THE EFFECT OF THE ACTIVATOR ADJUSTING INSTRUMENT IN THE TREATMENT OF CHRONIC SACROILIAC JOINT SYNDROME

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

I, Natasha Coetzee, do declare that this dissertation is representative of my own work in both conception and execution.

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DEDICATION

I dedicate this research to my late dad, Johann, and my mom, Cynthia, as well as my life-partner, Leigh-Ann. My parents always encouraged me to follow my dreams, and never to give up. This valuable life lesson is what kept me going, even when I wanted to give up. Leigh-Ann has been my rock for the past 8 years, and without her none of this would have been possible. Her patience and commitment has been flawless. Thank you to my family and friends for always believing in me, and for your ongoing encouragement. I love you all very much.

To my Heavenly Father, thank you for carrying me every step of this journey. Without your Grace and guidance I would have been lost. I hope that I have made you and my family proud.

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ABSTRACT

Objective:

Low back pain (LBP), and in particular sacroiliac joint syndrome, is a significant health concern for both patient and their chiropractor with regards to quality of life and work related musculoskeletal disorders. Therefore, chiropractors often utilise mechanical aids to reduce the impact on the chiropractor's health. It is, however, important to establish whether these mechanical aids are indeed clinically effective, therefore, this study evaluated the Activator Adjusting Instrument (AAI) against an AAI placebo to determine whether this adjusting instrument is an effective aid for both the chiropractor and the patient.

Method:

This randomised, placebo controlled clinical trial consisted of 40 patients (20 per group), screened by stringent inclusion criteria assessed through a telephonic and clinical assessment screen. Post receipt of informed consent from the patients, measurements (NRS, Revised Oswestry Disability Questionnaire, algometer) were taken at baseline, prior to consultation three and at the follow consultation. This procedure occurred with four interventions over a two week period.

Results:

The AAI group showed clinical significance for all clinical measures as compared to the AAI placebo group which attained clinical significance only for the Revised Oswestry Disability Questionnaire. By comparison

there was only a statistically significant difference between the groups in terms of the algometer readings (*p*= 0.037).

Conclusion:

Therefore, it is evident that the AAI seems to have clinical benefit beyond a placebo. However this is not reflected in the statistical analysis. It is, therefore, suggested that this study be repeated with a larger sample size in order to verify the effect on the statistical analysis outcomes.

Keywords:

Sacroiliac joint syndrome

Low back pain

Activator Adjusting Instrument

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DEFINITION OF TERMS

Absolute contraindications: A set of signs or symptoms whose presence categorically excludes one or more treatment possibilities for the patient's condition. (Redwood, 1997).

Activator Adjusting Instrument: A manual manipulative instrument capable of providing a dynamic thrust that includes a controlled force of adjustment at a precise and specific line of drive at high speed (Fuhr,1990).

Activator Methods Chiropractic Technique (AMCT) Protocol: The Activator Methods Chiropractic Technique (AMCT) is a gentle low force programme that utilises specific procedures to detect spinal joint dysfunction, analyse leg length inequality and detect body mechanical problems (Fuhr *et al.*, 1997). The AMCT uses the prone leg check as an approach to diagnose and determine if a leg length inequality exists and then uses pressure testing by the doctor to certain areas as well as particular hand/arm movements by the patient to determine where the fixated joint exists. The AAI is then applied to the appropriate area and a number of high-velocity, low-amplitude thrusts are delivered (Fuhr *et al.*, 1997).

Chronic low back pain: In the context of this study refers to more than three episodes of low back pain per year for the preceding five years (Whalen *et al.,* 2008).

Sacroiliac joint syndrome: is referred to as pain from a sacroiliac joint that exhibits no demonstrable pathology, but which is presumed to have some form of biomechanical dysfunction that causes pain (Morris, 2006).

Current episode of low back pain: In the context of this study current refers to a patient having signs and symptoms of pain in the low back for a period of six to twelve weeks (Whalen *et al*., 2008).

Diversified method of patient positioning: The positioning of a patient in such a manner so as to maximise the chiropractor's ability to impart a manual thrust (Bergmann *et al*., 1993).

Diversified technique: This technique is the manual assessment of the biomechanics of the spine and extremities in order to determine abnormal motion within these joints and apply a manual thrust technique to restore normal biomechanics and therefore motion. This simple technique is utilized as the most common technique within the chiropractic profession (Bergmann *et al.,* 1993).

Incidence: A rate which refers to the number of persons with new back pain occurring over a given time period among a known number of persons who were previously without back pain. (Giles and Singer, 1997).

Joint Fixation (restriction): The temporary immobilisation of a joint in a position that it may normally occupy during any phase of normal movement (Redwood,1997).

Low back pain: Is defined as pain which is primarily limited to the region between the low margins of the twelfth ribs (superiorly), the gluteal folds (inferiorly) and the mid-auxiliary line laterally (Galukande *et al.,* 2005).

Prevalence: The number of persons who have experienced back pain ever, even if they are not affected at present. (Giles and Singer, 1997).

Relative contraindications: A set of signs or symptoms whose presence indicates the need for treatment options to be modified for the patient's condition, so as to avoid possible patient injury as a result of the sign or symptom. (Redwood, 1997).

Spinal manipulation therapy (SMT): Is the application of a high-velocity low-amplitude thrust to target the biomechanical normalisation of joint function and related local or remote symptoms (Haldeman, 2005). The terms manipulation and adjustment have the same meaning and may be used interchangeably.

Syndrome: A set of symptoms that together indicate the presence of an abnormal condition.

LIST OF ABBREVIATIONS

AAI	Activator Adjusting Instrument
AMCT	Activator Methods Chiropractic Technique
ASIS	Anterior superior iliac spine
Asymp.	Asymptomatic
BMI	Body mass index
CNS	Central nervous system
HVLA	High-velocity, low-amplitude manipulation
LBP	Low back pain
NRS	Numerical pain rating scale
PIIS	Posterior inferior iliac spine
PSIS	Posterior superior iliac spine
Sig.	Significance
SMT	Spinal manipulative therapy
STD	Standard
TENS	Transcutaneous Electrical Nerve Stimulation
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Spinal manipulation therapy (SMT) is the application of high-velocity, low-amplitude (HVLA) manual thrusts carrying the spinal joints beyond the passive range of motion (Bergmann and Peterson, 2011; Dagenais and Haldeman, 2012). This thrust is aimed into the paraphysiological space of the joint (Sandoz, 1976; Vernon and Mrozek, 2005) in order to obtain increased movement within the joint (Bergmann and Peterson, 2011).

Hippocrates was the first to give a formal definition to the technique of manipulation; he referred to the spine as the epicentre of holistic bodily health (Dagenais and Haldeman, 2012). However, it is only in recent years that the use of SMT appears to be gaining popularity as increasing numbers of people with chronic low back pain (LBP) seek chiropractic care (Tatalias, 2006; Dagenais and Haldeman, 2012). Similarly there are increased numbers of clinical guidelines available to support the use of spinal manipulation for LBP (Airaksinen *et al*., 2006; Negrini *et al*., 2006; Bronfort *et al*., 2010).

Both these developments are important as LBP is a significant health problem that has a major impact on the person's quality of life and on health care costs (van Tulder *et al.,* 2002; Dagenais *et al*., 2008; Dagenais and Haldeman, 2012). Sacroiliac joint (SIJ) disorders have

been implicated as a contributing factor in 50-70% of adults presenting with LBP (Morris, 2006). Despite the lack of objective evidence to define the role of the SIJ in LBP, SIJ syndrome is a prevalent causative agent in a large proportion of the population (Kirkaldy-Willis and Burton, 1992; Morris, 2006).

Hertling and Kessler (1997), Hansen and Standiford (2003), Huijbreghts (2004), Robinson *et al.,* (2006), Van der Wurff *et al.,* (2006) and Szadek *et al.,* (2008) have described typical characteristics and symptoms of patients presenting with SIJ syndrome which include:

- Unilateral SIJ pain, local to the joint itself, but possibly referring down the leg (posterolaterally),
- The absence of lumbar articular signs and symptoms,
- A short period of morning stiffness that eases with movement and weight bearing,
- Increased pain with prolonged postures (sitting/standing),
- Pain aggravated by walking, rolling over in bed and climbing stairs and or
- Pain referral to the groin, greater trochanter and buttock.

According to McCulloch and Transfeldt (1997), Hansen and Standiford (2003), Huijbreghts (2004), Robinson *et al.,* (2006), Van der Wurff *et al.,* (2006) and Szadek *et al.,* (2008), patients presenting with SIJ syndrome generally present with pain and palpable tenderness over the SIJ, aggravated by provocation tests such as:

- the Posterior Shear or Thigh Thrust Test (Magee, 1987; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006; Szadek *et al.*, 2008),

- the Yeoman's Test (Magee, 1987; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006),
- the Patrick Faber Test (Magee, 1987; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006),
- the Gaenslen's Test (Magee, 1987; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006),
- the Sacroiliac Compression Test (Magee, 1987; Huijbreghts, 2004; Vizniak, 2005; Morris, 2006; Szadek *et al.*, 2008) and
- the clinical asymmetry with regards SIJ movements (Magee, 1987; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006).

In the context of the clinical presentation presented by Hertling and Kessler (1997) and McCulloch and Transfeldt (1997), there is evidence that manipulations of the SIJs can reduce chronic LBP of the SIJ and related disability (Haldeman, 2005; Vanelderen *et al*., 2010). In order to achieve this, clinicians can rely on manual (diversified techniques) or mechanical techniques (activator adjusting instrument (AAI)) in performing spinal manipulations; as these may aid in patient positioning and increasing mechanical advantage to the clinician. However, mechanical devices such as a chiropractic table, or handheld adjusting instruments (eg. AAI) assist the chiropractor in terms of providing treatment to their patients (Triano, 2000; Cooperstein, 1991).

The following studies in Table 1.1 have been compiled to show a comparison of previous studies done using the AAI:

Table 1.1: Research studies involving AAI			
Author	Type of study	Patient numbers	Study description
Gemmell and Miller, 2010	Pragmatic, randomized clinical trial	47	The relative effectiveness and adverse effects of cervical manipulation, mobilization and the activator
Schneider *et al.,* 2010	Observational, prospective, cohort study	92	Mechanical versus manual manipulation for LBP
Roy *et al*., 2008	Randomized clinical trial	66	The effects of manually assisted mechanical force (AAI) on cutaneous temperature
Pfefer, 2007	Randomized pilot study	40	Comparison of activator manipulation versus manual side posture manipulation in patients with LBP
Dugmore, 2006	Double-blinded, placebo controlled study	60	Determine the influence of the clinical ritual in instrument assisted adjusting in the management of LBP
Shearar, 2003	Randomized clinical trial	60	Manual versus mechanical force adjustments (Activator) in the treatment of sacroiliac syndrome.
Wood *et al.,* 2001	Prospective, randomized, comparative clinical trial	30	MFMA (AAI) versus HVLA in cervical spine dysfunction.
Keller and Colloca*,* 2000	Comparative clinical trial	40	Mechanical force spinal manipulation increases trunk muscle strength.
Hawk *et al.,* 1999	Preliminary study: two-period crossover design	18	The effects of a placebo chiropractic treatment with sham adjustments: the activator (zero tension) versus traction (flexion-distraction).
Yurkiw and Mior, 1996	A pilot study	14	A comparison of two chiropractic techniques in neck pain patients: MFMA (AAI) versus spinal manipulative therapy.
Gemmell and Jacobson*,* 1995	Randomized, controlled clinical trial	30	The relative effectiveness: activator versus meric adjustments on acute LBP

Figure 1.1 The Activator Adjusting Instrument

In all of the studies in Table 1.1 the AAI was used either within the AMCT protocol (Pfefer, 2007; Dugmore, 2006; Shearar, 2003; Wood *et al.*, 2001; Gemmell and Jacobson, 1995), or it was used in the diversified method and compared to another treatment (Gemmell and Miller, 2010; Schneider *et al*., 2010; Yurkiw and Mior, 1996). Outside of this, the AAI was utilised as a placebo (Hawk *et al*., 1999) or it was utilised in experimental studies (Roy *et al.,* 2008; Keller and Colloca, 2000). Thus, it is suggested that the AAI has not been researched outside of its AMCT protocol (Fuhr, 2011) in order to assess its clinical effects. This is particularly important as according to Dugmore (2006) who studied the AMCT protocol, it was found that there was no statistical difference (Present Pain Intensity score: p= 0.294; Short Form McGill: p= 0.085; Roland Morris Questionnaire: p= 0.855; NRS: p= 0.048) globally between the group that received AAI at full tension versus the group that received AAI at zero tension (placebo), indicating that the AMCT protocol had a significant influence in the clinical improvement of patients conditions. In contrast to Dugmore (2006), Shearar *et al.,* (2005)

and Shearar (2003) indicated that the outcomes compared between AAI in AMCT versus diversified manipulative techniques had no statistically significant difference (NRS: *p*= 0.000; Revised Oswestry Disability Questionnaire: *p*= 0.000; Orthopaedic Rating Scale: *p*= 0.000; Algometer: *p*= 0.000). Therefore, by elimination, if AAI placebo within AMCT is equivalent to AAI (active) within AMCT and AAI (active) within AMCT is equivalent to diversified manipulative techniques, it would imply that AAI placebo (within AMCT) is equivalent to the gold standard diversified manipulative techniques (Haldeman, 2005; Bergmann *et al*., 1993). This is nonsensical as it would imply that gold standard diversified manipulative techniques are no better than placebo. Or alternatively it implies that the AAI has no clinical benefit outside of the AMCT protocol.

Therefore in order to isolate the effect of the AAI to the exclusion of its often associated protocol (AMCT), this study will test the AAI set at full tension and using the diversified method of patient positioning (Byfield, 2005) against the AAI placebo set a zero tension and using the diversified method of patient positioning in the treatment of chronic LBP of SIJ syndrome origin.

1.2 Aims of the study

The aim of the study was to compare the Activator Adjusting Instrument (AAI) with a placebo AAI, using the diversified method of patient positioning, in the treatment of chronic SIJ syndrome.

1.3 Objectives of the study

Objective One: To determine whether adjusting the SIJ using the AAI set at full tension (AAI group) was effective in the treatment of chronic SIJ syndrome in terms of subjective and objective clinical findings.

Objective Two: To determine whether adjusting the sacroiliac joint using the AAI set at zero tension (placebo) was effective in the treatment of chronic SIJ syndrome in terms of subjective and objective clinical findings.

Objective Three: To compare the two aforementioned treatment interventions.

The Hypothesis: The hypothesis indicated that there would be a significant difference between the AAI group and the AAI placebo group in terms of the subjective and objective findings in this study.

The Null Hypothesis:

The null hypothesis indicated that there would be no significant difference between the AAI group and AAI placebo group in terms of the subjective and objective findings in this study.

1.4 Rationale

According to Fuhr and Menke (2005), the AAI is a safe and clinically useful tool, but its scientific validation requires testing (Fuhr and Menke, 2005). This concern has been confirmed by Fuhr (2011) (developer of the AAI), who has indicated that to his knowledge there have been no published studies that have compared the AAI against itself without the Activator Methods Chiropractic Technique (AMCT) protocol.

To date, research has been conducted with the AAI in the AMCT protocol setting (Gemmell and Jacobson, 1995; Wood *et al.*, 2001; Shearar, 2003; Dugmore, 2006; Pfefer, 2007), which was compared to other manipulative techniques (Yurkiw and Mior, 1996; Gemmell and Miller, 2010; Schneider *et al*., 2010) and in experimental studies (Keller and Colloca, 2000; Roy *et al.,* 2008). Based on these studies, it has been suggested that within the protocol and in comparison to other techniques, the AAI is safe and effective and has minimal risks as is evidenced by the patients improving with such intervention care (Shearar, 2003; Dugmore, 2006). This assertion, however, brings into question whether the AAI is in fact a valid tool in the treatment process if utilised outside of the protocol setting (Fuhr, 2011).

The latter is considered in that chiropractors utilise the AAI independent of the AMCT protocol setting as it is practically seen as a tool that has minimal risks and provides a safe alternative for patients, whilst preventing the development of degenerative joint disease in the chiropractor's joints (Leone, 1999; Leach, 2004; Mathews, 2006).

It is therefore appropriate that the AAI was tested in a placebo controlled environment in order to validate the use of the AAI, which set the basis for this study.

1.5 Benefits of the study

The outcomes of this study will provide a basis from which to guide chiropractors in the use of AAI, in terms of its ability to perform its stated functions in practice. Currently it is assumed that the AAI is safe and clinically effective (Fuhr, 2011), as it has had no adverse reactions in clinical practice. However, it is possible that in clinical practice those patients that do not perceive benefit from other forms of treatment or who have had adverse reactions to other forms of treatment are not likely to return to the practice at which they were treated (Dagenais and Haldeman, 2012).

Therefore, it is necessary to determine through a structured clinical trial (Mouton, 2006; Brink, 1996; Dagenais and Haldeman, 2012) that the AAI does actually conform to the requirements of all clinical interventions (viz. that they be evidence informed) (Hawk et al., 1999; Dagenais and Haldeman, 2012). This will also allow this form of intervention to meet the required standards of practice ethics (Johnson, 2005) and requirements of some regulatory agencies in approving the device for use in clinical practice.

1.6 Conclusion

In the remaining chapters, Chapter Two will review the literature on chronic SIJ syndrome, manipulation and the use of mechanically assisted devices in manual practice. In Chapter Three the researcher will describe in detail the methodology of this study. Chapter Four presents the statistics and the results together with the discussion thereof. Thereafter, the conclusion and recommendations will be made in Chapter Five.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covers the anatomy of the SIJ, low back pain and its relevance to SIJ syndrome; instrument manipulation with particular emphasis on the AAI, as well as a discussion on the placebo effect and its role in patient management.

2.2 Anatomy of the sacroiliac joint

2.2.1 Structure

The SIJ is a diarthrodial articulation between the surface of the lateral aspect of the sacrum and the auricular surface of the medial aspect of the ilium (Bergmann, 1993; Cramer and Darby, 1995; Marchiori, 1999; Morris, 2006; Standring, 2008; Bergmann and Peterson, 2011). The two SIJs are classified as atypical synovial joints with well-defined joint spaces between the two opposing articular surfaces (Cassidy and Mierau, 1992). The sacral auricular surface has a longitudinal groove, known as the sacral groove, which extends from the upper end to the lower end (Cramer and Darby, 1995; Standring, 2008). The posterior rim of this groove is thick and is known as the sacral tuberosity (Cramer and Darby, 1995; Standring, 2008). The iliac auricular surface has a longitudinal ridge, and the inferior end of this iliac ridge is known as the

posterior inferior iliac spine (PIIS) (Cramer and Darby, 1995; Standring, 2008). The sacral groove and the iliac ridge interlock for stability and assist to guide movement of the SIJs (Cramer and Darby, 1995; Morris, 2006).

To support the SIJ, an articular capsule lines the SIJ anterior aspect, whereas the SIJ's posterior aspect is covered by the interosseous sacroiliac ligament, with no articular capsule present along the posterior joint surface (Cramer and Darby, 1995; Moore and Dalley, 1999; Standring, 2008).

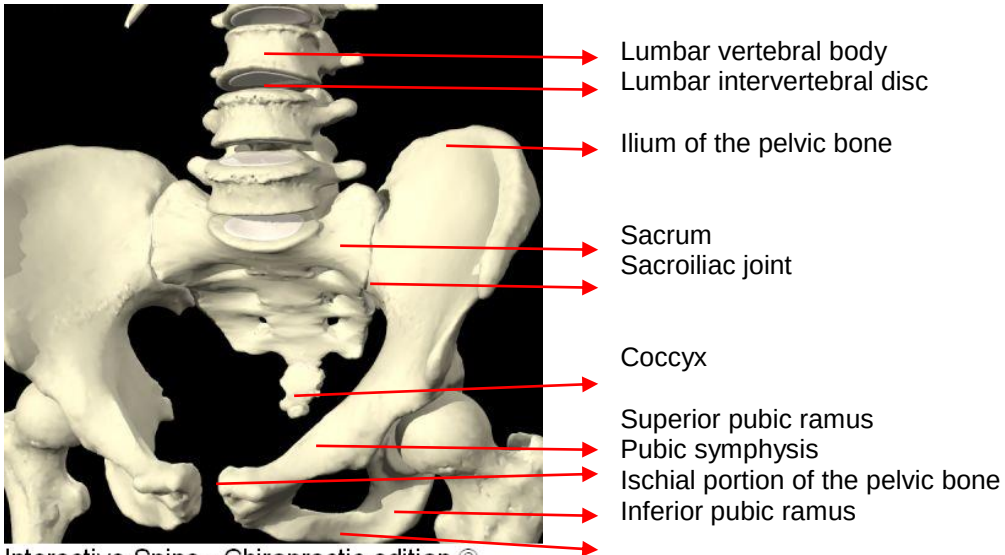

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Figure 2.1: Osseous structures of the low back

2.2.2 Ligaments

To re-inforce the SIJ capsule and the biomechanical joint locking system which is unique to the SIJ, local and global ligaments assist in providing stability for this region of the low back. Therefore, the following ligaments are associated with the SIJs (Norkin and Levangie, 1992; Cramer and Darby, 1995; Moore and Dalley, 1999; Standring, 2008):

- Local ligaments that have direct bearing on SIJ function:
    - Articular capsule: This is a fibrous capsule located along the anterior surface of the joint. There is no articular capsule on the posterior aspect of the SIJ.
    - Anterior sacroiliac ligament: To re-inforce the anterior capsule, the pelvic surface of each SIJ is covered by the anterior sacroiliac ligament. This ligament passes across the anterior aspect of the SIJ in the horizontal plane. It does not support the SIJ as strongly as either the posterior or interosseous sacroiliac ligaments.
    - Interosseous sacroiliac ligament: This bilateral ligament connects the three sacral fossae in one SIJ to the area around the iliac tuberosity on the ipsilateral side. This ligament consists of deep and superficial layers, of which the deep layer has a cranial band and a caudal band. The cranial band is orientated transversely, and the caudal band is orientated vertically. This orientation therefore allows for stability in the transverse and vertical planes, by limiting the degree of distraction that is possible within the SIJ (Norkin and Levangie, 1992; Morris, 2006).

- Posterior sacroiliac ligament: This ligament consists of short fibers connecting the tuberosity of the sacrum to the ilium, and is made up of two parts, namely, the long posterior sacroiliac ligament, and the short posterior sacroiliac ligament (Moore and Dalley, 1999). These ligaments limit the movement of the SIJ to slight gliding and rotary movements, except when the SIJ is subjected to considerable amount of force, for example in sport when a participant lands after a high jump (Moore and Dalley, 1999).

- Global or accessory ligaments that influence SIJ function indirectly (Norkin and Levangie, 1992; Moore and Dalley, 1999; Morris, 2006):
  - Iliolumbar: The iliolumbar ligaments prevent the fifth lumbar vertebra (L5) from sliding anteriorly by uniting the L5 vertebra to the ilia.
  - Sacrotuberous and Sacrospinous: These two ligaments allow for a limited upward movement of the inferior end of the sacrum, therefore providing stability to the sacroiliac region during heavy loading of the vertebral column, for example when jumping from a wall.
  - Thoracolumbar fascia: This fascia is large and divides into anterior and posterior layers, and covers the deep muscles associated with the low back. Within the deep muscles of the low back the fascia is thick and strong, but over the deep muscles within the thoracic area the fascia is almost transparent. The lumbar part of the thoracolumbar fascia extends from the 12^{th} rib to the iliac crest, and attaches

laterally to the internal oblique and transverse abdominal muscles.

- Pubic symphysis: The pubic symphysis joint is formed from the union of the bodies of the pubic bones within the medial plane. The ligaments that join these bones are thicker superiorly to form the superior pubic ligament, and inferiorly to form the inferior pubic ligament.

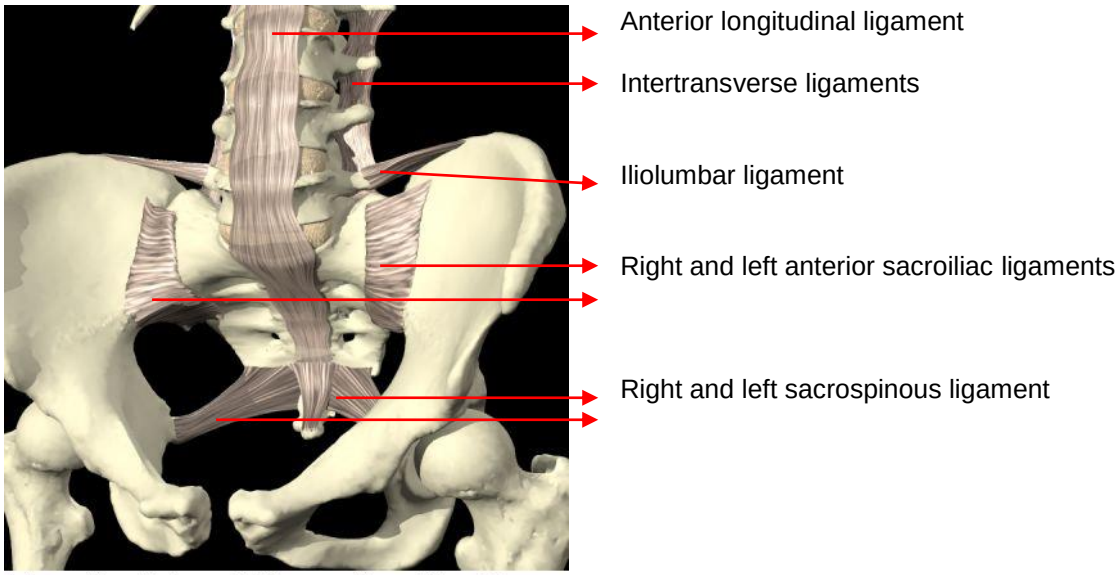

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Figure 2.2 : Ligaments of the low back (anterior)

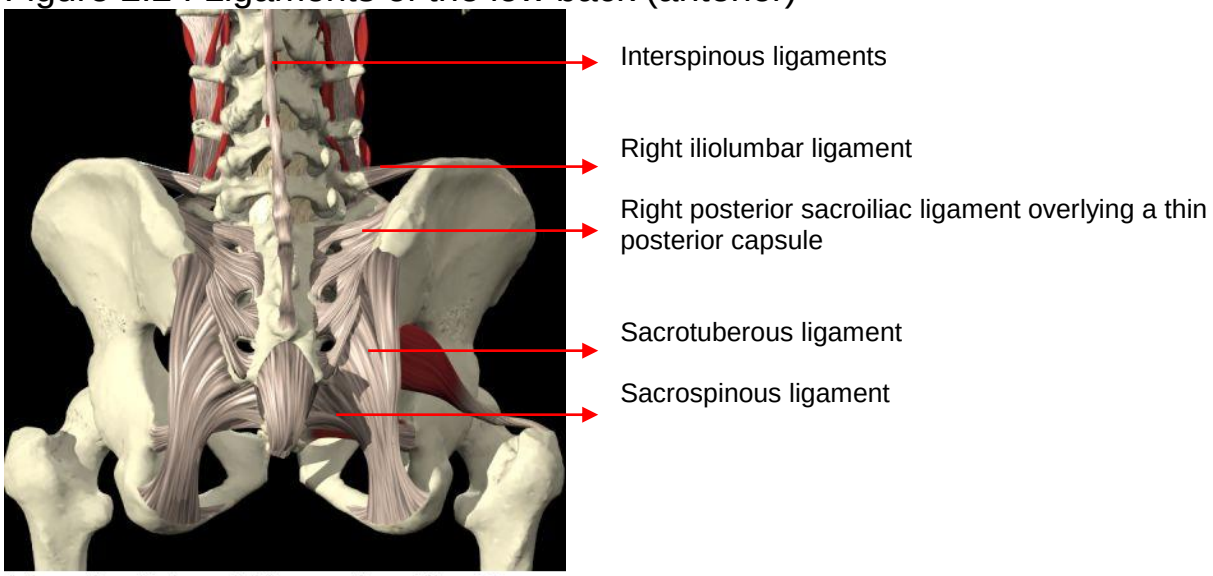

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Figure 2.3 : Ligaments of the low back (posterior)

2.2.3 Muscles as a base of support

Cramer and Darby (1995) stated that approximately 40 muscles can influence the biomechanics of the lumbar pelvic region, however, some of the most important muscles in SIJ syndrome are the erector spinae, quadratus lumborum, multifidus, iliopsoas, rectus abdominus, gluteus maximus, and piriformis. This concurs with the reports by Fligg (1986); Norkin and Levangie (1992) and Bergmann *et al*., (1993) and has been confirmed by Bergmann and Peterson (2011).

Table 2.1a: Muscles of the low back and pelvic region (Moore and Dalley, 1999)

Muscle name	Origin	Insertion	Innervation	Action
Iliopsoas	Sides of T12-L5 vertebrae and discs between them, to iliac crest, iliac fossa, ala of sacrum, and anterior sacroiliac ligaments	Lesser trochanter of femur, to tendon of psoas major, lesser trochanter, and femur distal to it	Ventral rami of lumbar nerves (L1-L3); femoral nerve (L2-L3)	Chief flexor of the thigh
Piriformis	Anterior surface of sacrum and sacrotuberous ligament	Superior border of greater trochanter of femur	Branches of ventral rami of S1 and S2	Laterally rotate the extended thigh and abduct flexed thigh; stabilizes femoral head in acetabulum

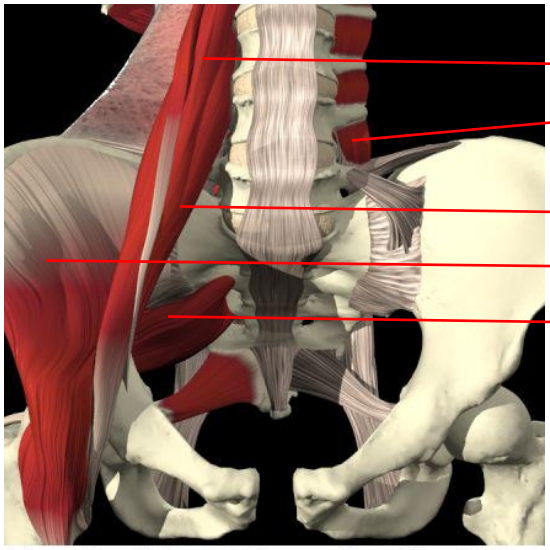

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Figure 2.4 Muscles of the low back (anterior)

Table 2.1b: Muscles of the low back and pelvic region (continued)(Moore and Dalley, 1999)

Muscle name	Origin	Insertion	Innervation	Action
Erector spinae	Arise from a broad tendon from posterior part of iliac crest, posterior surface of sacrum, sacral and inferior lumbar spinous processes, and supraspinous ligament	Lower ribs and cervical transverse processes; superiorly to spinous processes in upper thoracic region and to the skull	Dorsal rami of spinal nerves	Acting bilaterally, they extend the vertebral column and head; with flexion of the back they control movement by gradually lengthening their fibers; unilaterally, they laterally bend the vertebral column
Quadratus lumborum	Medial half of inferior border of 12th rib and tips of lumbar transverse processes	Iliolumbar ligament and internal lip of iliac crest	Ventral branches of T12 and L1-L4 nerves	Extends and laterally flexes the vertebral column; fixes 12th during inspiration
Multifidus	Sacrum and ilium, transverse processes of T1-T3, and articular processes of C4-C7	Fibers pass supero-medially to spinous processes of the vertebrae above, spanning 2-4 segments	Dorsal rami of spinal nerves	Stabilizes vertebrae during local movements of vertebral column
Rectus abdominus	Pubic symphysis and pubic crest	Xiphoid process and fifth to seventh costal cartilages	Thoraco-abdominal nerves	Flexes trunk (lumbar vertebrae) and compresses abdominal viscera
Gluteus maximus	Ilium posterior to posterior gluteal line, dorsal surface of sacrum and coccyx, and sacrotuberous ligament	Most of the fibers attach to the lateral condyle of tibia; some fibers insert on the gluteal tuberosity of the femur	Inferior gluteal nerve (L5, S1 and S2)	Extends thigh and assists in its lateral rotation; stabilizes thigh and assists in rising from sitting position

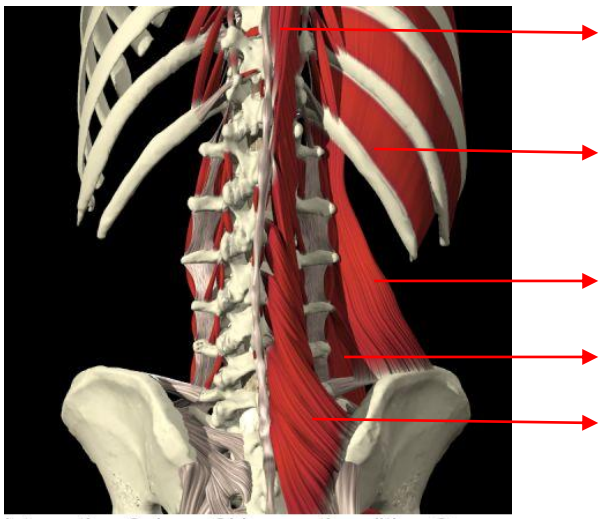

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Figure 2.5 Muscles of the low back (posterior – deep)

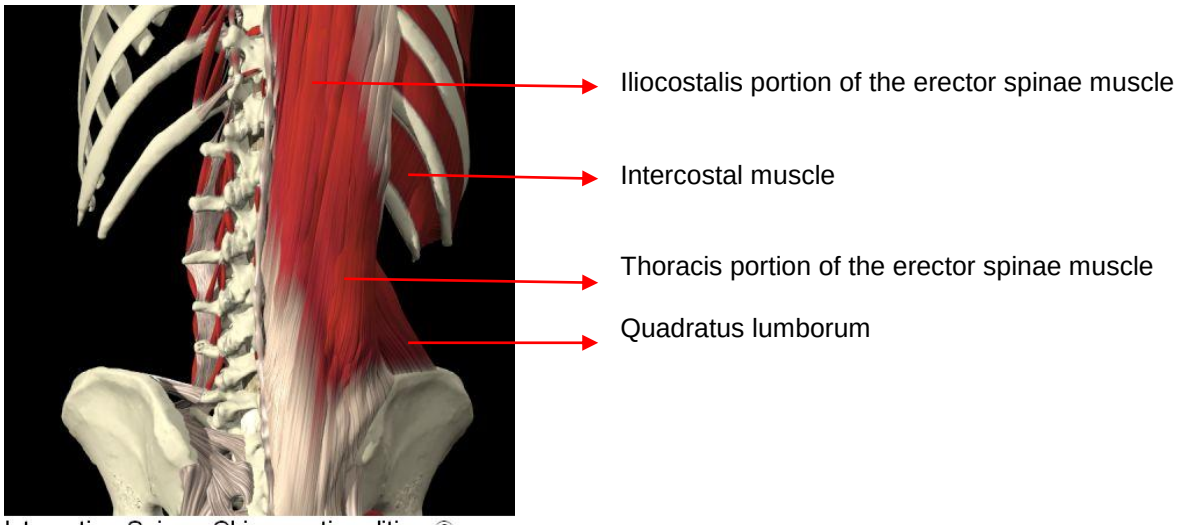

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Figure 2.6 Muscles of the low back (posterior – superficial)

2.2.4 Sacroiliac joint movement/motion

According to Norkin and Levangie (1992) and Cramer and Darby (1995) initiation of SIJ movements are made by the vertebral column and the lower extremities. The forces creating motion within the SIJ are gravity (trunk weight), ground reaction force (bouncing), and muscle contraction (Norkin and Levangie, 1992; Cramer and Darby, 1995; Andersson, 1998; Statistik Rapport, 2005; Weahrer *et al.*, 2005; Riihimaki *et al.*, 2002). Postural changes of the vertebral column such as during lying, sitting and standing, and motion of the vertebral column (flexion, extension, rotation) cause the sacrum to move relative to the ilium (Cramer and Darby, 1995). A change of thigh position during sitting, standing and standing on one leg, together with flexion, extension, abduction, adduction and rotation of the thigh cause the iliac surface of the SIJ to move relative to the sacral surface of the SIJ (Cramer and Darby, 1995). Abduction and adduction of the thigh causes some gapping motion within the SIJ (Cramer and Darby, 1995). In addition to the above movements, the joint also undergoes “nutation” which is described as being the “primary movements of anteroinferior to posterosuperior nodding of the sacral base relative to the ilium. This represents rotation along the sacral groove, with the centre of rotation located in the middle sacral fossa of the SIJ” (Cramer and Darby, 1995).

The SIJ in comparison to a lumbar motion segment can withstand six times more medially directed forces and seven times more lateral bending forces, whereas the lumbar motion segment is capable of withstanding twenty times more axial compression and two times more axial torsion (Morris, 2006). Therefore it could be assumed that the SIJ

is more prone to axial compression and torsional loading, which are vital components for daily activities, such as forward bending, lifting and twisting of the trunk (Morris, 2006).

Stability is increased and mobility is decreased with age (Cramer and Darby, 1995). Until puberty, stability is maintained mainly by ligaments, but after puberty the bony interlocking that increases stability start to form (Cramer and Darby, 1995). According to Cramer and Darby (1995), Kirkaldy-Willis and Burton (1992) and Marchiori (1999) osteophytes and ankylosis may begin to form from the fourth decade of life, which increases stability. SIJ movement usually completely stops from the eighth decade of life due to fibrous degeneration attempting to create stability (Cramer and Darby, 1995).

Functional stability is vital for sufficient movement and less mechanical stress on pain-sensitive structures (Morris, 2006).

2.2.5 Innervation

The SIJs are vastly innervated, and the joint capsule possesses both pain receptors (nociceptors) and joint position sensation receptors, also known as proprioceptors (Cramer and Darby, 1995; Sakamoto *et al*., 2001; Hillermann *et al*., 2006). The superior and inferior gluteal nerves (bilaterally) give rise to the articular branches of the SIJs, the sacral plexus and the dorsal rami of S1 and S2 (Ombregt *et al*., 1995; Moore and Dalley, 1999; Standring, 2008). The posterior aspect of the SIJ is primarily supplied by branches originating from the posterior primary rami of the L4-S2 spinal nerves (Kirkaldy-Willis and Burton, 1992; Standring, 2008). The anterior aspect of the SIJ is innervated by the

posterior branches from the L3-S2 nerve roots and the superior gluteal nerve L5-S2 (Standring, 2008).

These nociceptive receptors are thought to be the origin of SIJ syndrome when stimulated by a noxious stimuli such as an external stimulus that provokes pain (Hillermann *et al*., 2006).

The SIJ has variations in the innervation of the joint, and may differ from left to right sides in some individuals (Cramer and Darby, 1995). Due to the variable innervations of the SIJ a wide range of pain referral patterns exist and may explain why patients experience different symptoms in SIJ syndrome (Bernard and Cassidy, 1993; Souza, 2001). This wide variation of referral pain patterns may also explain the difficulty that researchers and chiropractors have in diagnosing SIJ pain and dysfunction (Cramer and Darby, 1995; Evans, 2001; Isaacs and Bookhout, 2002; Giles, 2003; Hebert and Fritz, 2012).

This may also be the reason that the degree to which SIJ syndrome contributes to the presence of LBP is unclear. As a result the statistics around the relationship between SIJ syndrome and LBP vary from study to study (Cramer and Darby, 1995). Therefore the next section will define LBP, contextualise sacroiliac syndrome in this definition, before outlining the epidemiology of LBP and drawing a conclusion on the prevalence of SIJ syndrome.

2.3 Definition of low back pain (LBP) and the context of sacroiliac joint syndrome

LBP is defined as pain which is primarily limited to the region between the low margins of the twelfth ribs (superiorly), the gluteal folds (inferiorly) and the mid-axilliary line laterally (Galukande *et al.,* 2005) (see Figure 2.7 for a schematic/anatomical representation of the low back). In the above context SIJ syndrome is referred to as “pain from a SIJ that exhibits no demonstrable pathology, but which is presumed to have some form of biomechanical dysfunction that causes pain” (Morris, 2006).

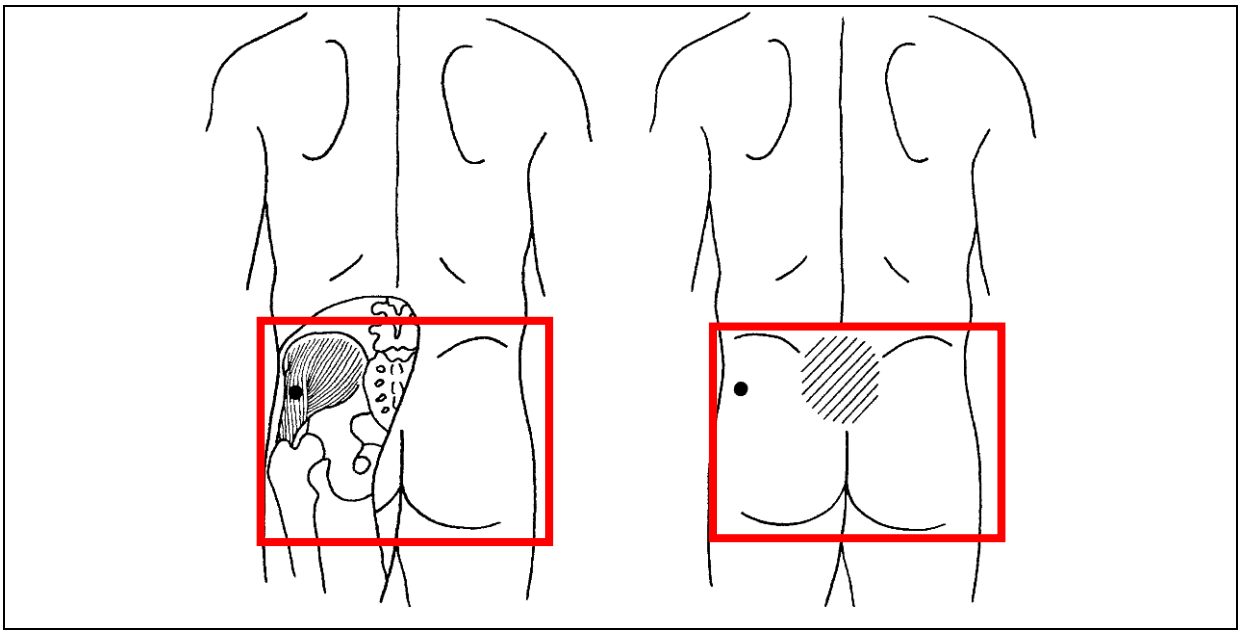

Figure 2.7 Schematic / anatomical representation of the low back
(Adapted from http://www.triggerpointbook.com/backpain.htm, 2012)

Outside of the non-mechanical causes of LBP (e.g. Tumours, infections, systemic arthropathies), Morris (2006) and Bergmann *et al*., (1993) indicated that the majority of mechanical LBP (50-70%) is a result of SIJ syndrome.

2.4 Low Back Pain

2.4.1 Incidence and prevalence of low back pain

LBP is the most prevalent musculoskeletal condition and the most common cause of disability in developed and developing countries (Woolf and Pfleger, 2003; Dagenais *et al.*, 2008; Chen *et al.*, 2009; Coole *et al.,* 2010). According to Morris (2006), LBP is the third most commonly reported site of pain, the second most frequent cause of worker absenteeism, and the most costly ailment of working-age adults in the United States. This may account for the lifetime prevalence of LBP (at least one episode of LBP in a lifetime) varies according to type of study, population type in the study and geographic region of the study (Dagenais and Haldeman, 2012). These are outlined briefly in Table 2.2.

Table 2.2 Review of the epidemiology of LBP (adapted from Raad, 2012; Dyer, 2012).

Authors	**Study type**	**Prevalence**		**Developed) / non developing**	**Region / population**
Frank *et al.,* (1998)	Epidemiological study	Lifetime	50% - 80%	Developed	General[1]
Bovenzi (1996)	Intervention study	Lifetime	66.4% - 83.8%	Unknown	Country not specified Tractor drivers and control drivers
		12 month	65.5% - 82.9%		
		7 day	45.6% - 62.4%		
Hillman *et al.,* 1996)	Epidemiological study	Lifetime	59%	Unknown	Country not specified General
		12 month	39%		
		Point	19%		
Van Der Meulen (1997)	Epidemiological study	Life time	57.6%	Developing	South Africa General
Cassidy *et al.,* (1998)	Epidemiological study	Lifetime	84%	Developed	Canada General
		6 month	69%		
		Point	29%		
Loney and Stratford (1999)	Review of literature	Lifetime	59% - 84%	Developed	Global General
		Point	14% - 29%		
Docrat (1999)	Epidemiological study	Lifetime	76.6% / 78.2%	Developing	South Africa General
Walker (2000)	Review of literature	Lifetime	11%-84%		Global
		12 month	22-65%		
		Point	12%-33%		

[1] General refers to the general population

Table 2.2 continued : Review of the epidemiology of LBP (adapted from Raad, 2012; Dyer, 2012).					
Authors	**Study type**	**Prevalence**		**Developed) / non developing**	**Region / population**
Picavet and Schouten (2002)	Epidemiological study	12 month	44.4%	Developed	Netherlands Population unspecified
Waddell (2004)	Epidemiological study	Lifetime	50% - 80%	Developed	United States of America General
Galukande *et al.*, (2005)	Incidence study	Point	20%	Developing	Uganda Hospital based
Van Vuuren et al., (2005)	Epidemiological study	Lifetime	64%	Developing	South Africa Mining specific
		12 month	56%		
		Point	36%		
Ghaffari (2007)	Epidemiological study	12 month	65% and 46% respectively	Developed	United Kingdom / Sweden General
Louw *et al.,* (2007)	Review of literature	Lifetime	36% - 62%	Developing	African (General)
		12 month	14% - 72 %		
		Point	32%		
Dagenais *et al.*, (2008)	Review of literature	Lifetime	5% - 65%	Developed	Global General
		2- week	15%		
Bell and Burnett (2009)	Review of literature	Lifetime	60% - 90%	Developed	Global Specific occupations
Helfenstein Junior *et al.,* (2010)	Review of current knowledge of LBP	Lifetime	50% - 80%	Developed	General

As a result of the prevalence of LBP, the pain has been connected to levels of disability, producing significant restrictions on activities of daily living and participation, such as the inability to work and socialise (Katz, 2006; Dagenais and Haldeman, 2008; Roffey *et al*., 2010a; Roffey *et al*., 2010b; Roffey *et al*., 2010c; Roffey *et al*., 2010d; Roffey *et al*., 2010e). Therefore, the financial and economic burden is of a particular concern in Africa, where there is restricted health care funds as they are principally directed toward epidemics such as HIV and AIDS (Walker, 2000; National Department of Health, 2010).

Thus, as can be seen from the high prevalence of LBP, it is important to remember that SIJ syndrome is thought to contribute significantly to LBP and therefore is a significant clinical entity that requires attention within musculoskeletal health of patients with LBP.

Therefore, in order to address this concern, it is important to understand the possible causes (aetiology), pathogenesis, presentation (signs and symptoms), diagnostic evaluation of the patient and treatment of SIJ syndrome. The next section presents SIJ syndrome in terms of these subheadings.

2.4.2 Causative factors (aetiology) of sacroiliac joint syndrome

According to Morris (2006), risk and prognostic factors for SIJ syndrome include sociodemographic factors, behavioural and physical factors, as well as spinal deformities. “Sociodemographic factors include age, sex, ethnicity, levels of education, levels of activity, marital status, employment status, employment type (occupation) and nutritional status” (Morris, 2006; Dagenais and Haldeman, 2012).

With respect to **gender:**

Fairbank *et al.,* (1984); Svensson *et al.,* (1988); Balague *et al.,* (1994) and Jin *et al*., (2004) indicated on average a higher prevelance of LBP in females than males. This is in agreement with studies by Viikari-Juntura *et al.,* (1991); Olsen *et al.,* (1992); Brattberg (1994); Salminen *et al.,* (1994); Troussier *et al.,* (1994) and Harreby *et al.,* (1999). However, Walsh *et al.,* (1992); Burton *et al.,* (1996b); Gunzburg *et al.,* (1999) and Feldman *et al.,* (2001), did not concur with these findings and suggested that males were more inclined to have a higher prevelance to LBP than females. The smallest difference is seen in the study done by Biering-Sorensen (1983), where it was found that 61,4% of females and 62.6% of males in the general adult population were found to

suffer from LBP. This was confirmed by Papageorgiou *et al*., (1995), who found that in a general population, a 59% prevalence rate was applicable for both males and females. These latter two studies also concur with and are supported by the findings by Heliövaara (1989); Battie *et al.,* (1990); Liira *et al.,* (1996) and Burdorf and Sorock (1997).

The variances in the gender prevalence percentages may be attributed to:

- The population(s) under study (Olsen *et al.,* 1992; Morris, 2006).
- The proportion of female to male participants (Mulimba, 1990; Waddell, 1994 and Reigo *et al*., 1999).
- The link between LBP prevalence and females in the postpartum period (linked to epidural anaesthesia) (Groves *et al*., 1995; Macleod *et al*., 1995) and / or
- The physiological changes that occur in a female's body during pregnancy (Valkenburg and Haanen, 1982; Svensson *et al.,* 1988; Biering-Sorensen, 1983; Ostgaard and Andersson, 1991; Orvieto *et al*., 1994; Clancy and McVicar, 2002).
- Body weight (Battie *et al.,* 1990) related to gender.
- Lastly, it is also possible that males tend to suffer more disabling pain than females (Hurwitz and Morgenstein, 1997; Power *et al.,* 2001) and females suffer more non-disabling pain according to Hurwitz and Morgenstein (1997).

However, the literature seems to accept that LBP is more common in females than males (Anderson, 1999; Morris, 2006), even though (over a 24 year period), Bildt Thorbjornsson *et al.*, (2000), found that social

relations, sedentary work and physical load had strong links to the prevalence of LBP in both genders.

With respect to **age:**

The prevalence of LBP increases as the population ages (The Editors (1995); Burton *et al.,* (1996b); Kristjansdottir (1996); Newcomer and Sinaki (1996); Hurwitz and Morgenstein (1997); Taimela *et al., (*1997); Louw *et al*., (2007); Leboeuf-Yde *et al.,* (2009); Plouvier *et al.,* (2011). As a result, Dagenais and Haldeman (2012) and Morris (2006) identified age as a prognostic factor for the development of LBP. However, in contrast to the above, Daltroy *et al.,* (1991) suggested that decreasing age was related to an increase in the onset of LBP and that increasing age was protective of the develpoment and onset of LBP. Whereas Biering-Sörensen (1983); Battie *et al.,* (1990); Burdorf and Sorock, (1997) seem to indicate that age has no relationship with LBP.

With respect to **education:**

Viikari-Juntura *et al.,* (1991) and Dionne *et al.,* (1997) noted that poor or a lack of education predisposed a person to an increased likelihood of LBP, but Hurwitz and Morgenstein (1997) and Deyo *et al.,* (1987) stated that education was more related to the severity of the LBP. In contrast, Bigos *et al.,* (1986); Riihimaki *et al.,* (1989) and Power *et al.,* (2001) stated that there is no relationship between education levels and the likelihood of developing LBP.

With regards to **marital status:**

Reisbord and Greenland, (1985); Biering-Sörensen and Thomson, (1986) and Cats-Baril and Frymoyer, (1991) noted that there was a higher prevalence of LBP in unmarried, widowed and divorced persons as compared to married persons.

With regards to **ethnicity :**

Hurwitz and Morgenstein, (1997) showed an increased likelihood for LBP in non-white ethnic groups. This finding might be related to access to healthcare for LBP (Deyo *et al.,* 1987; Heliövaara, 1989; Hurwitz and Morgenstein, 1997; Dagenais and Haldeman, 2012). Additionally, different ethnic groups experience pain differently (Green *et al*., 2002; Portenoy *et al.*, 2004).

Additionally, Morris (2006) stated that there are several behavioural prognostic factors associated with an increase in disability as well as pain. These include, but may not be limited to, psychological stress, somatisation, catastrophizing, fear avoidance, pain intensity, religion, maladaptive coping, depression/depressive symptoms, perceived stress/anxiety, history of depression/anxiety and / or alcohol/drug abuse history (Bongers *et al.,* 1993; Hoogendoorn *et al.,* 2000; Linton and Ryberg, 2000; Heneweer *et al.,* 2011).

By contrast, physical factors such as lifting (Roffey *et al*., 2010c), carrying (Roffey *et al*., 2010a) and manual handling (Roffey *et al.*, 2010e) have also been implicated as risk factors for the development of LBP in the workplace (Dagenais and Haldeman, 2012).

With respect to **occupational posture**:

Hoogendoorn *et al.,* (2000) and Heneweer *et al.,* (2011) noted that flexed (McGill *et al.,* 2000; Nazari *et al.,* 2011) and rotated positions alone and in combination (Frymoyer *et al.,* 1983; Potvin *et al.,* 1991; Roffey *et al.,* 2010c), for increased durations and / or repetitive actions are responsible for significant increases in the likelihood of developing LBP. In addition, the literature indicates that prolonged standing increases the likelihood of LBP (Pope *et al.,* 2002; Anderson *et al.,* 2007; Wai *et al.,* 2010b), whereas, prolonged sitting also increase the chances of LBP (Magora, 1972; Magora, 1974; Tissot *et al.,* 2009; Roffey *et al.,* 2010b).

With respect to **specific work related activities**:

Accumulation of increased loads (Hoogendoorn *et al.,* 2000; Heneweer *et al.,* 2011),

- Bending and twisting (Wai *et al.,* 2010b),
- Carrying and / or pulling (Pope *et al.,* 2002; Roffey *et al.,* 2010a),
- High load with high repetition (Roffey *et al.,* 2010b)
- Increased lifting (Hoogendoorn *et al.,* 2000; Heneweer *et al.,* 2011),
- Manual handling (Jansen *et al.,* 2004; Roffey *et al.,* 2010d; Heneweer *et al.,* 2011; Plouvier *et al.,* 2011),
- Physical loading while lifting (Roffey *et al.,* 2010d; Heneweer *et al.,* 2011; Plouvier *et al.,* 2011),
- Pushing (Pope *et al.,* 2002; Roffey *et al.,* 2010a),
- Repetitive tasks (Hoogendoorn *et al.,* 2000; Heneweer *et al.,* 2011) and
- Fatigue associated with repetitive tasks / positions (Roffey *et al.,* 2010c; Plouvier *et al.,* 2011),

- Sedentary work (Roffey *et al.,* 2010b) and / or
- Whole body vibration (Hoogendoorn *et al.,* 2000; Vingard and Nachemson*,* 2000; Krause *et al.,* 2004; Chung *et al.*, 2005; Heneweer *et al.,* 2011).

Other miscellaneous factors that need to be considered when dealing with a patient are health factors including levels of physical activity, body weight, genetics, smoking/tobacco use, and other factors such as the presence of possible systemic disease, physical and psychological comorbidities that could be related to the LBP (Dagenais and Haldeman, 2012).

With regards to **smoking and alcohol :**

Frymoyer *et al*., (2011) noted that smoking is a significant risk factor to LBP. This concurs with Toroptsova *et al.,* (1995); Harreby *et al.,* (1996); Walker *et al.,* (2004); Vindigni *et al*., (2005) and Skillgate *et al.,* (2007). In contrast to the above statement, Leino (1993); Manninen *et al.,* (1995) and Hurwitz and Morgenstein (1997) indicated in their studies that there was a limited or no association between smoking and the development of LBP. Therefore this has been a debate in the literature resulting in inconclusive evidence for the effect of alcohol and its relationship with LBP (Vallfors, 1985; Heliövaara *et al.,* 1991; Skillgate *et al.,* 2007).

Regarding **activity:**

Literature seems to agree that activity is protective of LBP development (Haldeman, 2005; Morris, 2006; Dagenais and Haldeman, 2012), although some debate exists between the following authors: Holmstroom *et al.,* (1992); Magnusson *et al.,* (1992); Salminen *et al.,* (1995); Harreby *et al.,* (1996); Heistaro *et al.,* (1998); Mortimer *et al.,* (2001) and Power *et al.,* (2001). This may be because different forms of activity predispose to or are protective of LBP (Heneweer *et al.,* 2011; Hoogendoorn *et al.,* 2000).

With regards to **height and weight:**

In a systematic review conducted by Leboeuf-Yde, (2004), on the association of body mass index (BMI) and prevelance of LBP, it was concluded that there was a very poor asssociation between the two phenomena. This was not supported by the study compiled by Mirtz and Greene, (2005) who concluded that a BMI under 30 resulted in a decreased chance of developing LBP, whereas, a BMI of 40 increases the risk of LBP. Therefore, an increased BMI, possibly in addition to other lifestyle factors, may be the precursors for LBP (Heneweer *et al.,* 2011).

With the conclusion of the causative factors of LBP, which followed a simple description of the anatomy and biomechanics of the SIJ, it is possible to focus on SIJ syndrome, which is the principle dysfunction that was treated in this study.

2.4.3 Signs and symptoms of sacroiliac joint syndrome

According to Morris (2006); Giles (2003); Evans (2001) and Isaacs and Bookhout (2002) and the classic symptoms of SIJ syndrome are:

- Aching pain over the SIJ
- Pain radiating into the buttock, posterior thigh, and at times to below the knee
- Discomfort into the groin, anterior aspect of the pelvis or thigh
- Sharp pain aggravated by movement

Signs of SIJ syndrome include (Morris, 2006; Evans, 2001):

- Tenderness localised over the SIJ
- Pain when the SIJ is stressed
- Hamstring tightness
- Pain on forward bending
- Absence of nerve root and neurological signs
- Decrease in SIJ movement
- Increase in sensitivity over the ipsilateral buttock extending into the posterolateral thigh

Hertling and Kessler (1997), Hansen and Standiford (2003), Huijbreghts (2004), Robinson *et al.,* (2006), Van der Wurff *et al.,* (2006) and Szadek *et al.,* (2008) have described typical characteristics and symptoms of patients presenting with SIJ syndrome which include:

- Unilateral SIJ pain, local to the joint itself, but possibly referring down the leg (posterolaterally),
- The absence of lumbar articular signs and symptoms,

- A short period of morning stiffness that eases with movement and weight bearing,
- Increased pain with prolonged postures (sitting/standing),
- Pain aggravated by walking, rolling over in bed and climbing stairs and/or
- Pain referral to the groin, greater trochanter and buttock.

However it was previously noted by Kirkaldy-Willis and Burton (1992) that the symptoms of sacroiliac syndrome include pain over the posterior aspect of the SIJ that varies in its degree of severity; referred pain to the groin, over the greater trochanter, down the back of the thigh to the knee, and occasionally down the lateral or posterior calf to the ankle, foot and toes. This concurs with the discussion in Section 2.2.5 and suggests that clinical identification of patients with SIJ syndrome is difficult. Therefore, any study including SIJ syndrome patients are required to have a set of stringent inclusion criteria in order to ensure that the patient selection results in a homogenous sample. This would include patients who are at the same stage of their pathogenesis and therefore have the potential to respond to an equal extent, allowing for the intervention to be tested in isolation without variable influences (Hebert and Fritz, 2012). To this end, associated clinical signs and provocative clinical testing (Section 2.4.5) are required to assist in homogenising the patient sample. These will now be discussed in the following two sections.

2.4.4 Associated clinical signs of sacroiliac joint syndrome

According to Gatterman (1990); Gatterman (1995) and Leach (2004) there are several components that need to be considered in any joint dysfunction. These include: myopathology (muscle changes), kinesiopathology (movement aberrations), neuropathophysiology (radicular and other soft tissue changes around the joint), and biochemical and histopathological changes within the joint (Gatterman, 1990; Gatterman, 1995; Leach, 2004). Therefore, once pain and changes in the activities of daily living have been reported by the patient, it is incumbent on the chiropractor to assess the above components.

In terms of SIJ syndrome, myopathyology includes the compromise of muscles affecting the function of the SIJ (Travell and Simons, 1983; Evans, 2001; Giles, 2003). These include, but may not be limited to: piriformis muscle (Evans, 2001; Haldeman, 2005), gluteus medius muscle (Thompson, 2002; Mould, 2003), gluteus maximus muscle and to a lesser extent gluteus minimus muscle, psoas muscle (Haldeman, 2005) and related hip flexor muscles (e.g. quadriceps femoris muscle group) (Suter *et al*., 1999; Hillermann, 2003; Hillermann *et al*., 2006). Therefore, palpation of these muscles for the presence of myofascial trigger points (Travell and Simons, 1983); muscle contracture assessment (Evans, 2001), changes in range of motion (Bisset, 2003; Cibulka, 2009) and compromised muscle function (e.g. strength) (Haslett *et al*., 2001; Vizniak, 2005; Boon *et al*., 2006). The combination of these various tests for use in the inclusion and exclusion criteria of this study and particularly in the context of SIJ syndrome will be discussed in Section 3.4.

By contrast, the assessment of kinesiopathology in the SIJ follows that which is stated by Gillet and Liekens (1969); Gillet and Liekens (1984); Schafer and Faye (1990); Hesch (1997), where hypomobility within the SIJ would result in the joint not effectively absorbing the stress from daily activities, therefore resulting in over-stress of the other related structures, contributing to musculoskeletal pain and dysfunction. Joint dysfunction of the SIJ is clinically assessed utilising general and specific motion palpation techniques as described by Schafer and Faye, (1990); Bergmann and Peterson, (2011); Bergmann *et al.*, (1993).

In much the same manner, the effects of neuropathophysiological changes related to the sacroiliac syndrome are assessed utilising a variety of clinical measures, which include but are not limited to (Haslett *et al*., 2001; Bickley, 2002; Vizniak, 2005; Boon *et al*., 2006):

- Neurological testing (reflexes, muscle strength and sensory tests)
- Abdominal assessments (including the inspection, auscultation, percussion and palpation for all the visceral structures in the abdomen and pelvis and
- Vascular assessments (including the peripheral and abdominal vascular tests).

And lastly, the biochemical and histopathological changes within the joint are usually tested clinically utilising provocative clinical tests (Magee, 1987; Reider, 1999; Evans, 2001; Giles, 2003) (as discussed in Section 3.4).

2.4.5 Diagnostic testing (provocative testing) for sacroiliac joint syndrome

According to McCulloch and Transfeldt (1997), Hansen and Standiford (2003); Huijbreghts (2004); Robinson *et al.,* (2006); Van der Wurff *et al.,* (2006), Szadek *et al.,* (2008), patients presenting with SIJ syndrome generally have one or more of the following signs that present with pain and palpable tenderness over the SIJ, aggravated by the following provocation tests:

Major Tests:

- Posterior Shear or Thigh Thrust Test (Magee, 1987; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006; Szadek *et al.*, 2008). This test records a positive finding if it elicits pain over the region of the tested SIJ. The reason for the increase in pain on this test is as a result of a posterior shearing stress to the SIJ and associated ligaments, as well as the hip joint. According to Laslett and Williams (1994), this test has the highest level of inter-examiner reliability.
- Yeoman's Test (Magee, 1987; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006). This test records a positive finding if it elicits local pain over the SIJ due to irritation to the joint.

Minor Tests:

- Patrick Faber Test (Magee, 1987; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006). A

positive finding with this test is pain elicited over the sacroiliac and /or gluteal area, indicating SIJ irritation or pathology.

- Gaenslen's Test (Magee, 1987; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006). This test records a positive finding when pain is produced over the SIJs.
- Sacroiliac Compression Test (Magee, 1987; Huijbreghts, 2004; Vizniak, 2005; Morris, 2006; Szadek *et al.*, 2008). This test stresses the posterior sacroiliac ligaments, eliciting pain in the sacroiliac, buttock or thigh region, which may be an indication of a possible ligament sprain, fracture or SIJ dysfunction.
- Clinical asymmetry with regards to the SIJ movements (Magee, 1987; Schafer and Faye, 1989; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006). The standing flexed knee raising test assesses the motion of the ilia (posterior superior iliac spine) in relation to the second sacral tuberacle. When both osseous landmarks move in unison (at one or more points within the range of motion), the SIJ is defined as being restricted in its ability to move freely within its range of motion.

According to the literature, at least one of the major tests has to be positive along with two or more of the minor tests, or both the major tests has to be positive (with or without any minor tests being positive) in order for the patient to be diagnosed with SIJ syndrome (Riggien, 2003). This is supported by studies that indicated that out of a cluster of six orthopaedic tests which indicate SIJ syndrome, at least three positive tests were found to be reliable in diagnosing SIJ syndrome (Magee, 1987; Hansen and Standiford, 2003; Huijbreghts, 2004; Vizniak, 2005;

Morris, 2006; Robinson *et al.,* 2006; Van der Wurff *et al.,* 2006; Szadek *et al.,* 2008).

2.4.6 Differential diagnoses

The clinical assessment of patients with SIJ syndrome, requires that the patient is also evaluated for diseases and conditions that may mimic the presentation of sacroiliac syndrome (Giles, 2003). Table 2.3 outlines a broad range of conditions that need to be screened for in any patient that is considered for manipulative therapy.

Table 2.3: The relative and absolute contraindications for spinal manipulative therapy (SMT)

Category	**Condition**		**No contraindication / consideration**
	Absolute contraindication	**Relative contraindication**	
Vascular	Aneurysms (e.g.) aorta (Bergmann *et al.*, 1993)	Atherosclerosis (Bergmann *et al.*, 1993) Anti-coagulant therapy (Bergmann *et al.*, 1993)	
Articular	Disc prolapsed with neurological deficit (Bergmann *et al.*, (1993)	Degenerative joint disease (Souza, 2001), Degenerative disc disease (Souza, 2001) Systemic arthritides (e.g. ankylosing spondylitis, rheumatoid arthritis, advanced osteoarthritis) (Souza, 2001; Bergmann *et al.*, 1993) Joint instability and hypermobility (Bergmann *et al.*, 1993)	Coccydynia (Haldeman, 2005)
Muscular	None	Piriformis syndrome, psoas insufficiency syndrome (Haldeman, 2005)	Lumbar facet syndromes (Souza, 2001)
Traumatic	Fracture of the sacrum, vertebrae and pelvis (Haldeman, 2005) Dislocation (Bergmann *et al.*, 1993)	Severe sprains and strains (Bergmann *et al.*, 1993)	None
Bone disorders	Bone tumours and bone infections (e.g. tuberculosis) (Bergmann *et al.*, 1993)	Osteomyelitis, osteoporosis and osteomalacia (Bergmann *et al.*, 1993)	None
Neurological	Neurological syndromes such as cauda equine (Souza, 2001)	Radiculopathies (central or peripheral) (Souza, 2001) Severe sacral nerve root compression (Bergmann *et al.*, 1993) Severe patient pain (Bergmann *et al.*, 1993)	None
Psychological	None	Malingering (Bergmann *et al.*, 1993) Hysteria (Bergmann *et al.*, 1993) Hypochondriasis(Bergmann *et al.*, 1993)	None
Other	Sinister pathologies such as malignancies (benign or malignant) (Souza, 2001) Gynaecological pathologies (e.g. ovarian cysts,fibroids, endometriosis) (Haslett *et al*., 2001) in females and in males prostate pathologies (e.g. benign prostatic hypertrophy and / or malignancy) (Souza, 2001)	Visceral conditions (renal stones) (Souza, 2001) Space occupying lesions (Bergmann *et al*., 1993)	Miscellaneous (e.g. fibromyalgia)

Adapted from Bergmann *et al.,* (1993)

2.5 Treatment of sacroiliac joint syndrome

“Common analgesics is a broad term used to refer to several classes of medications used to manage pain, which includes both non-steroidal anti-inflammatory drugs (NSAIDs), simple analgesics, and muscle relaxants” (Dagenais and Haldeman, 2012). These common analgesics have been used to treat LBP for many years (Dagenais and Haldeman, 2012). The World Health Organization (WHO) encourage guidance from a medical practitioner with regards to the use of medication for the treatment of chronic LBP (Dagenais and Haldeman, 2012). The WHO suggested that simple analgesics and NSAIDs should be used for the treatment for LBP, and if the desired response to these analgesics is not achieved, then the use of opioid analgesics is recommended. Muscle relaxants have demonstrated to be effective in the treatment of acute LBP. In terms of the side-effects of pain medication, simple analgesics include central nervous system (CNS) depression; NSAIDs includes gastrointestinal, renal, hepatic, and cardiovascular events, whereas muscle relaxants tend to cause potential liver toxicity (Dagenais and Haldeman, 2012).

Fuhr (2009), Dagenais and Haldeman (2012) indicated that surgery such as decompression, fusion surgery and disc arthroplasty are just examples of some surgeries indicated for lumbar pathologies. The use of surgery for patients suffering from chronic LBP is a complex issue as there may be other underlying causes for the LBP, and consideration has to be made whether the patients are valid candidates for surgery (Dagenais and Haldeman, 2012).

Injections into the SIJs have also been indicated for patients with SIJ syndrome (Morris, 2006).

By contrast to the above more invasive techniques / interventions, regular and moderate-intensity exercise (30 minutes per day, and 5 days per week) should be recommended by healthcare professionals for people who have a sedentary life-style (Dagenais and Haldeman, 2012). Yoga and pilates are other forms of recommended activities for suffers of chronic LBP (van Middelkoop *et al*., 2010). Additionally conservative therapies may include Chinese medicine, cognitive-behavioural therapy, energy therapies such as Reiki; stimulation techniques such as TENS, acupuncture, dry needling, vibration and acupressure; massage therapy and traction therapy and spinal manipulation (Fuhr, 2009; Dagenais and Haldeman, 2012).

According to Morris (2006), it was implied that high-velocity, low-amplitude (HVLA) manipulation restores the balance between joint kinematics and associated muscle function, which in turn normalizes the arthrokinetic reflex and breaks the pain cycle (Melzack and Wall, 1962). Therefore skilled manipulation is mandatory to discriminate the complex interaction of so many influential and pain-sensitive structures (Morris, 2006). Morris (2006) stated that even though the pathophysiology of the SIJ and its cause of pain remain uncertain (Giles, 2003), there is a growing body of evidence that would suggest that the SIJ responds positively to manipulative treatment (Agency for Health Care Policy and Research, 1994; Association of Chiropractic Colleges, 1997; Airaksinen *et al*., 2006; Negrini *et al*., 2006; Bronfort *et al*., 2010). A panel of 40 clinically experienced chiropractors, the American Chiropractic Association and the International Chiropractic Association were in

consensus that there was strong evidence to support the use of spinal manipulation/mobilization to reduce the symptoms of chronic LBP, and improve functionality (Globe *et al*., 2008).

Chiropractic treatments that are commonly used to treat SIJ syndrome include side-posture spinal manipulation, drop technique, blocking technique, and instrument guided method (Yeomans, 2010).

The application of manual therapies (in particular manipulation), however, results in significant physical wear and tear to the practitioner (Mathews, 2006; Pereira, 2009). Therefore, although manipulation is an advocated therapy for alleviating the symptoms of SIJ syndrome, many practitioners seek alternative methods by which to administer manipulative techniques to their patients. Instrumental manipulations are generally accepted to be clinically safer and less traumatic than manual manipulations (Fuhr *et al.*, 1997; Fuhr and Menke, 2005; Fuhr, 2009).

These forms of mechanically assisted manipulative techniques includes the Activator Adjusting Instrument (AAI) which is discussed as follows: (Fuhr, 2009).

2.6 Instrument manipulation with particular emphasis on the Activator Adjusting Instrument (AAI)

Instrument adjusting has been a method of applying manipulative techniques on patients since the early development of the Chiropractic profession (Fuhr, 2009). To this end, a range of devices have been developed to assist the practitioner decrease load on their own bodies, by utilising mechanical aids in the deliverance of spinal manipulation (e.g. Wooden mallets and sticks, a rubber hammer, toggle-recoil instruments and computer-operated devices). (Redwood and Cleveland, 2003; Leach, 2004; Haldeman, 2005).

In this context, the AAI is an adjusting instrument founded by Fuhr and Lee in the 1960's, and its popularity is due to the ease of application and perceived safety (Fuhr *et al*., 1997; Fuhr, 2009). These chiropractors found that repetitive use of the thumb toggle technique resulted in fatigue and injuries to the practitioner, decreasing their practice lifespan and therefore livelihood (Mathews, 2006; Pereira, 2009). Thus, AAI treatment involves the use of a low-force which is delivered through this hand-held adjustment instrument to impart a force into the spine/joint. This thrust (also referred to as manipulation) reduces the physical stress on the practitioner and enables increased control of speed, force and direction of the adjustment application (Fuhr and Smith 1986, Byfield 1991; Osterbauer *et al.*, 1995; Haldeman, 2005).

In the context of the patient, the hypothesised effects of the AAI are to restore the articular structures to some normality (normal joint movement), resulting in an increase of the mechanoreceptor effect (Gate

Control Theory and integrated pain theory) (Melzack and Wall, 1962; Leach, 2004), thereby reducing pain and inflammation within the joint(s) (Haldeman, 2005; Fuhr, 2009). These latter factors result in improving the patient's activities of daily living (Yeomans, 2000).

Additionally, Slosberg's (1988) has also acknowledged that factors such as fear, discomfort and resistance to manual manipulations are eliminated with the use of AAI (due to the decreased need for twisting the spine). This improves patient perception of the therapy, and may, therefore provide non-tangible benefits in the chiropractor-patient interaction (Dugmore, 2006).

2.7 The Placebo effect / The Hawthorne effect / Observer effect

Whenever a patient is exposed to newer technologies or instruments utilised in the chiropractor-patient relationship, it has been found that there is an increase in the patient's perception that the patient would get quicker results than standard manual therapy without such aids (Dugmore, 2006). This effect is known in the literature (Thomas, 1994; Mouton, 2006; Mouton, 2008):

- as the placebo effect (when the patient perceives that they are receiving active care),
- the Hawthorne effect (when the patient alters their behaviour as a result of being aware that they are being observed) and / or
- the Observer effect (where the chiropractor-patient is influenced by outside activities).

In this context, placebo is defined as “the ability or power of the doctor alone to make the patient feel better”, with or without the use of active medications or interventions (e.g. may be natural history) (Thomas, 1994; Dugmore, 2006; McDonald *et al*., 1983). By contrast, Kienle and Kiene (1996) and Kirsch (1998) use the term placebo to describe limitations of an intervention (e.g. where there is a perception that the therapy has no actual measureable effect). Therefore, some authors have suggested that a placebo is that effect, which results from contact between patients and healthcare practitioners, where this “therapeutic meeting” has the potential of initiating a placebo effect (Hrobjartsson, 1996).

Therefore, researchers have described the placebo effect as something that can be measured, observed (in the research milieu) or felt (by the patient) as an improvement in health not attributable to the intervention. This is important as current research and clinical trends require that patients are managed in an evidence based system (Dagenais and Haldeman, 2012). This demands that chiropractors are informed and therefore inform their patients of the effectiveness of interventions and the degree to which they differ from a placebo intervention.

2.8 Conclusion

The chiropractic management approach may thus have specific treatment effects or placebo effects, or both (Barker 1985; Jamison, 1998). Therefore in order to ensure that patients receive the minimally accepted standard care in chiropractic treatment rooms, it is important that interventions are tested against placebo in order to confirm that they

confirm to this requirement of evidence based medicine (Sackett *et al*., 1996).

Therefore, this study aimed at testing the AAI set at full tension and using the diversified method of patient positioning (Byfield, 2005) against the AAI placebo set a zero tension and using the diversified method of patient positioning in the treatment of chronic LBP of SIJ syndrome origin.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter discusses the methods used in the data collection from the patients and the intervention utilized, as well as the methods of statistical analysis and the process of the evaluation of the data. This study was a prospective, double-blinded, placebo-controlled, comparative clinical trial, quantitative in nature (the results were stipulated and calculated in a statistical numerical format to determine the outcome of each individual treatment group), investigating the effectiveness of the AAI in the treatment of chronic SIJ syndrome. The research involved two groups: one group received the AAI set at full tension; the other group received the AAI set at zero tension (placebo). Subjective and objective readings were taken at consults one, three and five in order to collect empirical data on the patients' response to the treatment intervention.

This study in its design (as outlined in this chapter) was approved by the IREC (Appendix K) in order to indicate that this study compiled with the principles set out in one or all of the Belmont, Nuremburg and Helsinki Declarations (Johnson, 2005).

3.2 Advertising

Advertisement flyers were posted onto notice boards at the DUT campus and at the DUT Chiropractic Day Clinic notifying potential candidates of the current research being conducted at the DUT Chiropractic Day Clinic. The advertising flyers noted the treatment of chronic LBP of SIJ origin for purposes of the research. (Appendix A).

Advertisement flyers were also posted at various community centres and places of communal gathering, if permission for such was granted. If candidates met the criteria they were eligible for free treatment (within the research protocol) of their chronic LBP of SIJ syndrome origin. (Appendix A).

3.3 Sampling

3.3.1 Size

40 patients were utilised for this study. An *a priori* analysis based on the minimally clinically important difference of the Numerical Pain Rating Scale (NRS) showed that a sample of 40 patients allowed for the detection of both clinical and statistical significance (Esterhuizen, 2012; Hammond, 2012).

3.3.2 Allocation

Patients were recruited by means of their response to the advertisements (thus self selection) (Howell, 1999; Mouton, 2006; Mouton, 2008), however once patients had been screened through the inclusion and exclusion criteria they were allocated randomly through concealed allocation (Howell, 1999; Mouton, 2006; Mouton, 2008) to one of two groups of 20 patients each.

A randomisation table was utilised for purposes of patient allocation to groups (Cottrell and McKensie*,* 2005). This table was generated by the statistician and submitted to a third party (clinic secretary) such that the researcher was not privy to group allocations until after the patients had been screened and was found to be eligible for the study.

3.3.3 Method

A telephonic interview was conducted initially, where relevant questions were asked to determine if the patient would qualify for this research.

The following questions were asked:

Table 3.1 Telephonic Questionnaire		
Question		Answer required for inclusion into the study
1	Would you be willing to answer a few simple questions in order for me to determine your eligibility for this study?	Yes
2	Are you between the ages of 18 and 45?	Yes
3	Do you currently have LBP?	Yes
4	Does the pain aggravate on - walking, - rolling over in bed and / or - climbing stairs and /or - prolonged sitting or standing ?	 Yes Yes Yes Yes
5	Do you have a history of recurrent LBP?	Yes
6	Are you on any short term medication ?	No

Once it was determined that the patient met the requirements as outlined in Table 3.1, from the telephonic interview, an appointment was scheduled at the Chiropractic Day Clinic for their initial consultation.

At the initial appointment, made at the Chiropractic Day Clinic, the prospective patient was required to first read, understand and then sign the Letter of Information and Informed Consent Form (Appendix B). At this point the patient was permitted to ask any questions of the researcher to clarify the process and procedures of the study prior to signing the Letter of Information and Informed Consent Form.

Thereafter, the researcher performed a full case history (Appendix C), physical examination (Appendix D) and regional evaluation of the lumbar spine as it also included the SIJs (Appendix E) in order to screen the prospective patient against the inclusion and exclusion criteria. All data was noted on a SOAPE note (Appendix F) for discussion with the clinical

supervisor and in order to ensure that the patient met all the research requirements (inclusion criteria).

3.4 Inclusion criteria

The inclusion criteria were:

- The patients were required to have LBP defined as “pain limited to the region between the lower margins of the 12th rib and the gluteal folds” (Galukande *et al.*, 2005), as the principle cause of their discomfort.

- Both males and females were accepted into the study and patients were required to be between the ages of 18 (as patients younger than this were considered minors) (South African Medical Research Council) and 45, as patients older than this may have already developed fibrous ankylosis in the SIJs (Kirkaldy-Willis and Burton, 1992; Marchiori, 1999).

- The patient was required to agree to and sign the Letter of Information and Informed Consent Form (Appendix B).

- The patients had to have a history of chronic LBP which is defined as more than three episodes of low back pain per year for the preceding five years (Whalen *et al.,* 2008), and the previous episode must have had a duration (on average) of more than 6 weeks, but less than 12 weeks (Morris, 2006; Whalen *et al.*, 2008).

- The current episode of chronic LBP must be less than two weeks in duration (Stig *et al.,* 2001; Morris, 2006).

- The patient was required to be currently suffering from SIJ syndrome, which was diagnosed through at least three out of five specific orthopaedic sacroiliac provocation tests being positive. The most common cluster of tests utilised in diagnosing SIJ syndrome are:

    - Posterior Shear or Thigh Thrust Test (Magee, 1987; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006; Szadek *et al.*, 2008),
        - Patient's position: Supine.
        - Examiner's position: standing on the side opposite to the suspected SIJ syndrome (i.e. on the left for a suspected right SIJ syndrome).
        - Method: The patient's right knee and hip are flexed and slightly adducted. The examiner places the left hand under the right SIJ and applies a downward, or posterior, shearing force on the right knee through the femur, while feeling for joint motion with the opposite hand. A positive test is recorded if this position elicits pain over the region of the right SIJ.

- Yeoman's Test (Magee, 1987; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006),
    - Patient's position: Prone
    - Examiner's position: Standing on the ipsilateral side as the suspected SIJ syndrome (i.e. on the right for a suspected right SIJ syndrome).
    - Method: The examiner places one hand under the right thigh above the knee, in order to extend the hip. The examiner's other hand presses downward over the crest of the right ilium, while the right hip is extended. A positive test is recorded if this position elicits pain over the region of the right SIJ.

- Patrick Faber Test (Magee, 1987; Kirkaldy-Willis and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006),
    - Patient's position: Supine.
    - Examiner's position: Standing on the ipsilateral side as the suspected SIJ syndrome (i.e. on the right for a suspected right SIJ syndrome).
    - Method: The patient's right knee and hip are flexed. The hip is then externally rotated. The examiner places his right hand over the patient's left iliac crest and his left hand pushes downward on the medial aspect of the

right knee. A positive test is recorded if this position elicits pain over the region of the right SIJ.

- Gaenslen's Test (Magee, 1987; Kirkaldy-Willis and Burton,1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006),
    - Patient's position: Supine.
    - Examiner's position: Standing on the ipsilateral side as the suspected SIJ syndrome (i.e. on the right for a suspected right SIJ syndrome).
    - Method: The patient's left knee and hip is flexed, while the examiner presses downward over the right thigh to hyperextend the hip. A positive test is recorded if this position elicits pain over the region of the right SIJ.

- Sacroiliac Compression Test (Huijbreghts, 2004; Vizniak, 2005; Morris, 2006; Szadek *et al.*, 2008),
    - Patient's position: Side-lying.
    - Examiner's position: Standing on the ipsilateral side to the suspected SIJ syndrome.
    - Method: Examiner places hands on superior ilium and applies downward pressure (compressing the pelvis).
- Clinical asymmetry with regards to the SIJ movements (Magee, 1987; Schafer and Faye, 1990; Kirkaldy-Willis

and Burton, 1992; Hansen and Standiford, 2003; Vizniak, 2005; Morris, 2006).

- Patient's position: Standing.
- Examiner's position: Seated behind the standing patient.
- Method (for right-sided ipsilateral flexion): Examiner places their right thumb on the right PSIS, and left thumb on second sacral tuberacle. The patient is then instructed to lift their right limb, flexing their knee in the process. The examiner watches and feels for movement of the PSIS, moving posteriorly and inferiorly, whilst forming a crescent shaped movement pattern. Lack of this movement or simultaneous movement between the osseous structures indicates restricted sacroiliac movement. The same process is followed on the left side for left-sided SIJ assessment. For extension restriction the procedure is the same, with the exception that the patient flexes the limb contralateral to the examiner's palpating thumbs.

At least one of the major tests (Posterior Shear or Yeoman's test) had to be positive along with two or more of the minor tests (Faber, Gaenslen's or Sacroiliac Compression Test), or both the major tests had to be positive (with or without any minor tests being positive) in order for the patient to be diagnosed with SIJ syndrome.

Studies indicated that out of a cluster of orthopaedic tests which indicate SIJ syndrome, at least three positive tests were found to be reliable in diagnosing SIJ syndrome (Hansen and Standiford, 2003; Huijbreghts, 2004; Morris, 2006; Robinson *et al.,* 2006; Van der Wurff *et al.,* 2006; Szadek *et al.,* 2008).

Patients who had taken analgesic medication (e.g. Ibuprofen, Paracetamol) were included following a three day wash out period (Poul *et al.,* 1993; Seth, 1999; Bennell *et al*., 2007; Park *et al*., 2010).

3.5 Exclusion criteria

The exclusion criteria were:

- Patients were screened for contraindications to manipulation (e.g. fractures), determined through the case history and physical examination (Gatterman, 1990; Haldeman, 2005; Morris, 2006).

- Patients taking anti-inflammatory drugs or pain killers for their condition. Alternatively, patients were required to endure a three day wash out period before being accepted for the study (Poul *et al.,* 1993; Seth, 1999; Bennell *et al*., 2007; Park *et al*., 2010).

- Patients having been part of another research trial were not permitted to take part in this study until a three month wash out period had taken place. Similarly, a patient who had attended/is attending the DUT Chiropractic Day Clinic for treatment were not permitted to take part in this study until a two week wash out

period had taken place (this was according to the DUT Chiropractic Day Clinic protocol).

- Any patient that required further investigations to confirm the diagnosis or who required exclusion of diagnoses, that would require alternative treatment, as the first line of intervention were also excluded (Ferri, 2004).

3.6 Intervention/Treatment types

After appropriate screening to determine whether the patient had SIJ syndrome, the standing sacroiliac mobility tests were utilised to determine whether the patient had a flexion or extension restriction in motion (Bergmann *et al*., 1993; Schafer and Faye, 1990). The outcome of the mobility assessment determined the intervention to be used (viz. flexion or extension per SIJ).

Group One (Treatment group)

1. Flexion restrictions

   Patient position: the patient was requested to lie in the diversified side posture position (the leg ipsilateral to the dysfunctional SIJ was flexed at the hip and the knee, and the arms were folded across the chest) with the restricted SIJ furthest away from the bed.

   Chiropractor position: the chiropractor stood in a fencer stance, angled approximately 45 degrees to the patient. Support was given to the patient by contacting the patient's thigh of the flexed limb with the inferior aspect of the chiropractor's thigh, or by the

chiropractor straddling the patient's bent limb between the chiropractor's thighs.

Contact point: the tip of the AAI.

Segmental contact point: the superior sacral base just medial to the posterior superior iliac spine, on the side of the SIJ syndrome.

Indifferent hand: the forearm of the indifferent hand contacted the psilateral (ipsilateral to the SIJ syndrome) upper arm of the patient, distracting superiorly.

Vector: posterior to anterior, and inferior to superior (angled towards the umbilicus anteriorly).

2. Extension restriction

Patient position: the patient was requested to lie in the diversified side posture position (the leg contralateral to the dysfunctional SIJ was flexed at the hip and the knee, and the arms were folded across the chest) with the restricted SIJ nearest to the bed.

Chiropractor position: the chiropractor stood in a fencer stance, angled approximately 45 degrees to the patient. Support was given to the patient by contacting the patient's thigh of the flexed limb with the inferior aspect of the chiropractor's thigh, or by the chiropractor straddling the patient's bent limb between the chiropractor's thighs.

Contact point: the tip of the AAI.

Segmental contact point: the mid-portion of the sacrum just medial to the posterior inferior iliac spine, on the side of the SIJ syndrome.

Indifferent hand: the forearm of the indifferent hand contacted the contralateral (contralateral to the SIJ syndrome) upper arm of the patient, distracting superiorly.

Vector: posterior to anterior, and superior to inferior (angled towards the pubic symphysis anteriorly).

Group Two (Placebo group)

1. Flexion restrictions

   Patient position: the patient was requested to lie in the diversified side posture position (the leg ipsilateral to the dysfunctional SIJ was flexed at the hip and the knee, and the arms were folded across the chest) with the dysfunctional SIJ furthest away from the bed.

   Chiropractor position: the chiropractor stood in a fencer stance, angled approximately 45 degrees to the patient. Support was given to the patient by contacting the patient's thigh of the flexed limb with the inferior aspect of the chiropractor's thigh, or by the chiropractor straddling the patient's bent limb between the chiropractor's thighs.

   Contact point: the tip of the chiropractor's finger.

   Segmental contact point: the superior sacral base just medial to the posterior superior iliac spine, on the side of the SIJ syndrome.

   Indifferent hand: the forearm of the indifferent hand contacted the ipsilateral (ipsilateral to the SIJ syndrome) upper arm of the patient, distracting superiorly.

   Vector: posterior to anterior, and inferior to superior (angle towards the umbilicus anteriorly).

2. Extension restriction

   Patient position: the patient was requested to lie in the diversified side posture position (the leg contralateral to the dysfunctional SIJ

was flexed at the hip and the knee, and the arms were folded across the chest) with the restricted SIJ nearest to the bed.

Chiropractor position: the chiropractor stood in a fencer stance, angled approximately 45 degrees to the patient. Support was given to the patient by contacting the patient's thigh of the flexed limb with the inferior aspect of the chiropractor's thigh, or by the chiropractor straddling the patient's bent limb between the chiropractor's thighs.

Contact point: the tip of the chiropractor's finger.

Segmental contact point: the midportion of the sacrum just medial to the posterior inferior iliac spine, on the side of the SIJ syndrome.

Indifferent hand: the forearm of the indifferent hand contacted the contralateral (contralateral to the SIJ syndrome) upper arm of the patient, distracting superiorly.

Vector: posterior to anterior, and superior to inferior (angle towards the pubic symphysis anteriorly).

Although the chiropractor's finger was in contact with the patient, the AAI was still activated in order to achieve a placebo effect.

3.7 Intervention frequency

The treatments were spaced in such a manner that there were no less than two days and no more than four days between treatments. The initial consult took approximately two hours, and thereafter follow up consults were no longer than 40 minutes (as outlined in Table 3.2).

Table 3.2 Treatment and Measurement Protocol

Week	Consult	Group One	Group Two
1	1	Baseline measurement : NRS, Algometer, Revised Oswestry Disability Questionnaire (Oswestry) Full tension Activator intervention	Baseline measurement : NRS, Algometer, Oswestry Zero tension Activator intervention
	2	Full tension Activator intervention	Zero tension Activator intervention
2	3	Measurement : NRS, Algometer, Oswestry Full tension Activator intervention	Measurement : NRS, Algometer, Oswestry Zero tension Activator intervention
	4	Full tension Activator intervention	Zero tension Activator intervention
3	5	Final measurement : NRS, Algometer, Oswestry	Final measurement : NRS, Algometer, Oswestry

3.8 Data collection

The patients' data was taken from a data collection sheet (Appendices G, H, I), and entered onto a Microsoft Office Excel spreadsheet.

3.8.1 Data collection instruments

A blinded assessor (Appendix J– letter of agreement to assist in taking readings), was utilised to take recordings of the clinical measurements at consultations one, three and five. This was done in order to ensure that the researcher had no input (who was treating the patients and thus no potential bias in terms of the noted improvements or lack thereof (Mouton, 2006; Mouton, 2008). To ensure blinded assessor consistency, she was trained prior to the commencement of the study in terms of:

- Placement of the algometer on each patient (ie. Medial to the PSIS).
- Familiarity with regards to the Oswestry and NRS tools.

Separate data sheets utilized by the blinded assessor were used for each patient, and the measurements taken on consults one, three and five for each patient were all recorded on these data sheet. The blinded assessor was in possession of the data sheets at all times, thereby eliminating any potential bias from the researcher. In order to ensure that the blinded assessor had no knowledge of which group each patient was in, the researcher and the reception staff were the only people who had access to the patient files. Each of the patients were blinded as to which group they were allocated to in order to eliminate any potential bias and/or expectations regarding the treatment received by each patient.

3.8.1.1 Subjective data:

Subjective measurements to determine the severity of the patient's LBP, pre and post treatments were achieved using the following:

1. **The Revised Oswestry Disability Questionnaire** (Yeomans, 2000) (Appendix H) - Subjective measurements were acquired by the use of a questionnaire which the patients answered as accurately as possible in order to determine the severity of their condition and they were asked to complete this questionnaire prior to their first and third treatments, and after their last treatment. According to Hsieh *et al*., (1992) the Roland Morris Questionnaire and the Revised Oswestry Disability Questionnaire were both shown to have good internal consistency (alpha coefficients higher than 0.77) as well as reliability for measuring LBP. The minimal clinically important difference is noted at 6% (Fairbank and Pynsent, 2000 and Fritz and Irrgang, 2001).

2. **Numerical Pain Rating Scale-101 (NRS)** (Yeomans, 2000) –used to measure the patient's subjective pain intensity. A pain rating score was taken before and after the treatment period, as to ascertain if the treatment had an effect on reducing the patient's symptomatic pain. The patient was asked to indicate on a line what their pain rating was, on a scale of 0-100. Zero (0) being no pain and one hundred (100) being the most excruciating pain they had ever experienced (Appendix G). Price *et al.,* (1994) insists a numerical rating gives a good indication

whether the pain has reduced or increased in-between consultations. The NRS has been shown to be reliable, valid and highly responsive (Ferreira-Valente *et al*., 2011). The minimal clinically important difference is noted at 20-25mm (Lee *et al.*, 2003; Ostelo and De Vet, 2005).

3.8.1.2 Objective data:

Objective measurements to determine the severity of the patient's LBP, pre and post treatments were achieved using the following:

1. **Algometer Pain/Pressure Meter**– According to Kinser *et al.,* (2009), the algometer is a reliable tool when collecting objective data. Pressure and pain threshold assessment by an algometer is a reliable measure of subjective tenderness and a suitable, convenient method of monitoring treatment effects (Potter *et al.,* 2008). The patients were instructed by the blinded assessor (Appendix J), as well as given a demonstration, of the differences between tenderness and pressure. The algometer was used to assess pressure and pain threshold over the SIJ surface just medial to the posterior superior iliac spine (over the joint capsule) before treatments one and three, and a final follow up in week three. (Appendix I). This was achieved by the blinded assessor placing the algometer just medial to the PSIS on the affected side. Pressure was then exerted from a posterior to an anterior direction until such time that the patient reported discomfort. At each of these consults, the blinded assessor took two algometer readings which were then averaged to reach a single

average figure for statistical analysis. This procedure was followed at each of the measurement consultations (i.e. First, third and fifth consultations). The minimal clinically important difference is noted at 15% (O'Leary *et al.*, 2007; Potter *et al*., 2006; Paungmali *et al.*, 2003).

3.9 Statistical Methodology

Data was collected from the Revised Oswestry Disability Questionnaire, NRS and the Algometer Pain/Pressure Meter.

Following consultation with a research statistician, statistical analysis was conducted on the data using SPSS version 20 (manufactured by SPSS Inc., 444N. Michigan Ave, Chicago, llinois, 60611, USA). The demographic data were compared between the two groups using Pearson's Chi-square tests for categorical variables and t-tests for continuous variables.

Repeated measures ANOVA testing was used to assess the effect of the intervention compared with the placebo. Correlations between changes in the outcome measures from pre to post intervention were done intra group using Pearson's correlation coefficient.

A two-tailed p value of <0.05 or a confidence interval of 95% was considered as statistically significant. In terms of age, occupation and gender, these input variables were controlled for in the analysis of the data to ensure that there was no bias between the groups with relation to these factors that influence LBP. The clinical significance for each individual measurement tool was set as follows: Revised Oswestry

Disability Questionnaire at 6 percent (%); NRS at 20-25mm; and the Algometer Pain/Pressure Meter at 15%.

3.10 Conclusion

With this chapter having outlined the recruitment procedure, inclusion and exclusion criteria, as well as treatment intervention, and the measurement tools, and their analyses; Chapter Four presents the results and discussion attained. Leaving Chapter Five to present the conclusions and recommendations.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This study consisted of 40 patients, with ages ranging from 18 to 45, and these patients were divided into two groups of 20 patients each. No consideration was made for gender, ethnic group or occupation.

One group was treated with the AAI set at full tension, and the other group was treated with the AAI set at zero tension (placebo). All the patients were treated in the diversified side posture position. Statistical analyses of the patients' pain and discomfort levels were carried out to assess the extent of the non-specific effects that occur between the two groups. Both intra and inter group comparisons were drawn. The results of these statistical analyses together with the discussion of the results will be presented in this chapter for ease of reference.

4.2 Data

4.2.1 Primary sources of data

The primary data used to collect information from the patients were:
- Numerical Pain Rating Scale (NRS) (Appendix G),
- Revised Oswestry Disability Questionnaire (Appendix H) and
- The Algometer Pain/Pressure Meter (Appendix I).

Other primary data were collected in the form of the case history (Appendix C), physical examination (Appendix D), regional evaluation of the lumbar spine (Appendix E) and the SOAPE note (Appendix F); in order to ensure patients' compliance with the respective inclusion criteria (Section 3.3.3 and Section 3.4).

4.2.2 Secondary sources of data

Secondary data sources included personal communication with the statistician (Esterhuizen, 2012); various books on statistical analysis (Bland, 1996; Swinscow, 1996; Wright, 1997; Campbell and Machin, 1999; Hinton, 2001) and communication and discussion with the supervisors of the research project (Korporaal, 2012; White, 2012). Discussion in Chapters Two and Five required literature from various books, journal articles and other applicable sources as stated in the reference list.

4.3 Abbreviations as pertinent to Chapter four

"*p*" refers to the *p*-value which indicates the data statistical significance (Bland, 1996; Swinscow, 1996; Wright, 1997; Campbell and Machin, 1999; Hinton, 2001).

"N" refers to the to the sample size. Sample in this case is defined as *"A subset of a population"* (Tropper, 1998).

"%" refers to percentage.

"<" refers to a figure "less than" the figure reported.

">" refers to a figure "greater than" the figure reported

"df" refers to differential.

“Sig” refers to significance (Bland, 1996; Swinscow, 1996; Wright, 1997; Campbell and Machin, 1999; Hinton, 2001).

“F” refers to frequency (Bland, 1996; Swinscow, 1996; Wright, 1997; Campbell and Machin, 1999; Hinton, 2001).

“=” refers to equals to.

4.4 Patient flow as per the Consort diagram

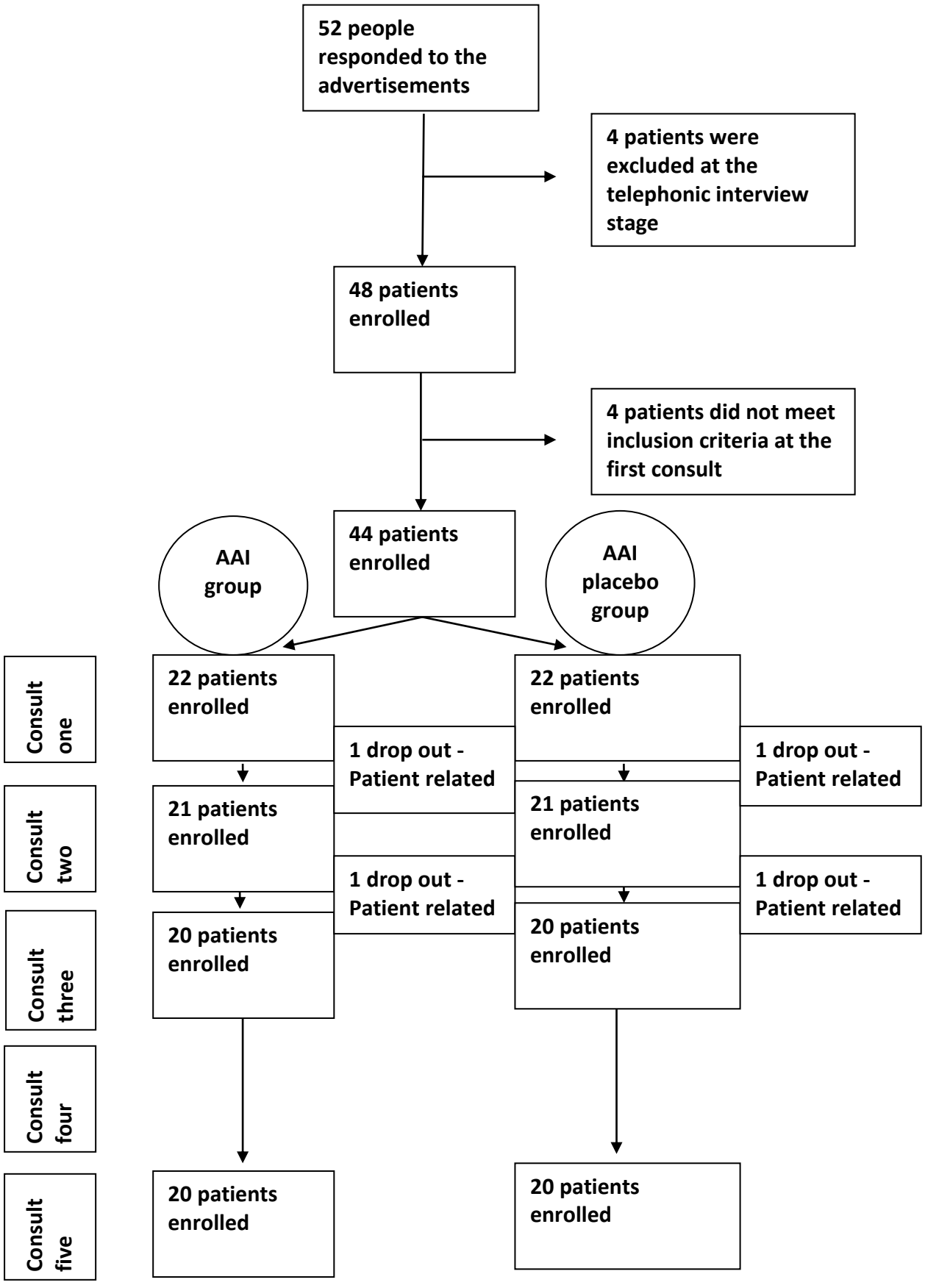

Figure 4.1 Consort diagram outlining patient flow in this study

4.4.1 Discussion of the Consort

“The Consort statement is made up of a checklist and a flow diagram for reporting a randomized controlled trial (RCT) (Moher *et al*., 2001). This checklist and flow diagram are used in writing, reviewing and evaluating reports of two-group parallel RCTs” (Moher *et al*., 2001).

From the Consort diagram (Figure 4.1), 52 people responded to the advertisements for this study, eight people were eliminated from the onset of the study for not meeting the inclusion criteria (either through the telephonic or clinical screening process). This indicates that the inclusion criteria were stringently applied in the study, allowing for the patients in each group to achieve a similarity or homogeneity so as to enable direct comparison between the groups without skewing of this comparison by the demographic data. Therefore, the strength of the results are more likely to display the effects of the intervention than those of demographic data differences between the groups. This is significant in that the randomisation process achieved its goal of obtaining two groups of a similar nature without bias or interference from the researcher (Mouton, 2006).

During the research process, it was noted that the four patients dropped out of the study (two from each group respectively). Of these one patient perceived not to benefit from the treatment and therefore decided to drop out of the study, and the remaining three patients could no longer fulfil their commitment to this study due to personal reasons. It can, therefore, be seen that the impact of the treatment was not the principle reason for the withdrawal of patients and that there were no instances in which

patients withdrew or were withdrawn due to adverse effects of the intervention. This implies that there is no bias that would have been introduced by excluding these patients from the study. The intention to treat analysis could not be utilised to retain the data from these patients, as they had not reached the point of having had their second readings taken and therefore computational analysis and assumption utilised was not possible. Therefore, the analysis was limited to only those patients that completed the entire study procedure.

Additionally, as two patients from each group dropped out, it could be stated that the effect of the drop outs was not detrimental to the outcomes of either group, and therefore did not have a negative impact on the outcome measurements of this study.

4.5 Results

As in Chapter Three, it needs to be stated that blinding was maintained throughout this study.

4.5.1Baseline results

4.5.1.1 Gender

There was no significant difference in gender between the two groups (*p*=0.327).

Table 4.1 Cross tabulations for gender between the groups

			GENDER		Total
			F	M	
Group	AAI	Count	14	6	20
		% within group	70.0%	30.0%	100.0%
	Placebo AAI	Count	11	9	20
		% within group	55.0%	45.0%	100.0%
Total		Count	25	15	40
		% within group	62.5%	37.5%	100.0%

Table 4.2 Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.960[a]	1	0.327
[a]. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.50.			

4.5.1.2 Age

Similarly, age was similar between the two groups (*p*=0.454).

Table 4.3 Group Statistics

	Group	N	Mean	Standard (Std.) Deviation	Std. Error Mean	*P* value
AGE	AAI	20	33.55	7.983	1.785	0.454
	Placebo AAI	20	31.65	7.896	1.766	

4.5.1.3 Occupation

Table 4.4 Intergroup comparisons of Occupations

AAI	**Category**	**AAI Placebo**	**Category**
Student	Sedentary	Student	Sedentary
Student	Sedentary	Student	Sedentary
Student	Sedentary	Student	Sedentary
Student	Sedentary	Student	Sedentary
Student	Sedentary	Student	Sedentary
Administrator	Sedentary	Administrator	Sedentary
Administrator	Sedentary	Self-employed	Sedentary
Engineer	Sedentary	Personal assistant	Sedentary
Clerk	Sedentary	Broker	Sedentary
Director	Sedentary	Crane driver	Sedentary
Accountant	Sedentary	Manager	Sedentary
Fund secretary	Sedentary	Manager	Sedentary
Broker consultant	Sedentary	Events manager	Sedentary
Teacher	Non sedentary	Domestic worker	Non sedentary
Sales representative	Non sedentary	Housewife	Non sedentary
Yoga instructor	Non sedentary	Housewife	Non sedentary
Car salesman	Non sedentary	Housewife	Non sedentary
Chiropractor	Non sedentary	Radiographer	Non sedentary
Chiropractor	Non sedentary	Body builder	Non sedentary
Librarian	Non sedentary	Domestic worker	Non sedentary

To determine the occupational comparison between the two groups in this study, it was determined that any person who worked for a period of greater than 4 hours per working day at a desk or was office bound was considered to be sedentary. This is in congruence with the definitions proposed by Vingard and Nachemson (2000), Harkness *et al*., (2003) and Yip (2004). The converse would be applicable for an active lifestyle/occupation (non sedentary).

4.5.2. Discussion of baseline results

As seen in Table 4.1, the AAI group had more than double the number of females than the placebo AAI group, however, the placebo group also had slightly more females, and therefore the differences between the groups were not statistically significant. The converse is true of the male patients in the study. This predominance of females concurs with the literature which indicates that low back pain, and more specifically SIJ syndrome, is more prevalent in the female population group (Cramer and Darby, 1995). Further to this, work load has been found to affect females to a greater extent (resulting in LBP) (Vingard and Nachemson, 2000). In contrast, work repetition (Vingard and Nachemson, 2000) has been shown to affect males to a greater extent (resulting in LBP) (Bildt Thorbjornsson *et al.,* 2000; Vingard and Nachemson, 2000).

In terms of age (Table 4.3), the two groups were not significantly different (p=0.454), however it is noted that the AAI group has a higher mean/average age (by approximately 2 years). This is not anticipated to have affected the results of this study (Mouton, 2006).

In comparison to the literature, it is generally noted that Leboeuf-Yde *et al.,* (2009) and Plouvier *et al.,* (2011) reported increasing age to be directly related to an increase in the prevelance of LBP. This would seem to contradict the younger age group that participated in this study. However, it is possible that if lifetime prevalence is higher in the mean/average age group, that the point prevalence is higher in the younger age groups, resulting in a greater likelihood that a study such as this draws younger pateints (Brink, 1996). This latter assertion however, is debatable as the literature seems to indicate contradictory evidence both for and against age being a prognostic factor in the development of LBP (Biering-Sörensen, 1983; Deyo and Tsui-Wu*,* 1987; Heliövaara, 1989; Mierau *et al.,* 1989; Svensson and Andersson, 1989; Battie *et al.,* 1990; Daltroy *et al.,* 1991; Heliövaara *et al.,* 1991; Riihimaki, 1991; Olsen *et al.,* 1992; Balague *et al.,* 1994; Skovron *et al.,* 1994; Troussier *et al.,* 1994; Burton *et al.,* 1996b; Kristjandottir, 1996; Newcomer and Sinaki*,* 1996; Burdorf and Sorock, 1997; Hurwitz and Morgenstein, 1997; Taimela *et al.,* 1997; Morris 2006; Louw *et al*., 2007; Dagenais and Haldeman 2012).

Additionally, the setting for this study was a university based clinic, which implies that there is an increased likelihood that respondents to this study would have been younger than those that may have responded if the clinic was in a general population setting and independant of the university. This presentation of patients according to age may have influenced the outcome of the study, in that the reponses to the interventions may have yielded quicker results than those that would have been anticipated in an higher than mean/average age patient group. Therefore, when utilising the outcomes of this study, it is cautioned that the results are contextualised within the appropriate age related context (Mouton, 2006).

In terms of occupation, it is noted in Table 4.4 that there is no difference between the groups in terms of whether or not their occupations were classified as sedentary or non sedentary (as per the literature definitions provided by Vingard and Nachemson (2000), Harkness *et al*., (2003) and Yip (2004). Therefore, this demographic data is also not expected to have influenced either group within their respective results (Mouton, 2006).

The similarities between the groups and the spread of occupations between the groups seem to reflect the various work related factors that have been related to the development of LBP (including but not limited to):

- Accumulation of loads (Hoogendoorn *et al.,* 2000; Heneweer *et al.,* 2011),
- Bending and twisting (Wai *et al.,* 2010b),
- Carrying and pulling (Pope *et al.,* 2002; Roffey *et al.,* 2010a),
- Increased lifting (Hoogendoorn *et al.,* 2000; Heneweer *et al.,* 2011),
- Manual handling (Hoogendoorn *et al.,* 2000; Jansen *et al.,* 2004; Heneweer *et al.,* 2011; Roffey *et al.,* 2010d; Plouvier *et al.,* 2011),
- Physical load while lifting (Hoogendoorn *et al.,* 2000; Jansen *et al.,* 2004; Heneweer *et al.,* 2011; Roffey *et al.,* 2010d; Plouvier *et al.,* 2011),
- Pushing (Ayoub and McDaniel, 1974; Pope *et al.,* 2002; Roffey *et al.,* 2010a),
- Repetitive tasks (Hoogendoorn *et al.,* 2000; Heneweer *et al.,* 2011)
- Tiring / repetitive positions (Roffey *et al.,* 2010c; Plouvier *et al.,* 2011)
- Whole body vibration (Hulsof and van Zanten, 1987; Bovenzi 1996; Bovenzi and Hulshof, 1998; Hoogendoorn *et al.,* 2000; Vingard and

Nachemson, 2000; Krause *et al.,* 2004; Chung *et al.*, 2005; Heneweer *et al.,* 2011).

Therefore, in summary, the patients in this study could have either developed LBP from high-load, high-repetition activity as well as sedentary work (Roffey *et al.,* 2010b).

As a result of the congruency of the groups according to the baseline demographics of age, gender and occupation, the groups are comparable and therefore homogenous. This similarly allowed for discussions and conclusions to be drawn more specifically to the intervention rather than extraneous variables (Mouton, 2006).

In addition to the demographic variables, it is noted that there were no significant differences between the baseline of the NRS, Oswestry and algometer measures (Esterhuizen, 2013), indicating that the groups had similar starting points in terms of the comparability of their SIJ syndrome. Thus, the effects of differences in terms of the clinical condition were also considered to have impacted a negligible impact (Mouton, 2006) on the outcomes obtained by the patients in each of the groups and therefore by the groups overall.

4.5.3. Intra and Inter group analyses

4.5.3.1 Numerical Pain Rating Scale (NRS)

Repeated measures ANOVA testing between groups showed that there was no significant effect of the intervention on NRS (p= 0.346). Figure 4.2 also shows that the two groups followed almost parallel trajectories over time, except there was a slight trend between time two and three for pain to continue to decrease in the AAI group and plateaued in the placebo group.

Table 4.5 Effect of Time and Time/Group : NRS

Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.403	12.503[b]	2.000	37.000	<0.001
	Wilks' Lambda	0.597	12.503[b]	2.000	37.000	<0.001
Time/ Group	Pillai's Trace	0.056	1.093[b]	2.000	37.000	0.346
	Wilks' Lambda	0.944	1.093[b]	2.000	37.000	0.346

a. Design: Intercept + Group / within Subjects Design: Time
b. Exact statistic

Table 4.6 Tests of Between-Subjects Effects : NRS

Measure: NRS Transformed Variable: Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	185810.700	1	185810.700	245.666	<0.001
Group	192.533	1	192.533	0.255	0.617
Error	28741.433	38	756.354		

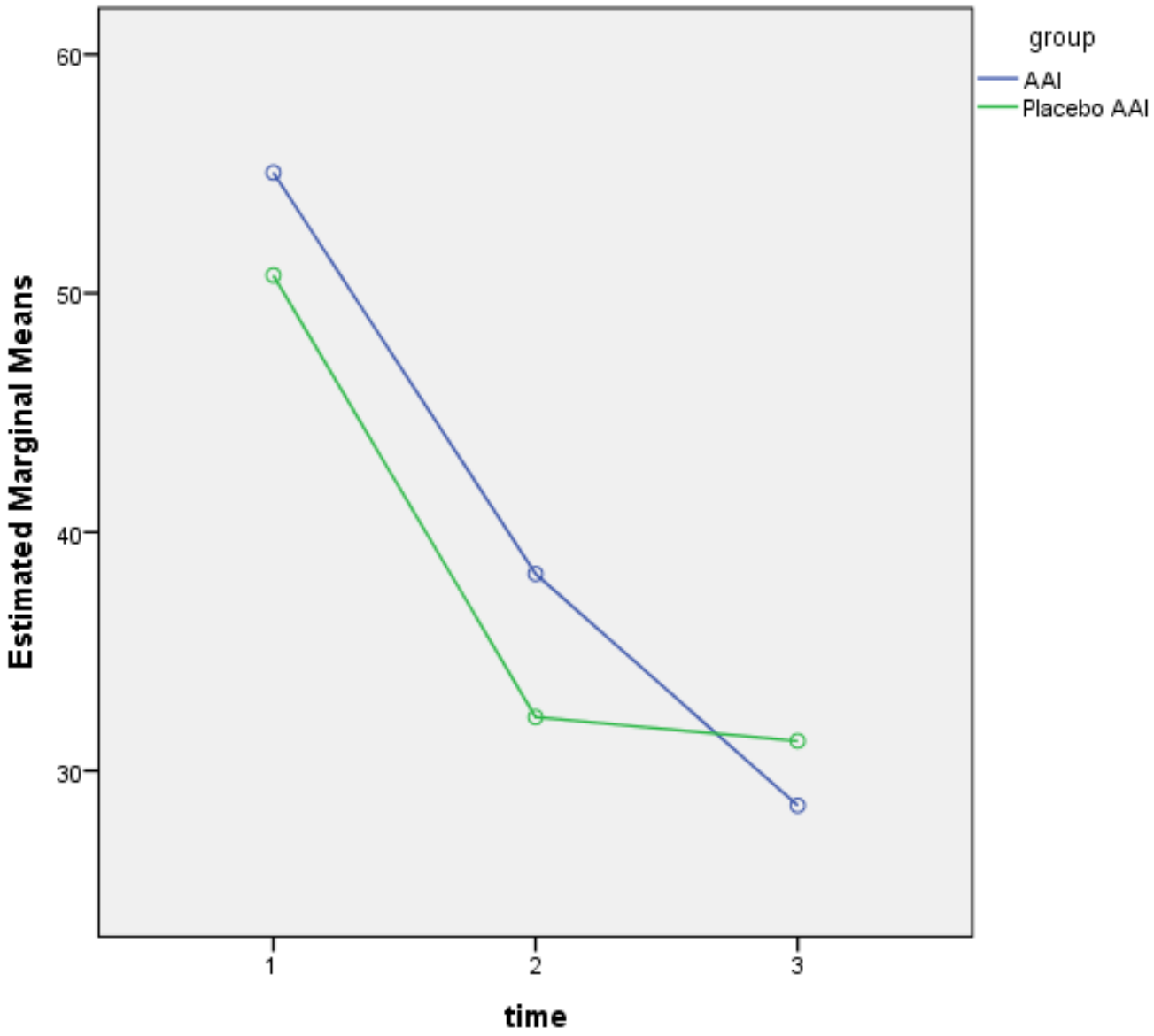

Figure 4.2: Profile plot of mean NRS by group and time

4.5.3.2. Algometer Pain/Pressure Meter

There was a significant effect of the intervention for algometer outcome (*p*= 0.037). Figure 4.3 shows that after the second treatment the AAI group continued to improve whilst the AAI placebo group achieved plateau.

Table 4.7 Multivariate Tests[a] : Algometer

Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.330	9.112[b]	2.000	37.000	0.001
	Wilks' Lambda	0.670	9.112[b]	2.000	37.000	0.001
Time/ Group	Pillai's Trace	0.163	3.594[b]	2.000	37.000	0.037
	Wilks' Lambda	0.837	3.594[b]	2.000	37.000	0.037

a. Design: Intercept + Group within Subjects Design: Time
b. Exact statistic

Table 4.8 Tests of Between-Subjects Effects: Algometer

Measure: MEASURE_1 Transformed Variable: Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	5936.133	1	5936.133	615.927	<0.001
Group	24.300	1	24.300	2.521	0.121
Error	366.233	38	9.638		

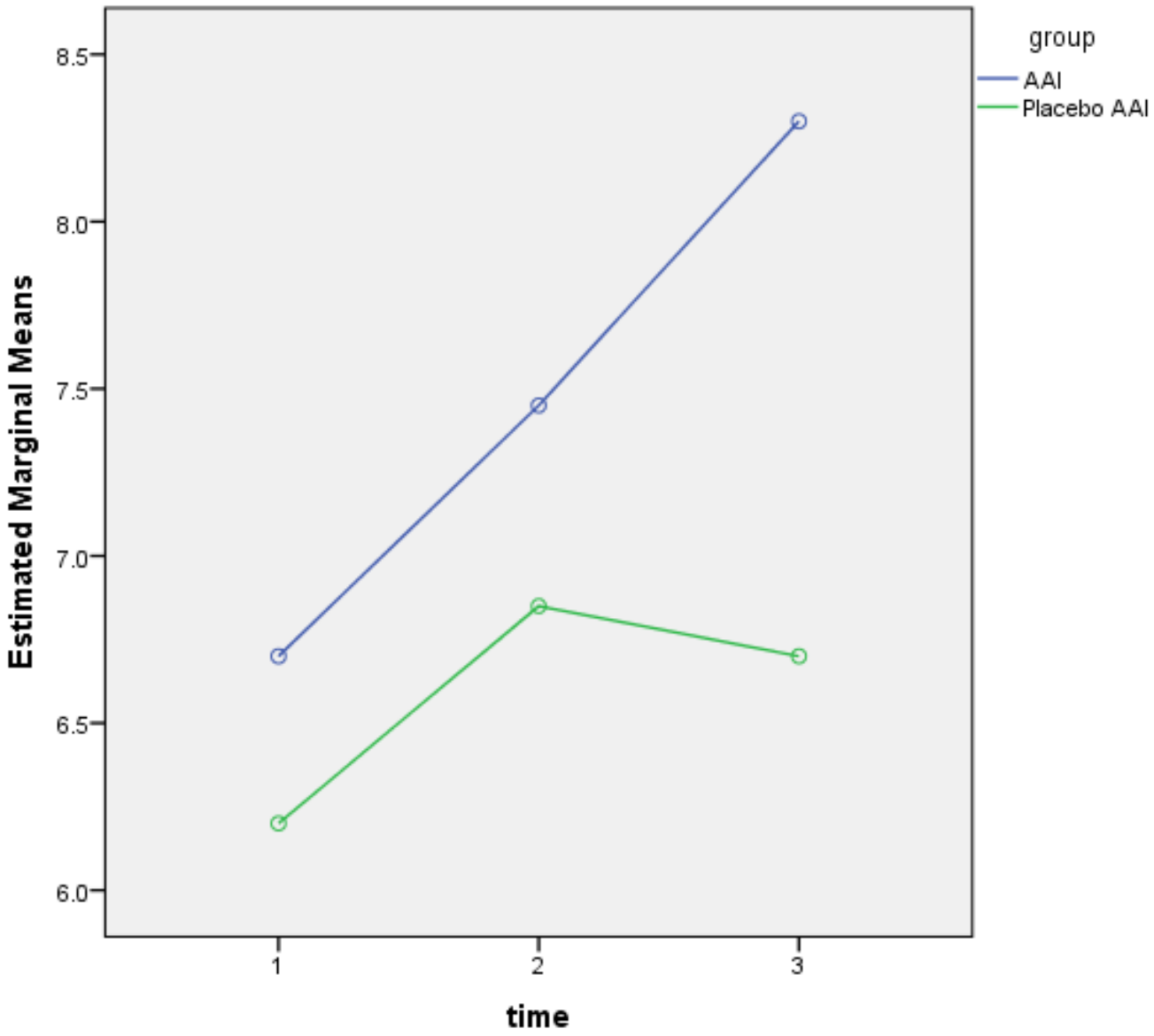

Figure 4.3: Profile plot of mean Algometer by group and time

4.5.3.3 Revised Oswestry Disability Questionnaire (Oswestry)

Repeated measures ANOVA testing between groups showed that there was no significant effect of the intervention on the Oswestry score (*p*= 0.876). Figure 4.4 also shows that the two groups followed almost parallel trajectories over time.

Table 4.9 Multivariate Tests[a] : Oswestry

Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	0.473	16.629[b]	2.000	37.000	<0.001
	Wilks' Lambda	0.527	16.629[b]	2.000	37.000	<0.001
Time/ Group	Pillai's Trace	0.007	0.133[b]	2.000	37.000	0.876
	Wilks' Lambda	0.993	0.133[b]	2.000	37.000	0.876

a. Design: Intercept + Group Within Subjects Design: Time
b. Exact statistic

Table 4.10 Tests of Between-Subjects Effects: Oswestry

Measure: MEASURE_1 Transformed Variable: Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	83424.133	1	83424.133	211.088	<0.001
Group	448.533	1	448.533	1.135	0.293
Error	15018.000	38	395.211		

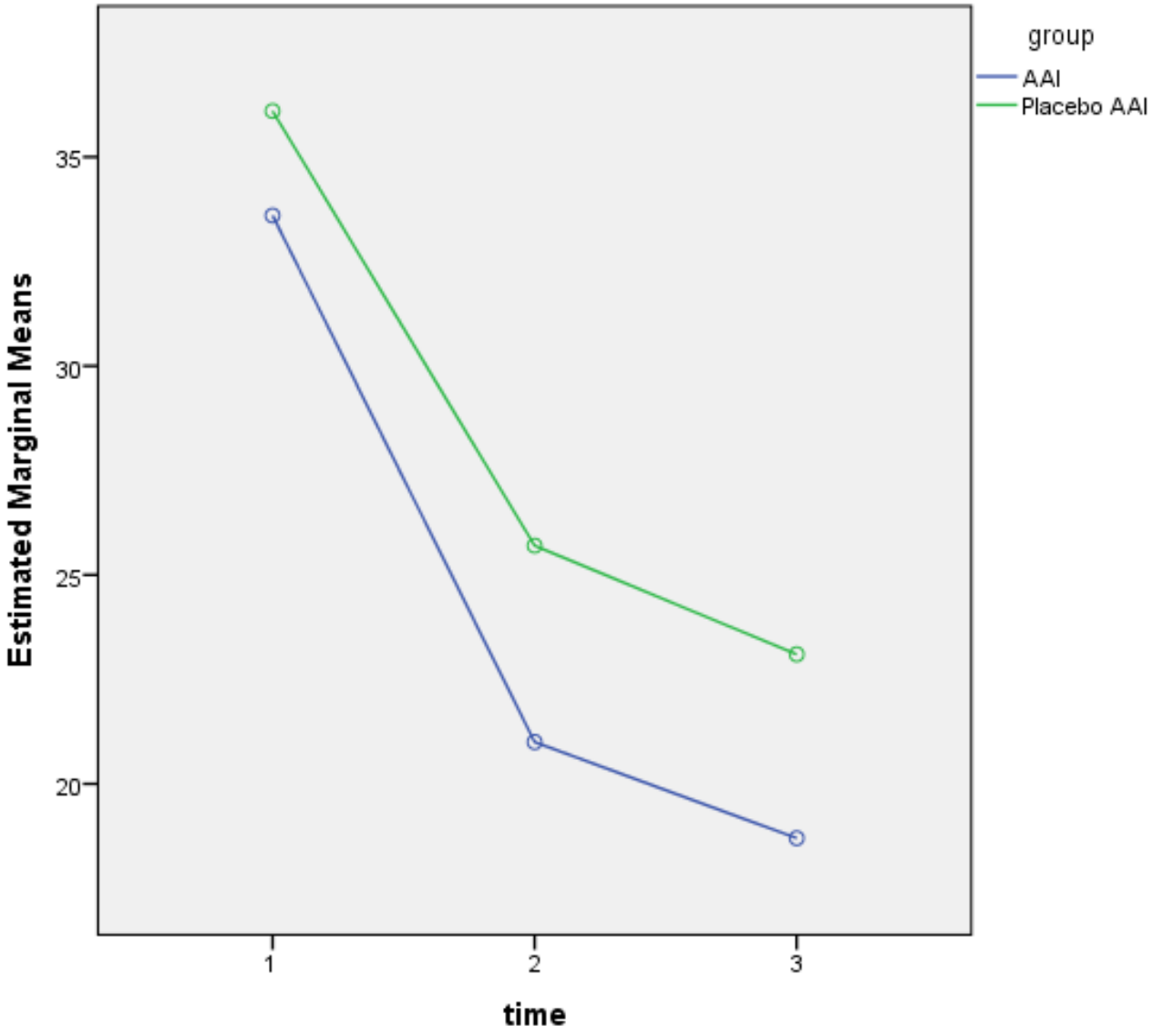

Figure 4.4: Profile plot of mean Oswestry by group and time

4.5.4. Discussion of the Intra and Inter group analyses

In terms of the outcomes of the study, it was determined that there was no significant difference (*p*= 0.346) between the AAI group and the AAI placebo group noted with reference to the ***NRS*** (Table 4.11). In terms of this study, the NRS is most likely reflective of pain in the SIJ (as per the inclusion criteria – see Section 3.4).

Initially (between time points one and two), there was a sharp decline in reported pain noted within the AAI and AAI placebo groups (Figure 4.2), this could be attributed to the Hawthorne effect or Observer effect (Brink, 1996; Hrobjartsson, 1996; Kirsch, 1998; Mouton, 2006), as the patients were exposed to a new and unfamiliar adjusting instrument. This may have increased the perception that they were actually reporting what they expected rather than their reality.

It is only from the second to the third time point that there is a difference between the groups, where the AAI group continues on its trajectory, whereas the AAI placebo group plateaued. This effect could potentially have been amplified if the study period were to have been increased (either by the number of treatments or by additional follow up measurements).

The difference between the two groups from a clinical vantage point may have been as a result of the effect that the AAI group received (joint mobilisation) (Fuhr *et al*., 1997; Byfield, 2005), which led to an increase in joint function (Bergmann *et al*., 1993; Fuhr *et al.*, 1997; Byfield, 2005) with a concomitant increase in mechanoreceptor stimulation (Sakamoto *et al*., 2001) and therefore a decrease in the inflammatory factors / oedema

within the SIJ (Khan *et al*., 1999; Peeters *et al*., 2001; Hoving *et al*., 2002; Leach, 2004; Hoving *et al*., 2006). This effect would not have been present in the AAI placebo group as this group would not have had the benefit of joint manipulation, and therefore, their readings were expected to plateau.

This difference would have further been amplified by the stimulation of the mechanoreceptors in the AAI group (as the manipulation would have facilitated normalised movement and muscle action) (Wyke, 1981; Sakamoto *et al*., 2001; Leach, 2004; Hillermann *et al*., 2006), invoking the greatest effect of the Gate Control theory (Melzack and Wall, 1962; Leach, 2004). These effects would not have been possible in the AAI placebo group, as this group would only have received the mechanical intervention effect of “touch therapy”, and that effect could not have been sustained as was the case for the AAI group.

By contrast, the ***algometer*** outcomes as per Figure 4.3, indicated that there was a significant difference noted with the algometer between the AAI group and the AAI placebo group of p= 0.037 (at the final analysis). This indicates that there as a significant difference in the perceived tenderness (and therefore an increased loading potential) of the soft tissues around the SIJ in favour of the AAI group. These findings may indicate the reason for this group improving the most.

This outcome was achieved by the AAI group showing a consistent increase in their algometer readings, indicating a decrease in the tenderness and / or sensitivity of the soft tissue structures in and around the SIJ. By contrast, the AAI placebo group showed an initial increase in the readings, but then a sharp decline in the readings.

Clinically there are two possible explanations for this outcome:

1. The first being related to the effects of “ischemic compression” as imparted by the AAI instrument, during the application of the intervention. The process of applying ischemic compression, usually results in a decrease in perceived pain and tenderness (Travell and Simons, 1983; Chaitow and Delany, 2000), particularly in soft tissue structures such as muscle or fascia (Travell and Simons, 1983; Chaitow and DeLany, 2000; Sahrmann, 2002).
2. Secondly the effects of AAI manipulation on joint movement (Fuhr *et al.*, 1997), results in increased motion and therefore improved functional relationships between the joint and the surrounding musculature, thereby normalising the biomechanics. This effect is only evident in the AAI group and not the AAI placebo group, where joint manipulation did not occur. Thus, the anticipated continued improvement of the AAI group was expected in contrast to the regression of the AAI placebo group. The AAI placebo group regression would further have been complicated by a joint dysfunction, that would not have been addressed clinically and may have precipitated reflex muscle contraction in order to “splint” a painful joint (Dvorak, 1985; Leach, 2004) or become inactive in order to prevent further injury to the joint (as found in arthrogenic muscle inhibition) (Dvorak, 1985; Suter *et al*., 1999; Sakamoto *et al.*, 2001; Hillermann *et al*., 2006). Both these scenarios of overactivity and / or underactivity have been noted as sources of myofascial trigger point formation (Travell and Simons, 1983; Gerwin *et al*., 1997; Chaitow and DeLany, 2000; Hong, 2006; Ge *et al*., 2011). This latter presence of myofascial trigger points would have resulted in the AAI placebo group not being able to accept higher loads with the algometer measures.

Lastly, in terms of the Oswestry, it was noted that there was no significant difference between the groups (p= 0.876). This was anticipated in the context of the results obtained in the NRS readings. Principally, disability is precipitated by the perception of pain, in that pain limits a patient's ability to complete tasks of daily living (Yeomans, 2000). Therefore, it is not unexpected that the patients reported a decrease in the Oswestry in congruence with the NRS outcomes.

Table 4.11 summarises the outcomes in this study, indicating the measures which were significantly different between the groups.

With respect to the clinical contextualisation of the results, it is important to consider the minimal clinical important differences. These are as follows for the:

- Numerical Pain Rating Scale-101 (Yeomans, 2000). The minimal clinical important difference is noted at 20-25mm (Lee *et al.*, 2003; Ostelo and de Vet, 2005). In this context, the AAI group improved to a greater extent than that which is required for clinical significance. This is not true of the AAI placebo group. Therefore, in terms of the NRS findings it is apparent that the AAI has a clinical effect greater than a placebo in terms of pain reduction.
- Algometer Pain / Pressure Meter (Potter *et al.,* 2008; Kinser *et al.,* 2009). The minimal clinical important difference is noted at 15% increase (Paungmali *et al.*, 2003; Potter *et al*., 2006; O'Leary *et al.*, 2007) or an increase of 1.77kg/cm^2 (Chesterton *et al*., 2007). Therefore, in the context of this study, it can be seen that the AAI group improved by 1.77kg/cm^2, this compares with a 0.5kg/cm^2 improvement in the AAI placebo group. Again from these results it would suggest that from a clinical perspective that the AAI has the

ability to attain clinical significance and therefore have a greater clinical effect than a placebo in terms of pain reduction.

- Oswestry (Yeomans, 2000). The minimal clinical important difference was noted at 6% (Fairbank and Pynsent, 2000; Fritz and Irrgang, 2001). Based on these parameters, it would seem to suggest that both groups in this study improved to a clinical significant level (as evidenced on Figure 4.4). This is interesting as the Oswestry would have been the most comprehensive of the subjective outcomes completed by the patients. This outcome supports the assertion of the Hawthorne / Observer effect noted in Section 4.5.4.

Table 4.11 Summary table showing the statistical and clinical significances

		Time effect	Time group / intervention effect (statistical significance)	Clinical significance	
				AAI Group	AAI Placebo Group
1	NRS	0.001 0.001	None	Significant (> 20% change)	Not significant (< 20% change)
2	Algometer	0.001 0.001	p= 0.037	Significant (> 1.77kg/cm^2)	Not significant (< 1.77kg/cm^2)
3	Oswestry	0.001 0.001	None	Significant (> 6% change)	Significant (> 6% change)

A collective explanation of these results may lie in the fact that :

- AAI group received both manipulation and muscle stretch (ipsilateral and contralateral – dependant on the fixation being one of flexion or extension (see Section 3.6).
- AAI placebo group received only muscle stretch (ipsilateral and contralateral – dependant on the fixation being either flexion or extension (see Section 3.6)).

The combination of the manipulation and the muscle stretch (irrespective of being ipsilateral or contralateral (Perl, 1959; Appelberg *et al.*, 1986; Munn *et al.*, 2004; Carroll *et al*., 2006), would have been effective in decreasing pain (NRS), muscle tenderness (algometer) and improving the function of the patients activities of daily living (Oswestry) from a clinical vantage point. Therefore, this would result in the clinical significant findings that have been reported in this study. This result is in contrast to the AAI placebo group, which would only have had the benefits of the ipsilateral or contralateral muscle stretching (Perl, 1958; Appelberg *et al.*, 1986; Munn *et al.*, 2004; Carroll *et al*., 2006), resulting in only improvement in the activities of daily living (Oswestry). Limited improvements in terms of NRS (pain of sacroiliac origin that does not benefit much from the muscle stretch) and algometer (muscle responds only post stretch for a limited period and not at follow up consults when readings were taken between two and four days after the previous intervention) were reported in terms of clinical findings.

When assessing the statistically significant findings, it is apparent that the manipulation (Leach, 2004) and stretch effects (Perl, 1958; Appelberg *et al.*, 1986; Munn *et al.*, 2004; Carroll *et al*., 2006) on the algometer readings in the AAI group are such that they result in a significant different to the effect of muscle stretch only as found in the AAI placebo group.

The similarity between the AAI placebo and the AAI groups in terms of the Oswestry and the NRS relate directly to the fact that the NRS would have decreased with minimal mechanoreceptive stimulation of either muscle, joint or both receptors. Therefore, there would have been no difference between their reported outcomes. By contrast however, with the Oswestry, the AAI placebo group would still have reported joint limitations

and effects of the biomechanical changes in their questionnaire, (e.g. delayed onset muscle stiffness) (Travell and Simons, 1983; Bergmann *et al.*, 1993 ; Chaitow and DeLany, 2000) as the body returned the biomechanical system to homoeostasis. These changes may indicate that their disability may seem similar from the questionnaire outcome.

These assertions, although based in the literature are at this point conjecture for this study, and therefore, it is recommended that future studies address the physiological effects of reflex phenomena in a clinical setting in order to determine the effect of (for e.g. muscle stretching) component parts of the manipulative procedure or patient positioning. One way in which this may be attained is by comparing two AAI placebo groups in patients with only extension restrictions in the SIJ. This would then be influenced by the patients in one group lying prone (no muscle stretch element) when the AAI is delivered and the second group utilising the same side lying procedure as in this study (see Section 3.6).

4.5.5 Correlations between changes over time in outcomes

Intra group correlations showed that within both groups there was a negative correlation between change in NRS and change in algometer, and a strong positive correlation between change in NRS and change in Oswestry. In the AAI placebo group there was a significant negative correlation between change in algometer readings and change in Oswestry scores.

Table 4.12 Correlations between changes over time in outcomes

Group			Change in NRS	Change in Algometer	Change in Oswestry
AAI	Change in NRS	Pearson Correlation	1	-0.487*	0.782**
		Sig. (2-tailed)		0.030	0.000
		N	20	20	20
	Change in Algometer	Pearson Correlation	-0.487*	1	-0.233
		Sig. (2-tailed)	0.030		0.322
		N	20	20	20
	Change in Oswestry	Pearson Correlation	0.782**	-0.233	1
		Sig. (2-tailed)	0.000	0.322	
		N	20	20	20
Placebo AAI	Change in NRS	Pearson Correlation	1	-0.529*	0.790**
		Sig. (2-tailed)		0.017	0.000
		N	20	20	20
	Change in Algometer	Pearson Correlation	-0.529*	1	-0.523*
		Sig. (2-tailed)	0.017		0.018
		N	20	20	20
	Change in Oswestry	Pearson Correlation	0.790**	-0.523*	1
		Sig. (2-tailed)	0.000	0.018	
		N	20	20	20

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

4.5.6 Discussion of the correlations between changes over time in outcomes

With reference to the discussion in the previous section, it is possible that the AAI placebo group had a significant correlation between the algometer and the NRS measurements as these outcome measures would have been affected synergistically by the combined action of the stretch and the manipulation. By contrast, however, the effect of the homeostatic process to restore biomechanical normalcy post the intervention would have resulted in a dampened effect on the improved Oswestry scores. This would, therefore, have resulted in the discordance between this questionnaire and the NRS / algometer outcomes, therefore negating the possibility of a significant correlation between the outcomes.

By contrast however, the AAI placebo group would have had a much lesser improvement in the NRS and the algometer, which would have been more consonant with the small improvement in the Oswestry, therefore allowing for a significant correlation of the findings between these outcomes.

4.5.7 Review of the objectives and hypotheses

The objectives as noted in Chapter One were as follows:

Objective One: To determine whether adjusting the SIJ using the AAI set at full tension (AAI group) was effective in the treatment of chronic LBP of SIJ syndrome origin in terms of subjective and objective clinical findings.

Objective Two: To determine whether adjusting the SIJ using the AAI set at zero tension (placebo) (AAI placebo group) was effective in the treatment of chronic LBP of SIJ syndrome origin in terms of subjective and objective clinical findings.

Objective Three: To compare the two aforementioned treatment interventions.

Hypothesis:

The AAI group will show a significant difference as compared to the AAI placebo group in terms of the subjective and objective findings in this study.

Null Hypothesis:

There would be no significant difference between the AAI and AAI placebo groups in terms of the subjective and objective findings in this study.

In terms of the statistical outcomes of this study, the null hypothesis was rejected for the algometer measures and not rejected for the Oswestry

and the NRS measures.

4.6. Summary and conclusion

In terms of the statistical outcomes of this study, it is evident that the AAI only has an effect beyond a placebo for the reduction of the algometer measures in patients with SIJ syndrome. This outcome however needs to be contextualised in the following limitations:

- A small sample size,
- The unknown effect of the muscle stretch that would have been induced by the patient position whilst applying the AAI intervention,
- No longer term follow up measures were taken in order to determine the intermediate and long term effect of the AAI in the context of its comparison to placebo and /or
- The difficulty in identifying patients at the same stage in the pathogenesis of their SIJ syndrome
- Prior exposure to manipulative therapy unknown.

Notwithstanding the above, it is possible that a larger sample and an increased number of follow up measures would have been beneficial in that the minimally important clinical differences (MCID's) obtained by the AAI group indicated that they had the potential to further improve and possibility to a greater extent than the AAI placebo group for all measures. This assertion, however, requires further investigation.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

With the high prevalence of LBP (and associated SIJ syndrome) in the general population it is of importance that clinicians apply as many clinical and therapeutic intervention tools at their disposal to this problem for purposes of decreasing morbidity, reducing the costs to the healthcare system and reducing the burden to society as well as optimising the health, quality of life and productivity of the patients. However within this context, the chiropractor is also responsible for ensuring their longevity and safety with regards to how they carry out interventions. As a result many clinicians utilise therapeutic intervention tools to safeguard themselves with respect to the impact their professional activities have on their own personal lives. One of these tools is the AAI. In order for this tool to be effectively utilised in practice, its contribution to the restoration of health in a patient needs to be documented and evaluated. Therefore, this study set out to isolate the effect of the AAI to the exclusion of its often associated protocol (AMCT). Thus, this study tested the AAI (set at full tension) using the diversified method of patient positioning against the AAI placebo (set a zero tension) also using the diversified method of patient positioning in the treatment of chronic LBP, specifically SIJ syndrome.

The study found that the AAI group differed significantly only in terms of the effects of the AAI on the algometer outcome measures, whereas the differences between the outcomes for the Oswestry were not statistically significant. By contrast and in terms of the MCID's, it was found that the AAI group improved to a clinically significant level for all measures (NRS, algometer and the Oswestry), whereas the AAI placebo group showed clinical significance for the Oswestry outcome only.

These results suggest that a larger study of a similar nature needs to be undertaken to verify these results and determine whether the AAI is indeed better than a placebo in all clinical measures utilised in this study. Currently, this study can only determine that the AAI is better than a placebo in terms of algometer outcomes.

5.2 Recommendations

These recommendations have been divided into methodological changes that are suggested for future studies, considerations for future studies based on the outcomes of this study and pragmatic recommendations for practitioners.

5.2.1 Methodological suggestions

- An increase in the sample size would be appropriate for a follow on study.
- Increased homogeneity of the patients in terms of age, gender, occupation, recreational activities, side of affected SIJ and type of restriction found within the SIJ.
- Increased duration of treatment (however, within the time

determined by the natural history of LBP) and / or increased follow up time points in order to determine the intermediate and long term effects of the intervention over a placebo.

- Assessment of prior exposure to manipulative therapy.
- Current clinic patients to be evenly split in terms of the allocation into groups.

5.2.2 Future studies

- Assessment of the effects of muscle stretch and patient position on the outcomes of the study in order to evaluate the effect of the interventions more appropriately.

5.2.3 Practical recommendations

- In terms of clinical practice, it is necessary to caution chiropractors in making exaggerated claims in terms of the clinical effectiveness of the AAI, as this study showed limited benefit over the short term, which was limited to one outcome measure.
- Therefore, the AAI should not be utilised in isolation, but rather as a tool within a comprehensive management plan for each patient, particularly those patients that are contra-indicated to manual therapy and can only have AAI interventions.

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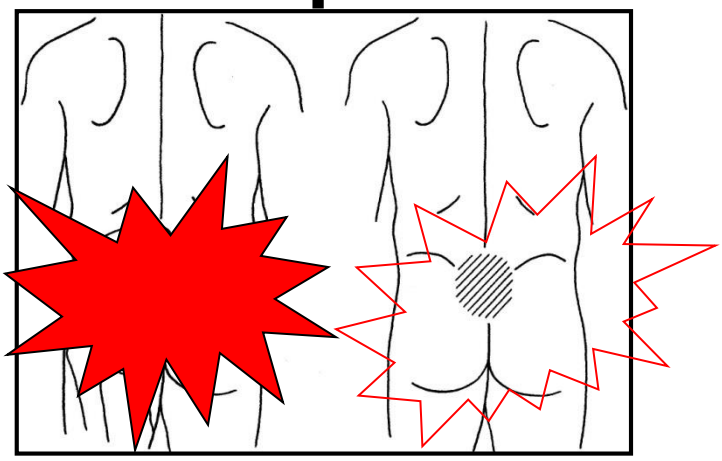
APPENDIX A: Advertisement

Do you have Low back pain ?



Research is currently being conducted at the Chiropractic Day Clinic – Durban University of Technology

If you are between the ages of 18 and 45 and suffer from chronic low back pain, treatment is available for those who qualify to take part in this study.

For more information call **Natasha Coetzee** :

031 3732205

APPENDIX B: Letter of Information and Informed Consent Form.

DEAR PARTICIPANT

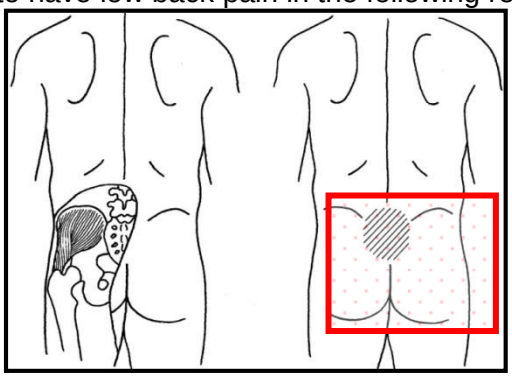
Welcome to my research project. Thank you for taking the time to consider participating in my study.

TITLE OF RESEARCH STUDY:
The effect of the Activator Adjusting Instrument in the treatment of chronic sacroiliac joint syndrome.

Principal investigator: Natasha Coetzee
Co-Investigator: Dr.H.White (M.Tech: Chiropractic, CCFC) (0827418097)

Introduction and Purpose of the study:
Low back pain is a big health problem. Sacroiliac joint (joints at the base of the spine) problems have been noted in more than half of adults who present with low back pain. In order to address this problem chiropractors sometimes use mechanical devices. Amongst these devices is a handheld instrument, called the Activator Adjusting Instrument (AAI). This study is aims, to test the AAI using a particular method of patient positioning in the treatment of chronic low back pain of sacroiliac joint syndrome origin. What this means is that the study will have 2 groups of patients, one that will receive treatment with the AAI and another that will not receive treatment with the AAI and the effects of these two interventions will then be measured to see which is better.

Inclusion criteria:
- You will be required to have low back pain in the following region :



- You will be required to be between the ages of 18 and 45 year of age.
- You will be asked to read, agree to and sign this letter.
- You will be required to have a history of chronic low back pain.
- If you are taking medication (e.g. Ibuprofen, Paracetamol) you will be asked to discontinue the medication for three days at minimum before I will be able to allow you onto the study. This is because the medication interferes with the readings that I need to take for my research.

Exclusion Criteria
- To safeguard you as the patient, you will be screened for contraindications to manipulation. If you have been part of another research trial will not be permitted to take part in this study until a three month wash-out period has taken place. Similarly if you have attended the DUT Chiropractic Day Clinic for treatment you will not be permitted into this study until a 2 week wash out period has taken place.

After the telephonic conversation with me, you will have had this appointment made and on arrival you will be given this letter of information and informed consent to read and understand. Should you agree to participate in this study you will now be asked to sign this letter of information and informed consent. You will then have a case history, physical and regional examination done in order to confirm your ability to participate. Once accepted onto the study you will be expected to attend 5 visits over a period of 3 weeks. The initial visit will take approximately 2 hours, and thereafter the remaining 4 visits will take no longer than 40 minutes.

Risks/discomforts and Benefits

You may feel transient stiffness or discomfort post treatment as is evident with any manual therapy, which should resolve without further complication to the patient. If not, please report this to me so that I can take the appropriate action on your behalf. In terms of the treatment, it is thought that the treatment group will receive treatment which is hypothesized to render benefit to you and your low back pain. However the placebo group will not receive active care for the duration of the study, but will be eligible for two free treatments after the completion of the study.

Remuneration: You will not be awarded any remuneration for taking part in this study.
Cost: Your participation in this research is free of charge.

Confidentiality:

Your personal information will remain confidential by the use of a coding system for data analysis and reporting. Your participation in this study is voluntary and refusal to participate will not result in any adverse consequences. You are free to withdraw from the study at any time.

Should there be a research related injury: The D.U.T Clinic Protocol will be followed and the injury would also need to be reported to the Health Research and Ethics Committee, so please ensure that you advise me of any such problems.

Persons to contact in the event of any Problems or Queries:

Supervisor: Dr White (M.Tech: Chiropractic, CCFC) Tel: 0827418097

HREC Research Administrator (IREC) Tel: 0313732900

Statement of Agreement to Participate in the Research Study:

I, ...Subject's full name .....(ID number) have read this document in it is entirely and understand its contents. Where I have had any questions or queries, these have been explained to me by Natasha Coetzee to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in this study.

Subject's name (print) .....
Subject's signature.
.....Date.....

Researcher's name (print) .....
Researcher's signature
.....Date.....

Witness name (print) .....
Witness signature
.....Date.....

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Olubizwangokuthi: Imitheleloyokusebenzisalthuluzilokulungisaukumakwamathamboethanjenilesinge

Umcwaningiomkhulu: Natasha Coetzee

Umphathikamcwaningi :uDokotelaH.White(M-Tech:Chiropractic ,CCFC)Inomboloyocingo: 0827418097

Ulwazingalolucwaningokanyenenhlosoyalo

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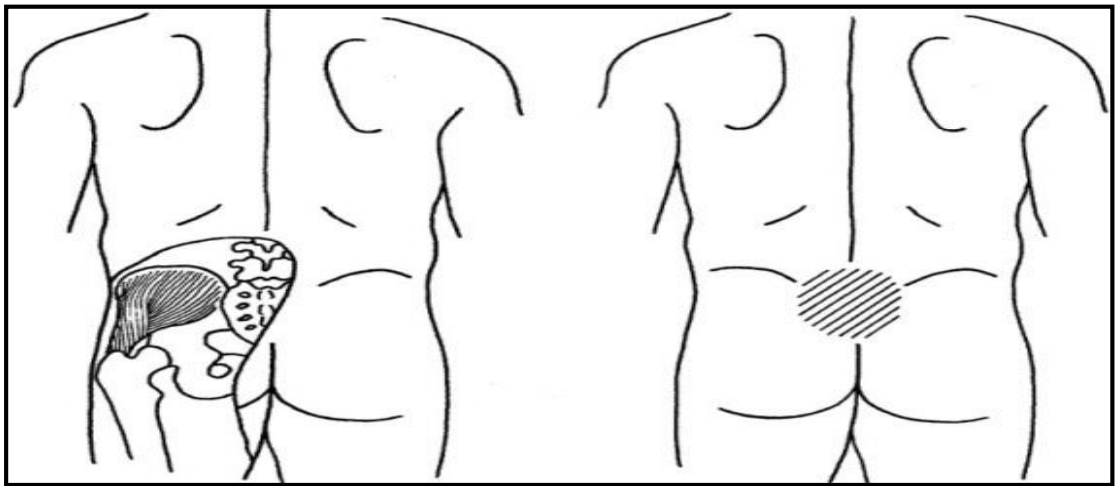

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<u>Indlelalolucwaningooluzokwenziwangayo</u>

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Ukukhokhelwa: Angekeuzeukhokhelwengokubaindlenyeyalolucwaningo.
Inanilemali: ukubaindlenyekwakhokulolucwaningokumahhala.

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<u>Abantuongabathintamayelananemibuzonomanezinkingaezimayelananalolucwaningo:</u>

Umcwaningiomkhulu: Natasha(031-373 2205)

Umphathikamcwaningi:uDokotela White (M-Tech:Chiropractickanye ne CCFC)
Inombolo yocingo:0827418097

IkomitielinakekelaamalungeloabantuumakweziwaucwaningoeDUT i-IREC
Inomboloyocingo<u>: 031-373</u> **2900**

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Isiginishayomcwaningi ……Usuku……..

APPENDIX C
DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: _____ Date: _____

File # : _____ Age: _____

Sex : _____ Occupation: _____

Intern : _____ Signature _____

FOR CLINICIANS USE ONLY:

Initial visit

Clinician: Signature :

Case History:

Examination:

Previous: Current:

X-Ray Studies:

Previous: Current:

Clinical Path. lab:

Previous: Current:

CASE STATUS:

PTT: Signature: Date:

CONDITIONAL:

Reason for Conditional:

Signature: Date:

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

Case Summary signed off: Date:

Intern's Case History:

1. **Source of History:**

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

3. **Present Illness:**

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

4. **Other Complaints:**

5. **Past Medical History:**

< General Health Status

< Childhood Illnesses

< Adult Illnesses

< Psychiatric Illnesses

< Accidents/Injuries

< Surgery

< Hospitalizations

6. Current health status and life-style:

< Allergies

< Immunizations

< Screening Tests incl. x-rays

< Environmental Hazards (Home, School, Work)

< Exercise and Leisure

< Sleep Patterns

< Diet

< Current Medication
Analgesics/week:
< Tobacco

< Alcohol

< Social Drugs

7. Immediate Family Medical History:

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

8. Psychosocial history:

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

9. Review of Systems:

< General

< Skin

< Head

< Eyes

< Ears

< Nose/Sinuses

< Mouth/Throat

< Neck

< Breasts

< Respiratory

< Cardiac

< Gastro-intestinal

< Urinary

< Genital

< Vascular

< Musculoskeletal

< Neurologic

< Haematologic

< Endocrine

< Psychiatric

APPENDIX D

DURBAN UNIVERSITY OF TECHNOLOGY

CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

Patient:_____ File#:_____ Date:_____

Clinician:_____ Signature:_____

Student:_____ Signature:_____

1. VITALS

Pulse rate:
Respiratory rate:
Blood pressure: R L Medication if hypertensive:
Temperature:
Height:
Weight: Any change Y/N If Yes : how much gain/loss

Over what period

2. GENERAL EXAMINATION

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

Urinalysis:

3. CARDIOVASCULAR EXAMINATION

1) Is this patient in **Cardiac Failure** ?
2) Does this patient have signs of **Infective Endocarditis** ?
3) Does this patient have **Rheumatic Heart Disease ?**

Inspection
- Scars
- Chest deformity:
- Precordial bulge:
- Neck -JVP:

Palpation:
- Apex Beat (character + location):
- Right or left ventricular heave:
- Epigastric Pulsations:
- Palpable P2:

- Palpable A2:

Pulses:
- General Impression:
- Radio-femoral delay:
- Carotid:
- Radial:
- Dorsalis pedis:
- Posterior tibial:
- Popliteal:
- Femoral:

Percussion: - borders of heart

Auscultation:- heart valves (mitral, aortic, tricuspid, pulmonary)
- Murmurs (timing,systolic/diastolic, site, radiation, grade).

4. RESPIRATORY EXAMINATION

1) Is this patient in **Respiratory Distress** ?

Inspection
- Barrel chest:
- Pectus carinatum/cavinatum:
- Left precordial bulge:
- Symmetry of movement:
- Scars:

Palpation
- Tracheal symmetry:
- Tracheal tug:
- Thyroid Gland:
- Symmetry of movement (ant + post)
- Tactile fremitus:

Percussion
- Percussion note:
- Cardiac dullness:
- Liver dullness:

Auscultation
- Normal breath sounds bilat.:
- Adventitious sounds (crackles, wheezes, crepitations)
- Pleural frictional rub:
- Vocal resonance
  - Whispering pectoriloquy:
  - Bronchophony:
  - Egophony:

5. ABDOMINAL EXAMINATION

1) Is this patient in **Liver Failure** ?

Inspection
- Shape:
- Scars:
- Hernias:

Palpation
- Superficial:
- Deep = Organomegally:
- Masses (intra- or extramural)
- Aorta:

Percussion
- Rebound tenderness:
- Ascites:
- Masses:

Auscultation
- Bowel sounds:

- Arteries (aortic, renal, iliac, femoral, hepatic)

Rectal Examination
- Perianal skin:
- Sphincter tone & S4 Dermatome:
- Obvious masses:
- Prostate:
- Appendix:

6. G.U.T EXAMINATION

External genitalia**:**
Hernias:
Masses:
Discharges:

7. NEUROLOGICAL EXAMINATION

Gait and Posture
- Abnormalities in gait:
- Walking on heels (L4-L5):
- Walking on toes (S1-S2):
- Rombergs test (Pronator Drift):

Higher Mental Function
- Information and Vocabulary:
- Calculating ability:
- Abstract Thinking:

G.C.S.:
- Eyes:
- Motor:
- Verbal:

Evidence of head trauma:

Evidence of Meningism:
- Neck mobility and Brudzinski's sign:
- Kernigs sign:

Cranial Nerves:

I Any loss of smell/taste:
Nose examination:

II External examination of eye:
- Visual Acuity:
- Visual fields by confrontation:
- Pupillary light reflexes = Direct:
  = Consensual:
- Fundoscopy findings:

III Ocular Muscles:
Eye opening strength:

IV Inferior and Medial movement of eye:

V
a. Sensory
- Ophthalmic:
- Maxillary:
- Mandibular:

b. Motor
- Masseter:
- Jaw lateral movement:

c. Reflexes
- Corneal reflex

- Jaw jerk

VI Lateral movement of eyes

VII a. Motor - Raise eyebrows:
- Frown:
- Close eyes against resistance:
- Show teeth:
- Blow out cheeks:

b. Taste - Anterior two-thirds of tongue:

VIII General Hearing:
Rinnes = L: R:
Webers lateralisation:
Vestibular function - Nystagmus:
- Rombergs:
- Wallenbergs:
Otoscope examination:

IX & Gag reflex:
X Uvula deviation:
Speech quality:

XI Shoulder lift:
S.C.M. strength:

XII Inspection of tongue (deviation):

Motor System:

a. Power
- Shoulder = Abduction & Adduction:
= Flexion & Extension:
- Elbow = Flexion & Extension:
- Wrist = Flexion & Extension:
- Forearm = Supination & Pronation:
- Fingers = Extension (Interphalangeals & M.C.P's):
- Thumb = Opposition:
- Hip = Flexion & Extension:
= Adduction & Abduction:
- Knee = Flexion & Extension:
- Foot = Dorsiflexion & Plantar flexion:
= Inversion & Eversion:
= Toe (Plantarflexion & Dorsiflexion):

b. Tone - Shoulder:
- Elbow:
- Wrist:
- Lower limb - Int. & Ext. rotation:
- Knee clonus:
- ankle clonus:

c. Reflexes - Biceps:
- Triceps:
- Supinator:
- Knee:
- Ankle:
- Abdominal:

- Plantar:

Sensory System:

a.	Dermatomes	- Light touch:
		- Crude touch:
		- Pain:
		- Temperature:
		- Two point discrimination:
b.	Joint position sense	- Finger:
		- Toe:
c.	Vibration:	- Big toe:
		- Tibial tuberosity:
		- ASIS:
		- Interphalangeal Joint:
		- Sternum:

Cerebellar function:

Obvious signs of cerebellar dysfunction:
= Intention Tremor:
= Nystagmus:
= Truncal Ataxia:
Finger-nose test (Dysmetria):
Rapid alternating movements (Dysdiadochokinesia):
Heel-shin test:
Heel-toe gait:
Reflexes:
Signs of Parkinsons:

8. <u>SPINAL EXAMINATION:</u>(See Regional examination)

Obvious Abnormalities:
Spinous Percussion:
R.O.M:
Other:

9. <u>BREAST EXAMINATION:</u>

Summon female chaperon.

Inspection	- Hands rested in lap:
	- Hands pressed on hips:
	- Arms above head:
	- Leaning forward:
Palpation	- masses:
	- tenderness:
	- axillary tail:
	- nipple:
	- regional lymph nodes:

APPENDIX E
REGIONAL EXAMINATION - LUMBAR SPINE AND PELVIS

Patient:_____ File#:_____Date:_________
Intern\Resident:_____ Clinician:_____

STANDING:

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

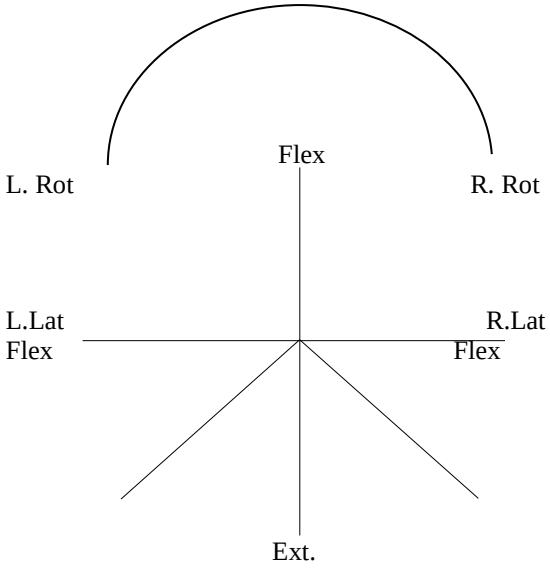
Minor's Sign
Muscle tone
Spinous Percussion
Scober's Test (6cm)
Bony and Soft Tissue Contours

GAIT:

Normal walking
Toe walking
Heel Walking
Half squat

ROM:

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



Which movt. reproduces the pain or is the worst?

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

SUPINE:

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

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

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

SITTING:

Spinous Percussion
Valsalva

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

Slump 7 test	**L**										
	R										

LATERAL RECUMBENT: L R

Ober's		
Femoral n. stretch		
SI Compression		

PRONE: L R

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

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

NON ORGANIC SIGNS:

Pin point pain
Axial compression
Trunk rotation
Burn's Bench test
Flip Test
Hoover's test
Ankle dorsiflexion test
Repeat Pin point test

NEUROLOGICAL EXAMINATION

Fasciculations

Plantar reflex

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

MYOTOMES

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

BASIC THORACIC EXAM

History
Passive ROM
Orthopedic

BASIC HIP EXAM

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

MOTION PALPATION AND JOINT PLAY

	L	R
Upper Thoracics		
Lumbar Spine		
Sacroiliac Joint		

FEB 2007

DURBAN UNIVERSITY of TECHNOLOGY

APPENDIX F

DURBAN UNIVERSITY OF TECHNOLOGY

Patient Name: ***File #:*** ***Page:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

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

0: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

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

O: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature***

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

O: ***P:***

E:

Special attention to: ***Next appointment:***

DURBAN UNIVERSITY OF TECHNOLOGY

Patient Name: ***File #:*** ***Page:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

0: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

O: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***
Attending Clinician: ***Signature***

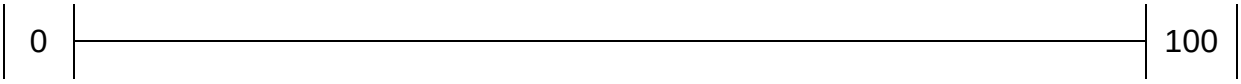
S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***
Least 0 1 2 3 4 5 6 7 8 9 10 Worst

O: ***P:***

E:

Special attention to: ***Next appointment:***

APPENDIX G: NRS

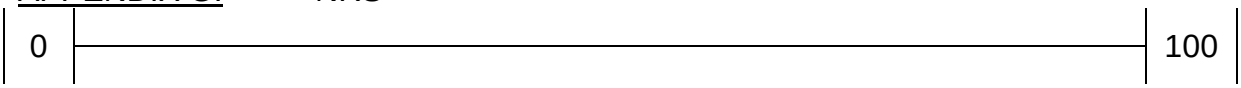


0 = least pain 100 = worst pain

APPENDIX I: Algometer readings

Patient name			File number	
	Date	Reading 1	Reading 2	Average
Baseline : visit 1				

APPENDIX G: NRS

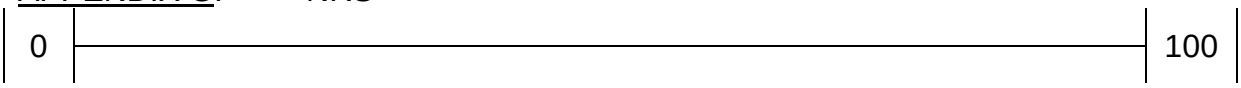


0 = least pain 100 = worst pain

APPENDIX I: Algometer readings

Patient name			File number	
	Date	Reading 1	Reading 2	Average
Visit 3				

APPENDIX G: NRS



0 = least pain 100 = worst pain

APPENDIX I: Algometer readings

Patient name			File number	
	Date	Reading 1	Reading 2	Average
Visit 5				

Appendix H

FORM C–2. REVISED OSWESTRY LOW BACK PAIN DISABILITY QUESTIONNAIRE

PLEASE READ: This questionnaire is designed to enable us to understand how much your low back pain has affected your ability to manage your everyday activities. Please answer each section by circling the ONE CHOICE that most applies to you. We realize that you may feel that more than one statement may relate to you, but PLEASE JUST CIRCLE THE ONE CHOICE WHICH MOST CLOSELY DESCRIBES YOUR PROBLEM RIGHT NOW.

SECTION 1—Pain Intensity

A The pain comes and goes and is very mild.
B The pain is mild and does not vary much.
C The pain comes and goes and is moderate.
D The pain is moderate and does not vary much.
E The pain comes and goes and is severe.
F The pain is severe and does not vary much.

SECTION 2—Personal Care

A I would not have to change my way of washing or dressing in order to avoid pain.
B I do not normally change my way of washing or dressing even though it causes some pain.
C Washing and dressing increases the pain, but I manage not to change my way of doing it.
D Washing and dressing increases the pain and I find it necessary to change my way of doing it.
E Because of the pain, I am unable to do some washing and dressing without help.
F Because of the pain, I am unable to do any washing or dressing without help.

SECTION 3—Lifting

A I can lift heavy weights without extra pain.
B I can lift heavy weights, but it causes extra pain.
C Pain prevents me from lifting heavy weights off the floor.
D Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, eg, on a table.
E Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned.
F I can only lift very light weights, at the most.

SECTION 4—Walking

A Pain does not prevent me from walking any distance.
B Pain prevents me from walking more than one mile.
C Pain prevents me from walking more than 1/2 mile.
D Pain prevents me from walking more than 1/4 mile.
E I can only walk while using a cane or on crutches.
F I am in bed most of the time and have to crawl to the toilet.

SECTION 5—Sitting

A I can sit in any chair as long as I like without pain.
B I can only sit in my favorite chair as long as I like.
C Pain prevents me from sitting more than one hour.
D Pain prevents me from sitting more than 1/2 hour.
E Pain prevents me from sitting more than ten minutes.
F Pain prevents me from sitting at all.

SECTION 6—Standing

A I can stand as long as I want without pain.
B I have some pain while standing, but it does not increase with time.
C I cannot stand for longer than one hour without increasing pain.
D I cannot stand for longer than 1/2 hour without increasing pain.
E I cannot stand for longer than ten minutes without increasing pain.
F I avoid standing, because it increases the pain straight away.

SECTION 7—Sleeping

A I get no pain in bed.
B I get pain in bed, but it does not prevent me from sleeping well.
C Because of pain, my normal night's sleep is reduced by less than one-quarter.
D Because of pain, my normal night's sleep is reduced by less than one-half.
E Because of pain, my normal night's sleep is reduced by less than three-quarters.
F Pain prevents me from sleeping at all.

SECTION 8—Social Life

A My social life is normal and gives me no pain.
B My social life is normal, but increases the degree of my pain.
C Pain has no significant effect on my social life apart from limiting my more energetic interests, eg, dancing, etc.
D Pain has restricted my social life and I do not go out very often.
E Pain has restricted my social life to my home.
F I have hardly any social life because of the pain.

(continued)

SECTION 9—Traveling

A I get no pain while traveling.
B I get some pain while traveling, but none of my usual forms of travel make it any worse.
C I get extra pain while traveling, but it does not compel me to seek alternative forms of travel.
D I get extra pain while traveling which compels me to seek alternative forms of travel.
E Pain restricts all forms of travel.
F Pain prevents all forms of travel except that done lying down.

SECTION 10—Changing Degree of Pain

A My pain is rapidly getting better.
B My pain fluctuates, but overall is definitely getting better.
C My pain seems to be getting better, but improvement is slow at present.
D My pain is neither getting better nor worse.
E My pain is gradually worsening.
F My pain is rapidly worsening.

COMMENTS:_____

NAME:_____ DATE:_____ SCORE:_____

From Fairbank J, Davies J, et al. The Oswestry Low Back Pain Disability Questionnaire. *Physiotherapy* 1980;66(18):271–273.

as available from Yeomans S, 2000. The clinical application of Outcomes of Outcomes Assessment. Appleton and Lange, Stanford, Connecticut, United States of America.

APPENDIX J: Letter of signed consent for the blinded assessor.

To: Natasha Coetzee

From: Mari Meyer

Re: Agreement to participate as a blinded assessor.

Date: 02 November 2011

As per our verbal agreement, I hereby agree in writing that I willingly wish to participate in your research as your blinded assessor. I am in agreement to the proposal as set out in the PG4a document, and I am aware that it is required of me to take the subjective and objective readings for all 70 patients, regardless of the time period that might be required to complete this study.

I trust you find the above in order.

Kind regards

Mari Meyer

DURBAN UNIVERSITY of TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)

27 January 2012

IREC Reference Number: **REC 16/11**

Ms N Coetzee
Postnet Suite 376
Private Bag x10
Musgrave Road
4062

Dear Ms Coetzee

The efficacy of the Activator Adjusting Instrument in the treatment of chronic sacroiliac joint syndrome

I am pleased to inform you that Full Approval has been granted to your proposal REC 16/11.

The Proposal has been allocated the following Ethical Clearance number IREC 002/12. Please use this number in all communication with this office.

Approval has been granted for a period of one year, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's. In addition, you will be responsible to ensure gatekeeper permission.

Please note that ANY amendments in the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

[redacted]

Prof T Puckree
Chairperson: IREC