CHAPTER TWO

2.1 Introduction

This chapter, according to the existing literature, describes the incidence and prevalence of sacroiliac syndrome, the anatomy of the sacroiliac and hip joints, the clinical presentation, diagnosis and treatment of sacroiliac syndrome, and the relationship between sacroiliac syndrome and hip joint functional ability.

2.2 Incidence and Prevalence of Sacroiliac Syndrome

At least 80 percent of the population suffers from low back pain at some time during their lives (Manga et al., 1993: 221) indicating a high incidence. But, the prevalence of low back pain at the time of any given survey is estimated to range from 5 to 30 percent of the population (Manga et al., 1993: 221).

In a study conducted by Van der Meulen (1997) in the formal black settlement of Chesterville in South Africa, he found that the lifetime incidence of low back pain was only 57.6% but the prevalence was 53.1%. In another study conducted in South Africa, Docrat (1999) found that the lifetime incidence of low back pain in Indian and Coloured communities was 78.2% and 76.6% respectively, and the prevalence was 45% and 32.6% respectively. Both studies indicate a relatively higher prevalence of low back pain in South Africa compared to international statistics. No studies exist to show the prevalence of sacroiliac syndrome in South Africa; however, with such a high prevalence of low back pain, one could assume that sacroiliac syndrome contributes significantly.

Sacroiliac syndrome is a common source of low back pain; however, it is frequently overlooked (Bernard and Cassidy, 1991: 2114). According to Daum (1995: 475) both the sacroiliac joint itself and the diagnosis of sacroiliac syndrome are underappreciated causes of pain in the low back, pelvis, and proximal lower extremities. A review of office records showed that of the patients who presented with back complaints, 40% were diagnosed with sacroiliac joint disease (Daum, 1995:475).

The differential diagnosis of back and leg pain should include sacroiliac joint disease (Hendler et al., 1995: 169). According to Schwarzer et al. (1995: 36) the prevalence of sacroiliac joint pain appears to range from 13%-30%, thus making the sacroiliac joint a significant source of pain in patients with chronic low back pain. The sacroiliac joint is widely accepted as a potential source of low back pain in the literature of manual medicine, and, in the medical literature, the prevalence of sacroiliac dysfunction in the population has been noted to be between 19.3% and 47.9% (Toussaint et al., 1999: 134).

2.3 Anatomy of the Sacroiliac Joint

The sacroiliac joint is comprised of a strong, weight bearing synovial articulation between the surfaces of the sacrum and ilium (Moore and Dalley, 1999: 340 and Palastanga et al., 1989: 414). Some interlocking of the bones is produced by irregular elevations and depressions on these surfaces (Moore and Dalley, 1999: 340 and Mooney, 1997: 37). The convexity of this auricular or C-shaped joint faces anteriorly and slightly inferiorly and there is a wide variation with respect to size, shape, and contour between individuals and from side to side in the same individual (Bernard and Cassidy, 1991: 2108 and Palastanga et al., 1989: 414).

There has been much confusion regarding the classification of the sacroiliac joint; however, according to Bernard and Cassidy (1991: 2109), it is now agreed to be a diarthrodial synovial joint due to the following criteria being fulfilled:

- Presence of a joint cavity containing synovial fluid
- Adjacent bones having ligamentous connections
- An outer fibrous joint capsule with an inner synovial lining
- Cartilaginous surfaces allowing motion

(DeFranca, 1996: 12)

However, the sacroiliac joints, because of their role in transmitting the weight of most of the body to the hip bones, possess little mobility unlike most synovial joints due to the interlocking of the articulating bones and the thick interosseous and posterior sacroiliac ligaments (Moore and Dalley, 1999: 340).

2.3.1 Ligaments

The sacrum is firmly attached to the iliac bones by the following ligaments: (Moore and Dalley, 1999: 340, Moore, 1992: 251 and DeFranca, 1996: 12)

- Interosseous Sacroiliac Ligament
- Posterior Sacroiliac Ligaments
- Anterior Sacroiliac Ligament

The accessory ligaments of the sacroiliac joints are:
(Moore, 1992: 251 and Palastanga et al., 1989: 416)

- Iliolumbar Ligament
- Sacrotuberous Ligament
- Sacrospinous Ligament

2.3.2 Muscles

Some of the largest and most powerful muscles of the body surround the sacroiliac joint; however, according to Bernard and Cassidy (1991: 2113), none of these muscles have direct influence on sacroiliac joint motion. Harrison et al. (1997: 610) agree and state that there is not one single muscle group or muscle that crosses the sacroiliac joint that acts as a primary mover of this articulation. Walker (1992: 72) also states that the sacroiliac joint is not crossed by any muscle. Contributions to the strength of the joint capsule and ligaments, and therefore to the joint's stability, are made by fibrous expansions from all adjacent muscles (Walker, 1992: 72). These expansions blend with the anterior and posterior sacroiliac ligaments.

When the muscle bellies contract, the tissues derived from muscle expansions may be placed in tension and, therefore, any symptoms arising from sacroiliac joint pathology are likely to increase with muscle activity (Walker, 1992: 72). Some of the adjacent muscles include:

- Quadratus Lumborum
- Erector Spinae
- Gluteus Maximus
- Gluteus Minimus
- Piriformis
- Iliacus

(Walker, 1992: 72)

Harrison et al. (1997: 610) state that the ligaments of the sacroiliac joint and the lumbar spine "fuse" with the thoracolumbar fascia. The primary attachment sites for the main movers and stabilizers of the spine and the lower extremity are these ligaments and fascia. Therefore, active muscle contraction causes compression of the sacroiliac joint surfaces thus creating a complex self-bracing mechanism necessary for the stability of the sacroiliac joints in resisting stresses under various loading conditions. Some of the muscles and fascia involved, according to Harrison et al. (1997: 610), include:

- Gluteus Maximus and Medius
- Multifidus
- Biceps Femoris
- Psoas
- Piriformis
- Thoracolumbar fascia

Thus the muscles function is not to cause motion at the sacroiliac joint, but rather to brace the area and create stability for effective load transfer (Harrison et al., 1997: 610).

In contrast, Heller (2003: 46) states that the Piriformis is the only muscle that crosses the sacroiliac joint, and it is frequently tight and short, and can directly affect the sciatic nerve. The attachments, innervation, and main actions of the

Piriformis muscle, according to Moore and Dalley (1999: 551) and Palastanga et al. (1989: 360), are as follows:

Piriformis:

Proximal Attachment: Anterior surface of sacrum and sacrotuberous ligament

Distal Attachment: Superior border of greater trochanter of femur

Innervation: Branches of ventral rami of S1 and S2

Main Action: Laterally rotate extended thigh and abduct flexed thigh; steady femoral head in acetabulum

The assertion is supported indirectly by Hendler et al. (1995: 171) in a clinical setting, where they state that bearing weight or lying on the affected side often increases the pain in sacroiliac syndrome, and that pain is often reproduced by external rotation of the hip (Hendler et al.,1995: 171).

In light of the above, it can be seen that there is controversy regarding the muscles which cross the sacroiliac joint. However, what is important in this study is that the Piriformis muscle lies in close proximity to the sacroiliac joint and is likely to become hypertonic with sacroiliac syndrome (Hendler et al., 1995: 171).

2.3.3 Innervation

The sensory innervation of the sacroiliac joint is extensive (Daum, 1995: 476). Posteriorly, the ligaments and joint capsule are supplied by the lateral branches of the posterior primary rami from L4 to S3, and the anterior innervation from L2 to S2 (Bernard and Cassidy, 1991: 2112). However, Bernard and Cassidy (1991: 2112) state that this nerve supply is variable. According to Ombregt et al. (1999: 691) posteriorly the capsule and ligaments of the sacroiliac joint are innervated by articular branches of the posterior primary rami from S1 and S2, and anteriorly by articular branches of the anterior primary rami from L3 to S2. Therefore, according to the above two references, the sacroiliac joint appears to be innervated from L2 to S3. Unmyelinated free nerve endings that transmit pain and thermal sensation are present in the synovial capsule of the sacroiliac joint and overlying ligaments, and nerve endings providing pressure and position sense information also innervate the sacroiliac joint capsule (Bernard and Cassidy, 1991: 2111-2112). The variable referred pain patterns seen in sacroiliac joint syndrome is explained by this extensive innervation (Bernard and Cassidy, 1991: 2112).

From the above it can be seen that the sacroiliac joint is innervated from L2 to S3, and that the sacroiliac joint capsule is also innervated by nerve endings providing position sense information. This is important in terms of proprioception and will be discussed at a later stage.

2.4 Biomechanics of the Sacroiliac Joint

The biomechanical function of the sacroiliac joint remains largely unknown despite many attempts to describe and measure motion in the joint (Cassidy and Mierau, 1992: 215). The postulated functions of the sacroiliac joint are to transmit or dissipate the loading of the upper trunk to the lower extremities and vice versa (Bernard and Cassidy, 1991: 2113 and Mooney, 1997: 41). The sacroiliac joint is very stable and capable of only minimal movement due to a combination of factors including the strong ligamentous complex, the irregular interlocking joint surfaces, and the large force required to disrupt the joint (Cassidy and Mierau, 1992: 215).

Motions in the lumbar spine, hip joint, and the symphysis pubis affect sacroiliac motion (Bernard and Cassidy, 1991: 2113 and Mooney, 1997: 41). According to Cassidy and Mierau (1992: 215) kinematic studies have shown a variable degree of motion in the sacroiliac joints using different measurement methods; however, the following trends have emerged:

- The range of motion is small and decreases with increasing age
- The range of motion is greater in women and increased during pregnancy
- The motions are coupled and dependent on some degree of joint separation
- The predominant motion is x-axis rotation coupled with some degree of z-axis translation

It is therefore hypothesized by the researcher that due to the small amount of motion observed in the sacroiliac joint (Mooney, 1997: 42), a possible increase in hip joint range of motion associated with sacroiliac joint manipulation is more likely to be due to a reflex relaxation of the surrounding musculature (Harrison et al., 1997: 616) rather than due to an increase in sacroiliac joint motion.

2.5 Clinical Presentation and Diagnosis of Sacroiliac Syndrome

Since the sacroiliac joint is a synovial joint and is subjected to the same inflammatory, infectious, and dysfunctional conditions affecting other synovial joints, it could logically be a source of pain (Bernard and Cassidy, 1991: 2107). Sacroiliac dysfunction, also known as sacroiliac syndrome, is defined, according to Dreyfuss et al. (1994: 1138), as a state of relative hypomobility within a portion of the joint's range of motion with subsequent altered structural (positional) relationships between the sacrum and ilium. Sacroiliac dysfunction occurs when the ilium slips on the sacrum and an irregular prominence of one articular surface becomes wedged upon the prominence of an opposed articular surface (Hendler et al., 1995: 171). The ligaments become taut, and the reflex muscle spasm and pain are intense, severe, and continuous (Hendler et al., 1995: 171).

Sacroiliac syndrome usually presents with pain over the sacroiliac joint in the region of the posterior superior iliac spine, with possible referral to the buttock, groin, greater trochanter, down the posterior thigh to the knee, and, occasionally, down the lateral or posterior calf to the ankle, foot, and toes (Kirkaldy-Willis, 1992:123). This pattern is sometimes indistinguishable from the discomfort of lumbar facet syndrome; however, what is key is that it does not follow a true radicular pattern (Daum, 1995: 476). Presentations of groin, anterior pelvis, or anterior proximal thigh pain, which may mimic hip joint pathology, are as a result of the pattern of joint innervation (Daum, 1995: 476).

The pain in sacroiliac syndrome can be sharp, aching, or dull, and is aggravated by bending, sitting or riding in a car and relieved by standing or walking (Bernard and Cassidy, 1991: 2115). The symptoms of sacroiliac dysfunction are generally exacerbated by activities that tend to load the pelvis asymmetrically e.g. stair climbing or bicycle riding (Daum, 1995: 477). Symptoms are usually unilateral with a right-sided predominance, and associated neurological symptoms of weakness, paraesthesias or dysaesthesias are rare (Bernard and Cassidy, 1991: 2115).

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

The patient appears most comfortable while sitting on the unaffected buttock, and, in order to remove the tension from the hamstrings that apply traction to the diseased joint, the patient may also assume a typically forward flexed posture while sitting (Hendler et al., 1995: 171). However, while standing, forward bending is limited and painful as a result of the forward excursion of the pelvis being limited by the tension of the hamstrings (Hendler et al., 1995: 171). Bearing weight or lying on the affected side often increases the pain, and often the pain is reproduced by external rotation of the hip (Hendler et al., 1995: 171). The presentation is nearly always chronic or subacute and rarely acute (Hendler et al., 1995: 171).

According to Bernard and Cassidy (1991: 2115) there is no direct method for isolating sacroiliac joint pain during physical examination; however, there are several provocative tests that seem to be selective for the sacroiliac joint. Bernard and Cassidy (1991: 2117) add that a positive test is only significant when the clinical history and remaining physical findings rule out other syndromes.

In general there are three types of tests used to examine the sacroiliac joint (Van der Wurff et al., 2000: 30):

1. motion palpation tests to assess movement
2. pain provocation tests to stress sacroiliac joint structures
3. tests for pelvic position

According to Bernard and Cassidy (1991: 2117) the following tests of the sacroiliac joint have a high degree of interexaminer reliability: Gillet’s, Patrick’s, Gaenslen’s, Yeoman’s, sacroiliac shear, and hip rotation tests.

Four pain provocation tests were used in this study:

1. Gaenslen’s test: According to Laslett and Williams (1994: 1247) this test had an interexaminer reliability of 88.2%.
2. Patrick’s Faber test: Results of a trial conducted by Broadhurst and Bond (1998: 344) found that this test showed a 77% sensitivity and 100% specificity for sacroiliac dysfunction.
3. Yeomann’s or Erickson’s test: Kirkaldy-Willis and Burton (1992) are of the opinion that this is the most specific and reliable test for the diagnosis of sacroiliac syndrome
4. Posterior Shear (POSH) or “Thigh Thrust” test: Laslett and Williams (1994: 1247) found an interexaminer reliability of 94.1%. Broadhurst and Bond (1998: 344) found this test to be 80% sensitive and 100% specific for sacroiliac joint dysfunction.

A description of how these tests are performed is covered in the methodology (chapter 3).

2.6 Anatomy of the Hip

The hip joint, a strong and stable multiaxial ball-and-socket type of synovial joint, is the most movable of all joints next to the shoulder joint (Moore and Dalley, 1999: 607). The hip joint is involved in the transmission of weight as it connects the lower limb to the trunk (Palastanga et al., 1989: 430). The joint must therefore possess great strength and stability which, according to Palastanga et al. (1989: 430), is determined by:

- The shape of the articular surfaces (a deep socket securely holding the femoral head)
- The strength of the joint capsule and associated ligaments
- The insertion of muscles crossing the joint, which tend to be at some distance from the centre of movement

2.6.1 Ligaments

The fibrous capsule attaches proximally to the acetabulum and transverse acetabular ligament, and allows free movement of the hip joint (Moore and Dalley, 1999: 607). Thick parts of the fibrous capsule form the ligaments of the hip joint, which, according to Moore and Dalley (1999: 607) and Palastanga et al. (1989: 436) are as follows:

- Iliofemoral ligament: This ligament prevents hyperextension of the hip joint during standing.
- Pubofemoral ligament: This ligament prevents overabduction of the hip joint.
- Ischiofemoral ligament: This ligament prevents hyperextension of the hip joint.
- The ligament of the head of the femur is weak and of little importance in strengthening the hip joint.

It can therefore be seen that the ligaments of the hip joint provide stability but do not, however, prevent free movement of the hip joint (Moore and Dalley, 1999: 607). It is therefore assumed that any restrictions in hip motion associated with sacroiliac syndrome are more likely to be due to neurological reflexes causing muscle spasm (Mellin, 1988: 669).

2.6.2 Muscles

(Moore and Dalley, 1999: 533, 534, 540, 551, 563, 613 and Salmons, 1995: 870-879)

FLEXORS	**INNERVATION**
Iliopsoas Tensor of fascia lata Rectus femoris	Ventral rami of lumbar nerves (L1-L3), Femoral nerve (L2 and L3) Superior gluteal (L4 and L5) Femoral nerve (L2, L3, and L4)
ADDUCTORS	
Adductor longus Adductor brevis Adductor magnus	Obturator nerve (L2, L3, and L4) Obturator nerve (L2, L3, and L4) Obturator nerve (L2, L3, and L4)
EXTERNAL ROTATORS	
Obturator externus Obturator internus Gemellli Piriformis Quadratus femoris	Obturator nerve (L3 and L4) Nerve to obturator internus (L5 and S1) Superior: same as obturator internus Inferior: same as quadratus femoris Branches of ventral rami of S1 and S2 Nerve to quadratus femoris (L5 and S1)
EXTENSORS	
Long head, Biceps femoris Gluteus maximus	Tibial division of sciatic nerve (L5, S1, and S2) Inferior gluteal nerve (L5, S1, and S2)
ABDUCTORS	
Gluteus medius Gluteus minimus	Superior gluteal nerve (L5 and S1) Superior gluteal nerve (L5 and S1)
INTERNAL ROTATORS	
Gluteus medius-anterior part Gluteus minimus-anterior part Tensor of fascia lata	Superior gluteal nerve (L5 and S1) Superior gluteal nerve (L5 and S1) Superior gluteal (L4 and L5)

2.6.3 Innervation

The innervation of the hip joint, according to Palastanga et al. (1989: 440) and DeFranca (1996: 46), is from the lumbar plexus by twigs from the femoral and obturator nerves, and from the sacral plexus by twigs from the superior gluteal nerve and the nerve to quadratus femoris. The nerve supply to the joint is derived from the same nerves which supply the musculature crossing the joint, and is therefore a typical example of articular innervation (Palastanga et al., 1989: 440). The articular supply consists of sensory nerve fibres, transmitting proprioceptive information, and vasomotor fibres (Palastanga et al., 1989: 440).

A root value of L2 to S1 (Palastanga et al., 1989: 440 and DeFranca, 1996: 46) gives the hip joint an overlapping innervation with the sacroiliac joint (L2 to S3) (Bernard and Cassidy, 1991: 2112 and Ombregt et al., 1999: 691). This is important in terms of hip proprioception and its relationship to sacroiliac syndrome and will be discussed later.

2.7 The Possible Relationship between Sacroiliac Syndrome and Pressure Threshold of the Piriformis Muscle

Heller (2003: 46) states that the Piriformis muscle is the only muscle that crosses the sacroiliac joint, and it is frequently tight and short, and can directly affect the sciatic nerve. Harrison et al. (1997: 610), however, state that there is not one single muscle group or muscle that crosses the sacroiliac joint and acts as a primary mover of this articulation. However, Harrison et al. (1997: 614) also state that most patients with sacroiliac syndrome seem to present with spastic or hyperactive muscles, thus potentially creating uneven or increased stress at the sacroiliac region, leading to pain and inflammation. In these cases, according to Harrison et al. (1997: 614), manipulation seems to be a logical treatment of choice. Hendler et al. (1995: 171) agree and state that with sacroiliac dysfunction the ligaments become taut, and the reflex muscle spasm and pain are intense, severe, and continuous.

It was assumed in this study that with hypertonicity of a muscle the pressure threshold of that muscle decreases. Due to the close proximity of the Piriformis muscle to the sacroiliac joint (Moore and Dalley, 1999: 551), the pressure threshold of the Piriformis muscle was assessed. It was hypothesized that as the sacroiliac syndrome was treated with sacroiliac joint manipulation the hypertonicity of the Piriformis muscle would decrease and the pressure threshold would increase. According to Harrison et al. (1997: 616), sacroiliac manipulation seems to be able to elicit reflexes which have the potential to decrease muscle activity (Korr, 1975 as cited in Leach, 1994: 99 and Kirkaldy-Willis and Burton, 1992: 250).

2.8 The Possible Relationship between Sacroiliac Syndrome and Hip Joint Range of Motion

In a study by Bisset (2003) investigating the effect of a sacroiliac joint manipulation on hip rotation ranges of motion in patients suffering from chronic sacroiliac syndrome, the results indicated that a sacroiliac manipulation has an effect on hip rotation on the side of sacroiliac syndrome, with a statistically significant increase in hip active and passive internal rotation. However, he recommended that further studies in this regard should contain a placebo group and more manipulations should be administered and the effects on hip rotation noted.

In addition to Bisset's (2003) study, a study by Mellin (1988: 668-670) investigating the relationships of hip mobility to low back pain and to lumbar spinal mobility in patients with chronic or recurrent low back pain, the results showed that for the correlations of hip joint mobility with low back pain, in the men, all measurements except external rotation had significant correlations with low back pain, whereas in the women, only flexion and extension did. In both genders, hip extension showed the strongest correlations.

Mellin (1988: 669) suggested the following to contribute to the relationship between back pain and hip mobility:

- Back pain may cause restriction of hip movements because of a decrease in general physical activity
- Back pain and spinal pathology, through neurological reflexes, may cause spasm in the muscles and changes in movement patterns of the spine, pelvis, and hips
- The Psoas muscle is regarded as having a stabilizing effect on the lumbar spine. Back pain may provoke activity and spasm in this muscle followed by shortening. The Psoas muscle is a hip flexor, thus giving possible explanation for the stronger correlations of extension with low back pain found in Mellin's study (1988: 668-670).
- Restriction of hip mobility may put excessive load on the spine, as has been described for arthrosis of the hip (Offierski and Macnab, 1983: 316-321)
- Hip stiffness may be etiologically associated with the development of low back trouble, which is indicated by the restriction of hip joint mobility found in young adults with a history of low back pain (Mellin, Unpublished data as cited in Mellin, 1988: 669).

In support of the above findings, a study by Cibulka et al. (1998: 1009-1015) and another by Fairbank et al. (1984: 461-464) was conducted to determine whether a characteristic pattern of range of motion in the hip is related to low back pain and to determine whether such a pattern is associated with and without signs of sacroiliac joint dysfunction. Results showed that in patients with low back pain without evidence of sacroiliac joint dysfunction, external rotation exceeded internal rotation bilaterally. Those with evidence of sacroiliac joint dysfunction had demonstrably more external rotation than internal rotation on the posterior innominate side, indicating greater asymmetry between the left and right sides. The results of this study showed a correlation between sacroiliac joint dysfunction and unilateral hip rotation asymmetry, and Cibulka et al. (1998: 1014) advised clinicians to consider evaluating for unilateral asymmetry in range of motion in the hip in patients with low back pain as it may help in diagnosing sacroiliac joint dysfunction if identified.

Ellison et al. (1990: 537) believe that asymmetry of internal and external hip rotation range of motion is prevalent in patients with low back dysfunction. In a study by Ellison et al. (1990: 537-541) investigating patterns of hip rotation range of motion comparing healthy subjects and patients with low back pain, results showed that in 27% of the healthy subjects and 48% of the patients had more external rotation than internal rotation at the hip. In explanation of this Ellison et al. (1990: 540) state that the high prevalence of this pattern in patients may indicate that this imbalance of hip rotation, in which internal rotation is less than external rotation, may predispose a person to back pain or may be a result of back pain, or both. These results suggest an association between hip rotation range of motion imbalance and the presence of low back pain.

2.9 The Possible Relationship between Sacroiliac Syndrome and Hip Joint Proprioception

Joints usually receive innervation from two sources (Kessler and Hertling, 1996: 33):

1. articular nerves that are branches of adjacent peripheral nerves
2. branches from nerves that supply muscles controlling the joint

A particular aspect of a joint capsule is innervated by branches of the nerve supplying the muscle or muscles that would, when contracting, prevent overstretching of that part of the capsule (Kessler and Hertling, 1996: 33).

According to Kessler and Hertling (1996: 33) joint receptors transmit information about the status of the joint to the central nervous system which interprets the information sent and responds by coordinating muscle activity around the joint.

Four types of joint receptors have been identified by Wyke (as cited in Leach, 1994: 90) and have been described by Kessler and Hertling (1996: 33-34) as follows:

Type 1: Postural - stimulated by changing mechanical stresses in the joint capsule; slowly adapting mechanoreceptor; provides information concerning the static and dynamic position of the joint.

Type2: Dynamic – stimulated by sudden changes in joint motion; rapidly adapting dynamic mechanoreceptor; fires only on quick changes in movement.

Type 3: Inhibitive – stimulated by stretch at end range; very slowly adapting dynamic mechanoreceptor; monitors direction of movement.

Type 4: Nociceptive – stimulated by marked mechanical deformation or tension; nonadapting pain receptors; inactive under normal conditions; active when related tissue is subject to marked deformation or other noxious mechanical or chemical stimulation; produces tonic muscle contraction.

Most of the mechanoreceptors identified in the sacroiliac joints are thought to be nociceptors (Sakamoto et al., 2001: E470) thus suggesting a possible source of lower back pain to be the sacroiliac joint. In the case of sacroiliac syndrome, nociceptor stimulation could produce muscle contraction around the joint (Kessler and Hertling, 1996: 34) as mentioned above.

The muscles responsible for movements of the hip (Moore and Dalley, 1999: 533, 534, 540, 551, 563, 613) have an overlapping innervation with the hip joint (L2 to S1) (Palastanga et al., 1989: 440) and sacroiliac joint (L2 to S3) (Bernard and Cassidy, 1991: 2112 and Ombregt et al., 1999: 691).

Proprioceptors receive impulses from muscles, tendons, and joints as well as from capsules, ligaments, and other fibrous membranes (Gatterman, 1990: 261). They are responsible for transmitting information from these structures to the spinal cord and brain, and provide information regarding the degree, direction, and rate of change of muscle tension (Gatterman, 1990: 261). The proprioceptors include the muscle spindle, Golgi tendon organs, pacinian corpuscles, Ruffini end-organs, labyrinthine receptors, and tonic neck receptors (Gatterman, 1990: 261).

Bernard and Cassidy (1991: 2126) hypothesize that manipulation forcefully stretches hypertonic muscles against their muscle spindles leading to a barrage of afferent impulse signals to the central nervous system. This results in reflex inhibition of gamma and alpha motor neurons which may lead to readjustment of muscle tone and relaxation (Korr, 1975 as cited in Leach, 1994: 99). In addition, Bernard and Cassidy (1991: 2126) state that manipulation could affect joints by stimulating type 1 and type 2 articular mechanoreceptors, as well as type 3 mechanoreceptors in the overlying ligaments, causing impulses to travel along medium and large diameter nerve fibers and inhibit pain impulses travelling through smaller fibers (Melzack and Wall, 1965).

In light of the above, the researcher hypothesized that with the stretching of hypertonic muscles and stimulation of mechanoreceptors associated with sacroiliac manipulation, proprioceptors would also be stimulated thus resetting hip joint proprioception measured via hip joint position sense. This is based on the assumption that the hypertonic muscles associated with sacroiliac syndrome decrease hip joint proprioception due to proprioceptors facilitated erratically due to the facilitation of the neuronal pool at the level of the involved hypertonic muscle (Korr, 1975 as cited in Leach, 1994: 98-99).

2.10 Sacroiliac Joint Manipulation and its Hypothesized Effect on Hip Joint Functional Ability

According to Cassidy and Mierau (1992: 221) the first line of treatment for sacroiliac syndrome is a regimen of manipulation. The goal of this form of treatment is to mobilize a stiff or fixed joint and not to reduce a misalignment (Cassidy and Mierau, 1992: 221). As is widely believed, manipulation of the painful sacroiliac joint is successful in the majority of cases (Cassidy and Mierau, 1992: 223). According to Kirkaldy-Willis and Burton (1992:248) a manipulation for 3 to 4 days often relieves pain and restores the joint movement in sacroiliac syndrome. Hendler et al. (1995: 173) concur and state that sacroiliac subluxation may be reduced by manipulation, and daily manipulation for up to 10 days is often quite helpful in self-limited cases. As mentioned earlier, Harrison et al. (1997: 614) believe that most patients with sacroiliac syndrome seem to present with spastic or hyperactive muscles, thus potentially creating uneven or increased stress at the sacroiliac region, leading to pain and inflammation. In these cases, according to Harrison et al. (1997: 614), manipulation seems to be a logical treatment of choice. In a report of 100 cases of sacroiliac joint subluxation treated by manipulation, most cases were cured after having been treated once, and in a small number of cases (about 10%) the subluxation needed to be reduced again (Xiaodong and Yonggang, 1994: 192-194).

The following are the reasons as to why it is hypothesized that sacroiliac manipulation will increase hip functional ability:

- According to Harrison et al. (1997: 616), sacroiliac manipulation seems to be able to elicit reflexes which have the potential to decrease muscle activity and thereby hypertonicity in muscles such as the Piriformis (Kirkaldy-Willis and Burton, 1992: 250). This may affect hip functional ability, especially with respect to range of motion, as the Piriformis is an external rotator of the hip (Moore and Dalley, 1999: 551).

- Joint mechanoreceptors are thought to be stimulated during manipulation, and this in turn creates reflexogenic muscle tone changes in the muscles that serve the joint (DeFranca, 1996: 294).
- Manipulation probably relieves pain by reducing hypertonicity or spasm in the posterior muscles that maintain the joint in a state of fixation (Kirkaldy-Willis and Burton, 1992: 250).
- According to Shekelle (1994: 858), there are four main hypotheses for lesions that respond to manipulation. The one that could be significant here is: relaxation of hypertonic muscle by sudden stretching.
- Manipulation forcefully stretches hypertonic muscles against their muscle spindles (Bernard and Cassidy, 1991: 2126) leading to pain inhibition and thereby normal firing of the proprioceptive reflexes (Korr, 1975 as cited in Leach, 1994: 99).
- The muscles responsible for movements of the hip (Moore and Dalley, 1999: 533, 534, 540, 551, 563, 613) have an overlapping innervation with the hip joint (L2 to S1) (Palastanga et al., 1989: 440) and sacroiliac joint (L2 to S3) (Bernard and Cassidy, 1991: 2112 and Ombregt et al., 1999: 691).

It is therefore hypothesized by the researcher that with sacroiliac manipulation in patients with sacroiliac syndrome, the surrounding muscles will relax and the pressure threshold of the Piriformis muscle will increase, the range of motion of the hip joint will increase, and hip joint proprioception, measured by hip joint position sense, will improve.