.5 below).

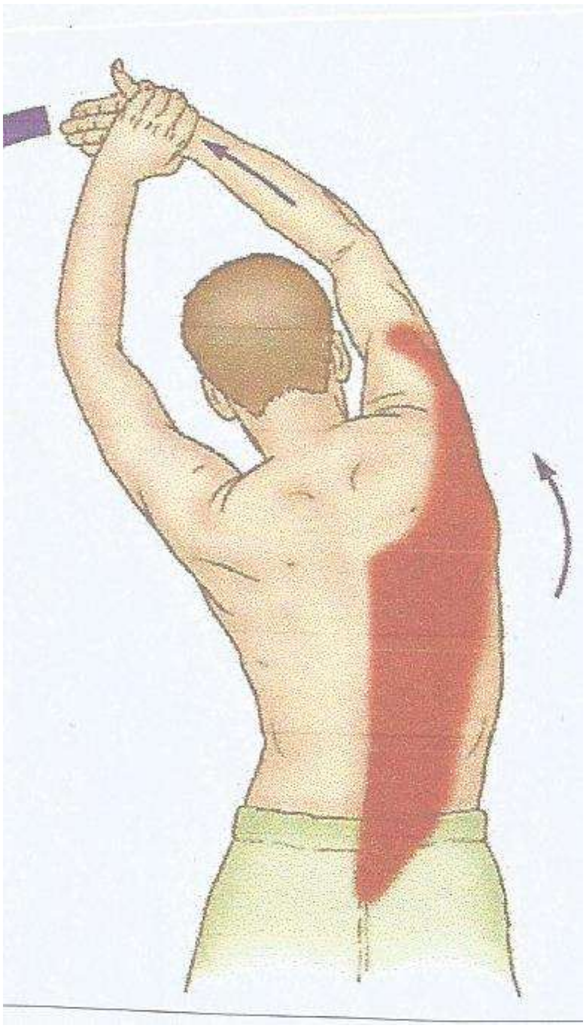


Figure 3.10: Latissimus dorsi home stretch

Adapted from Musculino, (2012)

- **<u>Erector spinae group</u>** – the participant was to sit on a chair with their knees shoulder width apart, bend forward with their arms between their legs. From that position, the participant would finger walk their fingers forward in order to achieve the stretch (refer to Figure 3.6 below).

Figure 3.11: Erector spinae muscle group home stretch

Adapted from Musculino, (2012)

- **<u>Gluteus maximus</u>** – the participant was to lie supine and flex their affected leg (gluteus maximus) and hold to the opposite shoulder, while keeping the opposite leg fully extended (refer to Figure 3.7 below).

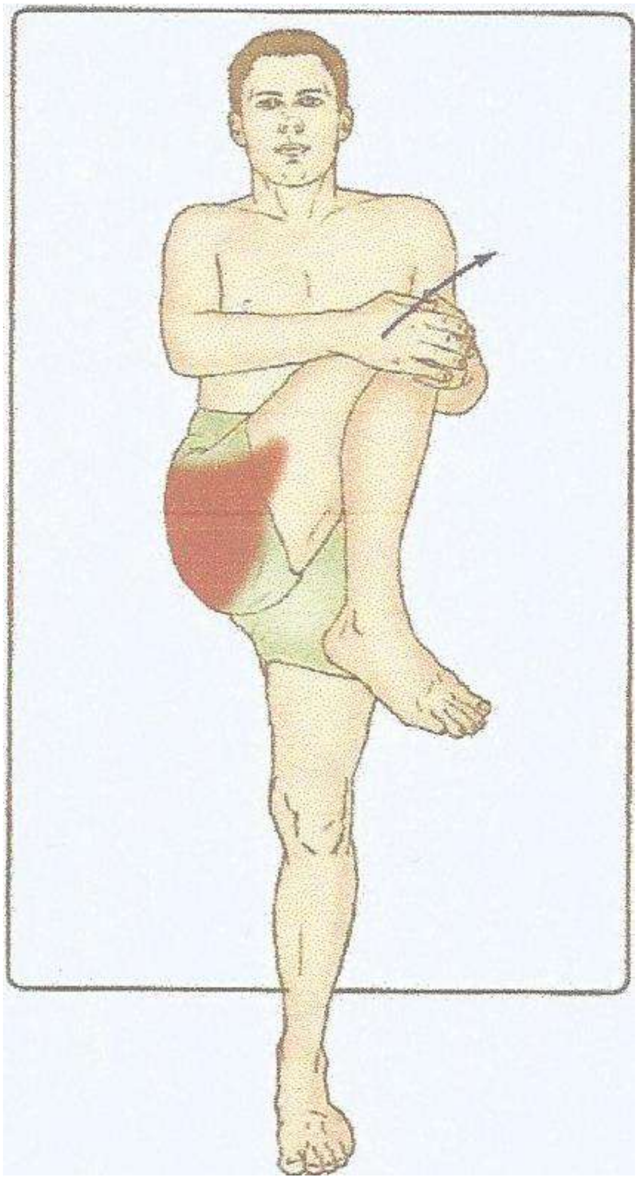


Figure 3.12: Gluteus maximus home stretch

Adapted from Musculino, (2012)

- **Biceps femoris** – the participant was seated on the floor with one leg flexed at 90º, while the affected side was fully extended. The participant would have to reach forward toward their toes to achieve the stress. (E.g. right hamstring was needed to be stretched, therefore: left leg flexed at 90º, and the right leg fully extended that was to receive the necessary stretch (refer to Figure 3.8 below).

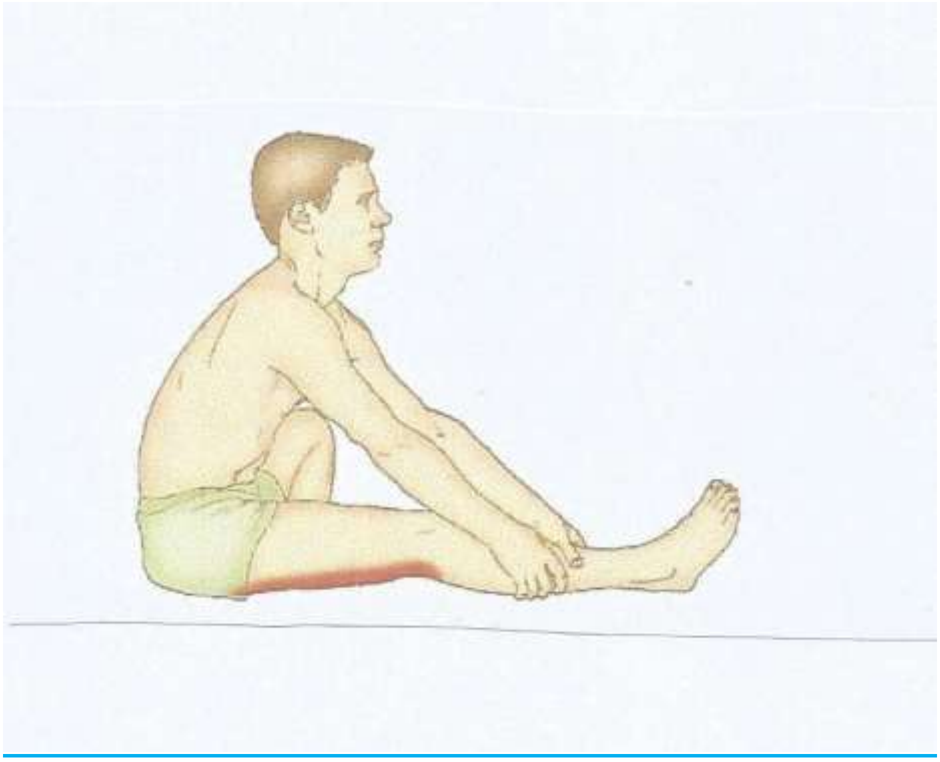


Figure 3.13: Biceps femoris home stretch

Adapted from Musculino, (2012)

3.8 MEASUREMENT TOOLS AND DATA COLLECTION

3.8.1 Subjective measurements

3.8.1.1 The Numerical pain rating scale (NRS)

The Numerical pain rating scale (NRS), measured the participants' pain severity and was taken before treatment, after the third and after the final treatment. The participant was asked to mark their pain intensity on a numerical scale 0-10 that described their perception of pain. The number 1 indicated the least pain and 10 best described the pain when it was at its worst.

3.8.1.2 The Oswestry Low Back Pain Disability Questionnaire

The Oswestry Low Back Pain Disability Questionnaire is a popular low back pain questionnaire that was used to determine an understanding of the disability level (Yeomans, 2000). The questionnaire was made up of ten categories, of which six responses are chosen to represent the level of low back disability for each category (Yeomans, 2000). Yeomans, (2000) concluded that this questionnaire is a reliable measurement for measuring low back pain disability. This questionnaire was taken before the first consultation, before the third and after the final consultation.

Each participant completed the respected pain questionnaires before the first, third, but after the fourth (final) consultation.

3.8.2 Objective measurements

3.8.2.1 The Digital Saunders Inclinometer

The Saunders Digital Inclinometer was used to measure participants' range of motion in the straight leg raise test. The inclinometer was used to measure surface movements of the innominate tilt. According to Cibulka et al (1998), they found that the inclinometer had been shown to be a useful device in measuring the innominate tilt. The participant was to lie on their stomach on the table with their knee fully extended. From the greater trochanter to the lateral femoral condyle, a line was visualised, and the base of the inclinometer was placed on this line. A leg raise with the knee extended was performed passively to the point of discomfort (Allison, 2012). At that point, a reading was taken. The reading was repeated three times to test for accuracy (Bierma-Zeinstra *et al*., 1998). The inclinometer measurements were performed by the research assistant.

3.8.2.2 Algometer

The algometer was used to measure the participant's pain threshold in a particular area of tenderness (Kinser *et al*., 2009). Potter *et al.*, (2006), found that the pressure algometer was a reliable and stable method to measure their pressure pain threshold and found that there was minimal measurement error. Fischer (1987) found the algometer to be reliable in a participant's assessment of pain - to measure SIJ tenderness, the algometer was placed over the participants' most painful area which was marked with a henna marker. The algometer probe was placed over the painful area and the pressure applied and the participant complained of pain. This indicated their pain threshold and the algometer reading was taken. This was repeated twice, and average readings of the two were recorded.
The reading was taken in Newton's per kilogram, which would indicate the sensitivity of the sacroiliac joint. The algometer readings were taken before the first and third consultation, but after the fourth (final) consultation. The algometer measurements were performed by the research assistant.

3.9 STATISTICAL ANALYSIS

The research data was collated by the researcher and researcher's assistant and then sent to the statistician for further statistical analysis. The data was analysed by the IBM SPSS version 22. A p value <0.05 was considered as statistically significant. Intra-group analysis was achieved by comparing the outcome values over time within each group separately using repeated measures ANOVA testing. Time was the within-subjects factor. Inter-group comparisons were achieved also using repeated measures ANOVA testing with a between subjects factor of treatment group as well as within subjects effects of time. The interaction between time and treatment indicated the differential treatment effect. Profile plots generated showed the rates of changes in outcomes over time by treatment group (Esterhuizen, 2015).

3.10 ETHICAL CONSIDERATIONS

- Each participant received a full explanation of the study taking place as well as a Letter of Consent informing them of their confidentiality. All data obtained from this study was reduced to file numbers; therefore the participants' identity was not available. To further maintain confidentiality, only the researcher, the researchers supervisor and co-supervisor, and IREC committee members had access to analyse the results. No files were removed from the confines of the Chiropractic Day Clinic at the Durban University of Technology. A letter of permission was received before the commencement of research to have the use of the DUT Chiropractic Day Clinic (Appendix O).

- Beneficence is a concept in research ethics where the researcher's goal should be to have the welfare of the participant as a priority. Beneficent actions can be taken to help prevent or remove harms or to simply improve the situation of others.
  Therefore, participants who do not have three out of the five orthopaedic tests positive when performed by the clinician. Due to the clinician excluding the participant, this will be treated with principle of beneficence, due to the participant taking the time to take part in the study. Therefore the participant will receive one free treatment, in accordance with the Chiropractic Day Clinic protocol for their involvement.

Chapter Four

4.1 INTRODUCTION

This chapter details the demographic data of all the participants included in this study. It also contains a detailed statistical analysis of the subjective and objective data collected throughout the duration of the study. This study consisted of 30 participants, with ages ranging from 18 to 45 years, and these participants were divided into two groups of 15 participants each. No consideration was made for gender, ethnic group or occupation.

4.2 ABBREVIATIONS

The statistical abbreviations that will be used in this chapter are:

F	This is the F-statistic and is the ratio between groups variance to the within group variance. It is the statistic test which is used to determine what type of ANOVA test to perform.
N	Number of participants
'df'	Differential
***p* value**	Observed level of significance. The *p* value is the smallest level of significance that would lead to the rejection of the null hypothesis. *P* is the probability that one would observe a difference as large as the one you have observed in your data if the null hypothesis were true
Sig.	Significance
Wilk's Lambda	Is a multivariate test statistic used in MANOZA (multiple or repeated measures ANOVA testing) to test the significance of effect sizes
NRS	Numerical Pain Rating Scale
OSW	Oswestry Low Back Pain Questionnaire
INC-1 (DEGREES°)	Inclinometer readings (in degrees)
AL-1 (KG/CM2)	Algometer readings
RUF	Right upper flexion
RLF	Right lower flexion
RUE	Right upper extension
RLE	Right lower extension
LUF	Left upper flexion
LLF	Left lower flexion
LUE	Left upper extension
LLE	Left lower extension

4.3 PRIMARY DATA

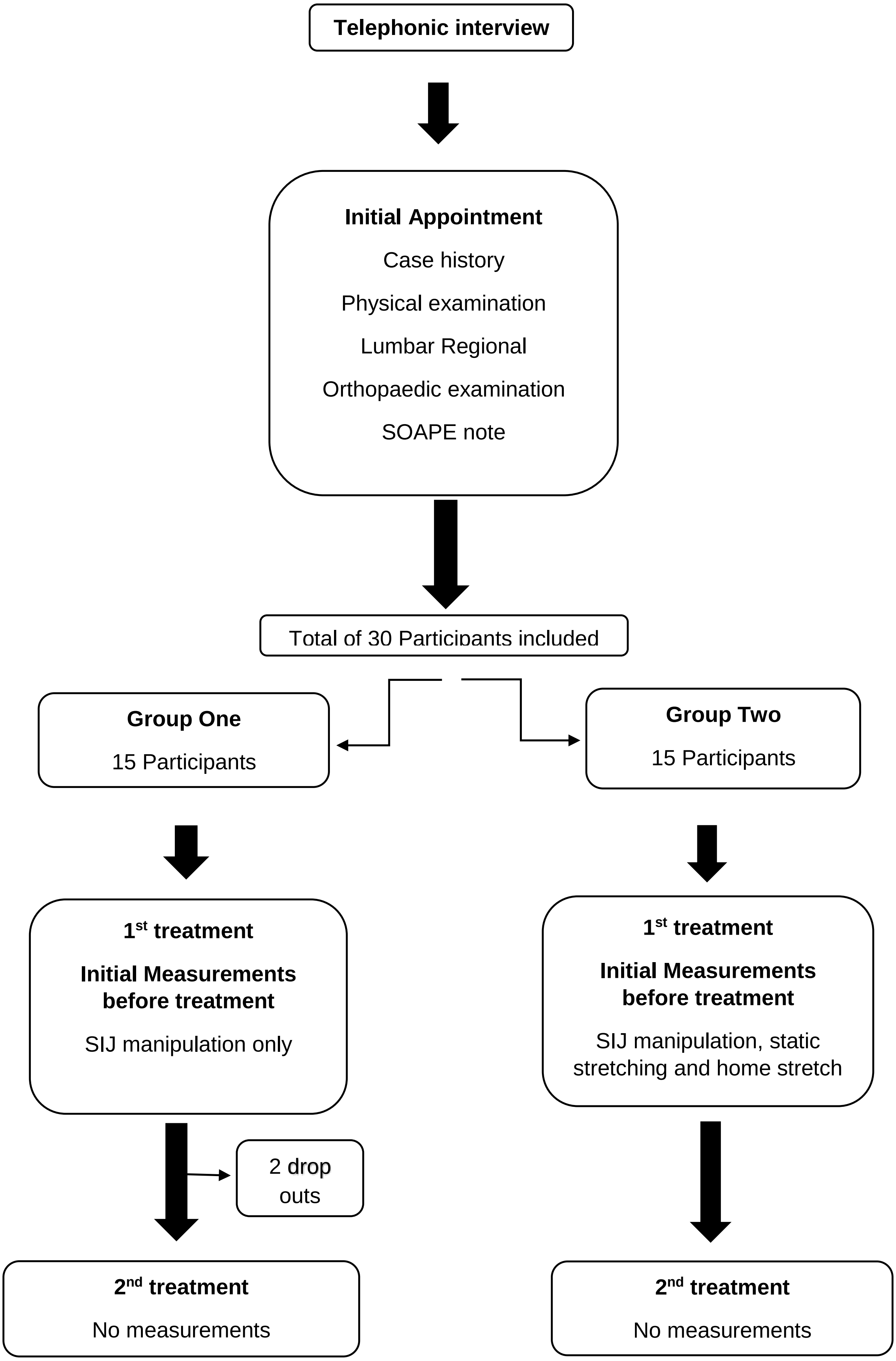
The primary data collected and utilized in this study consisted of a full case history, physical examination and a lumbar spine regional examination, collected from each participant on their initial appointment. A SOAPE (subjective, objective, assessment, and plan) note was completed on each of the appointments (total of four) with data regarding the participant's progress. Objective measurements were recorded on the first, third and fourth consultations using a Wagner Pressure Algometer and a Saunders Digital Inclinometer. Subjective measurements were recorded on the first, third and fourth visits using a Numerical Pain Rating Scale (NRS) and an Oswestry Low Back Pain Questionnaire (OSW).

4.4 SECONDARY DATA

The secondary data collected and utilized in this study was gathered from various medical text books, articles published in peer-reviewed journals that are available both online and from the DUT library, and from M.Tech: Chiropractic dissertations, also available online and from the DUT library. Data regarding the statistical analysis was gathered from e-mail communications with a statistician.

4.5 PARTICIPANT LOSS DUE TO DROPOUT

A total of eight participants dropped out between the initial consultation and the final consultation. Drop out reasons varied, from not being able to attend follow-up appointments within the given timeframe, and along with personal reasons with regard to family and work commitments. Four drop outs were from Group One and the other four were from Group Two, and the majority of these dropped out of the study between the first and second visits. These participants were excluded from the study and replaced. The loss of initial participants did not affect the results in any way. Four participants were excluded from the study at the first consultation, as upon assessment, they did not meet the correct inclusion criteria.


Telephonic interview
Initial Appointment
Case history
Physical examination
Lumbar Regional
Orthopaedic examination
SOAPE note
Total of 30 Participants included
Group One
15 Participants
Group Two
15 Participants
1st treatment
Initial Measurements before treatment
SIJ manipulation only
1st treatment
Initial Measurements before treatment
SIJ manipulation, static stretching and home stretch
2 drop outs
2nd treatment
No measurements
2nd treatment
No measurements

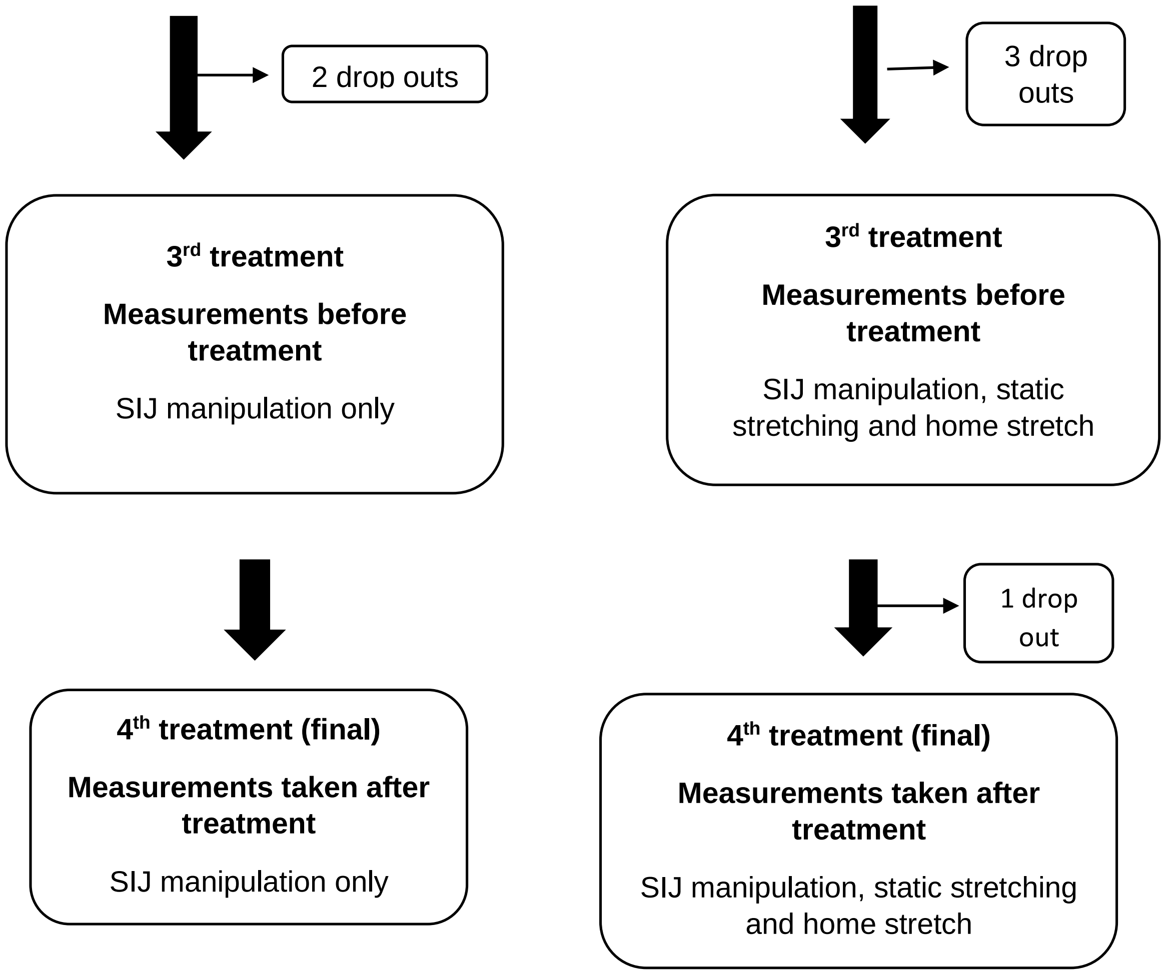


Figure 4.1: Consort diagram showing participant flow

4.6 STATISTICAL METHODOLOGY

IBM SPSS version 23 was used to analyse the data. A *p* value < *0.05* was considered as statistically significant. Differences between groups at baseline were tested for continuous variables using independent samples t-tests, and Pearson's chi square tests for categorical variables. Repeated measured ANOVA testing was used to compare the changes over time between and within-groups. Profile plots were used to assess the changes visually over time by group.

4.7 RESULTS

Table 4.1: Comparison of demographics by treatment group

			GROUP		*P* value
			Group One: no static stretching	Group Two: received static stretching and home stretch programme	
AGE	Mean		30.5	30.6	0.961
	Standard Deviation		8.2	6.3	
GENDER	Male	Count	7	9	0.464
		Column N %	46.7%	60.0%	
	Female	Count	8	6	
		Column N %	53.3%	40.0%	
ETHNICITY	White	Count	11	8	0.378
		Column N %	73.3%	53.3%	
	Black	Count	2	1	
		Column N %	13.3%	6.7%	
	Indian	Count	2	5	
		Column N %	13.3%	33.3%	
	Coloured	Count	0	1	
		Column N %	0.0%	6.7%	
SIDE OF FIXATION	RUF	Count	4	6	0.590
		Column N %	26.7%	40.0%	
	RLF	Count	2	0	
		Column N %	13.3%	0.0%	
	RUE	Count	1	1	
		Column N %	6.7%	6.7%	
	RLE	Count	0	0	
		Column N %	0.0%	0.0%	
	LUF	Count	7	6	
		Column N %	46.7%	40.0%	
	LLF	Count	1	2	
		Column N %	6.7%	13.3%	

Table 4.1 above shows that there were no significant differences between the two groups in terms of the demographic variables, thus the random processing of selecting the participants did not have any significant impact between the groups.

Table 4.2: Comparison of baseline outcomes between groups

		GROUP		*P* value
		Group One: no static stretching	Group Two: received static stretching and home stretch programme	
NRS-1	Mean	6.4	6.1	0.552
	Standard Deviation	1.5	1.5	
OSW-1 (%)	Mean	22.4	24.8	0.481
	Standard Deviation	8.8	9.6	
INC-1 (DEGREES°)	Mean	66.9	70.8	0.175
	Standard Deviation	6.5	8.8	
AL-1 (KG/CM2)	Mean	3.2	3.4	0.545
	Standard Deviation	0.9	1.1	

Table 4.2 above shows that there were no differences between the groups in terms of the baseline outcomes.

4.8 RESULTS FOR THE OBJECTIVES

4.8.1 Objective One

- To determine the effect of manipulation only of the SIJ in terms of subjective and objective findings.

4.8.1.1 Numerical Pain Rating Scale (NRS)

Table 4.3: NRS statistics for Group One

Multivariate Tests[a,b]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.764	21.084[c]	2.000	13.000	0.000
	Wilks' Lambda	0.236	21.084[c]	2.000	13.000	0.000
a. GROUP = no static stretching						
b. Design: Intercept Within Subjects Design: time						
b. Exact statistic						

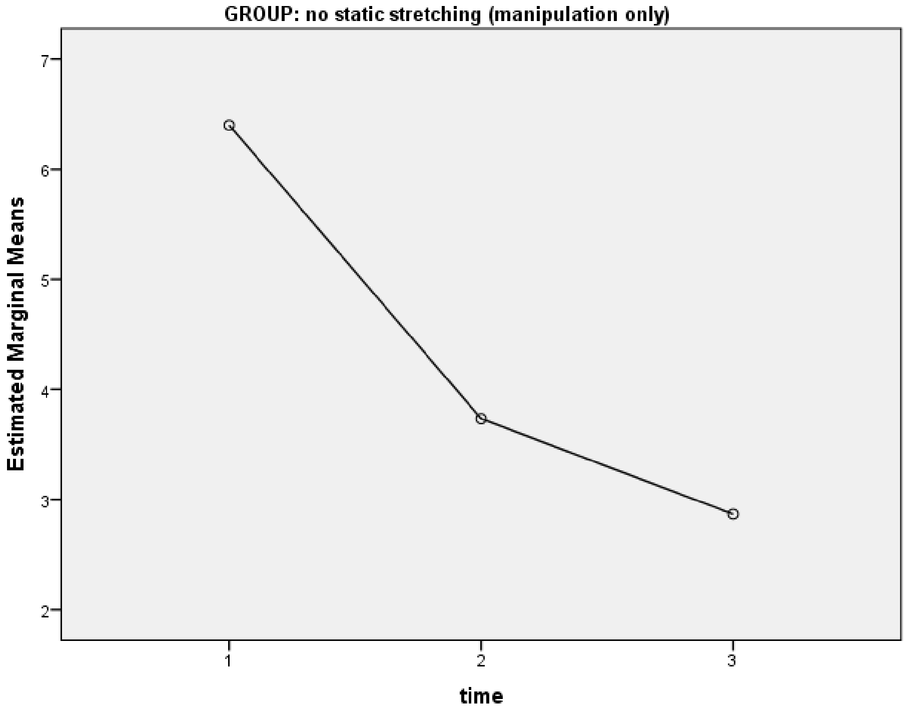


Figure 4.2: Profile plot of mean NRS by Group One and time

There was a highly statistically significant decrease over time for NRS in the group that did not receive static stretching ($p < 0.001$).

4.8.1.2 Oswestry Low Back Pain Questionnaire (OSW)

Table 4.4: OSW statistics for Group One

Multivariate Tests[a,b]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.821	29.767[c]	2.000	13.000	0.000
	Wilks' Lambda	0.179	29.767[c]	2.000	13.000	0.000
a. GROUP = no static stretching						
b. Design: Intercept Within Subjects Design: time						
b. Exact statistic						

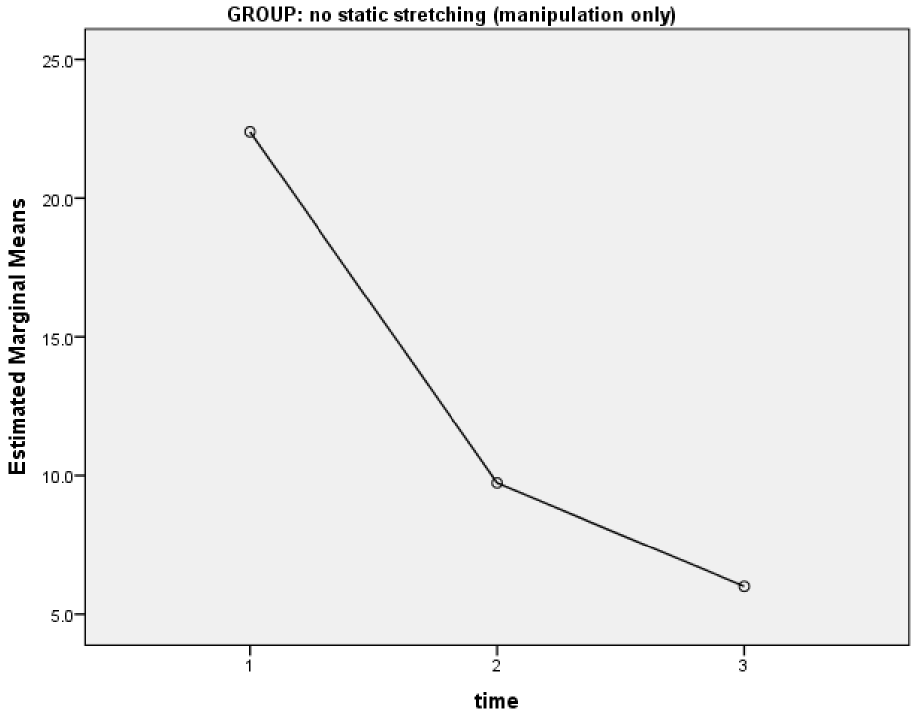


Figure 4.3: Profile plot of mean OSW by Group One and time

There was a highly significant decrease in OSW score over time (p < 0.001) in this group.

4.8.1.3 Digital Saunders Inclinometer

Table 4.5: Inclinometer statistics for Group One

Multivariate Tests[a,b]						
Effect		Value	F	Hypothesis df	Error df	Sig.
time	Pillai's Trace	0.644	11.773[c]	2.000	13.000	0.001
	Wilks' Lambda	0.356	11.773[c]	2.000	13.000	0.001
a. GROUP = no static stretching						
b. Design: Intercept Within Subjects Design: time						
b. Exact statistic						

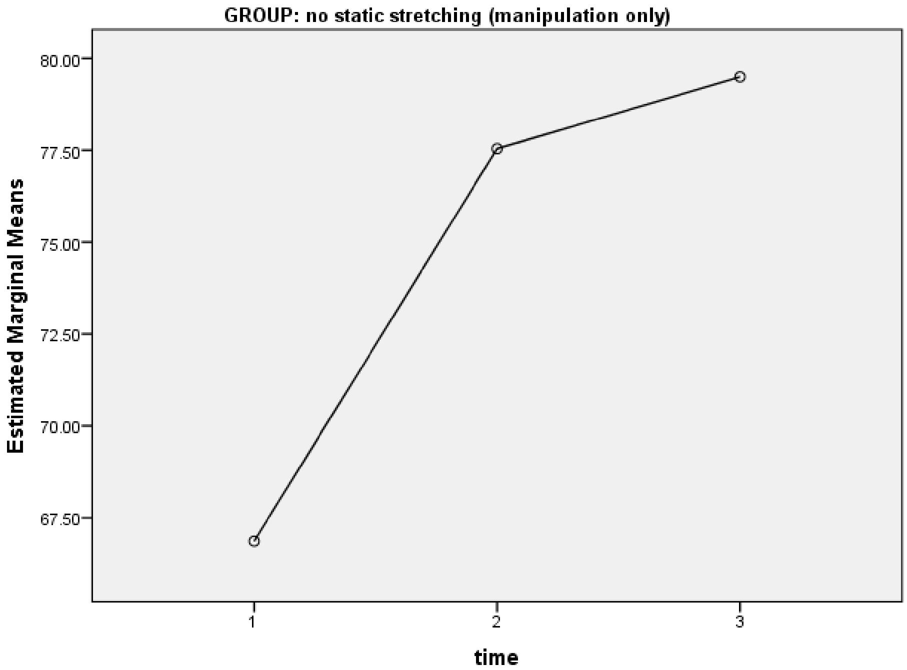


Figure 4.4: Profile plot of mean inclinometer by Group One and time

There was also a very significant increase in inclinometer readings over time in this group (p = 0.001).

4.8.1.4 Algometer

Table 4.6: Algometer statistics for Group One

Multivariate Tests[a,b]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.310	2.922[c]	2.000	13.000	0.090
	Wilks' Lambda	0.690	2.922[c]	2.000	13.000	0.090
a. GROUP = no static stretching						
b. Design: Intercept Within Subjects Design: time						
b. Exact statistic						

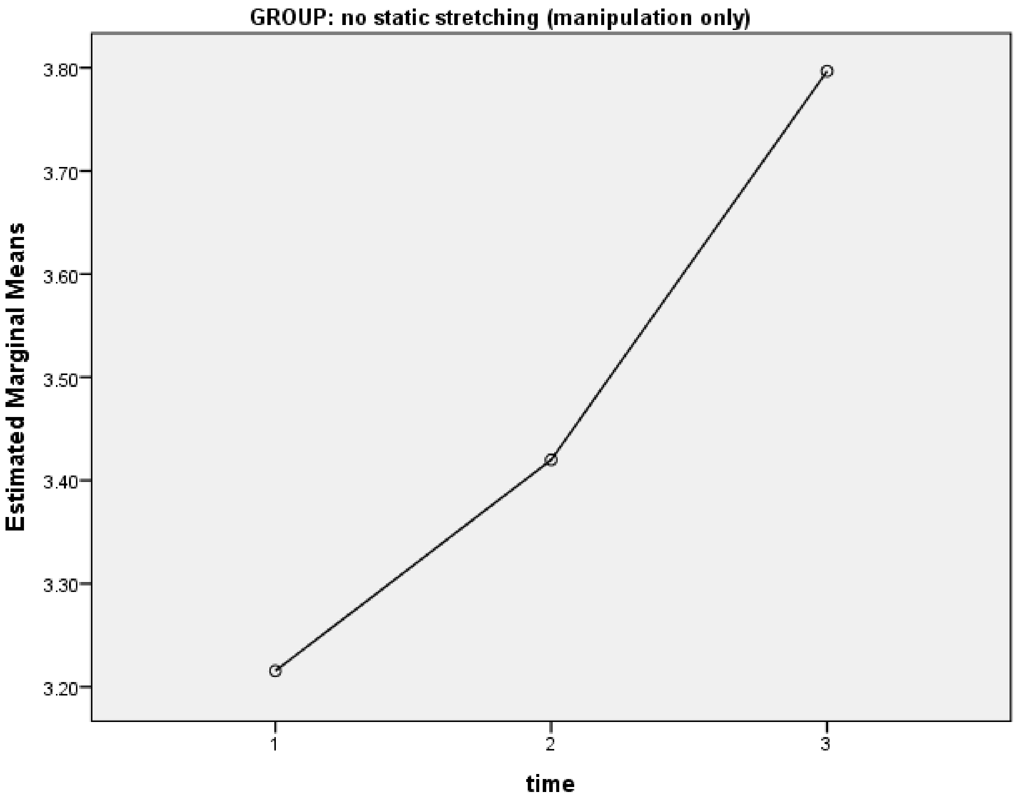


Figure 4.5: Profile plot of Algometer by Group One and time

While algometer readings did increase, this was not statistically significant (p = 0.090).

4.8.2 Objective Two

- To determine the effect of manipulation and static stretching of the gluteus maximus, latissimus dorsi, biceps femoris and erector spinae muscles in terms of subjective and objective findings.

4.8.2.1 Numerical Pain Rating Scale (NRS)

Table 4.7: NRS statistics for Group Two

Multivariate Tests[a,b]							
Effect		Value	F	Hypothesis df	Error df	Sig.
time	Pillai's Trace	0.767	21.377[c]	2.000	13.000	0.000
	Wilks' Lambda	0.233	21.377[c]	2.000	13.000	0.000
a. GROUP = received static stretching and home stretch program and manipulation						
b. Design: Intercept Within Subjects Design: time						
c. Exact statistic						

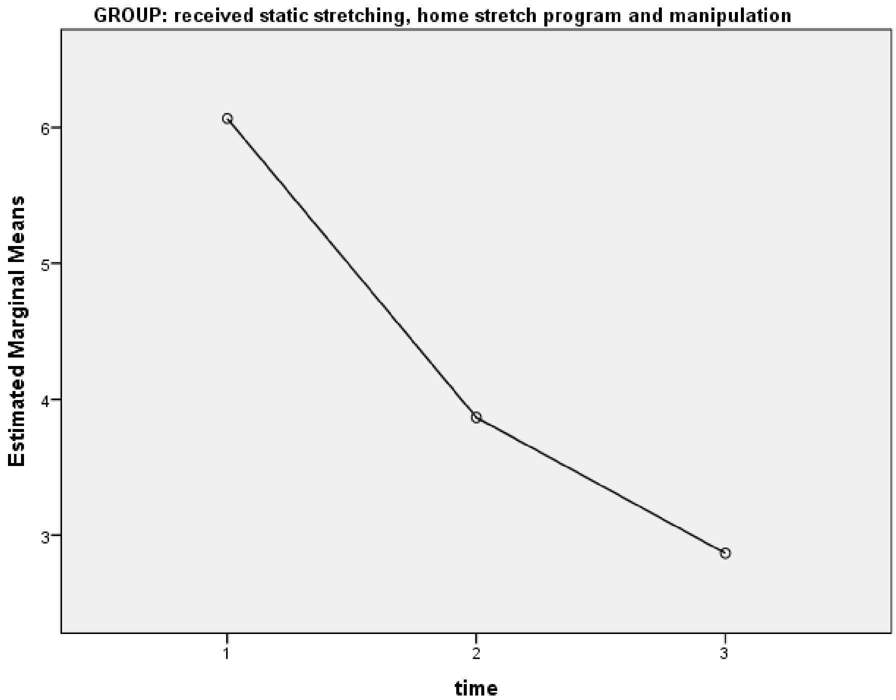


Figure 4.6: Profile plot of mean NRS by Group Two and time

The readings on the NRS also decreased very significantly in this group (p < 0.001).

4.8.2.2 Oswestry Low Back Pain Questionnaire (OSW)

Table 4.8: OSW statistics for Group Two

Multivariate Tests[a,b]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.786	23.812[c]	2.000	13.000	0.000
	Wilks' Lambda	0.214	23.812[c]	2.000	13.000	0.000
a. GROUP = received static stretching and home stretch program and manipulation						
b. Design: Intercept Within Subjects Design: time						
c. Exact statistic						

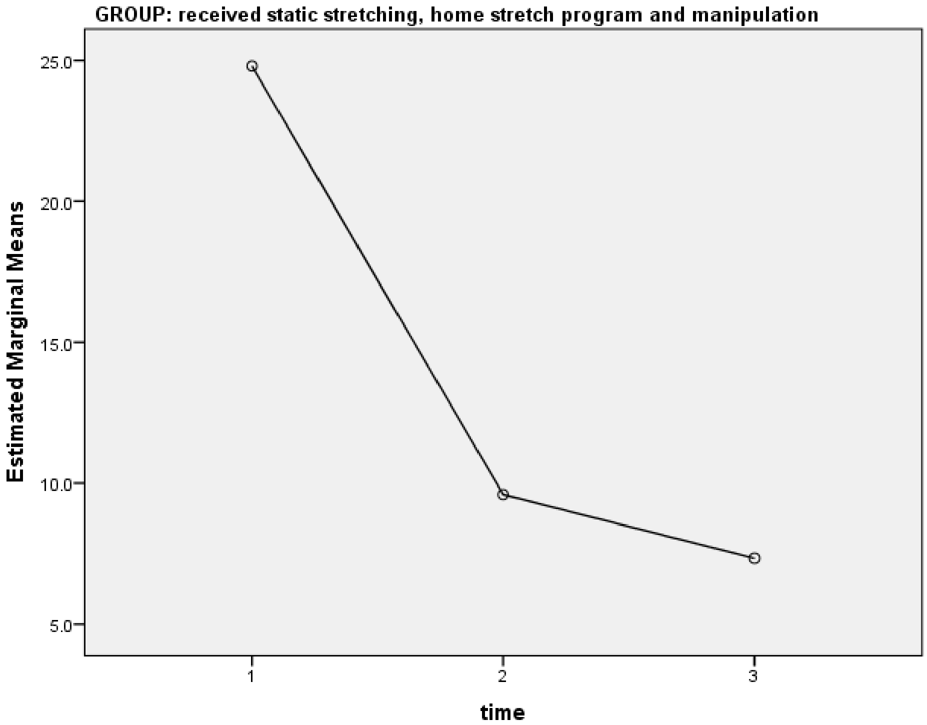


Figure 4.7: Profile plot of mean OSW by Group Two and time

The OSW score also decreased significantly in this group ($p < 0.001$).

4.8.2.3 Digital Saunders Inclinometer

Table 4.9: Inclinometer statistics Group Two

Multivariate Tests[a,b]						
Effect		Value	F	Hypothesis df	Error df	Sig.
time	Pillai's Trace	0.708	15.773[c]	2.000	13.000	0.000
	Wilks' Lambda	0.292	15.773[c]	2.000	13.000	0.000
b. GROUP = received static stretching and home stretch program and manipulation						
b. Design: Intercept Within Subjects Design: time						
c. Exact statistic						

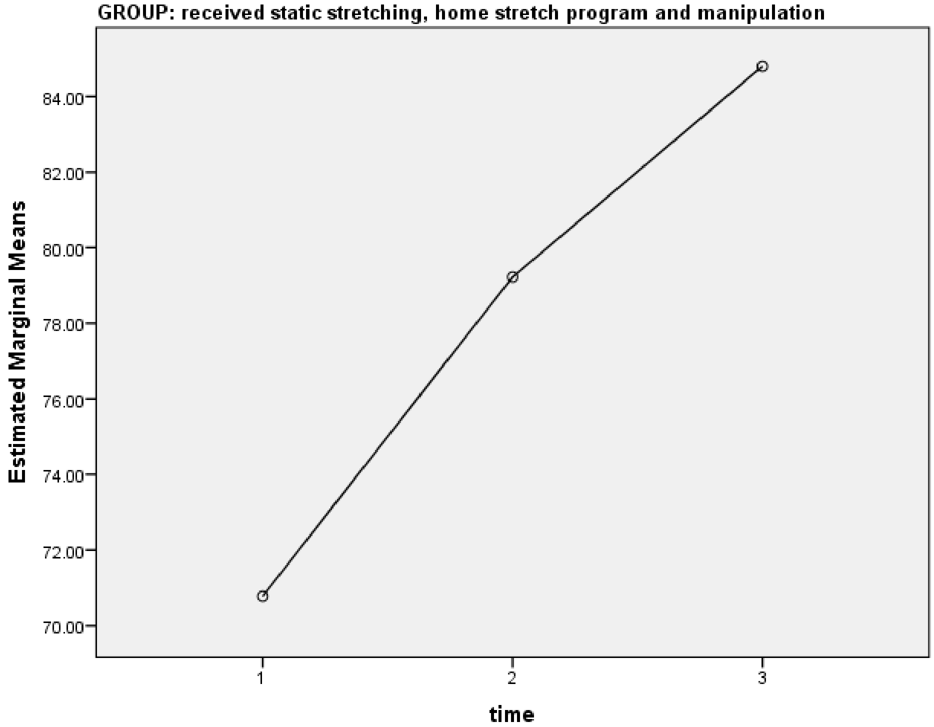


Figure 4.8: Profile plot of mean Inclinometer by Group Two and time

The inclinometer values increased significantly in this group ($p < 0.001$)

4.8.2.4 Algometer

Table 4.10: Algometer statistics for Group Two

Multivariate Tests[a,b]						
Effect		Value	F	Hypothesis df	Error df	Sig.
time	Pillai's Trace	0.677	13.597[c]	2.000	13.000	0.001
	Wilks' Lambda	0.323	13.597[c]	2.000	13.000	0.001
c. GROUP = received static stretching and home stretch program and manipulation						
b. Design: Intercept Within Subjects Design: time						
c. Exact statistic						

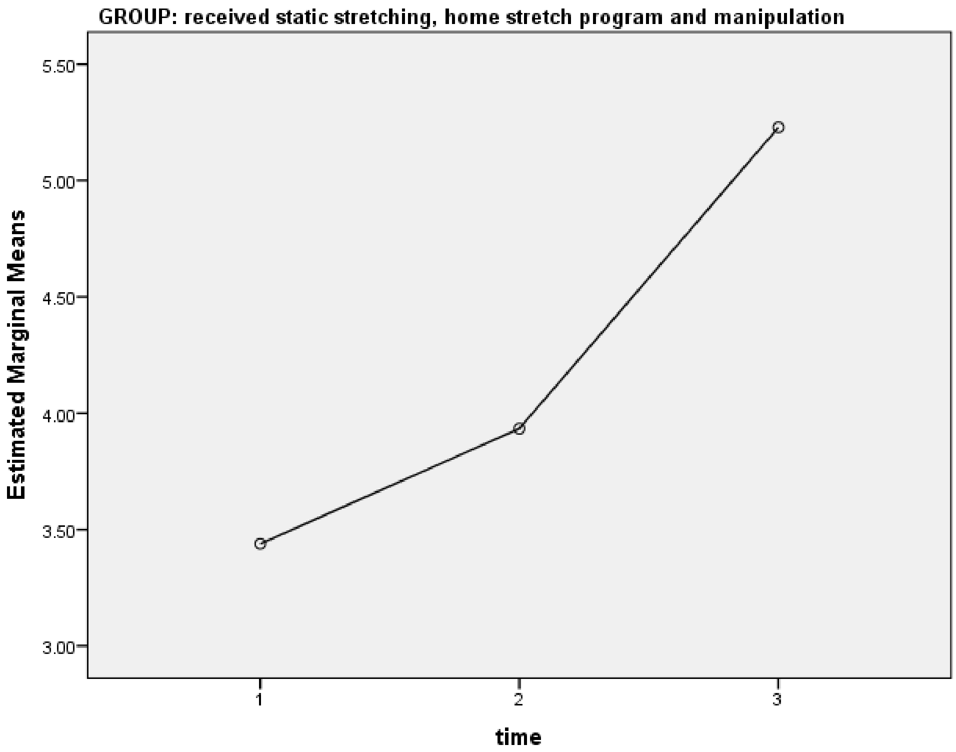


Figure 4.9: Profile plot of mean Algometer by Group Two and time

The algometer readings also increased significantly in this group (*p* = 0.001).

4.8.3 Objective Three

- Compare the outcomes of Objective One to Objective Two in terms of subjective and objective outcomes.

4.8.3.1 Numerical Pain Rating Scale (NRS)

Table 4.11: NRS statistic comparisons between Group One and Two

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.763	43.530[b]	2.000	27.000	0.000
	Wilks' Lambda	0.237	43.530[b]	2.000	27.000	0.000
time * GROUP	Pillai's Trace	0.029	0.399[b]	2.000	27.000	0.675
	Wilks' Lambda	0.971	0.399[b]	2.000	27.000	0.675
a. Design: Intercept + GROUP Within Subjects Design: time						
a. Exact statistic						

Table 4.12

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Transformed Variable: Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1664.100	1	1664.100	290.975	0.000
GROUP	0.100	1	0.100	0.017	0.896
Error	160.133	28	5.719		

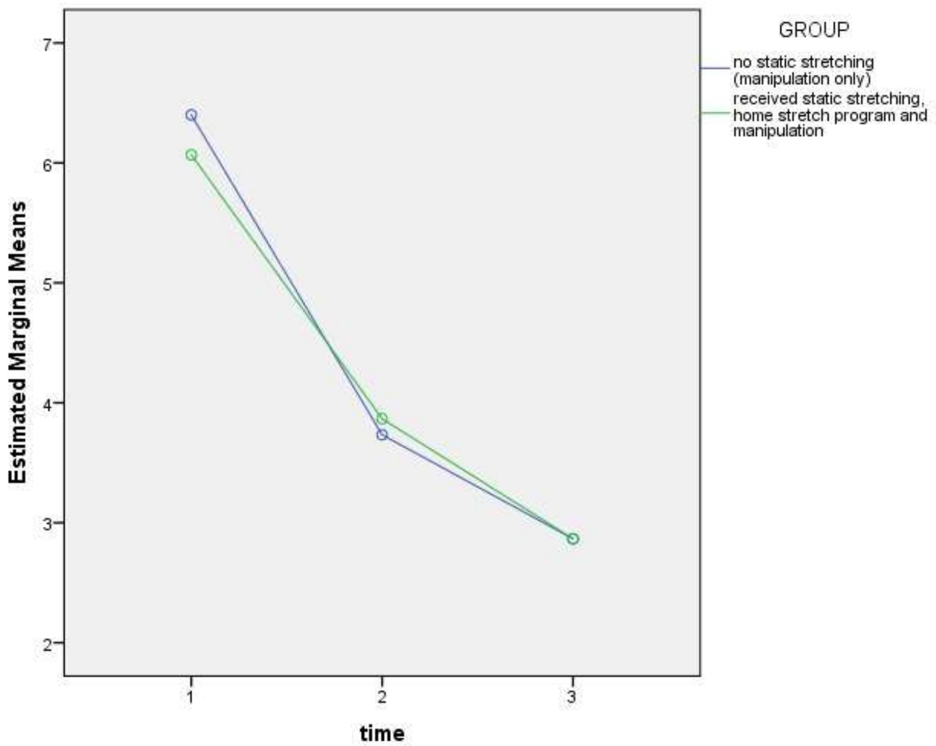


Figure 4.10: Profile plot of mean NRS by the Group One and Two and time

There was no difference in the effect of the two groups over time (p = 0.675). Therefore the treatment had no differential effect on the NRS as the lines in the graph are parallel.

4.8.3.2 Oswestry Low Back Pain Questionnaire (OSW)

Table 4.13: OSW statistic comparisons between Group One and Two

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.793	51.615[b]	2.000	27.000	0.000
	Wilks' Lambda	0.207	51.615[b]	2.000	27.000	0.000
time * GROUP	Pillai's Trace	0.036	0.500[b]	2.000	27.000	0.612
	Wilks' Lambda	0.964	0.500[b]	2.000	27.000	0.612
a. Design: Intercept + GROUP Within Subjects Design: time						
b. Exact statistic						

Table 4.14

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Transformed Variable: Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	15946.711	1	15946.711	96.880	0.000
GROUP	32.400	1	32.400	.197	0.661
Error	4608.889	28	164.603		

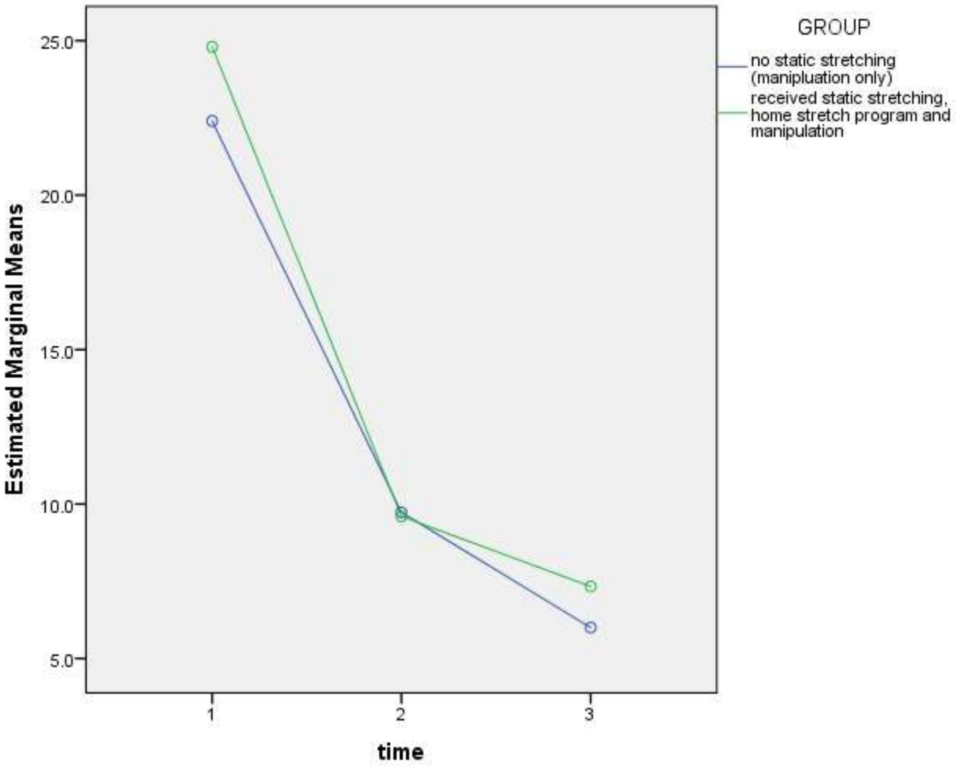


Figure 4.11: Profile plot of mean OSW by Groups One and Two and time

There was no difference in the effect of the two groups over time (p = 0.612). Therefore the treatment had no differential effect on the OSW score as the lines in the graph are parallel.

4.8.3.3 Digital Saunders Inclinometer

Table 4.15: Inclinometer statistic comparisons between Group One and Group Two

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.672	27.661[b]	2.000	2 7.000	0.000
	Wilks' Lambda	0.328	27.661[b]	2.000	27.000	0.000
time * GROUP	Pillai's Trace	0.065	0.938[b]	2.000	27.000	0.404
	Wilks' Lambda	0.935	0.938[b]	2.000	27.000	0.404
a. Design: Intercept + GROUP Within Subjects Design: time						
b. Exact statistic						

Table 4.16

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Transformed Variable: Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	526006.580	1	526006.580	1906.574	0.000
GROUP	297.134	1	297.134	1.077	0.308
Error	7724.946	28	275.891		

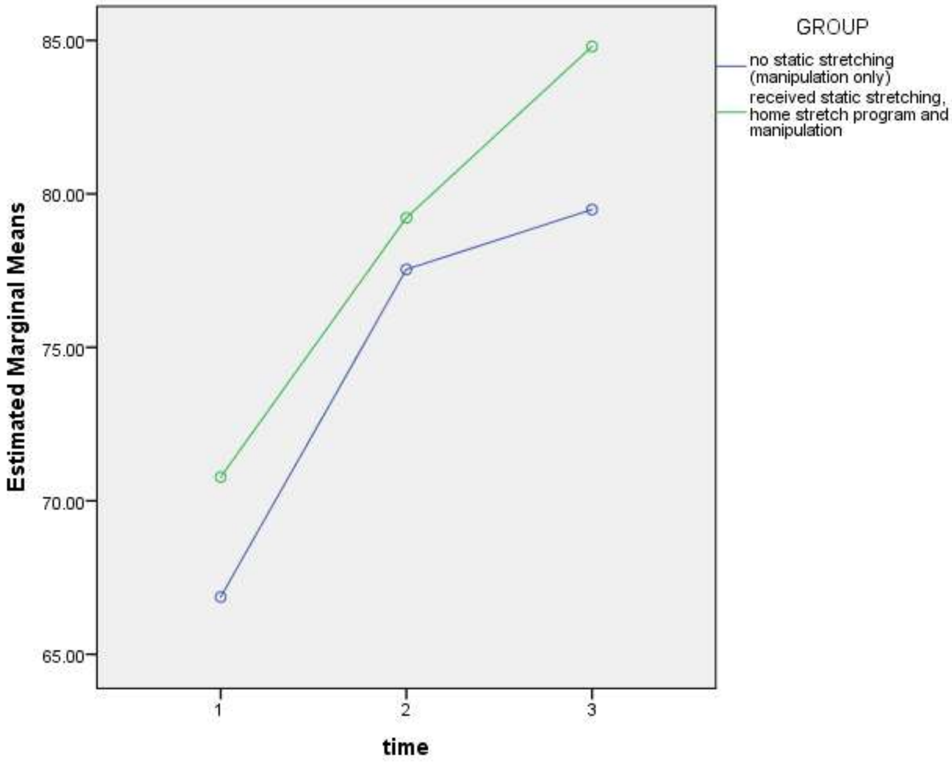


Figure 4.12: Profile plot of mean Inclinometer by Groups One and Two and time

There was no difference in the effect of the two groups over time ($p = 0.404$). Therefore the treatment had no differential effect on inclinometer values as the lines in the graph are almost parallel.

4.8.3.4 Algometer

Table 4.17: Algometer statistic comparisons between Group One and Group Two

Multivariate Tests[a]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.549	16.405[b]	2.000	27.000	0.000
	Wilks' Lambda	0.451	16.405[b]	2.000	27.000	0.000
time * GROUP	Pillai's Trace	0.256	4.637[b]	2.000	27.000	0.019
	Wilks' Lambda	0.744	4.637[b]	2.000	27.000	0.019
a. Design: Intercept + GROUP Within Subjects Design: time						
b. Exact statistic						

Table 4.18

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Transformed Variable: Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1326.336	1	1326.336	565.139	0.000
GROUP	11.765	1	11.765	5.013	0.033
Error	65.714	28	2.347		

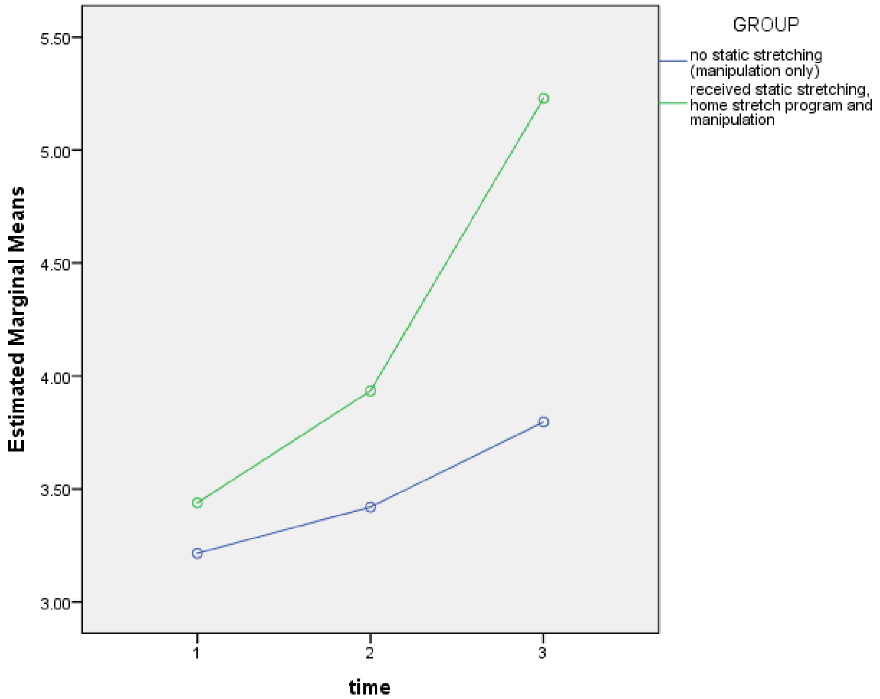


Figure 4.13: Profile plot of mean Algometer by Groups One and Two and time

There was a statistically significant treatment effect on the algometer readings (p = 0.019). Figure 4.13 above shows that the group which received static stretching did better.

4.9 SUMMARY AND CONCLUSION

The Algometer readings showed a statistical significant effect for the group that received static stretching (Group Two) as the time over treatment group interaction effect was significant (p = 0.019).

The rate of increase over time was not the same in both groups. The two graphs are not parallel, as Group Two improved at a steeper rate than the Group One (Figure 4.13). Although both groups showed improvement over time, it did make a difference if you were in the treated or control group since the treated group (Group Two) improved at a higher rate by 1.9%.

Chapter Five

5.1. INTRODUCTION

This chapter discusses and interprets the statistical results as highlighted in Chapter Four.

Subjective data was obtained using the NRS and the OSW.

Objective data was derived from the results of the Algometer and the Digital Saunders Inclinometer.

Intra- and Inter- group statistical analysis was then performed on the data groups.

5.2. DEMOGRAPHIC DATA

According to table 4.1, it was found that there were no significant differences between the two groups in terms of demographic variables. Thus, the selection process ensured an even distribution of age, gender, and motion palpation.

5.2.1. Age Distribution

This study was limited to include participants of between 18 to 45 years of age. It was found that the mean age for Group One (manipulation only) was 30.5 years and the mean age for Group Two (manipulation, static stretching and a home stretch programme) was 30.6 years.

Matkovich (2004) had a similar age restriction which resulted in a comparable mean. Bisset (2003), in his study of chronic SIJ syndrome, selected participants between ages of 18 to 49 with an average being 33.3 years.

As the age of participants was 18 to 45 years, it makes difficult to compare the results to the South African population at large.

5.2.2. Gender Distribution

The gender distribution within the sample of 30 participants with 15 participants placed in Group One and 15 participants placed in Group Two. Group One consisted of 46.7% men, and 53.3% women. Group Two consisted of 60% and the women was 40%.

Dyer (2012), in an epidemiological investigation of low back pain in the white population eThekwini district, South Africa, found the gender distribution was similar to the study (53.3%

female, 46.7 male).This female predominance is supported by Moodley (2002) in her study of chronic SIJ syndrome. Bisset (2003) however found a 50% - 50% gender distribution.

5.2.3. Ethnic Distribution

The ethnic distribution (table 4.7.1) in this study is varied, as 73.3% in group one were white, 13.3% were black, and 13.3% were Indian. In group two, the ethnic distribution varied, as 53.3% were white, 6.7% were black, 33.3% were Indian, and 6.7% were coloured.

The reason why the present study does not represent a similar ethnic distribution to parts of South Africa may be due to the small sample size and the convenience sampling method.

5.2.4. Motion palpation findings

The following motion palpation (table 4.1) findings were found in this study:

- Right upper flexion (RUF) group 1 = 26.7% group 2 = 40.0%
- Right lower flexion (RLF) group 1 = 13.3% group 2 = 0.0%
- Right upper extension (RUE) group 1 = 6.7% group 2 = 6.7%
- Right lower extension (RLE) group 1 = 0.0% group 2 = 0.0%
- Left upper flexion (LUF) group 1 = 46.7% group 2 = 40.0%
- Left lower flexion (LLF) group 1 = 6.7% group 2 = 13.3%

In Group One, 53.4% of the participants had left sided restrictions and 46.7% had right sided restrictions. In Group Two, 53.3% of the participants had left sided restrictions and 46.7% had right sided restrictions. This made the groups comparable. In this study it was found that the most common motion palpation findings in chronic SIJ syndrome are upper flexion restrictions. It is evident that there was a dominance of left upper flexion restrictions amongst the two groups. In the study by Moodley (2002) of chronic SIJ syndrome a right- sided predominance was evident.

5.3 INTRA-GROUP COMPARISONS

5.3.1 Subjective and Objective Data of Group One (Manipulation only)

Group One had a statistically significant reduction for pain (NRS) and disability (OSW). The NRS and OSW both had a statistically significant decrease in pain and disability respectively ($p<0.001$). For Group One, the inclinometer range of motion readings statistically and significantly improved ($p = 0.001$). Although the algometer pressure readings did increase, they weren't however statistically significant ($p = 0.090$).

5.3.2 Subjective and Objective Data of Group Two (Manipulation and static stretching)

Group Two had a statistically significant reduction for pain (NRS) and disability (OSW) ($p < 0.001$). The inclinometer readings had a statistically significant improvement in range of motion ($p < 0.001$). The algometer pressure readings also showed a statistically significant improvement ($p = 0.001$).

5.3.3 Summary

Although there was a statistically significant improvement within both groups for NRS, OSW, and inclinometer results, it would appear that Group Two fared better in terms of the algometer pressure results. The inclinometer readings for both Group One ($p = 0.001$) and Two ($p < 0.001$) readings had a significant improvement. This can further support that the POS muscles have an effect in restoration of joint movement in participants with SIJ syndrome (Kirkaldy-Willis and Barnard, 1999), and which in doing so, has alleviated the pain.

Even though there are no other studies to support this finding, it could be that the POS muscles have been shown to have an effect over the SIJ contributing to its pain (Vleeming *et al*., 1997), the algometer readings can therefore be in support this statement.

5.4 INTER- GROUP COMPARISONS

5.4.1 Subjective Data between Group One and Group Two

There was no statistically significant difference between the two groups in terms of the NRS results ($p < 0.001$) and the OSW results ($p < 0.001$).

5.4.2 Objective Data between Group One and Group Two

There was no statistically significant difference between the two groups as Group One inclinometer results ($p = 0.001$) and Group Two ($p < 0.001$) improved.

Group Two had a statistically significant improvement over Group One in terms of algometer readings ($p = 0.001$).

5.4.3 Overall Comparison

According to the results, there was no difference in the effect of the two groups over time for the NRS, OSW and inclinometer readings. This means that the treatment had no differential effect for the NRS and OSW and inclinometer results. This is evident by the graph lines that are parallel for the NRS ($p = 0.675$) (Figure 4.10), and the OSW score ($p = 0.612$) (Figure 4.11). Inclinometer values ($p = 0.404$) were almost parallel to each other (Figure 4.12).

The algometer values within Group Two suggested a statistically significant treatment effect ($p = 0.019$). Group Two who received static stretching in conjunction with the SIJ manipulation showed a statistically significant improvement in their treatment as compared Group One which received manipulation only (Figure 4.13).

From the intra-group comparisons of the subjective data, it can be seen that participants in both groups experienced a statistically significant improvement in terms of pain threshold levels and disability due to low back pain.

From the intra-group comparisons of the objective data, it can be seen that participants in both groups experienced a statistically significant improvement in terms of range of motion (Figure4.12). However, Group Two fared better in terms of algometric pressure readings ($p = 0.001$). This was supported by the inter-group comparison for algometer readings ($p = 0.019$) (Figure 4.13).

5.5 SUMMARY OF RESULTS

The present study is comparable to Mould (2003) that investigated the reciprocal activity (EMG readings) of certain POS muscles in patients with unilateral SIJ syndrome. Mould (2003) conducted a randomized, comparative, clinical trial that consisted of four treatment groups.

Mould's (2003) study suggests that the POS muscle group has an effect on the SIJ in SIJ syndrome. His study concluded that the group that received manipulation combined with static stretching of the ipsilateral gluteus maximus is effective at restoring the over activity of the gluteus maximus and underactivity of thee contralateral latissimus dorsi muscle in participants suffering with unilateral SIJ syndrome (Mould, 2003). Mould's (2003) study used surface EMG to evaluate the over and under activity of the muscles that have an effect over the SIJ, he however didn't assess algometric and inclinometer readings.

This present study showed that both treatment protocols were effective in reducing the signs and symptoms associated with SIJ syndrome. There is evidence that Group Two responded mildly better than Group One in terms of algometer readings (figure 4.13) ($p = 0.019$) but was found to not be statistically significant. There is insufficient literature of studies related to the POS muscles, therefore, comparisons are difficult to make.

This study has been able to establish the effectiveness of both manipulation of the SIJ only and the combination of manipulation and static stretching of the POS in the treatment of SIJ syndrome.

These research findings are in support of other studies which have shown that manipulation is an effective treatment for SIJ syndrome (Moodley (2002), Bisset (2003), Shearer (2003), Haldeman, (2005)).

Chapter Six

6.1 CONCLUSION

The aim of this study was to determine the effect of statically stretching the POS muscles in conjunction with SIJ manipulation, compared to SIJ manipulation only in the treatment of chronic SIJ syndrome.

The results of this study showed a statistically significant improvement for both treatment groups, however neither protocol was more effective than the other in the treatment of on chronic SIJ syndrome in terms of subjective readings. In terms of objective readings, there was no statistically significant difference between the two groups for inclinometer readings, but Group Two had a statistically significant improvement over Group One in terms of algometer readings.

Thus, apart from the algometer measurements with all other subjective and objective measurements taken into account, the null hypothesis is accepted.

As there was a statistically significant difference between the groups for the algometer measurements, further studies are needed with larger sample sizes to re-evaluate the combined treatment protocol.

6.2 LIMITATIONS OF THE STUDY

- The Oswestry Index (Fairbanks *et al*., 1980) was not specifically designed to evaluate SIJ syndrome, and this may have affected participant responses in term of improvement.

- Factors such as emotional stress, psychological problems and physical activities were not taken into consideration for this study which may have had a potential influence on the outcome of the study.

- Participants were encouraged to comply with the instructions of the home stretch programme. The researcher required a home stretch diary (Appendix M) be signed daily and brought through at their final appointment for the researcher to sign it off. However, it’s possible that the participants could have given the researcher false information.

- A limitation of the study failure to consider the greater joint laxity of female subjects as compared to males.

6.3 RECOMMENDATIONS

- A larger study involving increased number of participants may increase the significance of results.

- It is suggested that further studies investigate the prevalence and incidence of motion palpation findings in participants with chronic SIJ syndrome.

- Long term follow-up consultations (around 1month and then 6 months) should be incorporated into future studies. This would assist in addressing general efficacy of the treatment protocols utilised.

- Two groups of treatment options were included in this study. A manipulation only (control group), and a manipulation combined with static stretching of the POS muscle group. A third group could have been included to asses static stretching of the POS muscles only, in order to assess its effect on chronic SIJ syndrome.

- Further research needs to be done in order to be able to compare the POS muscle group in the combined treatment with SIJ syndrome.

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APPENDIX A

Do you suffer with long term low back pain????

If you are between the ages of 18 and 45, you could be eligible to participate in my study.

Should you qualify for the research, you will receive

FREE TREATMENT

This will include an assessment and treatment.

For more information to take part in my study, contact Shaylene 079 447 0606

Or the DUT Chiropractic Day Clinic on 031 373 2205

APPENDIX B

The prospective participants will then be asked the following questions to qualify:

Questions	Answers
“Would you mind answering a few questions to gauge your eligibility to participate in the study?”	No
“How old are you?”	Ages between 18 to 45
“For how long have you had the pain?”	More than 3 months
“Where is your pain?”	They may use their own words to describe: pain over the sacroiliac joint in the region of the posterior superior iliac spine, with the possibility of referral to the buttock, groin, and posterior and anterior thigh (Haldeman, 1992)
“Do you have a recent history of trauma?”	No
“Are you currently taking any anti-inflammatory medication?”	No

APPENDIX C

Letter of Information and Consent

Dear Participant,

Thank you for volunteering to be part of my study. I am a student currently completing my M. Tech: Chiropractic qualification at the Durban University of Technology. I have two years' experience while working as a Chiropractic Intern at the DUT Chiropractic Day Clinic.

Title of the Research Study:
"The effect of sacroiliac joint manipulation compared to manipulation and static stretching of the posterior oblique sling group of muscles in participants with chronic sacroiliac joint syndrome."

Principal Investigator/s/researcher: Shaylene Swanepoel

Co-Investigator/s/supervisor/s: Dr Heidi Kretzmann (supervisor) M. Tech Chiropractic
Dr Stuart Clifton (co-supervisor) M. Tech Chiropractic

Brief Introduction and Purpose of the Study:
The purpose of this study is to assess the efficacy of two treatment approaches in individuals with chronic sacroiliac joint syndrome. The one treatment will consist of stretching and manipulation, while another treatment will consist of manipulation only of the sacroiliac joint.

Outline of the Procedures:
All consultations will take place at the Durban University of Technology Chiropractic Day Clinic. At the initial consultation, participants will be screened for suitability to be included in the study. Suitability will be determined via a case history, physical examination and lower back regional examination. This appointment will take approximately two hours.

Once accepted you will be required to sign an informed consent form after a full explanation of what the research involves. You will have the opportunity to ask questions about the procedures. This study consists of two groups, one receiving only a manipulation protocol and the other receiving a static stretching of the posterior oblique sling muscles with added sacroiliac manipulation. By partaking in the study you will be required to attend the clinic for a total of four appointments in two weeks, with two appointments per week with a two to four day interval.

In order for the research results to be accurate you are asked to follow the instructions given. This study is a randomised clinical trial in a quantitative paradigm that will consist of two groups of 15 participants aged 18-45 years old with chronic sacroiliac joint syndrome. Participants in group one will receive sacroiliac joint manipulation only, and the participants in group two will receive sacroiliac joint manipulation and static stretches of the posterior oblique sling muscle group. Measurements taken will include the inclinometer to measure the sacroiliac joint range in motion, and an algometer that will be used to measure the participant's pain threshold in a particular area of tenderness. Subjective measurements will include the NRS pain rating scale and the Oswestry Low back Pain Questionnaire that will measure the pain severity and be taken before treatment, before the third and after the final treatment. Statistical analysis will be done before the first, third and after the fourth consultations to compare the results within and between the groups by an independent statistician. All inclinometer measurements, algometer measurements, NRS and the Oswestry Low Back Pain Questionnaire results will be conducted by a research assistant.

Risks or Discomforts to the Participant:
It is possible for one to feel stiffness and tenderness post manipulation, although this does not suggest damage to the area. If this post manipulation stiffness occurs simply inform the researcher at your next visit.

Reason/s why the Participant May Be Withdrawn from the Study:
You may be withdrawn from the study, if you do not arrive for your appointment, if you have not complied with the instructions given by the researcher (i.e. participants who don't comply with the home stretching program), or if you are involved in an accident or develop a condition that is a contraindication for spinal manipulative therapy. You are free to withdraw at any time and it will not affect future treatments at the chiropractic clinic should you return.

Remuneration:
By participating in this study there will be no cost to you nor will you receive any remuneration except for the free treatment.

Confidentiality:
This will be maintained as only the researcher and supervisor will have access to the patient files. In the dissertation no personal information will be disclosed only the demographics and results of each group will be discussed. Should you have any questions regarding the research please contact the researcher (Shaylene Swanepoel) on 031 3732205 or 0794470606.

Persons to Contact in the Event of Any Problems or Queries:
Please contact the researcher, Shaylene Swanepoel on (079 447 0606), Supervisor: Dr Heidi Kretzmann and Co-supervisor Dr Stuart Clifton on (031 373 2205) or the Institutional Research Ethics administrator on (031 373 2900). Complaints can be reported to the DVC: TIP, Prof S. MOYO on (031 3732382) or dvctip@dut.ac.za

CONSENT

Statement of Agreement to Participate in the Research Study:

I hereby confirm that I have been informed by the researcher, ____________ (name of researcher), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: ___________, I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.

I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.

In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.

I may, at any stage, without prejudice, withdraw my consent and participation in the study.

I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____________________ ___________ _______ ________________

Full Name of Participant **Date** **Time** **Signature**

I, ______________ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

__________________ ___________ ____________________

Full Name of Researcher **Date** **Signature**

__________________ ___________ ____________________

Full Name of Witness **Date** **Signature**

APPENDIX D

DUT DURBAN UNIVERSITY OF TECHNOLOGY | DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

CHIROPRACTIC PROGRAMME

CHIROPRACTIC DAY CLINIC CASE HISTORY

Patient: ______________________________ Date: __________

File #: __________ Age: __________

Sex: __________ Occupation: ______________________________

Student: ______________________ Signature ______________________

FOR CLINICIANS USE ONLY:

Initial visit

Clinician: Signature:

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

CASE STATUS:

PTT: Signature: Date:

CONDITIONAL:

Reason for Conditional:

Signature: Date:

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

Case Summary signed off: Date:

Student's Case History:

1. **Source of History:**

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

3. **Present Illness:**

	Complaint 1(principle complaint)	Complaint 2 (additional or secondary complaint)
Location		
Onset : Initial:		
Recent:		
Cause:		
Duration		
Frequency		
Pain (Character)		
Progression		
Aggravating Factors		
Relieving Factors		
Associated S & S		
Previous Occurrences		
Past Treatment		
Outcome:		

4. **Other Complaints:**

5. **Past Medical History:**

General Health Status

Childhood Illnesses

Adult Illnesses

Psychiatric Illnesses

Accidents/Injuries

Surgery

Hospitalizations

6. Current health status and life-style:

Allergies

Immunizations

Screening Tests incl. x-rays

Environmental Hazards (Home, School, Work)

Exercise and Leisure

Sleep Patterns

Diet

Current Medication
    Analgesics/week:
    Other (please list):

Tobacco
Alcohol
Social Drugs

7. Immediate Family Medical History:

Age of all family members
Health of all family members
Cause of Death of any family members

	Noted	Family member		Noted	Family member
Alcoholism			Headaches		
Anaemia			Heart Disease		
Arthritis			Kidney Disease		
CA			Mental Illness		
DM			Stroke		
Drug Addiction			Thyroid Disease		
Epilepsy			TB		
Other (list)					

8. Psychosocial history:

Home Situation and daily life
Important experiences
Religious Beliefs

9. Review of Systems (please highlight with an asterisk those areas that are a problem for the patient and require further investigation)

General

Skin

Head

Eyes

Ears

Nose/Sinuses

Mouth/Throat

Neck

Breasts

Respiratory

Cardiac

Gastro-intestinal

Urinary

Genital

Vascular

Musculoskeletal

Neurologic

Haematological

Endocrine

Psychiatric

APPENDIX E

DUT DURBAN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

CHIROPRACTIC PROGRAMME

PHYSICAL EXAMINATION: SENIOR

Patient Name: ______________________ **File no:** __________ **Date:** ________

Student: **Signature:**

VITALS:

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

GENERAL EXAMINATION:

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

SYSTEM SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION

NEUROLOGICAL EXAMINATION

COMMENTS

Clinician: **Signature:**

APPENDIX F

DUT DURBAN UNIVERSITY OF TECHNOLOGY | DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

CHIROPRACTIC PROGRAMME

Patient Name: | **File number:** | **Page:**

Date: **Visit:** **Student:**
Attending Clinician: **Signature:**

S: Numerical Pain Rating Scale (Patient) — Student Rating ☐
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

A:

0:

P:

E:

Special attention to: **Next appointment:**

Date: **Visit:** **Student:**
Attending Clinician: **Signature:**

S: Numerical Pain Rating Scale (Patient) — Student Rating ☐
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

A:

O:

P:

E:

Special attention to: **Next appointment:**

Date: **Visit:** **Student:**
Attending Clinician: **Signature**

S: Numerical Pain Rating Scale (Patient) — Student Rating ☐
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

A:

O:

P:

E:

Special attention to: **Next appointment:**

APPENDIX G

Orthopaedic Rating Scale

Name: ____________________________

Group: ______

DATE:	POSITIVE/NEGATIVE TEST
GaenslensTest	
Patrick Fabers Test	
Erichsons Test	
Sacral thrust Test	
Compression Test	

Verified by Clinician on Duty: ____

APPENDIX H

DURBAN UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

CHIROPRACTIC PROGRAMME

REGIONAL EXAMINATION
LUMBAR SPINE AND PELVIS

Patient: ______________________ File#: ____________ Date: ________

Student: ______________________ Clinician: ______________________

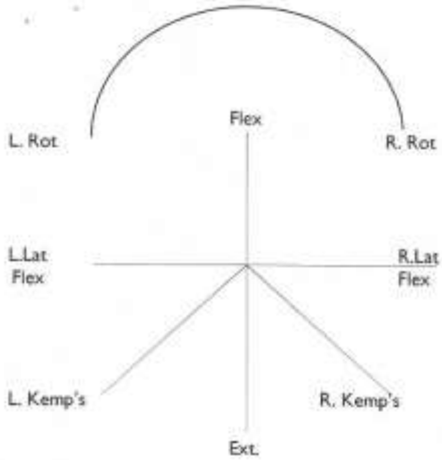
STANDING:

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

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

GAIT:

Normal walking
Toe walking
Heel Walking
Half squat



ROM:

Forward Flexion = 40-60° (15 cm from floor)

Extension = 20-35°
L/R Rotation = 3-18°
L/R Lateral Flexion = 15-20°

Which movement reproduces the pain or is the worst?

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

SUPINE:

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

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

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

SITTING:

Spinous Percussion
Lhermitte

Valsalva

TRIPOD SI, +, ++		Degree	LBP?	Location	Leg pain	Buttock	Thigh	Calf	Heel	Foot	Braggard
	L										
	R										

SLUMP 7 TEST	L										
	R										

LATERAL RECUMBENT:

	L	R
Ober's		
Femoral n. stretch		
SI Compression		

PRONE:

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

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

NON ORGANIC SIGNS:

Pin point pain
Trunk rotation
Flip Test
Ankle dorsiflexion test

Axial compression
Burn's Bench test
Hoover's test
Repeat Pin point test

NEUROLOGICAL EXAMINATION

Fasciculations

Plantar reflex

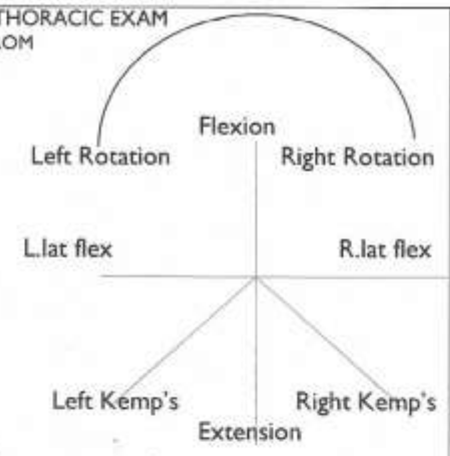
level	Tender?	Dermatomes		DTR		
		L	R		L	R
T12				Patellar		
L1				Achilles		
L2						
L3				Proprioception		
L4						
L5						
S1						
S2						
S3						

MYOTOMES

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

BASIC THORACIC EXAM

Passive ROM



History :

Orthopedic assessment:

BASIC HIP EXAM

History

ROM: Active

Passive: Medial rotation: A) Supine (neutral) If reduced

- hard \ soft end feel

B) Supine (hip flexed):

- Trochanteric bursa

MOTION PALPATION AND JOINT PLAY	L	R
Thoracic Spine		
Lumbar Spine		
Sacroiliac Joint		

APPENDIX I

Digital Inclinometer Measurements

Name: ____

Group: ______

Visit	Date	Reading 1	Date	Reading 2	Date	Reading 3	Average
1 (before treatment)							
2		-		-		-	-
3 (before treatment)							
4 (after treatment)							

APPENDIX J

Algometer Measurement Table

Name: ____________________________________

Group: _________

Visit	**Date**	**Group**	**Measurement before treatment**	**Average Measurement**	**Measurement after treatment**
1			1. 2.		-
2			**-**	**-**	**-**
3			1. 2.		-
4			-		1. 2.

APPENDIX K

Numerical Rating Scale - 101 Questionnaire

Date: ___________ **File no:** ____________ **Visit no:** _________

Patient name: __________________________________

Group: _________

Please indicate on the line below, the number between 0 and 10 that best describes the pain you experience **when it is at its worst**. A zero (0) would mean “no pain at all”, and ten (10) would mean “pain as bad as it could be”. Please write only **one** number.

0____10

SCORE: ____

APPENDIX L

Patient's Name________________________ Number__________ Date__________ Appendix L

LOW BACK DISABILITY QUESTIONNAIRE (REVISED OSWESTRY)

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

Section 1 - Pain Intensity

☐ I can tolerate the pain without having to use painkillers.
☐ The pain is bad but I can manage without taking painkillers.
☐ Painkillers give complete relief from pain.
☐ Painkillers give moderate relief from pain.
☐ Painkillers give very little relief from pain.
☐ Painkillers have no effect on the pain and I do not use them.

Section 2 – Personal Care (Washing, Dressing, etc.)

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

Section 3 – Lifting

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

Section 4 – Walking

☐ Pain does not prevent me from walking any distance.
☐ Pain prevents me from walking more than one mile.
☐ Pain prevents me from walking more than one-half mile.
☐ Pain prevents me from walking more than one-quarter mile
☐ I can only walk using a stick or crutches.
☐ I am in bed most of the time and have to crawl to the toilet.

Section 5 – Sitting

☐ I can sit in any chair as long as I like
☐ I can only sit in my favorite chair as long as I like
☐ Pain prevents me from sitting more than one hour.
☐ Pain prevents me from sitting more than 30 minutes.
☐ Pain prevents me from sitting more than 10 minutes.
☐ Pain prevents me from sitting almost all the time.

Scoring: Questions are scored on a vertical scale of 0-5. Total scores and multiply by 2. Divide by number of sections answered multiplied by 10. A score of 22% or more is considered significant activities of daily living disability.
(Score____ x 2) / (____Sections x 10) = __________ %ADL

Section 6 – Standing

☐ I can stand as long as I want without extra pain.
☐ I can stand as long as I want but it gives extra pain.
☐ Pain prevents me from standing more then 1 hour.
☐ Pain prevents me from standing more than 30 minutes.
☐ Pain prevents me from standing more than 10 minutes.
☐ Pain prevents me from standing at all.

Section 7 – Sleeping

☐ Pain does not prevent me from sleeping well.
☐ I can sleep well only by using tablets.
☐ Even when I take tablets I have less than 6 hours sleep.
☐ Even when I take tablets I have less than 4 hours sleep.
☐ Even when I take tablets I have less than 2 hours sleep.
☐ Pain prevents me from sleeping at all.

Section 8 – Social Life

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

Section 9 – Traveling

☐ I can travel anywhere without extra pain.
☐ I can travel anywhere but it gives me extra pain.
☐ Pain is bad but I manage journeys over 2 hours.
☐ Pain is bad but I manage journeys less than 1 hour.
☐ Pain restricts me to short necessary journeys under 30 minutes.
☐ Pain prevents me from traveling except to the doctor or hospital.

Section 10 – Changing Degree of Pain

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

Comments________________________________

Reference: Fairbank, Physiotherapy 1981; 66(8): 271-3, Hudson-Cook. In Roland, Jenner (eds.), Back Pain New Approaches To Rehabilitation & Education. Manchester Univ Press, Manchester 1989: 187-204

APPENDIX M

STRETCH DIARY

Name: ___________________________________ **Group: ____________**

The stretches to be performed at home are as follows:

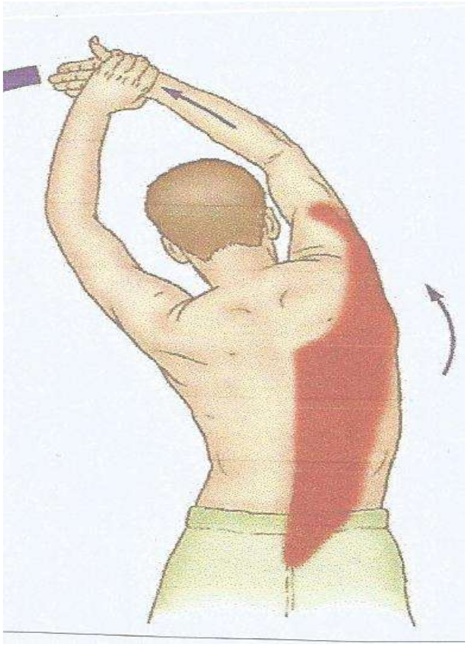
- Latissimus Dorsi
- Erector Spinae
- Gluteus Maximus
- Biceps Femoris

Hold each stretch for 30 seconds, and repeat 3 times. Please **ONLY** mark off the stretches you have completed and at which interval.

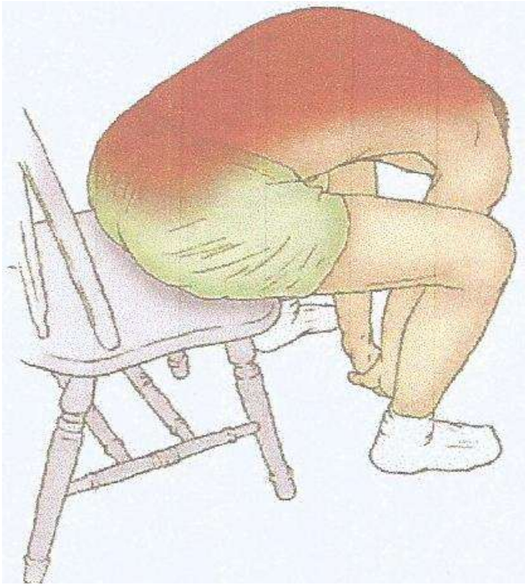
Day	**Date**	**Morning Stretch**	**Midday Stretch**	**Evening Stretch**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

STRETCHING TECHNIQUES

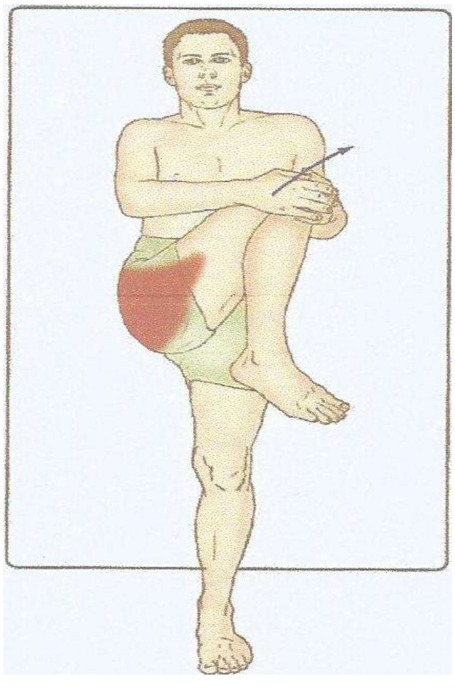
Each stretch is to be held for 30 seconds repeated 3 times



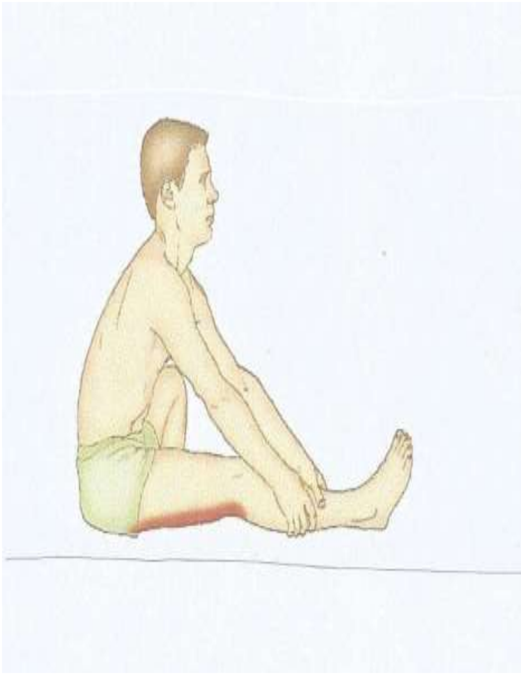
LATISSIMUS DORSI



ERECTOR SPINAE



GLUTUES MAXIMUS



BICEPS FEMORIS

(Muscolino, J.E. 2012. Know the Body. Elsevier, Inc. ISBN 978-0-323-08684-4)

APPENDIX O

MEMORANDUM

To : Prof Puckree
Chair : RHDC

Prof Adam
Chair : IREC

From : Dr Charmaine Korporaal
Clinic Director : FoHS Clinic

Date : 15.08.2015

Re : Request for permission to use the Chiropractic Day Clinic for research purposes

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Permission is hereby granted to :

Ms Shaylene Swanepoel (Student Number: 20902696)

Research title : "The effect of sacroiliac joint manipulation compared to manipulation and static stretching of the posterior oblique sling group of muscles in participants with chronic sacroiliac syndrome".

It is requested that Ms Swanepoel submit a copy of her RHDC / IREC approved proposal to the Clinic Administrators before she starts with her research in order that any special procedures with regards to her research can be implemented prior to the commencement of her seeing patients.

Thank you for your time.

Kind regards

Dr Charmaine Korporaal

Clinic Director : FoHS Clinic

Cc: Mrs Pat van den Berg : Chiropractic Day Clinic
Dr L O'Connor : Research co-ordinator
Drs H Kretzmann and Clifton : Research supervisors

APPENDIX P

Statement of Agreement to Participate in the Research Study as a Research Assistant:

I ……………….........................., ID number………………………………………………… voluntarily agree to participate in this study: **"The effect of sacroiliac joint manipulation compared to manipulation and static stretching of the posterior oblique sling group of muscles in participants with chronic sacroiliac joint syndrome."** as a research assistant**.**

I will ensure that I maintain a level of confidentiality with regards to the research data that is collected.

Research assistant's name (print) …………………………………………………………………….

Research assistant's signature: ………………………………… Date: …………………………………

Researcher's name (print)…………………………………………….. Signature: ……………………………………….

Date: ……………………………………

Witness name (print)…………………………………………………….. Signature………………………………………

Date: ………………………………….