THE RECIPROCAL ACTIVITY OF THE IPSILATERAL GLUTEUS MAXIMUS AND CONTRALATERAL LATISSIMUS DORSI MUSCLES: ITS ROLE IN UNILATERAL SACROILIAC JOINT SYNDROME.

BY

DEREK MOULD

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I, Derek Mould do declare that this dissertation is representative of my own work.

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Approved for final examination
Dr. A. van der Meulen Mast. Tech. Chiropractic
Supervisor

Date: 13/08/2003

DEDICATION

I dedicate this study to my Mother, my Father and my Sister. Your support and love have inspired me always and I am forever indebted to you. May the adventure never end!

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ABSTRACT

In recent years, sacroiliac syndrome has been widely accepted by many different health professions as one of the major contributors to low back pain. Manipulation to effect the relief of the condition has thus far proven to be one of the most effective methods. Comparatively little research has however been done on the different forms of physical therapy that can be used in conjunction with a manipulation so as to maximise its affect.

This study aimed at providing insight into the role the gluteus maximus and latissimus dorsi muscles play in sacroiliac syndrome. Recent literature suggests that these muscles have a strong association with mechanical low back pain, with the ipsilateral gluteus maximus showing over activity and contralateral latissimus dorsi showing under activity in individuals suffering with unilateral sacroiliac syndrome. It is postulated that effective treatment of these muscles will allow for longer lasting and more effective resolution of symptoms.

The study intended to confirm over activity in the ipsilateral gluteus maximus muscle and under activity in the latissimus dorsi muscle in unilateral sacroiliac syndrome sufferers and to determine which, if any, treatment protocol would have the greatest effect on restoring the aberrant function of these two muscles. The study was thus divided into four groups. Group A received sacroiliac joint (SIJ) manipulation alone, Group B received SIJ manipulation combined with static stretching of the ipsilateral gluteus maximus, Group C received SIJ manipulation combined with static stretching of the contralateral latissimus dorsi and Group D received SIJ manipulation combined with static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi.

The study design chosen was a randomised, clinical trial consisting of sixty voluntary subjects suffering with unilateral sacroiliac joint syndrome. There were four groups of fifteen subjects, each of which received four treatment consultations within a two-week period, and a final data capturing consultation within one week later.

The statistical data, surface electromyographic readings of the gluteus maximus and latissimus dorsi muscles, was collected at the initial consultation and at the final follow up visit. All the data was analysed at a 5% level of significance, i.e. $\alpha = 0.5$. Non-parametric test were used due to the small sample size of fifteen in each group. Inter-group analysis was done using the Kruskal-Wallis H Test, whilst intra-group analysis was done using the Wilcoxon Signed Rank Test.

The Inter-group analysis revealed that there was no significant difference in reducing the over activity of the ipsilateral gluteus maximus muscle between the four groups. Inter-group analysis of the latissimus dorsi muscles showed that no group was more effective at restoring the under activity in the contralateral latissimus dorsi.

The intra-group analysis revealed that only group B was effective in restoring the over activity of ipsilateral gluteus maximus muscle and under activity of the contralateral latissimus dorsi muscle in unilateral sacroiliac syndrome.

This study thus confirms that over activity of the ipsilateral gluteus maximus muscle and under activity of the contralateral latissimus dorsi muscle occurs in a high percentage of the population suffering with unilateral sacroiliac syndrome. This study concludes that manipulation combined with static stretching of the ipslateral gluteus maximus muscle is effective at restoring the over activity of the ipsilateral gluteus maximus and under activity of the contralateral latissimus dorsi muscles found in unilateral sacroiliac syndrome sufferers.

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DEFINITIONS

Adjustment:

The chiropractic adjustment is a specific form of direct articular manipulation using either a long or short lever technique and is characterized by a dynamic thrust of controlled velocity, amplitude and direction (Gatterman 1990: 405).

Articulation:

Place of union or junction between two or more bones of the skeleton (Gatterman 1990: 405).

Biomechanics:

The application of mechanical laws to living structures. The study and knowledge of biological function obtained from an application of mechanical principles (Gatterman 1990: 406).

Chiropractic:

Chiropractic is a discipline of the scientific healing arts concerned with the pathogenesis, diagnostic, therapeutic and prophylaxis of functional disturbances, patho-mechanical states, pains syndromes, and neurophysiological effects related to the statics and dynamics of the locomotor system, especially of the spine and pelvis (Gatterman 1990: 406).

Contra-indication:

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

Electromyography:

A record of the intrinsic electric activity in skeletal muscle, which aids in the diagnosing of neuromuscluar problems, and is obtained by applying surface electrodes or by inserting a needle electrode into the muscle and observing electrical activity (Anderson et al. 1990: 534).

Fixation:

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

Manipulation:

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

Motion Palpation:

Palpatory diagnosis of a passive and active segmental joint ranges of motion (Gatterman 1990: 412).

Palpation:

The application of variable manual pressure through the surface of the body for the purpose of determining the shape, size, consistency, position, inherent mobility, and health of the tissues beneath (Gatterman 1990: 412).

Sacroiliac Fixation:

The absence of normal motion at the sacroiliac joint demonstrable by motion palpation in which the axis of rotation has shifted to either the superior of inferior portion of the sacroiliac joint, or rarely a situation in which there is total joint locking with no axis of rotation (Gatterman 1990: 412).

Sacroiliac Syndrome:

Pain over the one sacroiliac joint in the region of the posterior superior iliac spine, which may be accompanied by referred pain over the buttock, greater trochanter, groin, posterior thigh, knee, and occasionally to the posterolateral calf, ankle and foot (Kirkaldy - Willis 1992:123).

Subluxation:

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

Translation:

Motion of a rigid body in which a straight line in the body always remains parallel to itself (Gatterman 1990: 415).

CHAPTER ONE : INTRODUCTION

1.1 Introduction.

Recent literature suggests that low back pain (LBP) is a common and disabling condition seen by health care practitioners, with an annual incidence estimated at 60 to 90% and a lifetime prevalence of 30% (Ross 1997). LBP is a public health problem that has a major impact on quality of life and on health care costs, with significant restrictions in daily activities experienced by persons suffering with LBP (Weiner et al. 2000).

LBP is commonly caused by dysfunction of the sacroiliac joint (SIJ) (Hesch 1997). It is estimated that in 22.5% to 40% of individuals presenting with LBP, the sacroiliac joint will be the source of the pain (Daum 1995, Bernard and Kirkaldy-Willis 1987: 266). Bernard and Cassidy (1991: 2110) and Toussaint (1999) believe that more attention should be given to the involvement of this joint in LBP.

A number of authors have noted an association between sacroiliac joint syndrome and aberrant function of the surrounding musculature. Kirkaldy - Willis and Burton (1992: 249) suggests that pain in sacroiliac syndrome results from, or is aggravated by, sustained contraction of the muscles overlying the SIJ. Gitelman (1980) focused his attention on the gluteus maximus and showed that hypertonicity often occurs during sacroiliac dysfunction. Travell and Simmons (1998: 607) point out that the gluteus maximus is one of the muscles attaching to the sacrum that commonly develops myofascial trigger points after sacroiliac displacement.

The latissimus dorsi muscle, through its attachment to the posterior layer of the thoracolumbar fascia, has also been identified as a possible influencing force on the SIJ (Bogduk et al. 1998).

There appears to be a reciprocal relationship between the gluteus maximus muscle on the one side and the latissimus dorsi on the other. This has been suggested by Gracovetsky (1995) through mathematical analysis of gait. Vleeming et al. (1995) have described the posterior layer of the thoracolumbar fascia as a possible mechanism of load transfer between the two muscles.

Mooney et al. (1995) confirmed this reciprocal relationship between the gluteus maximus on the one side and the latissimus dorsi on the other, using surface electromyography (EMG) on healthy individuals. Mooney et al. (1995) also noted that in a small sample (n = 5) of subjects suffering with unilateral sacroiliac syndrome, the surface EMG readings of the ipsilateral gluteus maximus showed over activity whilst the contralatal latissimus dorsi muscle showed under activity. The investigators suggested further research involving treatment of these muscles, in patients suffering with unilateral sacroiliac syndrome.

Manipulation has been considered as one of the most acceptable and popular forms of treatment for sacroiliac syndrome by a number of authors (Haldeman 1992, Kirkaldy-Willis 1992 and Mierau et al. 1992).

Manipulation combined with stretching of various muscles in close proximity to the SIJ has also been investigated and found to be beneficial in the treatment of sacroiliac syndrome (Ranwell 2001, Paton 2001). Khalil et al.(1992) found that muscle stretching resulted in an immediate gain as well as a cumulative gain (over the treatment period) in EMG muscle activity. Increased muscle force, range of motion and reduced pain levels were also noted.

There are however no studies which have directly investigated the effect of static stretching on the disturbed relationship of the ipsilateral gluteus maximus and contralateral latissimus dorsi muscles in unilateral sacroiliac syndrome.

The purpose of this study is to determine whether there is a particular treatment protocol, which will effectively restore the disturbed activity of the ipsilateral gluteus maximus and contalateral latissimus dorsi and hence provide insight into the possible causative or perpetuating factors in sacroiliac syndrome.

This study compares four treatment protocols aimed at restoring the imbalance mentioned above. They are SIJ manipulation alone, SIJ manipulation combined with static stretching of the ipsilateral gluteus maximus, SIJ manipulation combined with static stretching of the contralateral latissimus dorsi, SIJ manipulation combined with static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi.

1.2 Objectives of the Study

The purpose of this randomized comparative clinical trial is to determine the association between unilateral Sacroiliac Syndrome and gluteus maximus and latissimus dorsi muscle function.

The first objective is to confirm if unilateral sacroiliac syndrome is associated with disturbed ipsilateral gluteus maximus and contralateral latissimus dorsi activity in terms of surface EMG.

The second objective is to determine the effect of SIJ manipulation alone on ipsilateral gluteus maximus and contralateral latissimus dorsi muscle activity in terms of surface electromyographic findings.

The third objective is to determine the effect of SIJ manipulation combined with static stretching of the ipsilateral gluteus maximus on the ipsilateral gluteus maximus and contralateral latissimus dorsi muscle activity in terms of surface electromyographic findings.

The fourth objective is to determine the effect of SIJ manipulation combined with static stretching of the contralateral latissimus dorsi muscle on ipsilateral gluteus maximus and contralateral latissimus dorsi muscle activity in terms of surface electromyographic findings.

The fifth objective is to determine the effect of SIJ manipulation combined with static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi on ipsilateral gluteus maximus and contralateral latissimus dorsi muscle activity in terms of surface electromyographic findings.

CHAPTER TWO: REVIEW OF THE RELATED LITERATURE

2.1 Introduction.

The review of the literature will describe the incidence and prevalence of sacroiliac syndrome, the anatomy and biomechanics of the SIJ and the clinical features and diagnosis of sacroiliac syndrome. Furthermore the role that the surrounding musculature, particularly the gluteus maximus and latisimus dorsi muslces, plays in sacroiliac syndrome will be discussed.

2.2 Incidence of Sacroiliac Syndrome

LBP is one of the most common causes of disability and working days lost, particularly in industrialized countries, with a high lifetime prevalence and annual incidence (Mohseni - Bandpei et al. 1998).

It has been estimated that 70% - 85% of all people will suffer with LBP at some time in their life, with an annual prevalence of 15 - 45%; back pain is also the most common cause of activity limitation in persons under 45 years (Porter and Petersen 2000). Weiner and McCulloch (2000) note that LBP has a significant impact on both quality of life and health care costs.

LBP plays a significant role in the South African setting. Van der Meulen (1997) found the lifetime incidence of LBP to be 57% in the formal black settlement of Chesterville; whilst Docrat (1999) found that the lifetime incidence of LBP in Indian and coloured communities was 78.2% and 76.6% respectively.

In the literature of manual medicine the SIJ is widely accepted as a potential source of LBP. Some investigations have however detected SIJ dysfunction without concomitant LBP. According to Toussaint (1999), the medical literature estimates the prevalence of SIJ dysfunction to be between 19.3% and 47.9%.

Bernard and Cassidy (1991: 2114) state that the SIJ is frequently overlooked as the primary source of pain. Daum (1995) agrees that pathology of the SIJ is an underestimated cause of back or sciatic - type pain and elaborates that in a review of the records at a tertiary care centre, 40% of the diagnoses of patients with LBP included SIJ disease.

According to DonTigny (1999), lack of apparent movement of the SIJ and the density of the surrounding ligamentous structures has led to the assumption that the joint is immune to minor trauma. Compounding the problem is the incorrect evaluation of the joint, which together have led to an inaccurate diagnosis of up to 85%. DonTingy believes that a bomechanical lesion of the SIJ is the most likely mechanism of idiopathic LBP, which is easily treated and prevented with proper exercise and manipulation.

Although no epidemiological studies exist to definitively show the prevalence of SIJ syndrome within the South African population, with such a high prevalence of LBP, it would seem a fair assumption that SIJ syndrome contributes significantly to these numbers (Marzaleck 2002). In a study by Urli and Till (1995) on a sample of 30 South African nurses, it was found that in 33.3% the primary cause for LBP was SIJ syndrome, 6.6% had myofascial syndrome alone and 60% suffered with a combination of both.

In contrast to the above studies, there have been authors who have disputed that the sacroiliac joint plays such a large role in LBP. Nachemson (1992) questioned whether pain from the SIJ could be a differential diagnosis for LBP at all, due to the lack of validated reliability of clinical tests for SIJ dysfunction, as well as the relatively small amount to movement observed in a normal SIJ. Laslett (1997:

294) agreed and believed SIJ dysfunction causing LBP was as low as 3.5% - 6.5%.

Schwazer et al. (1995) believe that the true prevalence of SIJ syndrome is unknown and attributed this to the lack of validated clinical tests. Schwazer et al. thus conducted an athrographic investigation on 43 consecutive patients with LBP maximal below L5-S1. SIJ blocks, consisting of a 2% lignocaine solution, were administered under image intensifier. 13 (30%) of the patients experienced relief in symptoms and the SIJ was concluded as a significant source of LBP which warrants further research.

2.3 Anatomy of the sacroiliac joint:

The sacroiliac joint is in a unique and precarious position, both anatomically and functionally. It is either the end of the spine or the beginning of the lower extremity. It is called upon to bear significant forces but has little intrinsic articular stability (Daum 1995).

The SIJ is a true diarthrodial synovial joint consisting of a fibrocartilagenous iliac surface and a thicker hyaline sacral surface (Mior et al. 1999). The sacral surface is auricular or 'c' shaped and corresponds with the anteromedial aspect of the ilium. The SIJ is covered by a fibrous capsule attaching to the articular margins on either side. A synovial membrane (Palastanga et al. 2000: 390) lines the non-articular surfaces of the joint.

The surface characteristics of the opposing joint surfaces play an integral role in SIJ function. Bernard (1997:75) describes the iliac side as a rough fibrocartilagenous surface, compared to a smooth hyaline sacral side.

Ruch (1997: 324) noted irregularities of the joint surfaces were congruent on either side; elevations on the iliac surface matched depressions on the sacral side and vice versa. The function of these irregularities as suggested by Alderink (1991) is to allow for only slight sacral motion, which aids joint stability.

The Sacrum is suspended between the iliac bones by the interosseous and posterior sacroiliac ligaments (Moore 1992: 251). The ligaments are the strongest in the body and maintain stability in an otherwise unstable joint (Daum 1995). The SIJ is also surrounded by some of the most powerful muscles in the body, and although these muscles have no direct effect on the SIJ they do play an important role in sacroiliac movement (Bernard and Cassidy 1991: 2115/7). Both the role and function of the ligaments and muscles will be discussed in detail later in this chapter.

2.3.1 Age changes and sex variations

The SIJ first appears between the tenth and twelfth week of interuterine life and continues to develop until birth (Bernard and Cassidy 1991: 2108). By this stage the adjacent ilium has already ossified and hence the sacroiliac joint develops between the hyaline cartilage model of the sacral side and the newly ossified ilium (Bernard 1997: 73).

At birth the joint surfaces are smooth and flat, paralleling the long axis of the lumbar spine. A gradual change in joint contour and orientation occurs with age, with the iliac side becoming rough and bluish in colour and the sacral side remaining smooth and being creamy white (Bernard 1997: 75). These changes are presumed to be influenced by the mechanical forces of growth and bipedal gait (Bowen and Cassidy 1981).

A number of authors have described the degenerative changes, which occur in the SIJ following puberty. Kirkaldy-Willis (1992), (Bernard and Cassidy 1991: 2110) and Gatterman (1990: 112) describe evidence of joint cartilage degeneration (increased joint irregularities which begin to limit movement) in the 3rd decade for men and the 5th decade in females.

According to Mior et al. (1999: 214), thinning of the cartilagenous elements can lead to marginal ankylosis by the fourth decade and most joints are completely ankylosed by the eighth decade.

According to Gatterman (1990: 112), the degenerative changes, which occur, begin with crevice formation and fibrillation of the joint cartilage. Later changes include osteophyte formation, stiffening of the joint capsule and finally fibrous connections between the joint surfaces.

The differences between the sexes are apparent concerning the overall structure of the pelvis. The differences are linked to function (specifically parturition in women). Because of this, women may exhibit increased mobility of the SIJ compared with men, but the differences are not large and no definitive consensus has been reached (Harrison et al. 1997).

Cassidy and Mierau (1992: 211) on the other hand noted that the female SIJ was both smaller and flatter than the male and combined with hormonal weakening of the ligaments and the pubic symphysis in pregnant and menstruating females, may lead to hypermobility of the sacroiliac joints.

2.3.2 Sacroiliac ligaments

Bernard and Cassidy (1991: 2110 - 2111) divide the sacroiliac ligaments into primary and accessory ligaments.

The primary or intrinsic ligaments are formed by a thickening of the joint capsule and divided into anterior and posterior sacroiliac ligaments. The posterior or interosseous ligament forms the posterior border of the joint and binds the sacrum and ilium. It is the strongest of all the sacroiliac ligaments and one of the strongest in the body (Moore and Dally 1999: 340).

Harrison et al. (1997) describe the anterior sacroiliac ligament as an inferior thickening of the joint capsule. Its fibres are thin superiorly and become thicker inferiorly and attach horizontally across the joint. The ligament opposes translation of the sacrum up or down and prevents separation of the joint surfaces.

The accessory ligaments include the iliolumbar, sacrotuberous, and sacrospinous. The attachments according to Tobias et al. (1988: 174) are as follows:

Iliolumbar	- tip of the transverse process of L5 to the tip of the iliac crest. Pool-Goudzwaard et al. (2001) has described this ligament as the most important ligament for restraining movement at the lumbosacral junction, as well as restraining movement of the SIJ's).
Sacrotuberous	- posterior, superior and inferior iliac spines to the lateral edge of the lower sacrum and coccyx.

Sacrospinous	- runs transversely deep to the sacrotuberous ligament. Laterally it passes beyond the lateral margin of the sacrotuberous and its fibers attach to the lateral ischial spine.

Bernard and Cassidy (1991: 2110) describe the sacroiliac ligaments as forming a ligament complex, which functions to immobilize the sacrum between the two ilia and prevent x-axis rotation secondary to forces of gravity.

Wang and Dumas (1998) state that the stability of the sacroiliac is largely dependant on the surrounding ligamentous structures, whilst Pool-Goudzwaard et al. (1998) believe that continuous strain of these ligaments can lead to back pain.

2.3.3 Innervation of the Sacroiliac joint

Sensory innervation of the SIJ is extensive and highly varied (Daum 1995). This variation contributes to the varied pain referral patterns and diagnostic confusion (Gatterman 1990 111-128). Mior et al. (1999: 216) divide the sensory innervation of the SIJ into anterior and posterior surfaces. Posteriorly the nerves run between the superficial layer of the interosseous sacroiliac ligament and the dorsal sacroiliac ligament, and according to Ombregt et al. (1995: 691) are supplied by articular branches of the posterior primary rami from S1 and S2. The anterior surface of the joint, according to Bernard and Cassidy (1991: 2112) is innervated by the anterior primary rami of S1 and S2. Mior et al. (1999: 216) have also reported lateral branches of the posterior primary rami of L5 extending distally onto the joint.

Bernard and Cassidy (1991: 2112), also note that according to Hilton's Law (a joint may be innervated from any nerve that crosses it) the SIJ may be innervated from as cephalad as L2 to as caudad as S3 or S4. Bernard and Cassidy state that the synovial capsule of the SIJ and the overlying ligaments have free nerve endings that transmit pain, thermal sensation, pressure and position sense information.

Mior et al. (1999: 217) suggest that the rich innervation may be because the joint monitors the movement and position of the pelvic ring, contributing to keeping the body balanced and upright.

Indahl et al. (1999: 325 - 330) and Bernard and Cassidy (1991: 2111) describe non -specific articular nerve branches derived from muscles overlying the SIJ which are thought to have a unique feedback mechanism. The SIJ is thought to have a regulatory function on these muscles through an arthrokinetic reflex since the articular mechanoreceptors regulate muscle tone.

2.3.4 Biomechanics of the Sacroiliac joint

The postulated functions of the SIJ are to transmit or to dissipate the loading of the upper trunk to lower extremities (Bernard and Cassidy 1991: 2113). Moir et al. (1999: 221) state that the SIJ's position as link in the kinetic chain between the spine and legs makes it imperative that it has stability and mobility and yet be able to withstand the considerable forces acting on it. Examinations of the pelvis in skeletal specimens demonstrate that although the sacrum fits like a wedge into the pelvic ring, it is loaded in shear (DonTigny 1985). Considering the magnitude of the forces involved, other anatomic contributions to stability are necessary (Daum 1995).

The SIJ is surrounded by some of the largest and most powerful muscles in the body, but none have a direct effect on joint motion (Bernard and Cassidy 1991: 2113). Contractions of erector spinae, quadratus lumborum, piriformis, abdominal obliques and the gluteal muscles place shear and moment loads across the SIJ in proportion to their contraction force (Bernard and Cassidy 1991: 2114).

According to (Bernard and Cassidy 1991: 2113) the sacroiliac joints resist a downward shear load ranging from 300 to 1750 N, whilst Miller (1985) found that the SIJs could resist loads of 500 N without failure. During the act of lifting, the maximal compressive load at the L3 vertebra has been estimated to be 3500 N, this would translate to a shear load of 1750 N to each SIJ (Bernard and Cassidy 1991: 2113).

Mior et al. (1999: 221) relate that a number of authors have suggested that the vulnerability to shear may predispose the SIJ to subluxation superiorly. A protective 'self bracing mechanism' facilitated by the following characteristics is proposed:

1) The arch-like architecture of the pelvis
2) The joint longitudinal dimension being twice that of the transverse, thus increasing resistance to bending moments
3) Surface grooves and ridges resisting sliding movements
4) Higher coefficients of friction due to rough joint surfaces
5) The corkscrew appearance of the joint due to the wedge angles in the transverse cross sections at the two ends of the joint
6) Ligaments
7) Muscles

In a comprehensive study on the self bracing mechanism of the SIJ conducted by Snijders et al. (1993) it was found that the flat surfaces of the SIJ, in combination with the ligamentous system, point to a favorable intrinsic joint stability for the transfer of bending moments. The flat surfaces however, make the SIJ vulnerable to dislocation by shear. Snijders hypothesized that the compressive forces of the self-bracing mechanism counteract the large shear loads placed on the joint. A particular emphasis was placed on the gluteus maximus and sacrotuberous ligament. Anatomical preparations demonstrated that tension in the sacrotuberous ligament (preventing SIJ shear) can be enhanced by pull from the biceps femoris and gluteus maximus and part of the deep layer of the lumbodorsal fascia.

The SIJ allows for a small amount of anterior to posterior movement around a transverse axis. The movement occurs during flexion and extension of the trunk. The greatest change in position of the sacrum, in relation to the ilium results when the individual arises from a recumbent to a standing position. The sacral promontory moves forward as much as 5 - 6 mm when the body weight is taken by the sacrum (Hendler 1995).

Stresson (1997: 124) believes that the SIJ movements are very small, with an average rotation of 2.5 degrees and translation 0.7mm. Stresson also states that the male SIJ is thirty to forty percent less mobile than the females and only small differences occur in patients with unilateral versus bilateral SIJ pain.

Bernard and Cassidy (1991: 2113) believe that the predominant movement appears to be x-axis rotation (flexion and extension), with a degree of z-axis translation (anterior and posterior), but that the exact model of SIJ movement is unknown.

Smidt et al. (1995) felt that previous studies did not place the lower extremities in a position that would maximize sacroiliac motion and investigated 32 subjects in a 90% maximum stride position (termed the straddle position). The anterior and posterior iliac spines located by palpation, were digitized using a Metrecom probe and compared with those of the neutral position. The study found 9 degrees of oblique - saggital motion and 3 degrees of transverse motion.

According to Mooney (1993), the posterior ligament complex including the sacrospinous and sacrotuberous ligaments is the major contributor to stability of the SIJ. Mooney suggests that microscopic failure of these ligaments associated with the degenerative process or repetitive trauma is a likely component in the presentation of sacroiliac dysfunction.

2.3.5 Muscles

Moore and Dalley (1999: 550 - 551) describe the following muscles according to anatomy, attachments, actions, innervation and blood supply as follows:

2.3.5.1 Gluteus Maximus

The gluteus maximus is the most superficial gluteal muscle, it is the largest, heaviest and most coarsely fibred in the gluteal region. The gluteus maximus covers the other gluteal muscles except for the posterior third of the gluteus medius and forms a pad over the ischial tuberosity. The glutues maximus slopes inferolaterally at a 45-degree angle from the pelvis to the buttock. The proximal attachment is to the posterior ilium, dorsal surface of the sacrum and coccyx and sacrotuberous ligament. The insertion of the superior and larger part of the gluteus maximus and superficial fibres of the inferior part is to the iliotibial tract; whilst some deep fibres of the inferior part of the muscle attach to the greater tuberosity of the femur.

The main actions of the gluteus maximus are extension and lateral rotation of the thigh. The muscle extends the trunk over the lower limb and functions primarily between the flexed and standing position of the thigh, as when rising from a chair, straightening from the bending position, walking upstairs and running.

The gluteus maximus is innervated by the inferior gluteal nerve (L5, S1 and S2 nerve roots) and receives its blood supply from both the superior and inferior gluteal arteries.

2.3.5.2 Gluteus Medius and Minimus

These are smaller muscles and are fan-shaped, their fibres pass in the same direction as the gluteus maximus. The gluteus minimus and most of the gluteus medius lie deep to the gluteus maximus on the external surface of the ilium. They play an essential role during locomotion and are responsible for preventing sagging of the unsupported side of the pelvis during walking.

Their attachments are as follows:

Gluteus medius	- attaches from the external surface of the ilium between the anterior and posterior gluteal lines to the lateral surface of the greater trochanter of the femur.
Gluteus minimus	- attaches from the external surface of the ilium between the anterior and inferior gluteal lines to the anterior surface of the greater trochanter of the femur.

Both the gluteus medius and gluteus minimus are supplied by the superior gluteal nerve and receive their blood supply from the superior gluteal artery.

2.3.5.3. Latissimus Dorsi

According to Bogduk et al. (1998) the lastissimus dorsi is an intriguing muscle. From a relatively short, linear attachment on the humerus, this muscle covers the back of the thorax and influences the lumbar and sacral spine via its origin in the posterior layer of the thoracolumbar fascia. Bogduk notes that some authors have ventured to say that its aponeurosis crosses the midline to reach the contralateral posterior superior iliac spine, and that it is thereafter continuous with the contralateral gluteus maximus.

Mechanically, the latissimus dorsi is a powerful adductor and extensor of the humerus, but it has also been accorded an action on the lumbar spine and of late on the sacroiliac joint. It has been included as an extensor and lateral flexor of the back, and is purported to have a bracing effect on the sacroiliac joint, in concert with the gluteus maximus, through its action on the posterior layer of the thoracolumbar fascia.

Moore and Dalley (1999: 691) give the specific attachments of the latissimus dorsi as follows:

Origin:	Spinous process of the inferior 6 thoracic vertebrae, posterior layer of the thoracolumbar fascia, iliac crest and inferior 3 or 4 ribs.
Insertion:	floor of the intertubercular groove of the humerus.

2.3.5.4 The gluteus maximus and latissimus dorsi involvement in sacroiliac syndrome.

A number of authors have noted an association between the gluteus maximus and SIJ syndrome. Recent literature has also implicated the latissimus dorsi muscle as an influencing factor in load transfers in the lumbar spine and SIJ's. This sub-section will discuss these findings but more relevant to this study will elaborate on the suggested reciprocal relationship between these two muscles and their role in sacroiliac syndrome.

Indahl et al. (1999) questioned whether the SIJ plays a role in regulating reflex muscle activation, which controls trunk mobility, stability and locomotion. To investigate this, the researchers stimulated the sacroiliac joints and joint capsules of ten, 45 kg adolescent pigs using bipolar stimulation wire electrodes inserted into the ventral area of the SIJ. The study found significant electromyographic responses in the gluteus maximus and quadratus lumborum muscles, suggesting that the SIJ was involved in activation of these muscles. The EMG output for the latissimus dorsi muscles was not measured in this study.

Linberg (1997) noted hypertonicity and muscle spasm of the gluteus maximus in patients with SIJ subluxations, as did Cassidy and Mierau (1992) and Travell and Simonds (1992: 606) (who also noted active trigger points in the gluteus maximus in sacroiliac syndrome sufferers).

McGill (1992) correlated the EMG activity of the trunk musculature in eleven male subjects to various forces exerted on the lumbar spine whilst in different anatomical positions. The study revealed that the only muscle showing significant activity changes for different torque's placed on the lumbar spine was the latissimus dorsi. These findings suggest a regulatory function of the latissimus dorsi muscle on the lumbo-sacral spine. Conversely to Indahl et al. (1999) this study did not measure the EMG output of the gluteus maximus muscles.

Through dissections of the thoracolumbar spine, Vleeming et al. (1995) were able to demonstrate that the gluteus maximus muscle on the one side and the latissimus dorsi muscle on the other share an anatomical connection via the posterior layer of the thoracolumbar fascia. Mechanical displacement of the thoracolumbar fascia was also demonstrated when traction was placed on these muscles. Traction on either muscle resulted in a displacement that was large enough to affect the contralateral side, i.e. traction on the gluteus maximus displaced the latissimus dorsi on the contralateral side and vice versa.

Gracovetsky (1995) has also suggested a relationship between the gluteus maximus and contralateral latissimus dorsi through mathematical analysis of gait.

Mooney et al. (1995: 115) attempted to verify this interaction between the gluteus maximus on the one side and the latissimus dorsi on the other, using surface EMG analysis. Readings of the EMG activities in the gluteus maximus muscles and latissimus dorsi muscles were taken from 15 healthy subjects walking on a treadmill and undergoing trunk rotation on a torso rotation machine. The results confirmed the reciprocal relationship between the two muscles. The activity ratios of the muscles were shown to correlate with the normal reverse rotation of the shoulders versus the pelvis in normal gait, i.e. while the gluteus maximus on the one side contracted the latissimus dorsi on the other side was relaxed and vice versa.

Mooney et al. (1995: 115) then extrapolated their findings and postulated that this reciprocal relationship may have special significance in individuals with an 'incompetent' SIJ. An EMG analysis of five individuals suffering with unilateral sacroiliac syndrome was subsequently carried out, and it was shown that the ipsilateral gluteus maximus was over active and the contralateral latissimus dorsi was under active. The importance of these findings from a therapeutic sense is that it offers a rational treatment program for sacroiliac dysfunction, and the investigators suggest that treatment protocols including these two muscles should be investigated in patients suffering with sacroiliac syndrome.

According to Vleeming et al. (1995), in transferring forces between the spine, pelvis and legs, the posterior layer of the thoracolumbar fascia may play an important role; especially in rotation of the trunk and stabilization of the lower lumbar spine and SIJs. The gluteus maximus and the latissimus dorsi merit special attention because they conduct forces contralaterally, via the posterior layer. Harrison (1997) agrees and believes that through their reciprocal interaction, the gluteus maximus and contralateral latissimus dorsi function not to generate motion in a sacroiliac articulation but rather function to brace the area and create stability for an effective load transfer. Snijders et al. (1993) concur and proposes that these muscles, via their attachment to the thoracolumbar fascia, play a role in preventing harmful shear of the SIJ.

Vleeming et al. (1995) state that further studies must reveal whether muscles like the gluteus maximus and caudal part of the latissimus dorsi need to be emphasized in training programs in patients suffering with unilateral sacroiliac syndrome.

2.4 Mechanism of sacroiliac syndrome

In the literature on manual medicine, the sacroiliac joint is widely accepted as a potential source of LBP. On the other hand, some investigators have detected SIJ dysfunction without concomitant LBP (Toussaint 1999).

Osterbauer et al. (1993) state that sacroiliac syndrome being clinically distinct from other syndromes causing low back LBP is still controversial. According to Osterbauer et al., the difficulty in distinguishing these syndromes stems from an inability to clearly differentiate sacroiliac joint syndrome from other factors such as facet syndrome, disc lesions and other low back pathologies causing pain.

Osterbauer notes that the primary diagnostic criteria relied on thus far have been a) pain in the buttock or sacroiliac joint, b) pain elicitation by SIJ provocation tests and c) the absence of other factors.

According to Daum (1995) the sacroiliac joint as a source of LBP is gathering renewed interest. He attributes this renewed interest to advancements in spinal imaging, which enables physicians to eliminate pathological conditions of the disc or canal from the differential diagnosis with some assurance. Daum notes that a number of conditions can affect the SIJ but that the most common cause of sacroiliac dysfunction is acquired mechanical instability leading to either subluxation or hypermobiliy of the SIJ.

Hesch (1997: 535) agreed that a hypermobile SIJ would not adequately absorb stress from daily activities, causing surrounding structures to become overstressed. Snijders et al. (1993) discuss how the SIJ's flat surfaces are well suited for stresses applied to the joint through the load transfer from trunk to the lower extremities, but are vulnerable to shear forces which can lead to sacroiliac dysfunction and ultimately pain.

Vleeming et al. (1995) believe that the understanding of low back pain will be seriously hampered by neglecting the SIJs as elements of the load transfer between the spine and legs. Vleeming points out that pain in the area of the SIJ is generally not regarded as LBP and this is due to incomplete knowledge of the specific anatomy of the joint. Vleeming et al. (1996) believes that if one uses a descriptive anatomical model, it is tempting to regard pain in the area of the SIJ as a separate syndrome, but it should be remembered that the SIJ is part of an integrated system between the pelvis and legs.

Reid (1992: 661) states that pain from the sacroiliac area in young active people cannot be denied and the ability to access this joint requires special skills that are holistic and multidisciplinary in nature. Kirkaldy-Willis and Burton (1992: 126) agree that SIJ dysfunction is common, and further note that the sacroiliac syndrome has a well defined clinical presentation. Bernard and Cassidy (1991: 2114) also agree and reiterate that since the SIJ is a synovial joint and subjected to the same inflammatory, infectious and dysfunctional conditions as other synovial joints, it is logical to infer that the SIJ can be a source of pain.

Daum (1995) confirms that the SIJ is an anatomically atypical synovial joint. He also notes that the combination of the joint's extensive innervation as well as the constant and significant stresses placed on the joint and associated ligaments accounts for the multiple modes of presentation of sacroiliac syndrome.

Mior et al. (1999: 223) state that although the SIJ's role as a causative factor in the genesis of low back and leg pain is becoming increasingly accepted, the underlying mechanisms are speculative at best.

It has been suggested that pain about the SIJ is commonly mechanical in nature. Ostenbauer et al. (1993) state that most manual medicine practitioners believe that the underlying biomechanical lesions associated with SIJ dysfunction is fixation of the SIJ.

Dreyfuss et al. (1994) define dysfunction of the SIJ as a state of relative hypomobility within a portion of the joint's range of motion with subsequent altered structural (positional) relationship between the sacrum and ilium. Dreyfuss et al. subdivide sacroiliac dysfunction into:

> Sacro-iliac dysfunction which occurs when there is an alteration of the structural relationship between the sacrum upon the normally positioned stable ilium, or
>
> Iliac-sacral dysfunction which occurs when the ilium maintains an abnormal position to a 'normally' positioned stable sacrum.

SIJ dysfunction, often termed subluxation occurs when the ilium slips on the sacrum. An irregular prominence of one of the articular surfaces becomes wedged upon the prominence of an opposed articular surface. In this situation ligaments become taut reflex muscle spasm occurs causing intense, severe pain (Hendler 1995).

2.5 Clinical presentation and diagnosis of sacroiliac syndrome

The pain in patients presenting with sacroiliac syndrome can be sharp, aching or dull. It can be referred to the buttocks, groin, posterior thigh and occasionally below the knee. Symptoms are usually unilateral and have a right-sided predominance. Pain is aggravated by bending, sitting or riding in an automobile and frequently alleviated by standing or walking. Rarely are there neurological symptoms of weakness, paresthesias or dysesthesias (Bernard and Cassidy 1991: 2115).

Daum (1995) states that most patients will have pain and tenderness directly over the posterior SIJ. Discomfort rarely extends below the knee and this pattern is sometimes indistinguishable from the discomfort of lumbar facet syndrome. The key point according Daum is that there is no true radicular pattern and due to the extent of the joint's innervation, presentation can include pain referred to the groin, anterior pelvis or anterior proximal thigh.

According to Slipmann et al. (2000) the variable patterns of pain referral are due to the complex innervation of the joint, irritation of adjacent structures and varying locations of injury within the joint itself.

On physical examination the patient appears most comfortable while sitting on the unaffected buttock. Whilst sitting the patients may also assume an atypical forwardly flexed posture that removes tension from the hamstring, which applies traction to the diseased joint. In contrast, forward bending whist standing is limited and painful, since the tension on the hamstrings limits forward excursion of the pelvis (Hendler 1995).

Bernard and Cassidy (1991: 2115) note that physical findings common to sacroiliac syndrome include tenderness over the sacral sulcus and the posterior joint line. They also note that lumbosacral spine range of motion may elicit pain with flexion and extension, but usually not with lateral bending unless there is a concomitant posterior facet lesion. They agree with previous authors that hamstring tightness may be present.

According to Mior et al. (1999: 222), the patient may report parasthesias or a subjective decrease in sensation to light touch, but there is no neurological deficit. Mior et al. further note that weakness noted on examination is typically the result of pain or muscle imbalance as opposed to a hard neurological finding.

Ostenbauer (1993) states that primary diagnostic criteria relied on in the past have been:

pain in the buttock,

pain elicitation in SIJ by provocation

absence of other factors such as disc lesions, sciatica, radiating pain and neurological deficit.

According to Van der Wurf et al. (2000) a wide variety of sacroiliac tests are available to detect dysfunction of the joint, none appearing more superior to others. Van der Wurf describes three types of tests used to examine the SIJ:

a) motion palpation test to access movement
b) pain provocation tests to stress SIJ structures, and
c) tests for pelvic position

Ostenbauer (1993) however states that the iliac compression and pain on distraction tests are often considered the most reliable and pathognomonic of sacroiliac syndrome.

Bernard and Cassidy (1991: 2115) believes that there is no direct method for isolating SIJ pain, but agree that there are several provocation manoeuvres that appear to be selective for the SIJ. They also believe that a positive test is only significant when the clinical history and remaining physical findings rule out other syndromes.

Broadhurst and Bond (1998) examined three commonly used stress tests; namely Patrick Faber, Posterior Shear (POSH) and resisted abduction test (REAB). Their results showed a a 77% sensitivity and a 100% specificity, an 80% sensitivity and a 100% specificity and an 87% sensitivity and a 100% specificity respectively for each test.

According to Mior et al. (1999: 226) the most commonly used orthopedic tests used to assess the SIJ are the Yeomann's, Gaenslens, Patrick Faber and the sacroiliac (posterior) shear test.

Bernard and Cassidy (1991: 2115) describe the Yeomann's test as follows:
With the patient lying prone, the SIJ is stressed by extending the hip and rotating the ilium. A positive test produces pain over the posterior SIJ. This test however also extends the lumbar spine and stretches the femoral nerve.

Giles and Singer (1997: 397) describe the Gaenslens test as follows:
The patient lies supine on the table, both legs are drawn to the chest and then the unsupported leg is allowed to drop over the edge, while the opposite leg remains flexed. Pathology in the SIJ is indicated by invoked pain.

Giles and Singer (1997: 397) describe the Patrick Faber test as follows:
The patient lies supine on the table. The foot of the painful side is placed on the opposite knee. The hip is thus flexed, abducted and externally rotated. A positive test is indicated by pain over the SIJ.

Bernard and Cassidy (1991: 2115) describe the sacroiliac (posterior) shear test as follows:
With the patient lying prone, the palm of the hand is placed over the posterior iliac wing, and an inferiorly directed thrust produces a shearing force across the SIJ, often producing familiar pain in the symptomatic joint.

Both the Gaenslens and the sacroiliac shear tests have been shown to be reliable in studies by Laslett and Williams (1994) and Dreyfuss et al. (1994).

2.6 Treatment of sacroiliac syndrome

2.6.1 Manipulation

Manual therapies whose primary effect is on joint structures are physical manoeuvres designed to induce joint motion. They are intended to treat disorders of the neuromuscluoskeletal system by decreasing pain and improving joint range and quality of motion. This leads to their common application in the treatment of neuromusculoskeletal disorders that are associated with joint pain or hypomobiliy (subluxation or dysfunction) (Peterson and Bergmann 2002: 98).

According to Shakelle (1994) manipulation is a form of manual therapy that involves movement of a joint past its usual end range of motion but not past its anatomic range of motion; in an area, which has been termed the paraphysiological range. Mohseni - Bandpei et al. (1998) define manipulation as a small amplitude, high velocity thrust at the limit of a patient's range of motion so that the joint is briefly taken beyond the restricted range of motion.

Chiropractic management, in the form of manipulation, has been shown to be effective in the treatment of LBP in clinical trials and in reviews of the related literature (Triano et al. 1995, Meade et al.1995, Van Tulder et al.1997, Mohseni - Bandpei et al. 1998, Shakelle 1994).

Triano et al. (1995) conducted a randomized clinical trial on 145 patients to contrast the effectiveness of manipulation, a manipulation mimic and a back extension program in patients suffering with untreated LBP for seven weeks or longer, or having more than six episodes within 12 months. The results showed a significant improvement in the manipulation group in terms of pain and activity tolerance compared to the other groups and an immediate relief in pain following the manipulation, which lasted for the duration of the study. The investigators concluded that manipulation appears to be of clinical value in the treatment of LBP, even in patients suffering with LBP for 7 weeks or longer.

In comprehensive study by Meade et al. (1995) the effectiveness of chiropractic management was compared to hospital outpatient management for LBP. The study, conducted over a three-year period, included 741 patients between the age of 18 to 64. Patients, who were randomly assigned to treatment within a hospital setting or by a qualified chiropractor, evaluated their treatment outcomes at the end of the three-year period. The study found that pain and disability improvements were 29% greater for the group treated by chiropractors than the group treated within the hospital setting. The study concluded that chiropractic management was superior to hospital management in the long-term treatment of LBP.

In a review of 25 studies judged to demonstrate the efficacy of manipulation in the treatment of LBP, Mohseni - Bandpei et al. (1998) found that there is evidence suggesting that manipulation is more effective than other interventions in the long and short-term treatment of LBP. According to Mohseni – Bandpei et al. strong conclusions were not deducible as a large number of the studies reviewed had methodological flaws. Van Tulder et al. (1997) on the other hand reviewed 16 randomized clinical trials on the conservative treatment of acute and chronic nonspecific LBP and found strong evidence indicating that manipulation is more effective than other conventional treatments in the treatment of acute LBP.

Shakelle (1994) reviewed nine studies, of the effect of chiropractic manipulation on patients with acute or sub-acute LBP. Shakelle noted a wide range of quality among the studies and hence scored them with an explicit rating scale. The two best studies found clinically and statistically significant benefits of manipulation in terms of functional status in patients whose pain had persisted for 2-4 weeks before treatment. The combined results of all the reviewed studies also indicated that spinal manipulation was more effective than other interventions investigated by an average of 34%.

2.6.2 Sacroiliac Manipulation

A number of authors have shown manipulation of the SIJ to be an effective intervention in the treatment of sacroiliac syndrome (Reid and Peers 1996, Marzeleck 2002, Osterbauer 1993).

Reid and Peers (1996) compared two manipulative techniques used in the treatment of sacroiliac syndrome. This randomized controlled trial comprised two groups of fifteen subjects each. One group received a side posture 'roll' adjustment whilst the other received an adjustment over the posterior inferior ilium using a Thompson Drop Table. The study found that either method produced significant improvements in both subjective and objective findings. The study noted that a lager sample size would add to the validity of similar studies in the future.

Marzeleck (2002) investigated the effect of manipulation of the affected SIJ versus manipulation of the affected and unaffected SIJ, in the treatment of unilateral sacroiliac syndrome. This study was comprised of sixty subjects randomly assigned into one of two groups. Each individual received four manipulations over a period of two weeks; the one group naturally only having the affected joint manipulated and the other having both SIJ's manipulated. This study found that both groups improved in terms of objective and subjective findings and the researcher concluded that manipulation was a useful therapy in the treatment of unilateral sacroiliac syndrome.

Osterbauer (1993) evaluated a manually assisted, short lever adjustment in subjects suffering with chronic sacroiliac syndrome. In this study a diagnosis of primary, chronic, uncomplicated sacroiliac syndrome was made in 10 subjects following a strict evaluation of 153 consecutive new patients. Each subject underwent a six-week treatment program involving SIJ adjustments. The study found a significant decrease (from a base line value of 25 to 12) in pain intensity levels as measured by a visual analog scale. The average disability scores of the Oswestry disability index diminished from twenty eight to thirteen percent, and a reduction in the number of positive provocation tests was noted. A one year follow up was conducted and a stability of symptoms at a low level was also noted.

According to Hesch (1997) apparent hypermobiliy and hypomobility can often co-exist in the same SIJ. Hesch believes that mobility testing can reveal hypermobiliy in one direction accompanied by hypomobility in the other. Furthermore it is suggested that treatment of sacroiliac syndrome should be directed at restoring normal movement in the direction of the hypomobility, which will restore the apparent hypermobility to normal movement. Hendler et al. (1995) agree and state that sacroiliac subluxation may be reduced by manipulation and advocate the use of daily manipulation for up to 10 days in self-limited cases.

Daum (1995) is of the opinion that the purpose of physical therapy should be to plan a series of manipulations combined with pelvic muscle strengthening, which will both reduce and stabilize the presumptive instability or subluxation of the affected SIJ. Daum advocates the use of manual therapy for up to six weeks, after which alternative therapy should be investigated.

2.6.3 Muscle Stretching

According to Khalil et al. (1992) there are very few controlled studies which have been conducted to clarify the efficacy of stretching, mobilization and manipulation. Khalil et al. further note that a many of the studies do not provide complete description of the techniques used, making it difficult to duplicate the procedures described or fully understand the mechanism by which improvement may have occurred. Unspecified methodology, lack of control groups, and confusion of terminology were some of the errors noted.

Reid (1992: 80,81) defines stretching as the process of elongation and notes that this may be achieved by elastic or plastic deformation. Reid notes that stretching techniques are advocated with musculotendinous tightness and joint contractures, which may result from poor training techniques, muscle and joint injury and immobilization after trauma.

Manipulation combined with stretching of various muscles in close proximity to the SIJ has been investigated and found to be beneficial in the treatment of sacroiliac syndrome. Ranwell (2001) and Paton (2001) both conducted controlled clinical trials in which thirty subjects receiving manipulation alone were compared to thirty subjects receiving manipulation combined with proprioceptive neuromusclular facilitation (PNF) stretching in the treatment of sacroiliac syndrome. Ranwell combined manipulation with stretching of the piriformis muscle while Paton combined manipulation with stretching of the of the gluteus maximus muscle in their treatment groups. Although in both cases the control and experimental groups improved in terms of subjective and objective findings, the authors maintained that muscle stretching remains a useful adjunct in the treatment of sacroiliac syndrome.

Khalil et al. (1992) investigated the effectiveness of using a systematic, aggressive stretching procedure as an 'add on' therapy in the treatment of LBP. In the study, 28 chronic LBP sufferers were randomly assigned into one of two groups. The control group underwent a multimodal rehabilitation program, and the experimental group underwent the same rehabilitation program followed by the stretching procedure. The results showed that the both groups improved in terms of static strength of the back extensors, surface EMG readings of the back extensors and in pain intensity levels. The use of the stretching procedures however enhanced functional abilities to a greater extent when compared to the control group.

Prentice (1983) and Moore and Hutton (1980) have both compared static stretching to PNF stretching and found that either technique was effective at improving the outcome investigated. Prentice compared the effects of static stretching techniques to PNF on flexibility changes on the hip, and noted that both groups showed a significant improvement in hip mobility. Moore and Hutton used surface electromography on the hamstring muscle to investigate the two forms of muscle stretching, and noted that both groups showed an improvement in terms of surface EMG findings. The authors thus concluded that static stretching and PNF stretching were effective therapeutic interventions in the treatment of muscluoskeletal complaints.

2.7 Surface EMG.

A number of investigators have used surface EMG as an objective measuring tool of muscle function. This sub-section discusses the studies, which have used surface EMG for measuring muscle function of the trunk and low back and their possible association to LBP. The reliability and validity of surface EMG is also discussed.

Keller and Colloca (2000) used surface EMG to investigate a possible neuromuscular reflex response following a posteroanterior (PA) manipulative thrust in the lumbar spine in subjects suffering with LBP. Surface, linear-enveloped, electromyographic (sEMG) recordings were taken from 22 subjects via eight electrodes (leads) located over the L3 and L5 paraspinal musculature to monitor bilateral neuromuscular activity of the ererctor spinae muscles during the thrusts. sEMG neuromuscular reflex responses were calculated for each thrust and the study was successfully able to demonstrate a positive reflex response.

Lee and Kang (2002) assessed the effects of breathing and belt pressure on trunk muscle EMG activity during lifting tasks. EMG recordings of the latissimus dorsi, erector spinae, external obliques and the rectus abdominis were taken on eleven male subjects performing repetitive squat lifts. The recordings from the surface EMG demonstrated that the use of a belt in lifting significantly reduces back muscular activity, while it increases abdominal muscular activity.

Richardson et al. (2002) used surface EMG to verify muscle contractions of the transversus abdominis muscle in a study investigating relationship between SIJ joint laxity and contractions of the transversus abdominis muscle in LBP suffers. 11 male subjects performed two contraction patterns; the first involved contraction of the transversus abdominis independent of the other abdominal muscles and the second involved a bracing action of all the lateral abdominal muscles. The results demonstrated that contractions of the transversus abdominis significantly decreased the laxity in the SIJ.

Mooney et al. (1995: 115) used surface EMG on fifteen healthy subjects to evaluate a reciprocal interaction between the gluteus maximus and the latissimus dorsi muscle on the opposite side. The study recorded EMG output whilst patients walked on a treadmill and underwent a trunk rotation exercise. The researcher was able to use surface EMG to confirm this relationship between these two muscles. The researcher used surface EMG to demonstrate an over activity in EMG output of the ipsilateral gluteus maximus and an under activity of the contralateral latissimus dorsi muscle in patients suffering with unilateral sacroiliac syndrome.

Lehman (2002) investigated the clinical considerations in the use of surface EMG. The study examines issues of EMG asymmetry and repeatability in populations with and without LBP in three separate studies. The first study investigated the repeatable of EMG signals of the paraspinal musculature in the same person in three consecutive days. The second study used a population of chronic LBP sufferers to compare bilateral asymmetries of the paraspinal musculature at different segments during quiet stance. In the third study, persons with LBP and persons in a control group were assessed for dynamic asymmetries of the paraspinal musculature during forward bending. The results showed excellent repeatability of the signals in study one and no differences in bilateral asymmetry between painful and non-painful segments during quiet stance in study two. Study three however revealed that dynamic asymmetries existed in the lower erector spinae in LBP sufferers.

Lariviere et al. (2002) assesed the reliability and validity of EMG assessment of the back muscles. This prospective study investigated surface EMG on four pairs of homologous back muscles while subjects performed static trunk extension exercises. Twenty healthy males and twenty suffering with LBP were investigated. Thirteen healthy female subjects were also assessed to obtain a third group known to have lower muscle strengths and different muscle compositions. EMG parameters were shown to have good to excellent repeatability but appeared to be insensitive to back muscle strengths between the groups.

Abou-Chadi et al. (2001) agree that EMG is a reliable measurement tool when used correctly. According to Abou-Chadi et al., surface EMG provides an integrated system for analysis, which can be used to provide the physician with a diagnostic assist aid.

CHAPER THREE : MATERIALS AND METHOD

3.1 Introduction

This chapter gives a detailed description of the design, primary and secondary data, the subjects and interventions utilized. An overview of surface electromyographic readings taken is discussed as well as the methods of statistical analysis and the process of evaluation of the data.

The study design chosen was a randomized, comparative, clinical trial. This involved four treatment groups, one receiving chiropractic manipulation of the affected SIJ only, one group receiving chiropractic manipulation of the affected SIJ and static stretching of the ipsilateral gluteus maximus muscle, one group receiving chiropractic manipulation of the affected SIJ and static stretching of the contralateral latissimus dorsi, and one group receiving chiropractic manipulation of the affected SIJ and static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi.

3.2 The data

The data consisted of primary and secondary data.

3.2.1 The primary data

Clinical observation of muscle activity change through measurement using surface electromyography.

3.2.2 The secondary data

The secondary data consists of data obtained from various sources, including journal articles, books, medline and the internet, using relevant search engines.

3.3 The subjects

The subjects were drawn from the greater Durban area by means of pamphlets, distributed locally, as well as by advertisement placed at the Chiropractic Day Clinic, gyms, sports clubs, tertiary institutions and local newspapers and newsletters. Sixty subjects were selected from those who responded, using convenience sampling. No stratification of the patients took place and they were accepted without regarding gender, occupation, race, severity or chronicity of the condition.

Patients responded to the advertisements telephonically and a brief interview excluded patients who did not fit the age criteria of 18 - 60 yrs, were pregnant or who had recent lumbar surgery. All other patients were evaluated through a case history (APPENDIX E), relevant physical exam (APPENDIX F), low back regional examination (APPENDIX G) and orthopedic SIJ tests (APPENDIX H). A letter of information was provided (APPENDIX A) and a letter of informed consent (APPENDIX B) was signed prior to placing the patient into the study.

3.4 Inclusion and exclusion criteria

a) Kirkaldy - Willis and Burton (1992: 418) discuss the possibility of fibrous ankylosis of the sacroiliac joint after the sixth decade. For this reason only patients 60 years of age or younger were included into the study. Patients younger than 18 were also excluded to avoid parental consent legalities.

b) Only patients testing positive for at least 3 out of the 5 sacroiliac stress test, namely Gaenslen's, Yeomann's and Patrick Faber (Magee 1992: 319-343), posterior shear (Laslett and Williams 1994) and sacroiliac tenderness (Paton 2002), were included in the study.

c) Secondary concomitant mechanical conditions to sacroiliac syndrome (eg. latent myofascial trigger points or lumbar facet syndrome) did not exclude patients from the study, these conditions were however not treated.

d) Patients suffering with bilateral sacroiliac syndrome were excluded from the study.

e) Patients taking pain and/or anti-inflammatory medication up to three days prior were excluded from the study.

f) Patients with suspected contraindications to spinal manipulation (Gatterman 1990: 112) including: osteomyelitis, T.B of the spine, infectious arthritis, vertebral malignancies, spondylolisthesis, severe osteoporosis.

g) Patients presenting with signs of nerve root tension or cauda equina syndrome were excluded.

h) Patients were required not to receive any additional manual therapy for sacroiliac syndrome during the research period.

3.5 Ethical considerations

Following a full explanation of the study, each participant was furnished with a letter of information (APPENDIX A) about the study and given an opportunity to ask questions should there be any misunderstanding. Following this, provided the patient was satisfied, they were required to sign a letter of informed consent (APPENDIX B) to join the research program. The following points were highlighted for the patients well being:

- The study conducted comprised four groups. Each individual had an equal chance of being in any group.
- Patients were free to withdraw from the study at any stage without explanation.
- Treatment consisted of established and widely used interventions in the form of chiropractic manipulation and muscle stretching.
- All information was regarded as strictly confidential.
- Participation was voluntary and no financial benefit was provided to the patient.
- The rights and welfare of the patients were to be protected at all times.

3.6 Diagnosis

An initial screening consultation was conducted in order to make a diagnosis of SIJS. This consultation included a complete Case History (APPENDIX E), a brief physical examination (APPENDIX F) and a thorough Lumbar Spine Regional Assessment (APPENDIX G). A definitive diagnosis was then confirmed by the researcher using the following 5 criteria, three of which must be positive for the subject to be eligible to take part in the study:

Tenderness or pressure over the posterior superior iliac spine (Paton 2001); Positive sacroiliac provocation/stress tests ie. Yeomann's Extension test, Patrick Faber's test and Gaenslen's test (Magee 1992: 319,343); and finally the Thigh Thrust or Posterior Shear test evaluated favourably by Laslett and Williams

(1994) and Broadhurst and Bond (1998) for inter-examiner reliability, sensitivity and specificity (APPENDIX H).

3.7 The sample group

The sample for the study consisted of 60 patients, selected according to the criteria defined above. Patients were then randomly allocated into one of four groups without the use of stratification, depending of the number they drew from a box. Numbers 1-15 were allocated to group A, 16-30 to group B, 31-45 to group C, 45-60 to group D.

Group A received SIJ manipulation alone. Group B received manipulation combined with static stretching of the ipsilateral gluteus maximus muscle. Group C received manipulation combined with static stretching of the contralateral latissimus muscle and Group D received manipulation combined with static stretching of the ipsilateral gluteus maximus and the contralateral latissimus dorsi muscles.

3.8 Measurements

Surface electromyography (EMG)

Surface EMG readings were taken using the PowerLab/410 (137) unit (AD Instruments Pty Ldt, unit 6, Gladstone Rd, Castle Hill, NSW 2154, Australia). Raw EMG signals received were high pass filtered at 10 Hz, low pass filtered at 500-Hz, full wave rectified and smoothed to yield smooth rectified EMG (SEMG) readings. The readings were taken whilst each participant walked at a constant speed on a treadmill for one minute. Patients were told to face forward and walk as normally as possible.

Placement of the surface electrodes was done in accordance with Mooney et al. (1995: 115), and was as follows:

Electrodes on the gluteus maximus were placed just posteromedial to the greater trochanter. The electrodes on the latissimus dorsi muscle were placed one-centimeter inferolaterally to the inferior border to the scapula. The EMG readings were recorded in millivolts (mV)

Readings taken were to assess asymmetries in muscle activities. The gluteus maximus muscles were compared to one another, as were the latissimus dorsi muscles, at both the initial and final consultation. This enabled the researcher to confirm the assumption that the ipsilateral gluteus maximus would be over active, while the contraleral latissimus dorsi would be underactive, in subjects suffering with unilateral sacroiliac syndrome. Furthermore larger asymmetry in muscle activity at the initial consultation followed by a smaller asymmetry at the final consultation was considered a favorable outcome (improvement in the patients condition). A larger asymmetry at the final consultation was considered negative finding (a deterioration in the patient's condition).

To effectively analyze changes, the difference in muscle activity between either side was represented as a relative value (the activity difference as a percentage of the individuals total muscle activity). This was modeled on the way in which Keller and Colloca (2000) recorded and analyzed the surface EMG results in their study. This was done to allow for large variations in muscle EMG within the population, i.e. a large individual may have large EMG readings but a relatively small difference between each side, whilst a small individual may have lower EMG readings but have a relatively large difference between either side. The relative values calculated were rounded of to the nearest whole number. The mean values, which were used to calculate the test statistic, were however displayed to two decimal places. This ensures correct calculation of the p value, from which decisions were made.

Surface EMG has shown good to excellent repeatability (Lehman 2002 and Lariviere 2002) and is considered to be a reliable diagnostic assist aid and measurement tool when used properly (Abou-Chadi et al. 2001).

3.9 Interventions

Each subject who was accepted for the trial attended four consultations within a two-week period, with a final data capturing consultation approximately one week later. Participants within each group received the respective treatment protocol as described in section 3.7.

3.9.1 Manipulative therapy

Subjects received manipulation of the affected joint in accordance to the diversified technique described by Schafer and Faye (1990). The adjustment described involved lying the patient in a lateral recumbent position with the fixation side up. A hypothenar or thenar contact was then taken over the affected joint and a body drop thrust applied.

3.9.2 Muscle stretching

Each participant placed into one of the three stretch groups received a static stretch of the relevant muscle, in accordance to technique described by Travell and Simmons (1998: 132). Stretching of the gluteus maximus muscle involved lying the patient supine, drawing the affected knee towards the opposite shoulder, and placing pressure on the knee until the patient felt a stretch in the muscle. A series of three stretches were done, each lasting 10 - 15 seconds.

Stretching of the affected latissimus dorsi muscle involved seating the patient in the upright position, abducting the arm of the affected side to the ear, leaning the upper body towards the unaffected side and placing pressure on the arm until the patients felt a stretch in the muscle. A series of three stretches were done, each lasting 10 -15 seconds.

Patients were also instructed to stretch at home daily. They were required to stretch 3 times a day for two weeks. A Stretch Record Sheet (APPENDIX C) and a Stretch Technique Sheet (APPENDIX D) were supplied to facilitate compliance.

3.10 Treatment of the sub-problem

The purpose of this randomized comparative clinical trial is to determine the association between unilateral Sacroiliac Syndrome and gluteus maximus and latissimus dorsi muscle activity.

3.10.1 The sub-problems

The first sub problem was to confirm whether sacroiliac syndrome is associated with disturbed ipsilateral gluteus maximus and contralateral latissimus dorsi muscle activity in terms of surface EMG findings.

The second sub-problem was to determine the effect that manipulation, manipulation combined with static stretching of the ipsilateral gluteus maximus, manipulation combined with static stretching of the contralateral latissimus dorsi, manipulation combined with static stretching of both the ipsilateral gluteus maximus and contralateral latissimus doris muscles had on the ipsilateral gluteus maximus muscle activity in terms of surface electromyographic findings.

The third sub-problem was to determine the effect that manipulation, manipulation combined with static stretching of the ipsilateral gluteus maximus, manipulation combined with static stretching of the contralateral latissimus dorsi, manipulation combined with static stretching of both the ipsilateral gluteus maximus and contralateral latissimus doris muscles had on the contralateral latissimus dorsi muscle activity in terms of surface electromyographic findings.

3.11 Statistical Analysis

3.11.1 Statistical analysis

Statistical analysis was conducted on the objective data using the SPSS version 9.0 statistical software program (manufactured by SPSS Inc.,444N. Michigan, Chicago, Illinois, 60611, USA) and was presented in the form of graphs and tables. The statistical evaluation was aimed at measuring any significant changes in the surface electromyographic readings at the initial and final consultation.

The Durban Institute of Technology statistician was consulted concerning the manner in which the research study was analyzed. Due to the small sample size, i.e. fifteen in each group, non-parametric tests were used.

Inter-group analysis was done using the Kruskal-Wallis H test, whilst intra-group analysis was made using the Wilcoxon Signed Rank Test. All data were analyzed at a 5% level of significance and decisions made using the appropriate p value. The p value is a probability, with a value ranging from zero to one.

3.11.2 Hypothesis testing and the decision rule.

3.11.2.1 Kruskal-Wallis H Test

The Kruskal - Wallis H test is a non-parametric test that compares three or more independent groups and was used to determine if there was any significant difference in the surface EMG changes between reading one and reading two (the variable of interest) among the four groups A,B,C and D.

The null hypothesis (Ho) stated that there was no difference among the four groups with regard to the variable of interest. The alternative hypothesis (H1) stated that there was a difference between the four groups with regard to the variable of interest.

- Ho : $M_A = M_B = M_C = M_D$ (The population mean differences between readings one and two are all equal among all four treatment groups).
- H1 : (At least one population mean difference is not equal)
- $\alpha = 0.05$ = level of significance of the test

Decision Rule:

For a two tailed test:

- reject Ho at α level of significance of $p < \alpha/2$
- Accept Ho at α level of significance if $p \geq \alpha/2$

According to Daniel (1978: 211,213), if the null hypothesis is rejected for the multiple comparison Kruskal-Wallis test, then a Dunn's procedure must conducted to isolate which population groups differed.

3.11.2.2 Wilcoxon Signed Rank Test

This non-parametric test was used to make intra-group comparisons. This was in order to determine whether any significant change occurred between mean values within each group between the initial and final consultation. Note the mean values (variable of interest) are calculated as a ratio i.e: the EMG difference in the two muscles divided by the total EMG muscle activity.
$\alpha = 0.05$ = level of significance

Hypothesis testing:
The null hypothesis Ho stated that there was no difference between consultations with regard to the variable of interest. The alternative hypothesis H1 stated that there was a difference between consultations with regard to the variable of interest.

- Ho : The two readings yield identical population means
- Hi : The population mean post treatments is greater or less than the population mean prior to treatments .
- $\alpha = 0.05$ = level of significance of the test

The decision rule:
For a two tailed test:
- reject Ho at α level of significance of $p < \alpha/2$.
- Accept Ho at α level of significance if $p \geq \alpha/2$

CHAPTER FOUR: THE RESULTS

4.1 Introduction

This chapter deals with the results obtained from the statistical analysis of the data recorded in the trial. It also includes demographic information of all patients accepted into the trial

Information obtained from the case history, low back regional examination and surface EMG was used as data for the study. The researcher took all the surface EMG readings.

This study consisted of 60 subjects, with 15 in group A, 15 in group B, 15 in group C and fifteen in group D. The results from the inter and intra-group analysis were represented in tables. The tabulated statistical results included the level of significance (p-value). The descriptive data were represented in pie and bar graphs. The p-value was compared to the significance, which was set at α = 0.0 5 for all the tests.

4.2 Descriptive statistics

4.2.1 The sample

Eighty seven patients, from the greater Durban area, responded to the advertisement for the treatment of low back pain. Patients were screened telephonically to ensure they met the study criteria. Following this, 69 of the 87 were then assessed at the Durban Institute of Technology Chiropractic Day Clinic of whom 63 satisfied the selection criteria and were accepted onto the study. Three patients were excluded from the study due to non-compliance. These subjects were replaced, leaving the total sample size at 60 (15 per group).

Table 4.1

Patients excluded from the study (n =24)

Exclusion criteria	**Number**	**Percentage**
Age <18	2	8.3%
Age >60	4	16.6%
Bilateral SI Syndrome	12	50.0%
Signs of N.R.E	1	4.2%
Orthopaedic Test Criteria	5	20.8%
Total	**24**	**100%**

N.R.E = Nerve Root Entrapment

4.2.2 Demographic Data:

Demographic data included gender, racial distribution, age and which side the affected SIJ was on.

4.2.2.1 Gender distribution

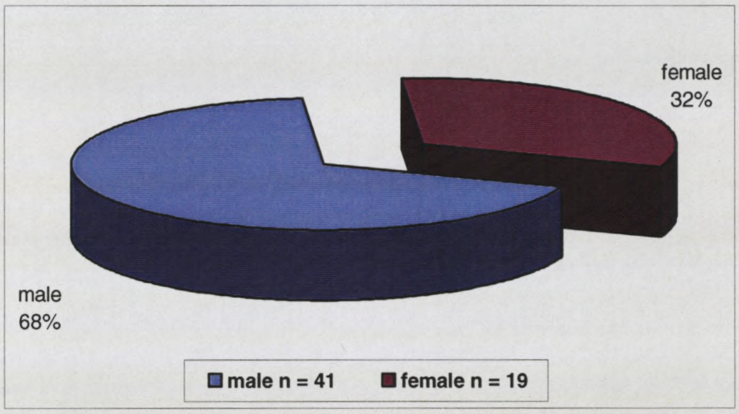

Figure 4.1 <u>Gender distribution (n = 60)</u>

The age distribution illustrated above was dissimilar to the studies of both Marzalek (2002) and Sawyer (2000), who noted no gender bias. Placement of advertisements for the research, in areas possibly frequented more by male than female candidates (e.g. local gymnasiums), is a possible explanation for these demographics.

4.2.2.2 Racial Distribution

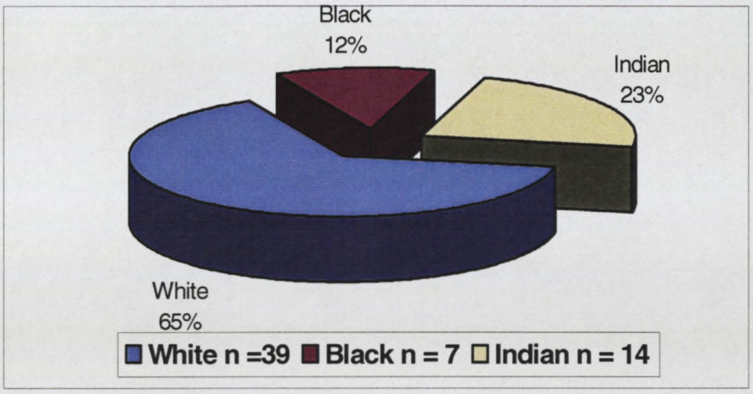

Figure 4.2 **Racial Distribution (n = 60)**

The majority of patients in this study were from the white community. The method of advertisement as well as the areas of distribution may be a possible explanation for these demographics.

4.2.2.3 Age Distribution

Table 4.2 **Age Distribution (n = 60)**

AGE GROUP	NUMBER	PERCENTAGE
18-30 yrs	30	50%
31-40 yrs	11	18%
41-50 yrs	6	10%
51-60 yrs	13	22%
Total	**60**	**100%**

Patients between the ages of 18 and 30 years made up the majority of the study (50%). This could also be attributed to the advertisements distributed at tertiary education facilities and local gymnasiums, where a younger age group is more prevalent. The free treatment received for participation in the study may also have appealed to a younger (student) population.

4.2.2.4 Side of sacroiliac dysfunction

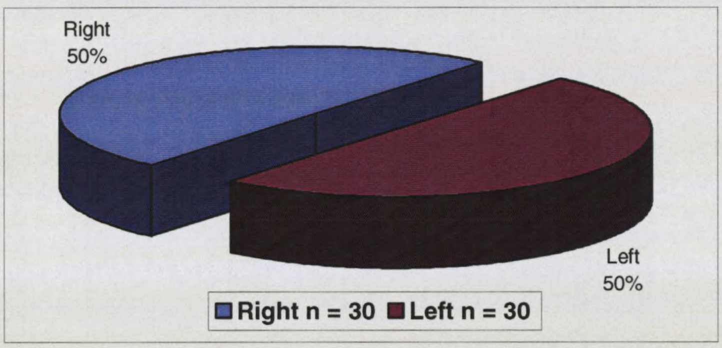

Figure 4.3 **<u>Symptomatic joint (n = 60)</u>**

These demographics are not in keeping with Bernard and Cassidy (1991: 2115), who believe that a right-sided predominance exists. No explanation, other than chance, is suggested for the distribution found.

4.2.2.5 Muscle Activity Ratio

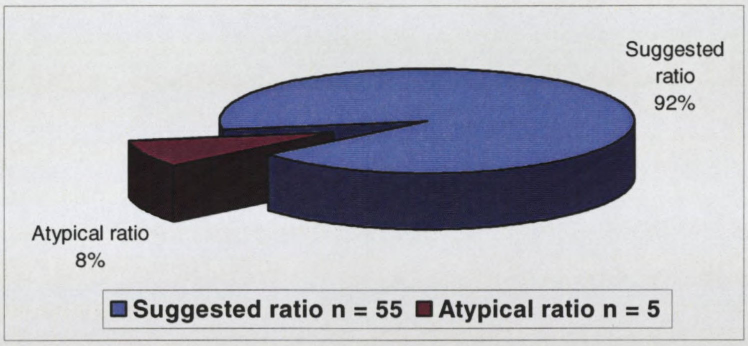

Figure 4.4 <u>Muscle activity ratio (n = 60)</u>

The term 'suggested ratio' refers to the subjects presenting with the muscle activity as suggested by Mooney et al. (1995: 115) i.e. over activity of the ipsilateral gluteus maximus muscle and under activity of the contralateral latissimus dorsi muscle. The term 'atypical ratio' refers to the subjects who presented with any muscle activity pattern different from that suggested by Mooney et al.

4.3 Analytical Statistics

4.3.1 Statistical analysis of the of the Gluteus Maximus EMG readings

4.3.1.1 Inter-group analysis - Kruskal-Wallis Test

Table 4.3 Inter-group comparison of the relative over activity of the ipsilateral gluteus maximus muscle at the initial consultations.

Group	Mean Ratio	Standard dev	Mean Rank	P-Value
A	25.67	16.26	26.37	**0.591**
B	29.20	14.79	28.70	
C	32.80	14.50	32.80	
D	32.20	13.98	34.13	

Table 4.4 Inter-group comparison of the relative over activity of the ipsilateral gluteus maximus muscle at the final consultations.

Group	Mean Ratio	Standard dev	Mean Rank	P-Value
A	11.87	12.37	24.37	**0.029**
B	19.00	15.00	33.53	
C	27.00	17.66	40.33	
D	11.67	8.01	23.77	

Table 4.5 <u>Inter-group comparison of the change in the relative over activity of the ipsilateral gluteus maximus muscle between the initial and final consultations.</u>

Group	Mean Ratio initial cons (1)	Mean Ratio final cons (2)	Difference 1 - 2	P-Value
A	25.67	11.87	13.80	**0.064**
B	29.20	19.00	10.02	
C	32.80	27.00	5.80	
D	32.20	11.67	20.53	

In the tables above, the mean ratio refers to the relative value assigned to the difference between the affected (ipsilateral) and unaffected (contralateral) gluteus maximus muscle, i.e. the difference between the two gluteus maximus muscles expressed as a percentage of the total muscle activity. Due to the majority of patients (92%) presenting with over activity of the ipsilateral gluteus maximus muscle, the mean ratio in the table above was considered as a mean over activity.

In Table 4.3, the null hypothesis was accepted for the inter-group comparison of the gluteus maximus muscles the initial ($p = 0.591$) consultation. This indicates that at the $\alpha = 0.05$ level of significance, there was no statistical difference in the over activity of the ipsilateral gluteus maximus muscle between the four groups at the initial consultation.

In Table 4.4, the null hypothesis was accepted for the inter-group comparison of the gluteus maximus muscles the final ($p = 0.029 > 0.025 = \alpha/2$) consultation. This indicates that at the $\alpha = 0.05$ level of significance, there was no statistical difference in the over activity of the ipsilateral gluteus maximus muscle between the four groups at the final consultation.

In Table 4.5, the null hypothesis was also accepted for the inter-group comparison of the change in the relative over activity of the ipsilateral gluteus maximus muscle between the four groups ($p = 0.064$). This indicates that at the $\alpha = 0.05$ level of significance there was no statistical difference in the change of the over activity of the ipsilateral gluteus maximus muscle between the four groups.

4.3.1.2 Intra-group comparison - Wilcoxon Signed Rank Test

Table 4.6 Intra-group comparison of the changes in the relative over activity of the ipsilateral gluteus maximus muscle between the initial and final consultations.

Group	Rank	N	P-Value
Group A	Negative	13[a]	**0.006**
	Positive	1[b]	
	Ties	1[c]	
Group B	Negative	11[a]	**0.009**
	Positive	4[b]	
	Ties	0[c]	
Group C	Negative	9[a]	**0.054**
	Positive	4[b]	
	Ties	2[c]	
Group D	Negative	14[a]	**0.001**
	Positive	0[b]	
	Ties	1[c]	

a. A negative rank represents an improvement in the gluteus maximus ratio i.e. the difference between the affected (ipsilateral) and unaffected (contralateral) gluteus maximus readings were closer together on the final consultation.
b. A positive rank represents a worsening in the patients muscle ratio i.e. the difference between the affected and unaffected gluteus maximus readings were further apart on the final consultation
c. A tied rank represents no significant difference in patients muscle ratio between the initial and final consultation

The null hypothesis thus was rejected for groups A ($p = 0.006$), B ($p = 0.009$) and D ($p = 0.001$). This indicates that at the $\alpha = 0.05$ level of significance, there was a statistically significant improvement, between the initial and final consultation, in the over activity of the ipsilateral gluteus maximus muscles for these groups.

The null hypothesis was however accepted for Group C ($p = 0.054$). This indicates that at the $\alpha = 0.05$ level of significance, there was no statistically significant improvement, between the initial and final consultations, in the over activity of the ipsilateral gluteus maximus muscle in this group.

4.3.2 Latissimus dorsi results

4.3.2.1 Inter-group analysis - Kruskal-Wallis Test

Table 4.7 Inter-group comparison of the relative under activity of the contralateral latissimus dorsi muscle at the initial consultation.

Group	Mean Ratio	Standard dev	Mean Rank	P-Value
A	29.67	18.09	28.37	**0.706**
B	37.27	19.59	34.20	
C	31.40	10.58	27.60	
D	33.67	20.28	31.83	

Table 4.8 Inter-group comparison of the relative under activity of the contralateral latissimus dorsi muscle at the final consultation.

Group	Mean Ratio	Standard dev	Mean Rank	P-Value
A	22.13	15.25	27.20	**0.563**
B	28.87	18.96	33.43	
C	27.80	9.06	34.00	
D	22.67	16.84	27.37	

Table 4.9 <u>Inter-group comparison of the change in the relative under activity of the contralateral latissimus dorsi muscle between the initial and final consultations.</u>

Group	Mean Ratio initial cons (1)	Mean Ratio final cons (2)	Difference 1 - 2	P-Value
A	29.67	22.13	7.54	**0.482**
B	37.27	28.87	8.40	
C	31.40	27.80	3.60	
D	33.67	22.67	11.00	

In the tables above, the mean ratio refers to the relative value assigned to the difference between the affected (contralateral) and unaffected (ipsilateral) latissimus dorsi muscle, i.e. the difference between the two latissimus dorsi muscles expressed as a percentage of the total muscle activity. Due to the majority of patients (92%) presenting with under activity of the contralateral latissimus dorsi muscle, the mean ratio in the table above was considered as a mean under activity.

In Table 4.7, the null hypothesis was accepted for the inter-group comparison of the latissimus dorsi muscles at the initial ($p = 0.706$) consultation. This indicates that at the $\alpha = 0.05$ level of significance, there was no statistical difference in the under activity of the contralateral latissimus dorsi muscle between the four groups at the initial consultation.

In Table 4.8, the null hypothesis was accepted for the inter-group comparison of the latissimus dorsi muscles at the final ($p = 0.563$) consultation. This indicates that at the $\alpha = 0.05$ level of significance, there was no statistical difference in the under activity of the contralateral latissimus dorsi muscle between the four groups at the initial consultation.

In Table 4.9, the null hypothesis was also accepted for the inter-group comparison of the change in the relative under activity of the contralateral latissimus dorsi muscle between the four groups ($p = 0.482$). This indicates that at the $\alpha = 0.05$ level of significance there was no statistical difference in the improvements of the under activity of the contralateral latissimus dorsi muscle between the four groups.

4.3.2.2 Intra-group comparison - Wilcoxon Signed Rank Test

Table 4.10 Intra-group comparison of the changes in the relative over activity of the contralateral latissimus dorsi muscle between the initial and final consultations.

Group	Rank	N	P-Value
Group A	Negative	9[a]	**0.055**
	Positive	5[b]	
	Ties	1[c]	
Group B	Negative	12[a]	**0.008**
	Positive	3[b]	
	Ties	0[c]	
Group C	Negative	12[a]	**0.163**
	Positive	3[b]	
	Ties	0[c]	
Group D	Negative	12[a]	**0.027**
	Positive	3[b]	
	Ties	0[c]	

a. A negative rank represents an improvement in the latissimus dorsi ratio i.e. the difference between the affected (contralateral) and unaffected (ipsilateral) latissimus dorsi muscle readings were closer together on the final consultation.
b. A positive rank represents a worsening in the latissimus dorsi ratio i.e. the difference between the affected and unaffected latissimus dorsi muscle readings were further apart on the final consultation
c. A tied rank represents no significant difference in latissimus dorsi ratio between the initial and final consultation

The null hypothesis was thus rejected for groups B ($p = 0.008$). This indicates that at the $\alpha = 0.05$ level of significance there was a statistically significant improvement, between the initial and final consultations, in the under activity of the contralateral latissimus dorsi muscle for group B.

The null hypothesis was however accepted for Groups A ($p = 0.055$), C ($p = 0.163$) and D ($p = 0.027 > 0.025 = \alpha/2$). This indicates that at the $\alpha = 0.05$ level of significance there was no statistically significant improvement, between the initial and final consultations, in the under activity of the contralateral latissimus dorsi muscle for groups A, C and D.

CHAPTER 5: DISCUSSION

5.1 Introduction.

This chapter discusses the data obtained at the initial and final consultations. The data being the surface EMG readings of the gluteus maximus and latissimus dorsi muscles at these consultations.

The results are discussed according to the Inter-group findings and the intra-group findings

Inter-group results: inter-group evaluation of the data determined any difference between the treatments groups between the initial and final consultations.

Intra-group results: intra-group evaluation of the data represents the efficacy of the treatment program for each group.

5.2 Confirmation of the muscle asymmetries in unilateral sacroiliac syndrome sufferers

This study found that 55 (92%) of the 60 patients suffering with unilateral sacroiliac syndrome presented with over activity of the ipsilateral gluteus maximus and under activity of the contralateral latissimus dorsi muscles. These results are comparable with those of Mooney et al. (1995: 118), who noted this muscle activity pattern in all five unilateral sacroiliac sufferers in their study, and with the suggestions of Gracovetsky (1995) and Vleeming (1995) that such a muscle pattern may exist. Due to the larger sample size (n = 60), this study was able to assign more significance to this muscle activity pattern, suggesting that a large percentage of unilateral sacroiliac sufferers present with over activity of the ipsilateral gluteus maximus and under activity of the contralateral latissimus dorsi muscle. A prevalence study with a larger sample size, as well as a control, is a suggested future study. This would more accurately establish the frequency of this muscle pattern in unilateral sacroiliac syndrome sufferers.

Five (8%) subjects did not present with the typical ratio of over activity of the ipsilateral gluteus maximus and under activity of the contralateral latissimus dorsi muscle. The researcher however noted that the ratios that these persons presented with (although atypical) were low. This implies that the muscle activity between each side was similar and hence these subjects presented with a relatively normal activity pattern. A mild or less acute sacroiliac syndrome is suggested as a possible explanation for these muscle activities, and a future study relating the extent of the abnormal muscle ratio to the clinical presentation of the sacroiliac syndrome is recommended.

5.3 Inter-group results

5.3.1 Gluteus Maximus findings

Inter-group analysis of the surface EMG readings for the gluteus maximus muscles can be found in tables 4.3, 4.4, and 4.5.

Statistical analysis at the first consultation revealed no statistical difference in the over activity of the ipsilateral gluteus maximus muscle among the four groups. This indicates that over activity of the ipsilateral gluteus maximus muscle was not significantly different for all the participants entering the study and no bias existed.

Statistical analysis of both the difference between the groups at the final consultation and the change in the over activity of the ipsilateral gluteus maximus muscle also revealed no statistically significant results. The results prove that no treatment group was able to improve the over activity of the ipsilateral gluteus maximus muscle to a significant greater extent when compared to the other treatment groups.

Manipulation combined with static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi muscle (group D) was the treatment protocol which showed the greatest improvement (64%) in the mean over activity of the ipsilateral gluteus maximus muscle. Manipulation (group A) followed by manipulation combined with static stretching of the ipsilateral gluteus maximus muscle (group B) also showed improvement in the mean over activity of the ipsilateral gluteus maximus muscle with improvements of 54% and 35% respectively. Manipulation combined with static stretching of the contralateral latissimus dorsi muscle (group C) showed the least improvement (18%) in the over activity of the contralateral latissimus dorsi muscle. It should be noted that the description above indicates only the trends of the study and is distinct from the statistical analysis done by the Kruskal-Wallis Tests.

5.3.2 Latissimus dorsi findings

Inter-group analysis of the surface EMG readings for the latissimus dorsi muscles can be found in tables 4.7 and 4.8.

Statistical analysis at the first consultation revealed no statistically significant difference in the under activity of the contralateral latissimus dorsi muscle among the four groups. This indicates that under activity of the contralateral latissimus dorsi muscle did not differ significantly for all the participants entering the study and that no bias was present.

Statistical analysis of both the difference between the groups at the final consultation and the change in the under activity of the contralateral latissimus dorsi muscle also revealed no statistically significant results. The results prove that no treatment group was able to improve the under activity of the contralateral latissimus muscle to a significant greater extent when compared to the other treatment groups.

Manipulation combined with static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi muscle (group D) was the treatment protocol which showed the greatest improvement (33%) in the mean under activity of the contralateral latissimus muscle. Manipulation (group A) followed by manipulation combined with static stretching of the ipsilateral gluteus maximus muscle (group B) also showed improvement in the mean under activity of the contralateral latissimus muscle with improvements of 25% and 23% respectively. Manipulation combined with static stretching of the contralateral latissimus dorsi muscle (group C) showed the least improvement (11%) in the under activity of the contralateral latissimus. It should be noted that in the description above indicates only the trends of the study and is distinct from the statistical analysis done by the Kruskal-Wallis Test.

5.3.3 Summary

The initial aim of the inter-group analysis was to deduce whether there was or was not a difference between the treatment groups in terms of the surface EMG findings for the gluteus maximus and the latissimus dorsi muscles. A difference would demonstrate one treatment protocol to be more effective than another in restoring the over activity of the ipsilateral gluteus maximus muscle and the under activity of the contralateral latissimus dorsi muscle, in persons suffering with unilateral sacroiliac syndrome.

The Null hypothesis which stated that all four population mean changes were equal, was accepted for the EMG readings of the gluteus maximus muscles. This indicates that at a 5% level of significance, the four groups were equally effective at improving the over activity of the ipsilateral gluteus maximus muscle in unilateral sacroiliac syndrome sufferers.

The Kruskal-Wallis null hypothesis also accepted for the EMG readings of the latissimus dorsi muscles. This indicates that at a 5% level of significance, the four groups were not significantly different at improving under activity of the contralateral latissimus muscle in unilateral sacroiliac syndrome.

5.4 Intra-group results

5.4.1 Gluteus maximus findings

Intra-group analysis of the surface EMG readings for the gluteus maximus muscles can be found in table 4.6

Intra-group analysis compares the initial consultation readings to those at the final consultation for each group. A statistically significant improvement in the over activity of the ipslateral gluteus maximus was noted in group A ($p = 0.006$), B ($p = 0.009$) and group D (0.001). Group C however did not show any statistically significant improvement in the over activity of the ipsilateral gluteus maximus (since $p = 0.054 > 0.025 = \alpha/2$). The mean percentage changes within each group, highlighting the trends of the ipsilateral gluteus maximus improvements in the study, are discussed in the inter-group comparisons above.

The results show a strong statistical improvement in the over activity of the ipsilateral gluteus maximus muscle in the group which received manipulation combined with static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi muscles (group D). Manipulation (group A) and manipulation combined with static stretching of the ipsilateral gluteus maximus muscle (group B) also showed statistically significant improvements in the over activity of the ipsilateral gluteus maximus muscle.

5.4.2 Latissimus dorsi findings

Intra-group analysis of the surface EMG readings for the latissimus dorsi muscles can be found in table 4.9

Intra-group analysis compares the initial consultation readings to those at the final consultation for each group. No statistically significant improvement in the under activity of the contra lateral latissimus dorsi muscle was noted in group A ($p = 0.055$) or C ($p = 0.163$) or D ($p = 0.027 > 0.025 = \alpha/2$). Group B ($p = 0.008$) however did show statistically significant improvement in the under activity of the contralateral latissimus dorsi muscle. The mean percentage changes within each group, highlighting the trends of the contralateral latissimus dorsi improvements in the study, are illustrated above in Figure 4.5.

Results show strong statistical improvement in the under activity of the contralateral latissimus dorsi muscle in the group that received manipulation combined with static stretching of the ipsilateral gluteus maximus muscle (group B). Manipulation (group A), manipulation combined with static stretching of the contralateral latissimus dorsi muscle (group C) and manipulation combined with static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi muscle (group D) did not show any significant improvement in the under activity in the contralateral latissimus dorsi muscle.

5.4.3 Summary

The aim of the intra-group analysis was to deduce whether there was or was not a change in the surface EMG findings of the gluteus maximus and the latissimus dorsi muscles with in each group.

Manipulation, manipulation combined with static stretching of the contralateral latissimus dorsi muscle and manipulation combined with static stretching of the ipsilateral gluteus maximus and contralateral latissimus dorsi muscle were not shown to significantly improve the over activity of the ipsilateral gluteus maximus and the under activity of the contralateral latissimus dorsi in unilateral sacroiliac syndrome sufferers.

Manipulation combined with static stretching of the ipsilateral gluteus maximus muscle was however able to show significant improvements in the over activity of the ipsilateral gluteus maximus and the under activity of the contralateral latissimus dorsi in unilateral sacroiliac syndrome sufferers.

5.5 Comparison of results

No study was found in the literature that combined manipulation with static stretching of the ipslateral gluteus maximus muscle and the contralateral latissimus dorsi muscle to asses its affects on the muscle asymmetries mentioned. It was thus not possible to make a direct comparison of the results.

Mooney et al. (1995: 118) noted that a two-month strengthening program by five individuals suffering with sacroiliac syndrome improved the asymmetries in surface EMG findings of the gluteus maximus and latissimus dorsi muscles. Mooney et al. noted that the improvements in the muscle activity asymmetries correlated with the resolution of the sacroiliac syndrome. This study also showed improvement in these muscle asymmetries, but did not correlate these findings to subjective or objective measurements of the sacroiliac syndrome. It is the researcher's opinion however that the majority of subjects experienced relief of symptoms over the duration of the study.

It is noted that although the interventions were somewhat different (a strengthening program in Mooney et al's. study compared to manipulation and muscle stretching in this study), both studies found improvement in the muscle asymmetries. This suggests that improvements in the muscle asymmetries may be due to the resolution of the sacroiliac syndrome itself, implying that over activity of the ipsilateral gluteus maximus and under activity of the contralateral latissimus dorsi is a clinical sign in unilateral sacroiliac syndrome.

If this were indeed the case, two explanations are suggested. The first being that the sacroiliac syndrome may induce, or be due to, the aberrant functioning of the usual reciprocal relationship between these two muscles, and the second being that these muscles may change their usual pattern of activity as a means of protecting the joint. Snijders (1993) (as discussed in section 2.7) noted that the SIJ was vulnerable to shear forces and placed particular importance on contractions of the gluteus maximus muscle as a means of protecting the SIJ from these shear loads. The over activity of the ipsilateral gluteus maximus found in this study correlates with the view of Snijders, suggesting that this over activity is compensatory mechanism which protects the affected SIJ (by preventing any further shear of the joint).

Possible explanations of under activity of the contralateral latissimus dorsi muscle are more complex. Based on the evidence (Mooney et al. 1995:116, Vleeming 1995, Gracovetsky 1995) indicating a reciprocal antagonist relationship between the gluteus maximus and the contralateral latissimus dorsi muscle, it is suggested that the under activity may be secondary to the over activity of the gluteus maximus. This implies that the under activity of the contralateral latissimus dorsi allows for the over activity of the ipsilateral gluteus maximus, which in turn braces the SIJ.

Khalil (1992) noted that muscle stretching of the erector spinae muscle resulted in an immediate gain as well as a cumulative gain in EMG activity in the specified muscle. This study also noted an increase in EMG activity of the under active latissimus dorsi muscle, in the group that combined manipulation with static stretching of the gluteus maximus (opposite side) and the affected latissimus dorsi muscle (this improvement was not shown to be statistically significant for this sample size but an improvement was none the less noted). Although no treatment group in this study received only stretching of the latissimus dorsi muscle, the results do compare with those of Khalil, suggesting that muscle stretching is effective at improving muscle EMG activity.

An increase in EMG activity was however also noted in the under active latissimus dorsi when only the sacroiliac joint and gluteus maximus muscle were adjusted and stretched respectively, i.e. no therapy was given directly to the latissimus dorsi in this group. It is thus suggested that manipulation of the SIJ and stretching of the ipsilateral gluteus maximus (and the associated resolution of the sacroiliac syndrome) facilitated improvements in the contralateral latissimus dorsi activity. This promotes further evidence for the reciprocal relationship between the gluteus maximus and the contralateral latissimus dorsi muscle.

CHAPTER SIX: RECOMMENDATOINS AND CONCLUSIONS

6.1 Recommendations

A number of recommendations are suggested to improve studies investigating the role of the ipsilateral gluteus maximus and contralateral latissimus dorsi muscle in patients suffering with unilateral sacroiliac synrome.

6.1.1 Sample size

A larger sample size would be desirable. Each group in this study consisted of only fifteen individuals. The researcher was thus required to use non-parametric testing to analyze results, not allowing subtle trends to be made apparent. A larger sample size reduces the chance of a type II error being made and allows for more accurate results.

6.1.2 Homogeneity

To improve the homogeneity, stratification of the sample is suggested. This would match patients of similar age, sex, duration and severity of the complaint. Stratification can however lead to selection bias.

6.1.3 Blinding

Blinding the study would eliminate the possibility of researcher bias. The collection of the data is suggested to be taken by an individual not aware of which group the participant is in or the desired outcome of the study.

6.1.4 Duration

A long-term follow up is suggested. This would allow evaluation of the long-term effects of the interventions in this study.

6.1.5 Placebo Group

No placebo group was included in this study. A placebo group is suggested to note any changes that might occur through natural progression of the condition.

6.1.6 Normative Values

Normative value of the surface EMG readings of the affected muscles would be of particular use. This would assess any asymmetries occurring in asymptotic individuals, which could then be compared, to the symptomatic individuals. This may allow for an objective measurement of the severity of the condition.

6.1.7 Scheduling of participants

Each participant received four treatment consultations followed by a final data capturing consultation with in one week. There was no strict time frame between the treatment consultations, and it is suggested that more scheduled approach may have allowed for greater consistency in the findings of the study.

6.2 Conclusions

The aim of this study is to determine the effect of four different treatment protocols on the surface EMG activity of the ipsilateral gluteus maximus and contalateral latissimus dorsi, in patients suffering with unilateral sacroiliac syndrome. The study thus hoped to provide insight in to the possible role that these muscles play in pathogenesis of sacroiliac syndrome.

Initial investigation revealed that 92% of the unilateral sacroiliac sufferers entering the study presented with over activity of the ipsilateral gluteus maximus and under activity of the contralateral latissimus dorsi muscles, in term of surface EMG findings. This data gives strong evidence that these muscle imbalances occur in a high proportion in unilateral sacroiliac sufferers.

The subjects were then divided into four groups. Group A received manipulation, Group B received manipulation combined with static stretching of the ipsilateral gluteus masimus muscle, Group C received manipulation combined with static stretching of the contralateral larissimus dorsi muscle and Group D received manipulation combined with static stretching of the ipsilateral gluteus masimus muscle and contralateral latissimus dorsi muscle.

At a 5% level of significance it was found that Group B was effective at restoring the over activity of the ipsilateral gluteus maximus and under activity of the contralateral latissimus dorsi muscle. Group A, C and D were not shown to effectively restore the asymmetries in muscle activity for the gluteus maximus and latissimus dorsi muscle.

This study thus concludes that manipulation combined with static stretching of the ipslateral gluteus maximus muscle is effective at restoring the over activity of the ipsilateral gluteus maximus and under activity of the contralateral latissimus dorsi muscle in patients suffering with unilateral sacroiliac syndrome.

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APPENDIX A - letter of information

Dear Patient

Welcome to my research study on low back pain. I am investigating a condition known as sacroiliac joint syndrome, which is a common and often misunderstood cause of low back pain. This study hopes to provide new insight into the possible causes and aggravating factors of this condition.

The study will consist of sixty individuals randomly divided into four groups of fifteen each. Group A will receive SIJ manipulation alone, Group B will receive SIJ manipulation combined with stretching of the gluteus maximus muscle on the affected side, Group C will receive SIJ manipulation combined with stretching of the opposite latissimus dorsi muscle and Group D will receive SIJ manipulation combined with stretching of both the gluteus maximus and the latissimus dorsi. You have an equal chance of being in either group.

Please be assured that both manipulation and stretching are widely recognised and safe forms of treatment for low back pain. There is a possibility, as with all manual therapy, of aggravation of symptoms, however your condition will be monitored and the appropriate referral will be followed if required. The therapy offered should in most cases result in resolution of symptoms.

Each group will receive four treatments (+- 20 min) in a two-week period followed by a fifth data capturing consultation one week later. Please be assured that all information will be regarded as strictly confidential, however authorities may inspect the records. Please also note that treatment if free of charge and you are free to withdraw from the study at any time. No financial remuneration will be given for participating in the study.

To participate in the study the following criteria are required:

a) You must be between the age of 18-60 years.
b) If any contraindications to manipulation or stretching are suspected, you may not be included in the study
c) No pain or anti - inflammatory medication is to be taken for the duration of the study and at least three days before the commencement of the study.
d) No other forms of manual therapy may be undertaken during the course of the study.
e) There should be no change from your usual daily activities.

Please note you will be asked to complete a number of questionnaires during the study, there are no right or wrong answers and I appeal to you for an accurate and honest answer as possible. All treatments will be performed under supervision of a qualified chiropractor. For any Queries please contact:

Derek Mould (w) 031-2042511 (h) 031-2074151 or Dr A. Van Der Meulen (w) 031-2662288 (h) 031-2660805

Yours sincerely

Derek Mould **(Chiropractic Intern)**

APPENDIX B

INFORMED CONSENT FORM

Date :______________

Title of research project: Reciprocal activity of the ipsilateral gluteus maximus and contralateral latissimus dorsi muscles: its role in unilateral Sacroiliac Joint Syndrome

Supervisor **Dr**

Student researcher **Derek Mould**

Please circle the approprioate answer **YES** **NO**

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

If you have answered no to any of the above, please obtain the information before signing

Please print in block letters:

Patient/ subject Name:____

Signature:____

Witness Name:____

Signature:____

Research Student Name:____________________________________

Signature:

APPENDIX C

Stretch Record Sheet.

NAME:

Please tick off the appropriate block once you have completed the stretch
E.G.:

DAY 1	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3(p.m.)	

DAY 1	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 2	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 3	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 4	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 5	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 6	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 7	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 8	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 9	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 10	STRETCH 1(a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 11	STRETCH 1(a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 12	STRETCH 1(a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 1 3	STRETCH 1(a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	
DAY 1 4	STRETCH 1 (a.m.)		STRETCH 2 (mid day)		STRETCH 3 (p.m.)	

APPENDIX D - Stretch Technique Sheet

STRETCHING TECHNIQUES

Please attempt to complete the stretching techniques as shown to you by the researcher in your initial consultation and described below. Please note that each stretch should be held for ten (10) seconds and complete three (3) times consecutively. This procedure should be done three times a day, once in the morning, once at mid day, and once in the evening.

GLUTEUS MAXIMUS STRECH (BUTTOCK)

1) Lye on your back
2) Draw your knee up towards the opposite shoulder
3) Using both hands, pull the knee towards the shoulder till you feel the buttock muscle stretching
4) Hold the stretch for ten seconds
5) Complete the stretch three times

LATISSIMUS DORSI STRETCH (SIDE)

1) Stand upright
2) Bring the arm on the side opposite to your back pain up towards your ear, bend the elbow and place your forearm on top of your head.
3) With your other hand pull the elbow towards the other ear
4) Lean towards the side you are pulling
6) Hold the stretch for ten seconds
5) Complete the stretch three times

APPENDIX H
ORTHOPAEDIC RATING SCALE

DATE:		POSITIVE/NEGATIVE TEST
SIJ TENDERNESS		
YEOMANN'S		
PATRICK FABER		
GAENSLEN'S		
POSTERIOR SHEAR		

APPENDIX I

Are you aged between 18 – 60 and suffering from

LOW BACK PAIN?

Research is currently being carried out on SACROILIAC JOINT SYNDROME at the Durban Institute of Technology Chiropractic Day Clinic.

TREATMENT IS FREE

(IF YOU FIT THE RESEARCH CRITERIA)

Contact DEREK MOULD on 2042205/2042512