RELATIVE EFFECTIVENESS OF THREE TREATMENT PROTOCOLS WITH AND WITHOUT BRACE AIDED PELVIC STABILIZATION IN PATIENTS WITH CHRONIC LOW BACK PAIN.

By

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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, Ricardo David Marques, 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 parents, my dad, David and my mom, Vera. These two special individuals were very influential in making all my dreams come true and giving me the encouragement when the end seemed so far away. I am, forever thankful for all that they have given me and sacrificed so I can be where I am now. This research is a tribute to them and how important they were in getting me here. I love you guys.

I commit this research to my Lord Jesus Christ, thank you for keeping me on the straight and narrow and for the necessary inspiration to complete this dissertation. I love you till the end of days, and help me to live my life and not let life live me.

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ABSTRACT

Background: Wong and Deyo (2001) believe that 98% of the LBP cases are musculoskeletal (mechanical) in origin and 51,7% of these individuals are chronic sufferers (Andersson, 1999). Weak spinal stability muscles have shown to be an aetiological cause (Chok, Lee and Latimer, 1999). Wolff, Weinik and Maitin (2003) agree a combination of brace aided pelvic stabilization combined with a spinal stability programme may be the best treatment intervention for chronic low back pain (CLBP).

Objective: The purpose of this research was to determine the relative effectiveness of three treatment protocols with (Group A-Groovi-SI-Belt®; Group B-standard SI belt) and without (Group C-control) brace aided pelvic stabilization in patients with CLBP.

Method: Forty-six patients suffering from CLBP were randomly allocated to one of the three treatment groups. A spinal stability programme was progressively taught and enforced in all three groups. Weekly follow-up consultations were required to assess subjective and objective outcomes of the three treatment interventions. Outcomes were obtained by using the Numerical Pain Rating Scale (NRS); Quebec disability scale; Active straight leg raiser test; Biofeedback device and the static trunk extensor endurance test.

Results: Data was analysed using the SPSS version 15.0 (SPSS Inc. Chicago, Ill, USA).Comparing pre and post outcome measurements using a p value <0.05 which was considered to be statistically significant. All three treatments improved most outcomes significantly over time. The Groovi-SI-Belt® showed non significant trends of quicker rates of improvement.

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Conclusion: This study revealed that brace aided pelvic stabilization combined with a spinal stability programme was a beneficial treatment intervention with the Group A being superior to Group B.

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

Chapter 4

LIST OF FIGURES

Chapter 2

Chapter 4

DEFINITION OF TERMS

Active straight leg raise (ASLR): This is a test performed in the supine position with the patient's legs straight and feet 20 cm apart. The patient has to raise their legs, one after the other, 20 cm above the examination table without bending the knee. A positive ASLR has been associated with the patient having difficulty: in raising their leg, the speed at which they raise their leg; and the amount of rotation of the trunk. The patient's verbal and non-verbal expressions will also reflect the amount of difficulty they are experiencing in doing these movements. This is a validated test used to assess load transfer through the pelvis (Mens, Vleeming, Snijders, Koes and Stam, 2001).

Acute pain: Refers to pain duration less than 4 weeks and prior to this episode, the patient must be pain free for at least 3 months (Roelofs., Swinkels-Meewisse., Oostendorp., Verbeek and Vlaeyen, 2005).

Chronic pain: Refers to pain lasting longer than three months (Silfies, Squillante, Maurer, Westcott and Karduna, 2004).

Force closure: Refers to how muscle forces act dynamically across the lumbo-pelvic region and how they maintain the integrity of fascial structures. Furthermore these local muscles are made up of the transverse abdominus, internal oblique, multifidus, diaphragm and pelvic floor muscles (Hodges, Holm, Holm, Ekström, Cresswell and Hansson, 2003).

Groovi-SI-Belt®: This is a light fabric which is wrapped around the pelvic girdle and secured with Velcro, further compression is provided by two power straps (separate strong elastic bands), each with a central Velcro attachment, so that the power strap is then stretched from the central point in two different directions (Bell, 2008).

Incidence: Incidence is the rate at which healthy people develop a sickness or symptom over a projected period of time within a given population. Lifetime incidence reflects the number of individuals who will be affected by a condition at some point in their lives (Borenstein, Wiesel and Boden, 1995).

Instability: Is when there is a loss of normal spinal motion and thus an increase in aberrant motion which can lead to pain or neurological dysfunction (Panjabi, 2003).

Low back pain: This is pain, muscle tension or stiffness localized in an area below the costal margin and above the inferior gluteal folds, with or without leg pain (sciatica) (Van Tulder, Koes and Bouter, 1997).

Prevalence: Is the number of people in a given population who are suffering from that condition at a specific time (Borenstein *et al.,* 1995).

Spinal stability: Refers to the muscular control around the lumbar spine. These muscles are crucial in maintaining functional stability of the lumbar spine (Akuthota and Nadler, 2004)

Standard SI belt: This is a device which supports and stabilizes the SI joints. Composed normally of nylon or elastic bands which fit tightly around the hips by Velcro fasteners. If applied correctly it can alleviate certain forms of LBP (Huguelet, 2003).

LIST OF ABBREVIATIONS

LBP: Low back pain

SI: Sacro-iliac

NRS: Numerical pain rating scale

ASLR: Active straight leg raiser

QDS: Quebec disability scale

ASIS: Anterior superior iliac spine

PSIS: Posterior superior iliac spine

CHAPTER ONE

INTRODUCTION

1.1. The problem and its setting

The causes of low back pain (LBP) are multi-factorial in nature with acute LBP being benign, transient and self-limiting (Huntoon and Huntoon, 2004). If pain persists for longer than 2-6 weeks, systemic and rheumatic disorders must be ruled out. Wong and Deyo (2001) mentioned that 98% of the LBP cases are musculoskeletal (mechanical) in origin and 51,7% of these individuals are chronic sufferers (Andersson, 1999).

One of the mechanisms through which mechanical lower back pain is caused, is sacro-iliac (SI) instability (Panjabi, 2003). In order for SI instability not to occur three important musculoskeletal subsystems exist, namely: passive (form closure), active (force closure) and control (motor subsystem) (Panjabi, 2003). The active subsystem is provided predominantly by the local muscles, namely the transverse abdominus and multifidus (Akuthota and Nadler, 2004). Local muscles cannot act alone to produce spinal stability and this is only achieved once there is co-operation between the local and global muscles which brings about force closure (Jull and Richardson, 2000; Stevens, Witvrouw, Vanderstraeten, Parlevliet, Bouche, Mahieu and Danneels, 2006). The passive subsystem refers to the involvement of osteo-articular structures namely joints and ligaments (Mens, Vleeming, Snijders, Koes and Stam, 2005). The control subsystem is that which co-ordinates all necessary actions through the central and peripheral neural connections (Mens *et al*., 2005). These three subsystems work in conjunction to produce approximation of the joint surfaces and SI stability (Snijders, Vleeming and Stoeckart, 1993).

There is evidence to suggest that individuals with chronic LBP have lower muscle endurance (Pool-Goudzwaard, Hoek van Dijke, van Gurp, Mulder, Snijders and Stoeckart, 2004), an example of a poorly performing active subsystem. A recent study revealed that subjects with chronic LBP have increased co-activation of their erector spinae and rectus abdominus muscles while walking compared to healthy subjects (van der Hulst, Vollenbroek-Hutten, Rietman and Hermens, 2009). This demonstrates the body's reliance on the global muscles and the inadequate response of the local muscles when an individual is experiencing pain. Therefore it is plausible to supplement the management of LBP with a spinal stability programme as suggested by Wolff, Weinik and Maitin (2003).

Chok, Lee, Latimer and Tan (1999) observed that an endurance training regime of the trunk three times a week for three weeks had a positive effect on a patient with sub-acute LBP. This muscle reconditioning decreased pain and improved overall function. Akuthota and Nadler (2004) stated that it is not only important to strengthen the spinal stability muscles, but the relearning of inhibited is just as important. However, due to the lack of research there is no general consensus on the period a spinal stability programme should be implemented to achieve the desired benefits. Chok *et al.,* (1999) suggested 3 weeks, Jull and Richardson (2000) 10 weeks and more recently, Airaksinen, Hildebrandt, Mannion, Ursin, Brox, Klaber-Moffett, Reis, Zanoli, Cedraschi, Kovacs and Staal (2004) suggested 3-6 months.

Literature suggests that one of the best forms of treatment for chronic LBP is a combination of an SI belt as well as a spinal stability programme (Wolff *et al.,* 2003). Heller (2006) stated that a SI belt is helpful in the spinal stability programme as it reinforces and retrains the needed motion. Mens, Vleeming, Stoeckart, Stam and Snijders (1996) support the idea of brace aided pelvic stabilization (SI belts) as low back pain was drastically decreased in half of their patients. Thus the belt both reduces pain and induces correct recruitment patterns. Furthermore, Mens *et al.,* (2005) observed that the stiffness of the SI joint increases when an SI belt is applied to the pelvis. Bell (2008), the manufacturer of the Groovi-SI-Belt®, claims that the SI belt acts as an adjunct to the restoration of force closure. This SI belt is unique as its compression can be adjusted (increased or decreased) in accordance to the weakened force closure either anteriorly (transverse abdominus) or posteriorly (multifidus) by the 'power straps'(Bell, 2008).

The active straight leg raise (ASLR) test is a validated test for measuring effective load transfer from the trunk to the lower limbs (Mens *et al.,* 2001). It has also been observed that if one applies manual compression over the ilium while the ASLR is being performed it can reduce the effort of lifting the 'heavy' leg (Mens, Vleeming, Snijders, Stam and Ginai, 1999). This is helpful to determine exactly where and how much compression is needed. Lee (2005) elaborated that by varying the location of compression across the pelvis, information can be gained regarding which of the local stabilizers are deficient. So, theoretically manual compression to approximate the anterior superior iliac spine (ASIS), replicates force closure anteriorly as if increasing activity of the transverse abdominus. Similarly compression posteriorly approximates the posterior superior iliac spine (PSIS) and replicates force closure posteriorly as if increasing the activity of the multifidus. Hence, this information makes it possible to determine if the SI stability is due to a weakened force closure.

The Groovi-SI-Belt® should be worn only for a duration when the patient is active (Bell, 2008). An SI belt is only beneficial for short term periods and patients must be taught to decrease the compression and allow the core muscles to function fully, which can only happen when neuromuscular control of posture is re-educated (Wolff, *et al.,* 2003; Bell, 2008 and Liebenson, 2004). Continual bracing for a prolonged period has numerous adverse effects; some of these are altered motor control, possible loss of core body musculature, psychological dependence and decreased spinal mobility (Vleeming, 1997 and Wolff, *et al*., 2003).

Therefore, this research is essential to determine if individuals suffering from chronic low back pain due to decreased force closure will have any added benefits by using the Groovi-SI-Belt®.

1.2. Aims of the study

The aim of the research was to determine the relative effectiveness of three treatment protocols with and without brace aided pelvic stabilization in patients with chronic low back pain.

1.3. Objectives of the study

Objective One: To determine the relative effectiveness of the Groovi-SI-Belt® and a spinal stability programme on patients who are known to have a decreased force closure in terms of objective and subjective findings.

Objective Two: To determine the relative effectiveness of the SI Belt and a spinal stability programme on patients which are known to have a decreased force closure in terms of objective and subjective findings.

Objective Three: To determine the relative effectiveness of a spinal stability programme on patients who are known to have a decreased force closure in terms of objective and subjective findings.

Objective Four: To compare the relative effectiveness of the three treatment interventions against one another.

Objective Five: To determine the possibility of any adverse effects of the Groovi-SI-Belt®.

- **Null hypothesis:** It was hypothesized that the Groovi-SI-Belt® facilitated with a spinal stability programme would not be as effective as the other forms of intervention on chronic low back pain sufferers, in terms of both subjective and objective findings.

1.4. Rationale

The most common reason an individual visits a physician is due to LBP (Diaz-Ledezma, Urrutia, Romeo, Chelen, Gonzalez-Wilhelm and Lavarello, 2009). Ninety eight percent of LBP is musculoskeletal in origin (Wong and Deyo, 2001). This LBP is associated with a high socio-economic burden (Diaz-Ledezma *et al*., 2009). Pending the results from this research, the above facts could be addressed and ameliorated.

Weak spinal stability can increase the incidence of LBP (Lederman, 2008 and Chok *et al.,* 1999). Additionally, reduced force closure can lead to instability and thus LBP and if not addressed this can develop into a perpetual cycle producing chronic pain (O'Sullivan and Beales, 2007). Therefore, effective treatment protocols on individuals with decreased force closure could decrease the prevalence of LBP

Force closure is dependent on spinal stability, mainly the local muscles, namely the transverse abdominus and multifidus (Akuthota and Nadler, 2004), then pain inhibition by pain stimuli is problematic. According to Wollff *et al.,* (2003) individuals suffering from chronic LBP will benefit from a spinal stability programme.

It is thought that a spinal stability programme in addition to a standard SI-belt, which is believed to provide stability, may have better results. Through the underlying theory that the belt compresses the articular surfaces of the SI joints together, thereby decreasing incongruence, inflammation and therefore also pain, this may facilitate improved muscles recruitment outcomes (Mens, Damen, Snijders and Stam, 2005).

Bell (2008) claims the Groovi-SI-Belt® acts as an adjunct to the restoration of force closure, hence aiding in decreasing the chance of pelvic instability and chronic LBP. Furthermore an SI belt can facilitate in a spinal stability programme as it has been shown that it reinforces and retrains the needed motion (Heller, 2006).

1.5. <u>Conclusion</u>

In the remaining chapters, the research will review the literature on chronic LBP (Chapter Two): describe in detail the methodology of this study (Chapter Three): present the statistics and the results and the subsequent conclusion (Chapter Four). Thereafter recommendations will be made for suggested improvements in the management of chronic LBP (Chapter Five).

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter reviews the latest literature and clinical trials on patients suffering from chronic LBP.

The management of chronic LBP (musculoskeletal) in general, will be discussed with particular focus on the relationship between a spinal stability programme; brace aided pelvic stabilization (SI belts) and LBP.

2.1.1. Definition of low back pain

LBP is muscle tension or stiffness localized in an area below the costal margin and above the inferior gluteal folds, with or without leg pain (sciatica) (Van Tulder, Koes and Bouter, 1997).

2.2. Epidemiology of low back pain

2.2.1. Incidence and prevalence of low back pain

LBP due to musculoskeletal conditions is one of the most common causes of patients visiting their physicians, however spontaneous resolution occurs within two-six weeks in 85% of the cases but recurrences are common (Wong and Deyo, 2001).

According to Andersson (1999), the annual world-wide prevalence of LBP is between 15-45%. However, lifetime prevalence varies according to literature. Wong and Deyo (2001) stated that 66,7% of the population will suffer at some time with LBP. More recently Lin, Jen-Hwa Hu and Liu Sheng (2005) argued that 80% of the population will suffer from LBP at any given time. In the United States this figure is as high as 90% and is the highest cause of activity limitation in people younger than 45 years of age (Andersson, 1999).

2.2.2. Gender and Low back pain

Wong and Deyo (2001) stated that there is a slightly greater risk of women suffering from LBP than men. This is due to their increased risk of osteoporosis causing weakness and furthermore, 50-70% of pregnant females suffer from LBP during pregnancy as this nullifies the spinal stability muscles (Wong and Deyo, 2001). A survey conducted by Praemer, Furnes and Rice (1992) observed back pain in general was more common in woman (70.3 per 1000 population) compared to men (57.3 per 1000 population). This survey also demonstrated that back pain is more common in the White population (68.7 per 1000 people) than in the Black population (38.7 per 1000 people). Similar findings were observed by Docrat (1999) in the Coloured and Indian communities where predominately females suffered from LBP.

2.3. Aetiology of Low back pain

LBP is multi-factorial in nature with acute LBP being benign, transient and self-limiting (Huntoon and Huntoon, 2004). If pain persists for longer than two-six weeks, systemic and rheumatic disorders must be ruled out (Wong and Deyo, 2001). These disorders can also be suspected when the initial case history is carried out, especially if the patient's history highlights the following (Huntoon and Huntoon, 2004):

:

- Advanced age.
- Bowel or bladder incontinence.
- Constant and progressive pain at night.
- Fever.
- History of intravenous drug use.
- History of prior cancer.
- History of trauma.
- Prolonged systemic steroid use.
- Saddle anaesthesia.
- Systemic illness or infection.
- Unexplained weight loss.

Wong and Deyo (2001) mentioned that 98% of the LBP cases are musculoskeletal (mechanical) in origin and 51,7% of these individuals are chronic sufferers (Andersson, 1999). Vleeming (1997) explains that this is caused through reduced optimal stability in a joint causing increased motor units firing, thus increasing muscle contraction, leading to hypoxia causing chemical changes and hence pain.

2.3.1. Aetiology of Chronic low back pain in the general population

This symptom of pain suggested by Boon, Colledge, Walker and Hunter (2006) is patient specific because its aetiology, location, duration, quality, and intensity is only possible due to their sensory experience. Therefore, these researchers point out that this must also be accounted for when making a diagnosis.

The precise site of back pain is difficult to diagnose due to the unique anatomical arrangement of the back and the possibility of referred pain from another area (Huntoon and Huntoon, 2004). Chronic back pain sufferers experience fluctuation in their pain levels as Morris (2006) explains their pain comes in cycles with an overall duration on average of six weeks.

Literature has shown that psychological implications along with age and site of the symptoms have an important contributing factor in the transition from acute to chronic (Roelofs, Swinkels- Meewisse, Oostendorp, Verbeek and Vlaeyen, 2005; Andersson, 1999). These researchers showed that an increased age difference of twenty-three years doubled the odds of patients accumulating at least six months of sick leave from work, and lumbar symptoms were 2.86 times more likely than thoracic symptoms to become chronic.

O'Sullivan (2005) stated that the majority of mechanical LBP stems from the following three diagnoses:

1. Lumbar facet syndrome
2. Sacroiliac syndrome
3. Lumbar radicular syndrome

These syndromes can be attributed to the following:

1. Sprains/strains
2. Poor posture
3. Disuse
4. Overuse
5. Developmental abnormalities
6. Joint dysfunction (restriction/hypermobility)
7. Degenerative changes
8. Combination of any of the above

2.3.2. Muscles of the Trunk

2.3.2.1. Global and Local muscles

In essence the global and local muscle systems are linked and, when working in unison they provide spinal stability (Jull and Richardson, 2000). Lederman (2008) stressed this importance due to the fact that a passive (form closure) human spine is an unstable structure.

The global muscles are large superficial muscles, having their origins on the pelvis and insertions on the thoracic cage (van der Hulst, Vollenbroek-Hutten, Rietman and Hermens, 2009). These torque producing muscles provide for gross movement of the spine and are anatomically more remote from the joint, this is useful for spinal orientation and for balancing external loads (Jull and Richardson, 2000; Heller, 2006).

The local muscles are deep and anatomically closely related to individual vertebra and are capable of increasing spinal segmental stiffness (Jull and Richardson, 2000). The local muscles predominately involved are the transverse abdominus, multifidus and the pelvic floor muscles (Heller, 2006), Lederman (2008) insists that the transverse abdominus is the most important muscle for segmental stability anteriorly. Furthermore, Lederman (2008) states that the local muscles work independently of other trunk muscles.

2.3.2.2. Concept of spinal stability

Spinal stability hinges on three important subsystems namely: passive (form closure), active (force closure) and control (motor subsystem) (Panjabi, 2003). The passive subsystem refers to the involvement of osteo-articular structures namely joints and ligaments (Mens, Damon, Snijders and Stam, 2005) and the control subsystem co-ordinates all the necessary actions through the central and peripheral neural connections (Mens *et al*., 2005). These three subsystems work in conjunction to produce approximation of the joint surfaces (Snijders, Stoeckart and Vleeming, 1993). Hence, if there is decreased form closure increased force closure is then required (Vleeming, 1997).

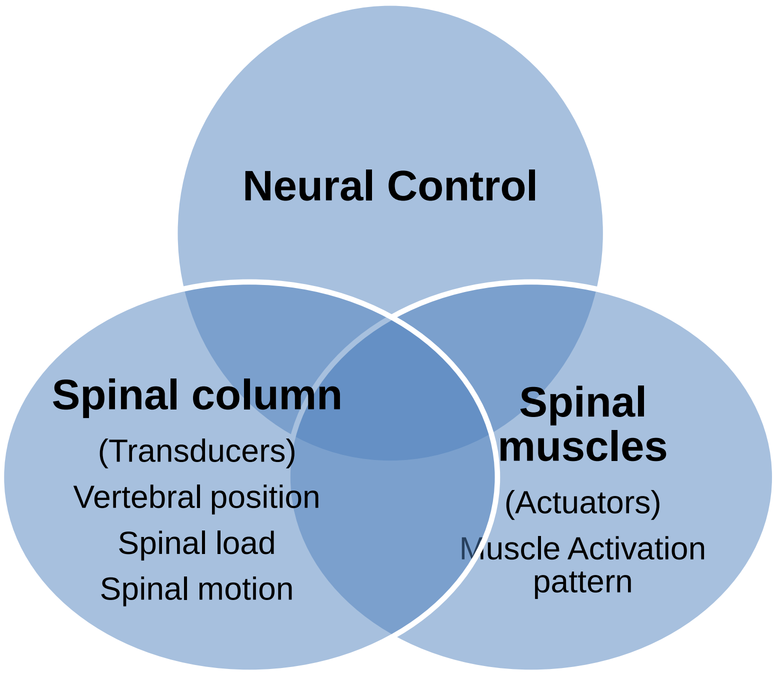

Figure 2.1: Spinal Stabilizing System (Panjabi, 2003)

Force closure (active subsystem) is provided predominantly by the local muscles, namely the transverse abdominus and multifidus (Vleeming, 1997). These structures are deep and have a bracing effect on the spine, thus producing a force closure that is more superior to the superficial muscles (Akuthota and Nadler, 2004; Vleeming, 1997). Furthermore, Akuthota and Nadler (2004) believe that force closure depends on the muscle contribution in the following two ways:

- Muscles are capable of generating a direct compressive force on the SI joint, thus increasing stiffness.
- Muscles have the ability to change the position of the joint leading to increased tension in the ligamentous structures.

The pelvic floor muscles are also considered local muscles and are important in producing force closure. This is due to the coccygeus and levator ani muscles, which form a muscular diaphragm. This diaphragm opposes the downward thrust when there is an increased intra-abdominal pressure. So, whenever there is an increase in intra-abdominal pressure, there is an increase in the overall stiffness of the lumbar spine (Akuthota and Nadler, 2004).

As mentioned earlier Lederman (2008) points out that the transverse abdominus is the most important muscle in producing force closure and along with stabilizing the spine, it also controls the pressure in the abdominal cavity for vocalisation, respiration, defecation and vomiting. In addition the transverse abdominus forms the posterior inguinal canal where it functions like a valve to prevent viscera from popping out through the canal (Lederman, 2008).

Numerous articles state the importance of both the local and deep muscles working together to provide spinal stability (Jull and Richardson, 2000; Heller, 2006 and Lederman, 2008). Liebenson (2004) believes pelvic stabilization is due to three muscular slings formed by these muscles and they include:

- Longitudinal sling: Multifidus which is attached to the sacrum.
  The deepest layer of the thoracolumbar fascia.
  Long head of biceps femoris attached to the sacrotuberous ligament.
- Posterior oblique sling: latissimus dorsi and opposite gluteus maximus; biceps femoris.
- Anterior oblique sling: pectorals; external oblique; transverse abdominus and internal oblique.
- Other muscles: diaphragm and pelvic floor.

2.3.3. Sacroiliac joint

2.3.3.1. Applied anatomy

This joint is formed by the union of the sacrum and the ilium (pelvis). Due to its unique anatomy of the SI joint it was long thought that it was an immobile joint (Lee, 2005). Mens *et-al.,* (2005) research showed that the SI joint allows for small degrees of movement. However, Akuthota and Nadler (2004) argue that the female SI joint is twice as mobile compared to their male counterpart whereas O'Sullivan and Beales (2007) insist that the SI joint is inherently stable irrespective of gender. This stability hinges on the effectiveness of Panjabi's (2003) three subsystems (O'Sullivan and Beale, 2007; Lee, 2005; Akuthota and Nadler, 2004).

The best way to analyse the passive subsystem is by comparing the amplitude and symmetry of motion between the sacrum and ilium. By placing the SI joints in their closed pack position (sacral nutation/posterior rotation of the ilium) it allows the examiner to determine if the ligaments are intact or have been stretched/torn. Healthy intact ligaments will demonstrate no translation as well as produce no pain. If ligaments are stretched or torn, translation will occur and subject would indicate ligamentous pain. However if there is no translation but increased motion of the SI joint in its closed pack position it is suggestive that there is impairment in either the active subsystem or the control subsystem (Lee, 2005).

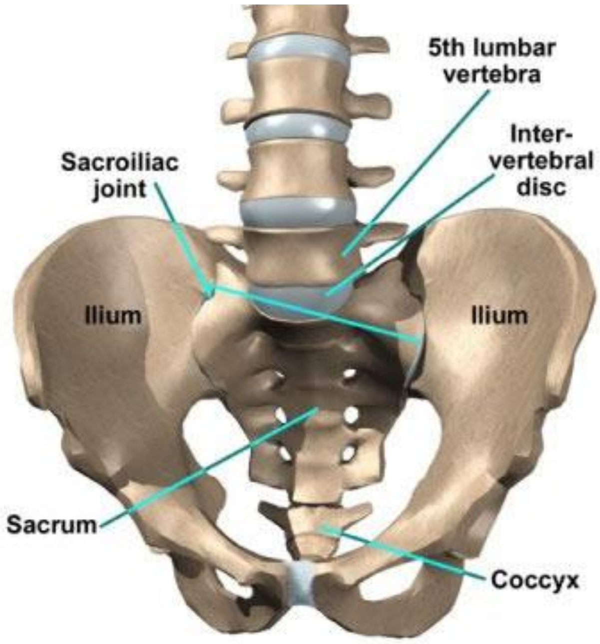

Figure 2.2: Diagram depicting location of the SI joint (Aldous, 2003)

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2.3.3.2. Functions of the Sacroiliac joint

The left and right SI joints have different functions (Vleeming, 1997). However their overall function is load transfer of body weight or gravity during walking, standing, sitting and other functional tasks (O'Sullivan Beales, 2007; Lee, 2005). SI joints are specifically designed for load transfer (O'Sullivan and Beales, 2007). The small amount of movement which the SI joint allows is essential in providing for shock absorption and overall protection to the biomechanical chain (Lee, 2005). Liebenson (2004) believes the SI joint has numerous nociceptors which makes it an important source of pain and activity intolerances. This source of pain has been shown to influence the motor control causing either excessive or inadequate force closure, both cases causing a perpetual cycle. Insufficient force closure leads to an unstable SI joint and further pain (O'Sullivan and Beales, 2007). Excessive force closure blocks off the flow of the capillary beds leading to ischaemic changes and further muscle pain (Vleeming, 1997).

2.3.3.3. The active straight leg raiser (ASLR) test

The active straight leg raiser test is performed in the supine position with the patient's legs straight and feet 20 cm apart. The subject has to raise their legs, one after the other, 20 cm above the examination table without bending the knee. A positive ASLR has been associated with the patient having difficulty: in raising their leg, the speed at which they raise their leg; and the amount of rotation of the trunk. The patient's verbal and non-verbal expressions will also reflect the amount of difficulty they are experiencing in doing these movements (Mens, Vleeming, Snijders, Koes and Stam, 2001).

The ASLR test is a validated test for measuring effective load transfer from the trunk to the lower limbs (Mens *et al.,* 2001). According to Liebenson (2004) the ASLR can determine which SI joint is unstable. It has also been shown that if a Chiropractor applies manual compression over the ilium while the ASLR is being performed it can reduce the effort of lifting the 'heavy' leg (Mens, Vleeming, Snijders, Stam and Ginai, 1999) which is helpful in determining exactly where and how much compression is needed. Lee (2005) elaborated that by varying the location of compression across the pelvis, information can also be gained in terms of identifying which of the local stabilizers are deficient. So, theoretically manual compression to approximate the anterior superior iliac spine (ASIS), replicates force closure anteriorly as if increasing activity of the transverse abdominus. Similarly, compression posteriorly approximates the posterior superior iliac spine (PSIS) and replicates force closure posteriorly as if increasing the activity of the multifidus. Hence, this information makes it possible to determine if the SI stability is due to a weakened force closure and potentially identifies the muscle(s) at fault.

A recent study was performed by Beales, O'Sullivan and Briffa (2009), in Australia, on 12 patients with chronic pelvic girdle pain. This study required the subjects to perform an ASLR with and without compression. The results of the study revealed that it was easier to lift their leg when manual compression was applied. However, according to O'Sullivan and Beales (2007) individuals with increased force closure have a negative ASLR and when compression is applied this is usually provocative (producing pain along with difficulty in raising their leg).

2.3.3.4. ASLR and SI Belts

A study performed in Holland by Mens *et al.,* (2005) on 25 female patients suffering from pelvic girdle pain revealed that the stiffness of the SI joints increased when SI belts were applied. Patients initially expressed difficulty lifting their leg without the belt and when the belt was applied, they believed their leg became a lot lighter. Hence, increased SI stability makes load transfer increasingly effortless for the patient.

The theory behind the belt is that the articular structures of the SI joint will be pressed together or that the SI joint will be placed in a "closed packed" position to provide stability. Unfortunately there is no proof of this mechanical effect (Mens *et al.,* 2005) however; numerous studies have mentioned the beneficial effects of SI belts on diminishing SI instability (Bell, 2008; Vleeming, 1997; Mens *et al.,* 2005).

2.4. <u>Management of Chronic Low back pain</u>

2.4.1. The management of mechanical low back pain in the general population

Most patients recover quickly and spontaneously from LBP without loss of their residual function (Wong and Deyo, 2001; Andersson, 1999). Overall, 60-70% recover by 6 weeks, 80-90% recover by 12 weeks and thereafter recovery is slow and uncertain (Andersson, 1999).

A study carried out in Holland on 394 pregnant females to demonstrate the different effects of treatment interventions before and after delivery. The interventions were as follows: medication; massage; manual therapy; local injections (steroids and sclerosing): surgery; bed rest with exercises; SI belt and lastly physiotechnic applications. Each application showed moderate improvement but nothing conclusive was shown (Mens, Vleeming, Stoeckart, Stam and Snijders, 1996). Therefore, Walker (1997) concluded that further research is required in this field.

Wong and Deyo (2001) point out that patients should be strongly encouraged to pursue usual levels of activity due to the fact bed rest does not improve the patient's rate of recovery but can usually prolongs it. The use of exercises is a method to motivate patients to regain normal motion of the lumbo-sacral spine.

2.5. Spinal stability exercises

2.5.1. The effects of spinal stability exercises

Chok, Lee, Latimer and Tan (1999) believe that exercise has a beneficial effect on emotional and cognitive aspects of pain. Akuthota and Nadler (2004) state the importance of a spinal stability programme, as it not only improves strength but also facilitates the relearning of inhibited muscles. Similarly, Jull and Richardson (2000) stress that a spinal stability programme is essential in reversing motor control problems responsible for key movements in the local system and restoring normal synergistic motion.

Due to the lack of research there is no general consensus in how long a spinal stability programme should be implemented until desired benefits are attained. Chok *et al.,* (1999) suggests 3 weeks, Jull and Richardson (2000) 10 weeks, and Airaksinen *et al.,* (2004) suggest 3-6 months.

2.5.2. Effects of a spinal stability exercises associated with LBP

Research by Lederman (2008) and Chok *et al.,* (1999) state that weak spinal stability muscles are one of the aetiological causes of LBP. This causes inhibition to the local muscles leading to atrophy of the transverse abdominus and multifidus (Heller, 2006).

Pool-Goudzwaard, Hoek van Dijke, van Gurp, Mulder, Snijders and Stoeckart (2004) state that there is evidence to suggest that individuals with LBP have lower muscle endurance. Chok *et al.,* (1999) performed a study in Singapore, on 66 individuals suffering from LBP. The control group was advised to use hot packs at home and received postural and back care advice but no other treatment was provided for this group. The experimental group was asked to perform an endurance training regime of the trunk three times a week. It was observed that muscle reconditioning had a positive effect on decreasing pain and improving function over a short term, at three weeks after exercise intervention. Therefore, enhancing muscle endurance through a spinal stability programme helps reduce LBP.

A recent study performed in the Netherlands, observed 96 patients (63 patients with chronic LBP and 33 healthy patients). The results revealed that subjects with chronic LBP had increased co-activation of their erector spinae and rectus abdominus muscles while walking compared to healthy subjects (van der Hulst *et al.,* 2009). Therefore it is plausible to supplement the management of LBP with a spinal stability programme as suggested by Wolff, Weinik and Maitin (2003). Similarly, O'Sullivan and Beale (2007) proposed a cycle referred to as a perpetual cycle in which LBP diminishes motor control which ultimately decreases force closure producing an unstable SI joint. This initiates a self-protective mechanism by which there is increased activation of the global muscles producing 'guarding'. Guarding is the term used when there is insufficient muscle relaxation (van der Hulst *et al.,* 2009)

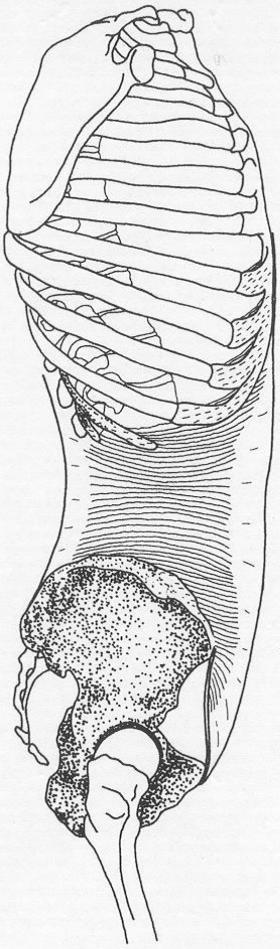
2.5.3. Timing issues

Lederman (2008) noted that there is a delayed contraction of the transverse abdominus in individuals suffering from chronic LBP compared to asymptomatic individuals. Due to the loss of their normal anticipatory function, the delay in contraction postpones the normal pre-programmed function for support (Jull and Richardson, 2000). Hence, in theory back pain can improve by simply normalizing the timing of the local muscles, which is attained through continual and sustained contraction of the transverse abdominus. Unfortunately, no study to date can verify that a spinal stability programme will reset onset timing in chronic LBP patients (Lederman, 2008).

2.5.4. Co-contraction between transverse abdominus and multifidus muscles

Jull and Richardson (2000) believe the initial and pivotal focus is the retraining of the co-contraction of the transverse abdominus and the multifidus. During the retraining process, the local muscles are activated cognitively and as independently as possible from the global muscle system. The transverse abdominus is innervated by 7^{th} -12^{th} intercostals, iliohypogastric and ilioinguinal nerves. The multifidus is innervated by the dorsal primary division of the spinal nerves.

TRANSVERSUS ABDOMINIS



Trunk—lateral view

Origin	Lateral part of inguinal ligament, iliac crest, thoracolumbar fascia, cartilage of lower six ribs	**Action**	Compresses abdomen
		Nerve	Seventh to twelfth intercostal, iliohypogastric, ilioinguinal nerves
Insertion	Abdominal aponeurosis to linea alba	**Relationships**	Deepest of the three lateral abdominal muscles

Note: Important in forced expiration, coughing, sneezing.

Figure 2.3: Transverse abdominus and its attachments, action and innervation

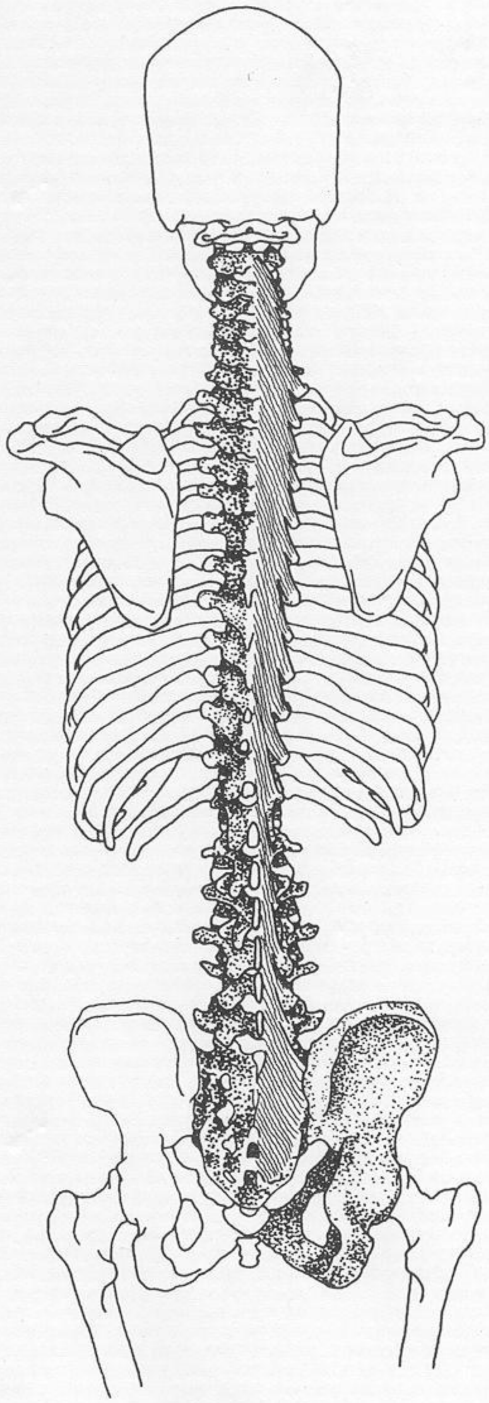
(The University of Auckland, Bioengineering Institute, www.auckland.ac.nz).

MULTIFIDIS*

Origin	Sacral region—along sacral foramina up to posterior superior iliac spine
	Lumbar region—mamillary processes† of vertebrae
	Thoracic region—transverse processes
	Cervical region—articular processes of lower four vertebrae (C4–C7)
Insertion	Spinous process two to four vertebrae superior to origin
Action	Extend and rotate vertebral column
Nerve	Dorsal primary division of spinal nerves

*Part of transversospinalis.

†Posterior border of superior articular process.



Trunk—dorsal view

Figure 2.4: Multifidus and its attachments, action and innervation

(The University of Auckland, Bioengineering Institute, www.auckland.ac.nz).

Hyatt and Cram (2003) propose initially, cognitively activating both the transverse abdominus and multifidus requires patients to be lying on their back with their spine neutral, inhaling and while exhaling, they must tighten their abdominal muscles and pull the umbilicus towards the spine. Patients must concentrate on contracting muscles below the umbilicus without flattening their lower back against the floor.

Hallam (2004) states that the fundamental importance of the initial co-contraction and only once there is sufficient co-ordination must patients progress to further, more challenging exercises. If progression occurs before mastering the fundamentals, individuals negate the benefits of performing these exercises.

2.6. <u>SI Belts</u>

2.6.1 Effects of SI belts associated with LBP

Mens *et al.,* (2005) observed that the stiffness of the SI joint increases when a belt is applied to the pelvis. Following this, he observed 95% of the individuals ASLR significantly improved. Therefore, in contrast to Vleeming's study, Bell (2008) claims that an SI belt acts as an adjunct to the restoration of force closure however, SI belts should only be utilized for short term use.

A study was performed in the Netherlands, on 394 pregnant females that required 55 of them to wear an SI belt before and after childbirth. The results demonstrated that there was a decrease in pain in approximately half the subjects who wore the belt before delivery. Following birth, two-thirds of the subjects wearing the belt were further relieved (Mens *et al.,* 1996). Pregnancy is a contributing factor to an unstable or dysfunctional SI joint due to the fact it disrupts normal muscle functioning and decreases force closure (de Groot, Pool-Goudzward, Spoor and Snijders, 2006). Similarly, this dysfunction is present in individuals suffering from

LBP (O'Sullivan and Beales, 2007). Therefore an SI belt is theoretically an ideal intervention in treating and managing LBP.

However, continual bracing for a prolonged period has numerous adverse effects, some of these are: altered motor control, possible loss of core body musculature, psychological dependence and decreased spinal mobility (Vleeming, 1997 and Wolff *et al.*, 2003).

2.6.2. Groovi-SI-Belt®

The Groovi-SI-Belt® is a light fabric which is wrapped around the pelvic girdle and secured with Velcro. Further compression is provided by two power straps (separate strong elastic bands), each with a central Velcro attachment, so that the power strap is then stretched from the central point in two different directions (Bell, 2008).

The advantage of the, Groovi-SI-Belt® is that the compression can be adjusted (increased or decreased) in accordance to the weakened force closure either anteriorly (transverse abdominus) or posteriorly (multifidus) by means of the power straps (Bell, 2008).

The Groovi-SI-Belt® should be worn only for a duration when the patient is active (Bell, 2008), when irritation of the joint is possibly at the highest. SI belts are only beneficial for short term periods and patients must be taught to decrease the compression and allow the core muscles to function fully, which is indicated when neuromuscular control of posture is re-educated (Wolff *et al.,* 2003; Bell, 2008 and Liebenson, 2004).

Figure 2.5: The Groovi-SI-Belt® (Bell, 2008)

2.7. Summary

Research supports the theory that the most acceptable means to stabilize a dysfunctional SI joint that may be symptomatic, is to strengthen the abdominal spinal stability muscles as this decreases the mechanical stress (Panjabi, 1992; Jull and Richardson, 2000).

Clinical trials observed that individuals suffering from LBP who were encouraged to take up a core stability muscle training programme had positive results (Chok *et al.,* 1999; O'Sullivan and Beales, 2007).

Research suggests that optimal core muscle strength, timing and endurance working synergistically with the rest of the neuromusculoskeletal system is necessary for SI stability (Panjabi, 2003; Chok *et al.,* 1999; Jull and Richardson, 2000; Pool-Goudzwaard *et al.,* 2004; Lederman, 2008).

Therefore in order to address all the components of LBP, it may be best to provide SI stability through the combination of both a spinal stability programme and a SI belt (Wolff *et al.,* 2000; Heller, 2006).

The Groovi-SI-Belt® is a new innovative product which is believed to be superior compared to the standard SI belt, due to the fact that the compression either anteriorly or posteriorly can be adjusted through the power straps (Bell, 2008).

Therefore, this research is essential in determining if patients suffering from chronic low back pain due to decreased force closure (SI instability) will have any added benefits by using the new Groovi-SI-Belt®.

CHAPTER 3
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, randomized, experimental clinical trial investigation to determine the effectiveness of three treatment protocols with and without brace aided pelvic stabilization in patients with chronic low back pain. The research involved three groups with all three groups getting taught a spinal stability programme. Two of the three groups also received SI belts: one group received the Groovi-SI-Belt® and the other a standard SI Belt. Numerous subjective and objective readings were taken on each visit in order to gather empirical data on the patients' response to the treatment intervention.

3.2. Advertising

Advertising was carried out through posters and leaflets which were distributed to the greater Durban area. This included universities, sports clubs, shopping centres and private enterprises - with the permission of the respective authorities. See Appendix A.

3.3. Sampling

3.3.1. Size

The research required a total of 46 patients suffering from chronic low back pain. The 46 patients were randomly allocated into one of three treatment groups, each group containing a minimum of 15 patients in order to achieve statistical validity. All patients volunteered to be part of the study and only once strict criteria were met were they then eligible for the study, this was explained in the Letter of Information (see Appendix B).

3.3.2. Allocation

Patients who met the requirements for the research, according to the inclusion and exclusion criteria were randomly allocated into one of the three treatment groups. Randomization was carried out by the receptionist on duty, because they were required to draw a letter (A; B; C) from a bowl. Each letter was written on a piece of paper and folded so the receptionist was blinded to what letter he/she would pull. Each letter represented a group. Letter A represented the group of patients who were taught a spinal stability programme and were required to wear the Groovi-SI-Belt®. Letter B represented the group of patients that were taught a spinal stability programme and were required to wear the standard SI belt. Letter C represented the group of patients that were taught a spinal stability programme (Control Group). Due to randomization a large proportion of professional rugby players were allocated to Group C so their athletic nature was taken into consideration.

3.3.3. Method

A telephonic interview was conducted initially, were pertinent questions were asked to determine if the patient would be eligible for this research. The following questions were asked:

- Are you between 18 and 45 years of age?
- Where is the area of pain? Is it low back?
- How long have you been suffering from low back pain? Longer than 3 months?
- Are you currently taking any pain medication and if so when was the last medication taken? Longer than 3 days ago?

These questions decreased the chance of accepting patients into the study who did not meet the research criteria. There was one test (ASLR) which required the patients to come to the D.U.T Chiropractic clinic. The ASLR (Appendix H) was used to determine if one leg was subjectively “heavier” than the other as the ASLR is a validated test (Mens, Vleeming, Snijders, Stam and Ginai 1999; Mens, Vleeming, Snijders, Koes and Stam, 2001). A positive response could indicate ineffective load transfer. By applying compression over the pelvis while the patient performed the ASLR, deficiencies could be noticed in muscle responsible for force closure (Lee, 2005).

Compliance with the following criteria was obtained at the first consultation from the patients case history (Appendix C), physical (Appendix D), and Lumbar Spine Regional (Appendix E), in order to assess whether the patients qualified for the study.

3.4. <u>Inclusion criteria</u>

The inclusion criteria were:

- Patients had to be suffering from chronic mechanical LBP (Van Tulder, Koes, and Bouter, 1997; Silfies, Squillante, Maurer, Westcott and Karduna, 2004).
- SI dysfunction had to be noted by the patient from the ASLR test producing symptoms of pain or difficulty in raising their leg (Goldstein, 2002).

- Patients had to be between the ages of 18 - 45 years (Kirkaldy-Willis and Burton, 1992; Buchthal, 1957).
- Patients had to give informed consent to participate in the research (Mouton, 1996).
- Patients had to be clinically diagnosed to have decreased force closure with use of the ASLR either anteriorly or posteriorly (O'Sullivan and Beales, 2007; Mens *et al.*, 2001).
- Compression test and Biofeedback device had to show relevant weakness in either the transverse abdominus or multifidus muscle (Lee, 2005; Cairns, Harrison and Wright, 2000).

3.5. <u>Exclusion criteria</u>

The exclusion criteria were:

- Patients who were experiencing acute or sub-acute LBP (Van Tulder, *et al.,* 1997; Roelofs, Swinkels-Meewisse, Oostendorp, Verbreek and Vlaeyen, 2005).
- Patients LBP could not be related to systemic or rheumatic disorders (Huntoon and Huntoon, 2004; Wong and Deyo, 2001).
- Patients could not have a positive ASLR either due to a weak passive (form closure or a weak control (motor control) (Panjabi, 1992).
- Patients who were conta-indicated to exercise therapy: including but not limited to uncontrolled hypertension; previous myocardial infarction; cerebrovascular disease; peripheral vascular disease and respiratory disorders (Chok, Lee, Latimer and Tan, 1999).
- Any signs of nerve root pathology, which was demonstrated with decreased tendon reflexes, sensory loss, and motor deficit (Chok *et al*., 1999).
- Patients receiving medication other than analgesics and non-steroidal anti-inflammatory drugs (Chok *et al*., 1999).

3.6. Intervention / Treatment Types

The first group- Group A, received **1 consultation weekly for 4 weeks**.

During the first consultation, patients were introduced and educated on the use of the Groovi-SI-Belt®. Patients were asked to wear the belt whenever they were active throughout the four weeks of the research process, for example: walking for long periods, exercising and when performing outdoor activity.

On the first visit patients were taught the first two exercises of the Sahrmann protocol (Hyatt and Cram, 2003) and were expected to perform these exercises three times a week (see Appendix M). Following this, each patient received an exercise diary which they were expected to complete.

During their second consultation patients were asked to perform the Sahrmann protocol exercises (Hyatt and Cram, 2003) that they were shown the week before, to ensure they were doing it properly. Following that, patients were taught how to perform the next two exercises of the Sahrmann protocol (Hyatt and Cram, 2003) as it is a progressive exercise routine.

During the patients third consultation patients were asked to perform the Sahrmann protocol exercises (Hyatt and Cram, 2003) that they were shown during the two previous weeks, to ensure they were doing it properly. Following that, patients were taught how to perform the last exercise of the Sahrmann protocol (Hyatt and Cram, 2003) as it is a progressive exercise routine. On patient departing the clinic, it was requested that the patient bring their exercise diary with them on their next appointment.

There was no treatment intervention on the fourth visit. The patient was only asked to hand in their exercise diary. They were also advised that they could keep their Groovi-SI-Belt®.

The second group- Group B, received **1 consultation weekly for 4 weeks**.

During the first consultation, patients were introduced and educated on the use of the standard SI belt. Patients were asked to wear the belt whenever they were active throughout the four weeks of the research process, for example: walking for long periods, exercising and when performing outdoor activity.

On the first visit patients were taught the first two exercises of the Sahrmann protocol (Hyatt and Cram, 2003) and were expected to perform these exercises three times a week. Following this, each patient received an exercise diary which they were expected to complete.

During their second consultation patients were asked to perform the Sahrmann protocol exercises (Hyatt and Cram, 2003) that they were shown the week before, to ensure they were doing it properly. Following that, patients were taught how to perform the next two exercises of the Sahrmann protocol (Hyatt and Cram, 2003) as it is a progressive exercise routine.

During the patients third consultation patients were asked to perform the Sahrmann protocol exercises (Hyatt and Cram, 2003) that they were shown during the two previous weeks, to ensure they were doing it properly. Following that, patients were taught how to perform the last exercise of the Sahrmann protocol (Hyatt and Cram, 2003) as it is a progressive exercise routine. On patient departing the clinic, it was requested that the patient bring their exercise diary with them on their next appointment.

There was no treatment intervention on the fourth visit. The patient was only asked to hand in their exercise diary. They were also advised that they could keep their standard SI belt.

The third group- Group C (control) received **1 consultation weekly for 4 weeks**.

On the first visit patients were taught the first two exercises of the Sahrmann protocol (Hyatt and Cram, 2003) and were expected to perform these exercises three times a week. Following this, each patient received an exercise diary which they were expected to complete.

During their second consultation patients were asked to perform the Sahrmann protocol exercises (Hyatt and Cram, 2003) that they were shown the week before, to ensure they were doing it properly. Following that, patients were taught how to perform the next two exercises of the Sahrmann protocol (Hyatt and Cram, 2003) as it is a progressive exercise routine.

During the patients third consultation patients were asked to perform the Sahrmann protocol exercises (Hyatt and Cram, 2003) that they were shown during the two previous weeks, to ensure they were doing it properly. Following that, patients were taught how to perform the last exercise of the Sahrmann protocol (Hyatt and Cram, 2003) as it is a progressive exercise routine. On patient departing the clinic, it was requested that the patient bring their exercise diary with them on their next appointment

There was no treatment intervention on the fourth visit. The patient was only asked to hand in their exercise diary.

3.7. Intervention frequency

Patients were required to attend four consultations over four weeks, which was one consultation a week. On each consultation all patients were taught new spinal stability exercises, except for the last visit which just required the patient for data collection.

3.8. Data collection

3.8.1. Frequency

The groups completed subjective and objective measurement on each consultation. The subjective measurements included the Numerical Pain Rating Scale (NRS), (Flaherty, 2007); the Quebec Pain Disability Scale (QDS), (Kopec, Esdaile, Abrahamowicz, Abenheim, Wood-Dauphine, Lamping and Williams, 1995) and the ASLR (Mens *et al.,* 1999; Mens *et al.,* 2001). The objective measurements included the Biofeedback Pressure Unit (Cairns *et al.,* 2000) and the Static Trunk Extensor Endurance Test (Liebenson, 2004). These measurements were performed weekly for four weeks.

3.8.2. Data collection instruments

3.8.2.1. Subjective data:

Subjective data was collected using the following measuring instruments:

1. <u>Active Straight Leg Raiser (ASLR)</u>

This is a test which was performed in the supine position with the patients' legs straight and feet 20 cm apart. The test requires the patient to lift their leg one at a time 20 cm off of the bed. The patient was then asked to score the impairment on a six-point scale. 0=not difficult at all; 1=minimally difficult; 2=somewhat difficult; 3=fairly difficult; 4=very difficult and 5=unable to perform (Mens *et al.,* 1999; Mens *et al.,* 2001). By applying compression over the pelvis while the subject performs the ASLR, deficiencies can be noticed in muscle responsible for force closure (Lee, 2005). This greatly reduces the patients' impairment, so the patient was asked to perform the ASLR twice and score the impairment, one without compression and the other with compression.

2. <u>Numerical Pain Rating Scale</u>

Numerical pain rating scale (NRS) was used to assess the amount of pain that the patient was experiencing and to note if there was any change in the pain post assessment. This was determined because the patient picked a number between 1 and 10, which best described their pain they were feeling at that time, with 1 being the least pain and 10 the most. Flaherty (2007) insists the NRS is the best in assessing subjective outcomes. Price, Bush, Long and Harkins (1994) insist a numerical rating gives a good indication whether the pain has reduced or increased in-between consultations.

3. Quebec Pain Disability Scale

The Quebec Back Pain Disability Scale (QDS) (Kopec *et al.,* 1995) is a 20-item self-administered instrument, incorporated to determine the level of functional disability in patients with low back pain. It adopts a generally accepted conceptual definition of disability as a restriction of ability to perform daily activities.

The scale contains 20 items and covers six empirically derived sub-domains of disability in back pain. All items contribute to the assessment of global disability and are relevant and acceptable to the patients. The items are scored 0 to 5 and the scale provides an overall disability score, ranging from 0 to 100, by simple summation of the scores for each item (Kopec *et al*., 1995).

The scale is brief and easy to self-administer. Comparisons with the Roland and Oswestry scales suggest that the QDS is more reliable and is more sensitive to changes (Kopec *et al*., 1995).

3.8.2.2. Objective measures:

Objective data was collected using the following measuring instruments:

1. Biofeedback Pressure Unit

Stabilizer manual Chatanooga Group Inc., 4717 Adams Road, Hixson TN 37343, USA.

This device was utilized to determine the presence of adequate core stability activation using the abdominal draw-in-test. This clinical intervention has been proven as a satisfactory tool in measuring and retraining of the transverse abdominus and multifidus (Cairns *et al.,* 2000).

<u>The **Prone test** for transverse abdominus and internal oblique:</u>

A 3-chamber pressure cell was placed centrally under the abdomen. With the umbilicus in the centre of the inflatable sleeve, and inflated to a baseline of 70mmHg. The patient was then instructed to draw the abdominal wall up and in, without moving the spine or pelvis. The pressure reading should decrease 6-10mmHg.

A variation of 2mmHg is allowed for normal breathing pattern. The measurement was taken at the time at which the patient can no longer hold the contraction at the baseline level (70mmHg-6 to 10mmHg)

2. <u>Static Trunk Extensor Endurance Test</u>

Patient was prone with their anterior superior iliac spine (ASIS) positioned at the end of the table. Arms at their side, thighs and ankles are fixed to the table by straps. Patients were then asked to maintain the horizontal position for as long as they could, for a maximum of 240 seconds (four minutes).The timing begins once they were able to maintain the horizontal position unsupported.

Patient was allowed one additional chance if they drop below the horizontal position but if they drop twice, the time was recorded. If the patient reported cramping in their legs or LBP the test was stopped and the time was recorded (Liebenson, 2007).

The Static Trunk Extensor Endurance Test was an appropriate test to perform to determine the endurance capabilities of the extensor muscles. If these muscles are weak it has been shown to decrease proprioceptive awareness as well as an overall decrease in the individuals' productivity in the workplace (Pope, Moffroid, Haugh, Haig and Henry, 1993). A low score on this test is, according to Pool-Goudzwaard, Hoek van Dijke, van Gurp, Mulder, Snijders and Stoeckart (2004), a good indicator of decreased muscle endurance which could also imply that the patient has LBP.

3.9. Statistical Methodology

Data was collected from the ASLR, NRS, QDS, Biofeedback Pressure Unit and the Static Trunk Extensor Endurance test.

Statistical analysis was completed with the help of a statistician from the University of Kwa-Zulu Natal Medical School. The subjective data was obtained through the Active Straight Leg Raiser (ASLR), Numerical Pain Rating Scale (NRS) and the Quebec Disability Scale (QDS). The objective data was gathered through the Biofeedback Pressure Unit and the Static Trunk Extensor Endurance Test.

Data was analysed using SPSS version 15.0 (SPSS Inc. Chicago, Ill, USA). A p value <0.05 was considered to be statistically significant. Intra-group analysis was used to test the effectiveness of each treatment separately by comparing pre and post outcomes measurements in paired analyses. For quantitative normally distributed outcomes, the paired t-test was used.

Inter-group analysis was used to compare the change from pre to post intervention between the three treatment groups using repeated measures ANOVA testing. If a significant time * group interaction effect was found, post-hoc Bonferroni adjusted pairwise comparisons was made in order to determine which interventions were different from the control group and whether the two intervention groups differed from each other. Profile plots will be used to describe the trends and directions of the treatment effects.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Introduction

The standard format for a dissertation generally is such that the results are in Chapter Four and the discussion in Chapter Five; this dissertation is presented in such manner as to present the results along with the discussion within one chapter, Chapter Four. This route was taken in order to ensure that the discussion between groups' improvements or lack thereof did not become a repetitive focus.

4.2. Tools used in obtaining data

The subjective tools used were: Numerical Pain Rating Scale (NRS), Quebec disability scale and the active straight leg raiser (ASLR). The Objective tools used were: Biofeedback device and static trunk extensor endurance test.

4.3. Abbreviations

Group A	:	Groovi-SI-Belt®
Group B	:	Standard SI belt
Group C	:	Control
BMI	:	Body mass index
N	:	Sample size
p	:	Probability
$<$	:	Less than

4.4. <u>Demographics</u>

4.4.1. Randomisation

Forty-six patients suffering from chronic LBP were randomized to three treatment groups. Group A had sixteen patients and Group B and Group C had fifteen.

4.4.2. Comparison of age, BMI and duration of pain

There were no significant differences between the three groups in terms of age, duration of pain and BMI. Although BMI showed a trend towards the control group BMI being higher than that of the other two groups, due to the athletic nature of the patients. However, this difference was not statistically significant as shown in table 4.1.

Table 4.1: Comparison of mean age, duration of pain and BMI between the three treatment groups.

Group		Age	Duration of pain / instability (years)	BMI
Group A	Mean	29.25	6.2138	24.908
	N	16	16	16
	Std. Deviation	9.015	4.22221	5.1375
Group B	Mean	27.93	6.7333	24.013
	N	15	15	15
	Std. Deviation	7.750	4.83243	4.4887
Group C	Mean	27.13	5.5047	28.240
	N	15	15	15
	Std. Deviation	6.424	5.19176	5.5329
Total	Mean	28.13	6.1520	25.703
	N	46	46	46
	Std. Deviation	7.707	4.67408	5.2832
p value		0.750	0.778	0.066

4.4.3 Comparison of ethnic groups and gender

There were also no significant differences between the groups in gender (p=0.133) and ethnicity (p= 0.614) (Table 4.2).

Table 4.2: Comparison of percentages in race and gender groups by treatment group.

		Groups						*p* value
		Group A		Group B		Group C		
		Count	Column %	Count	Column %	Count	Column %	
Gender	Female	9	56.3%	9	60.0%	4	26.7%	0.133
	Male	7	43.8%	6	40.0%	11	73.3%	
Race	Black	1	6.3%	2	13.3%	3	20.0%	0.614
	Coloured	0	.0%	0	.0%	1	6.7%	
	Indian	1	6.3%	2	13.3%	2	13.3%	
	White	14	87.5%	11	73.3%	9	60.0%	

4.4.4 Participant loss to follow up/drop outs

Five possible patients suffering from chronic low back pain did not meet the inclusion criteria due to failing the requirements set for the ASLR test, these patients were excluded immediately. One patient dropped out of Group A in between their second and third consultation due to non-compliance (time-constraints). One patient dropped out of Group C in between their second and third consultation due to non-compliance (time-constraints). These two drop outs had no significance in the overall research, as their data was not utilized this prevented bias.

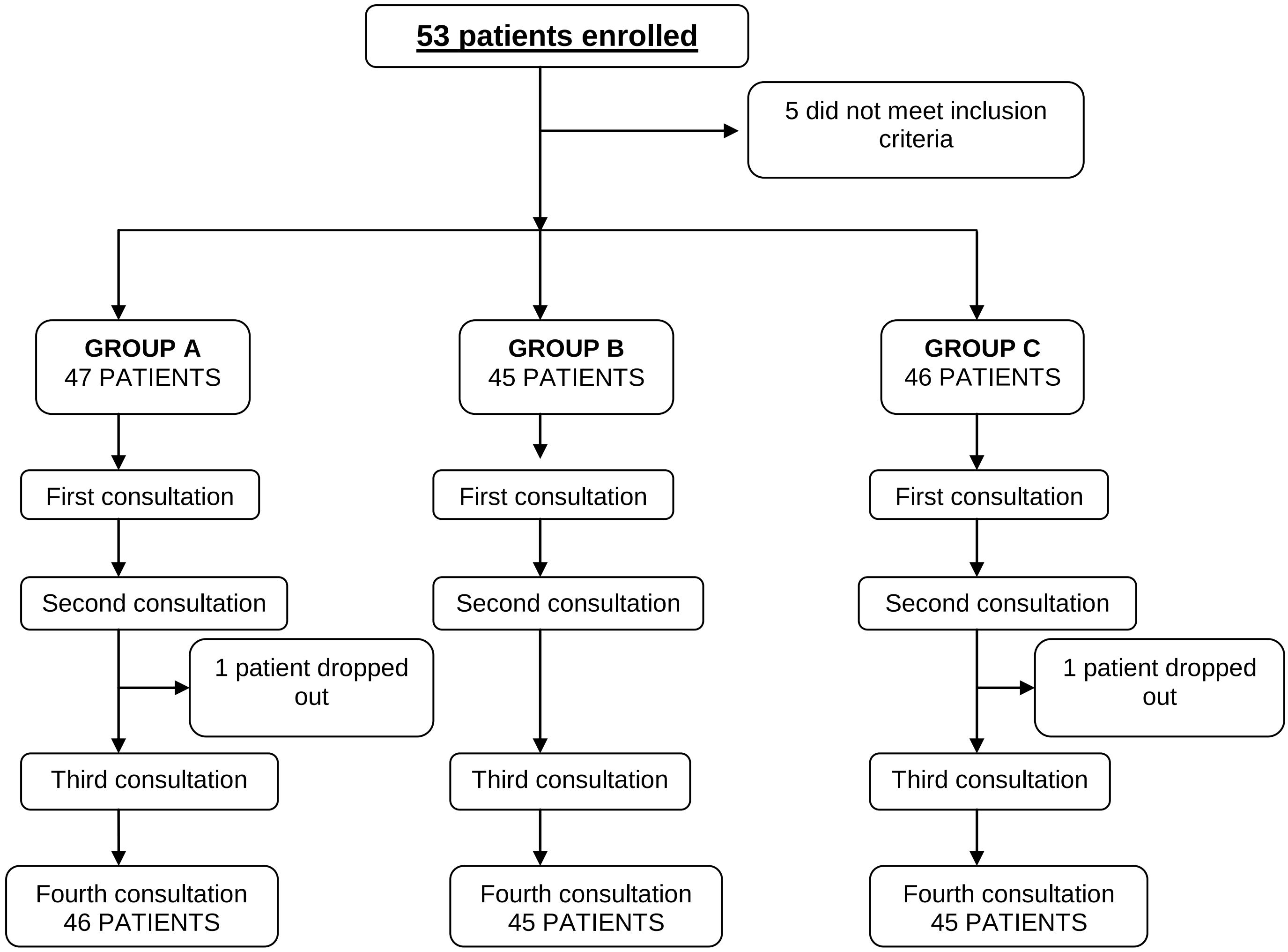


Figure 4.1: Flow diagram depicting the drop out of patients

4.4.5 Discussion

This study was unable to verify the results of Wong and Deyo's (2001) study that LBP is more prevalent in women than in men. Although the mean age throughout the groups was 28.13 and none of the female patients were pregnant at the time. Therefore this decreases the aetiology of LBP in women in this study (Praemer, Furnes and Rice, 1992).

However this study could concur with Praemer *et al.,* (1992) that white patients suffer predominately with LBP.

4.5. <u>Results as related to objectives</u>

4.5.1. Objective One

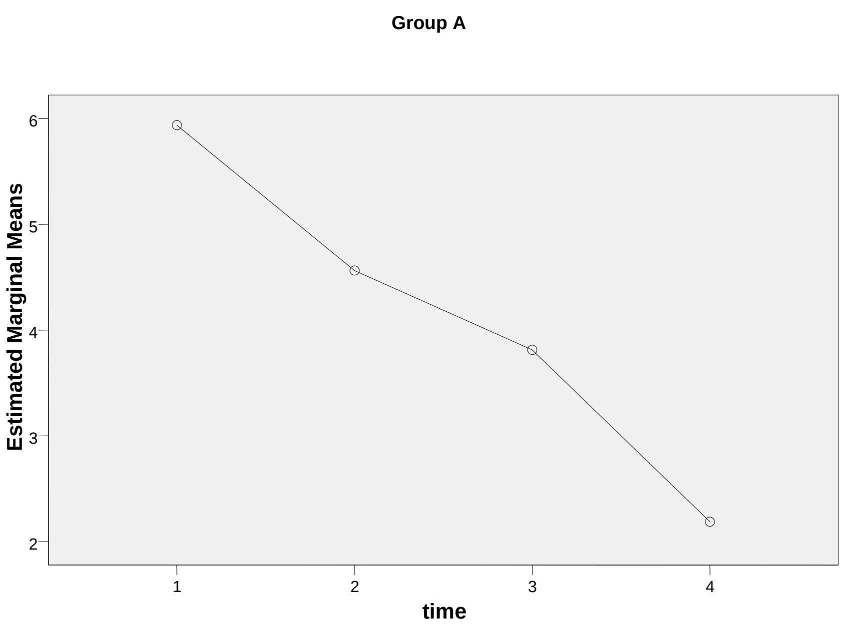
To determine the effectiveness of the Groovi-SI-Belt® and a spinal stability programme on patients who are known to have a decreased force closure in terms of objective and subjective findings.

4.5.1.1. Numerical pain rating scale- subjective outcome

There was a highly significant decrease over time in Group A for pain.

Table 4.3: Effect of time on NRS in Group A

Effect	Statistic	*p* value
Time	Wilk's lambda =0.044	<0.001



<u>Figure 4.2: Mean NRS over time in Group A</u>

4.5.1.1.1. Discussion

This study supports the theory by O'Sullivan and Beales (2007) that by increasing force closure manually or through strengthening the spinal stability muscles, patients experience less pain.

Liebenson (2004) stresses the importance of sensation in the low back. So improvement may have been due to the sensory input of the Groovi-SI-Belt®. Due to the large width of the belt compared to the standard SI belt, it nullifies a larger proportion of nociceptors as depicted on Figure 4.23. This encompasses the gate control theory proposed by Melzack and Wall (1965) that by stimulating large afferent fibres this may cause inhibition of the small nociceptive fibres by activating the inhibitory interneurones in the substantia gelatinosa of the spinal cord.

Pain is not a diagnosis it is a symptom (Boon, Colledge, Walker and Hunter, 2006). This intensity can only be verified by patients. So this sudden decrease in pain may have been a result of the Hawthorn effect. The Hawthorn effect is clearly an example of social desirability, patient answers examiners questions to make themselves appear well adjusted even though the patients answers may not be totally true (Mouton, 1996).

4.5.1.2. Quebec disability scale- subjective outcome

There was a highly significant decrease over time in Group A for functional daily disability.

Table 4.4: Effect of time on QDS in Group A

Effect	Statistic	*p* value
Time	Wilk's lambda =0.225	<0.001

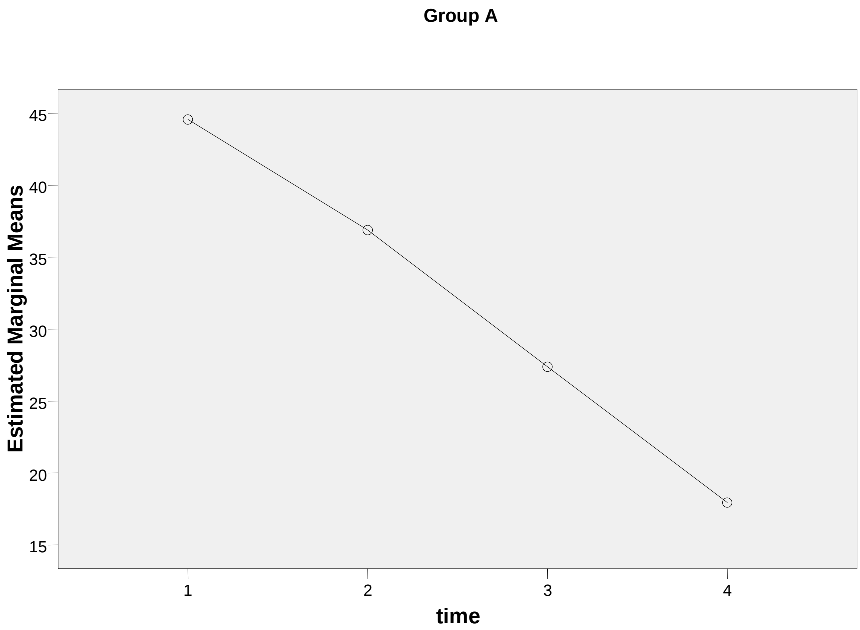


Figure 4.3: Mean QDS over time in Group A

4.5.1.2.1. Discussion

These findings correlate with previous studies, that strengthening spinal stability muscles or increasing stability decreases pain during functional daily tasks (Jull and Richardson, 2000; Chok, lee, Latimer and Tan, 1999 and Mens, Damen, Snijders and Stam, 2005).

However the Hawthorne effect cannot be eliminated due to the subjective nature of the assessment (Boon *et al.,* 2006).

4.5.1.3 ASLR- subjective outcome

4.5.1.3.1. Without compression

There was a highly significant decrease in values over time in Group A for ASLR values without compression (p<0.001).

Table 4.5: Friedman test to compare median ASLR value without Compression over time in Group A

Effect	Statistic	*p* value
Time	Friedman Chi square=40.624	<0.001

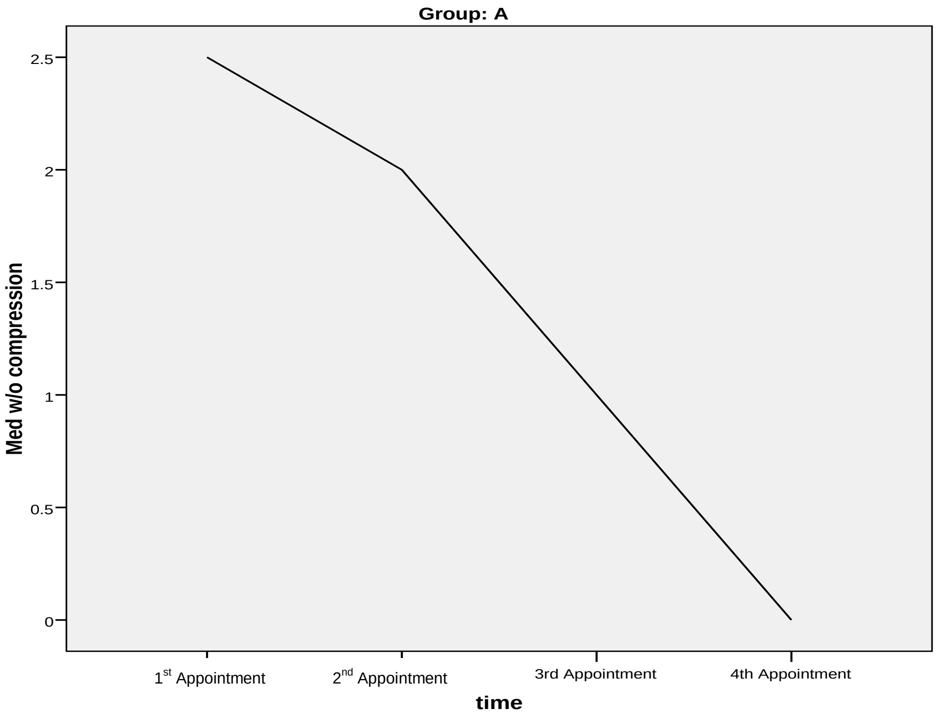


Figure 4.4: Median ASLR without compression over time in Group A

4.5.1.3.2. With compression

There was no significant change over time in this group for ASLR values with compression.

Table 4.6: Friedman test to compare median ASLR value with compression over time in Group A

Effect	Statistic	*p* value

Time	Friedman Chi square=2.259	0.520

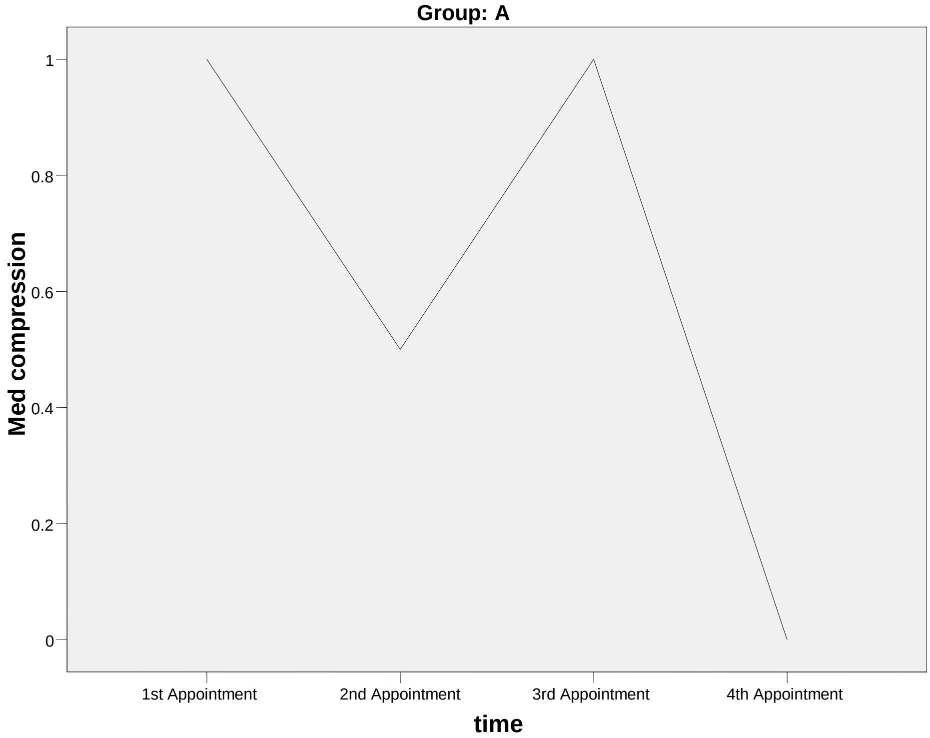


Figure 4.5: Median ASLR with compression over time in Group A

4.5.1.3.3 Discussion

This study correlates with the results of Beales, O'Sullivan and Briffa's (2009) research showing patients with decreased force closure found it easier to raise their leg when manual compression was applied to their pelvis. Furthermore, this study supports Jull and Richardson (2000) that strengthening of the spinal stability muscle over time is important in restoring normal synergistic motion (Figure 4.4).

The Groovi-SI-Belt® supported Heller's (2006) concept that the use of an SI belt in a spinal stability programme may be favourable as it reinforces and retrains the needed motion over time (Figure 4.4).

The results from this study contradicts O'Sullivan and Beales (2007) findings, that strengthening of the spinal stability muscles and increasing the force closure usually produces a negative ASLR and when manual compression is applied the ASLR is more difficult. However, there is lack of consensus on how long a spinal stability programme should be implemented until desired benefits are attained. Due to time constraints and literature suggesting benefits could be attained within four weeks (Chok *et al.,* 1999) this short time-line was implemented for this research. While Jull and Richardson (2000) believe benefits will be noticed at 10 weeks and Airaksinen *et al.,* (2004) suggested 3-6 months. Therefore a longer treatment intervention may have produced different results.

Due to the unique nature of the graph in Figure 4.5 questions need to be asked about the flexibility and rigidity of the Groovi-SI-Belt®.

Lastly, the Hawthorne effect cannot be eliminated due to the subjective nature of the assessment (Boon *et al.,* 2006).

4.5.1.4. Biofeedback device- objective outcome

4.5.1.4.1. Time prone (seconds)

There was a highly significant change in time prone over time in Group A ($p <$ 0.001)

Table 4.7: Effect of time on Time prone in Group A

Effect	Statistic	p value
Time	Wilk's lambda =0.263	<0.001

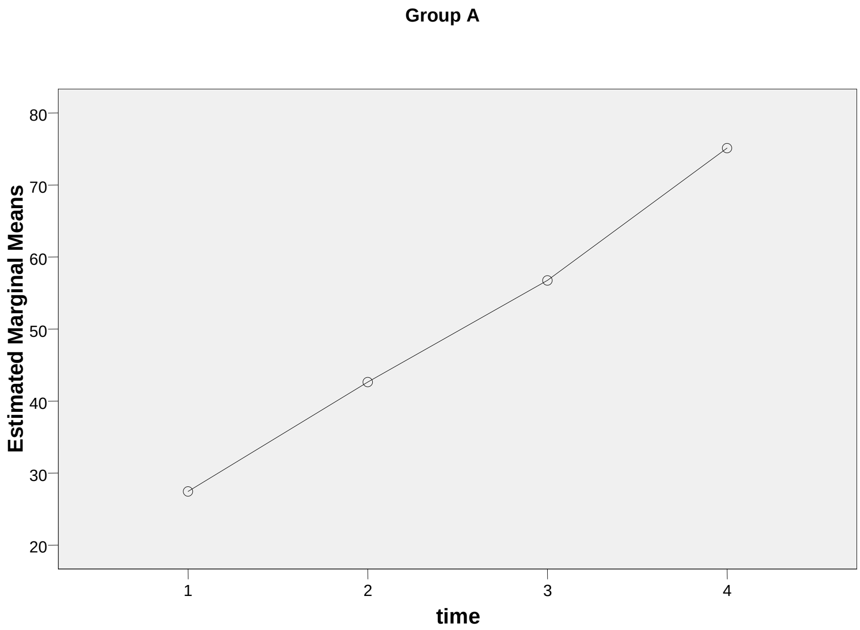


Figure 4.6: Mean time prone over time in Group A

4.5.1.4.2. Time supine (seconds)

There was a significant change in time supine over time in Group A (*p*= 0.015).

Table 4.8: Effect of time on Time supine in Group A

Effect	Statistic	*p* value
Time	Wilk's lambda =0.459	0.015

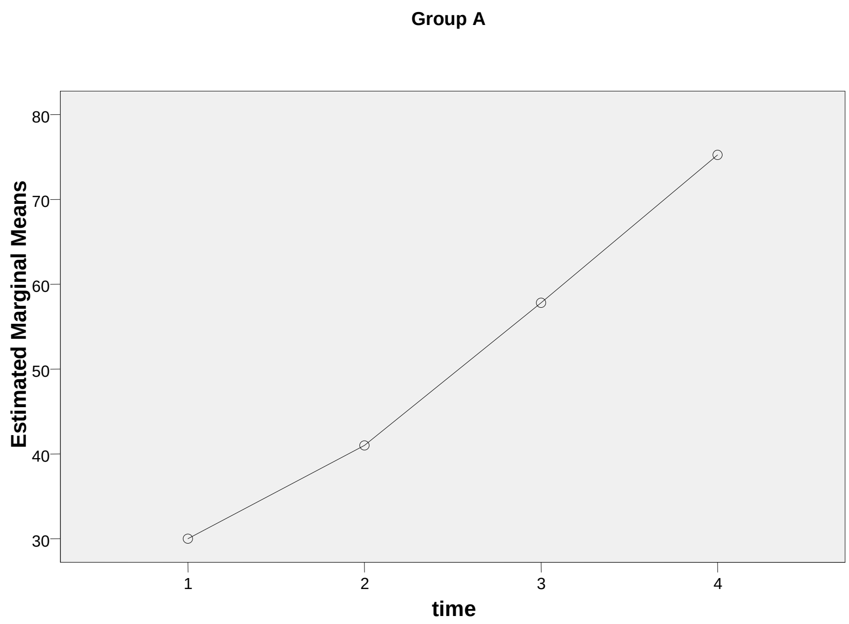


Figure 4.7: Mean time supine over time in Group A

4.5.1.4.3. Discussion

The results from the study compare favourably with the findings from Cairns, Harrison and White (2000) that strengthening of the transverse abdominus and multifidus enables the patient to progressively hold the draw-in contraction for longer (Figure 4.6 and Figure 4.7).

4.5.1.5. Static trunk extensor endurance- objective outcome

There was a highly significant increase in this outcome over time in Group A.

Table 4.9: Effect of time on static trunk extensor endurance in Group A

Effect	Statistic	*p* value
Time	Wilk's lambda =0.177	<0.001

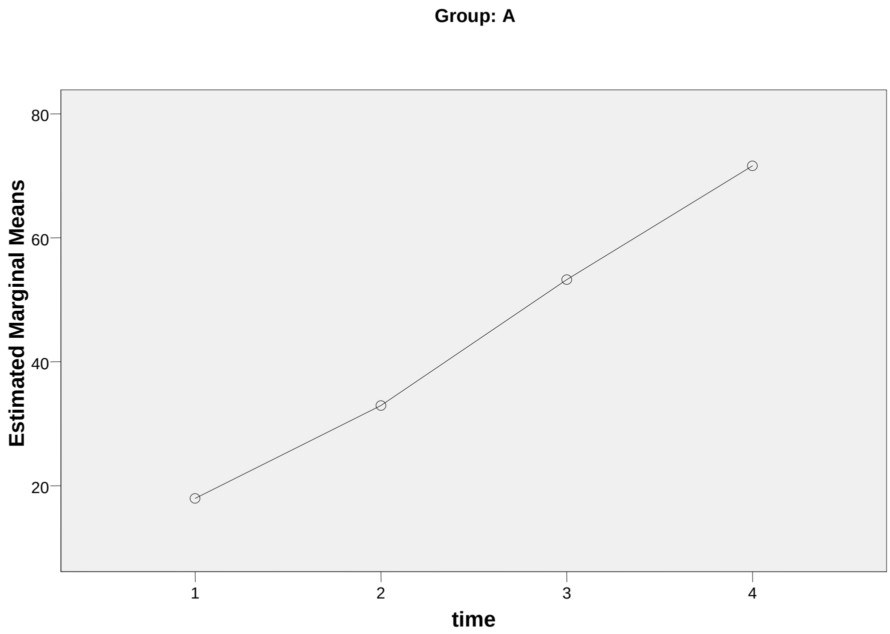


Figure 4.8: Mean static trunk extensor endurance over time in Group A

4.5.1.5.1 Discussion

The results from this study agree with the findings conducted by Chok *et al.,* (1999) that the endurance capabilities of muscles improved when a spinal stability programme was implemented (Figure 4.8).

4.5.2. Objective Two

To determine the effectiveness of the standard SI belt and a spinal stability programme on patients who are known to have a decreased force closure in terms of subjective and objective findings.

4.5.2.1. Numerical pain rating scale- subjective outcome

There was a significant decrease over time in Group B for pain.

Table 4.10: Effect of time on NRS in Group B

Effect	Statistic	*p* value
Time	Wilk's lambda =0.284	0.001

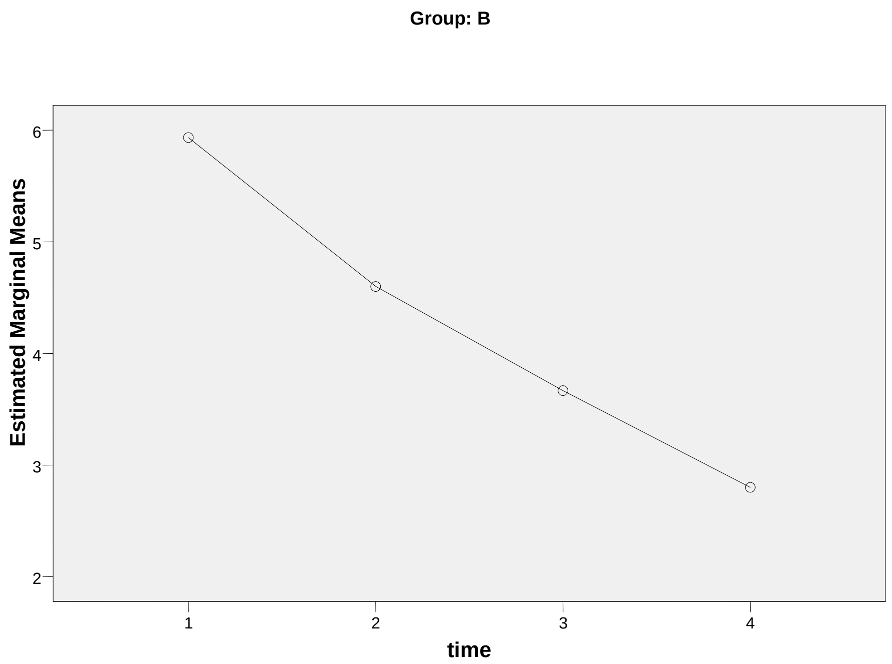


Figure 4.9: Mean NRS over time in Group B

4.5.2.1.1. Discussion

This study supports the theory by O'Sullivan and Beales (2007), that increasing force closure manually or through strengthening the spinal stability muscles, patients experience less pain.

Liebenson (2004) stresses the importance of sensation in the low back. So improvement may have been due to the sensory input (gate control theory) of the SI belt (Melzack and Wall, 1965).

However the Hawthorne effect cannot be eliminated due to the subjective nature of the assessment (Boon *et al.,* 2006).

4.5.2.2. Quebec disability scale- subjective outcome

There was a significant decrease over time in Group B for daily functional disability.

Table 4.11: Effect of time on QDS in Group B

Effect	Statistic	*p* value
Time	Wilk's lambda =0.298	0.002

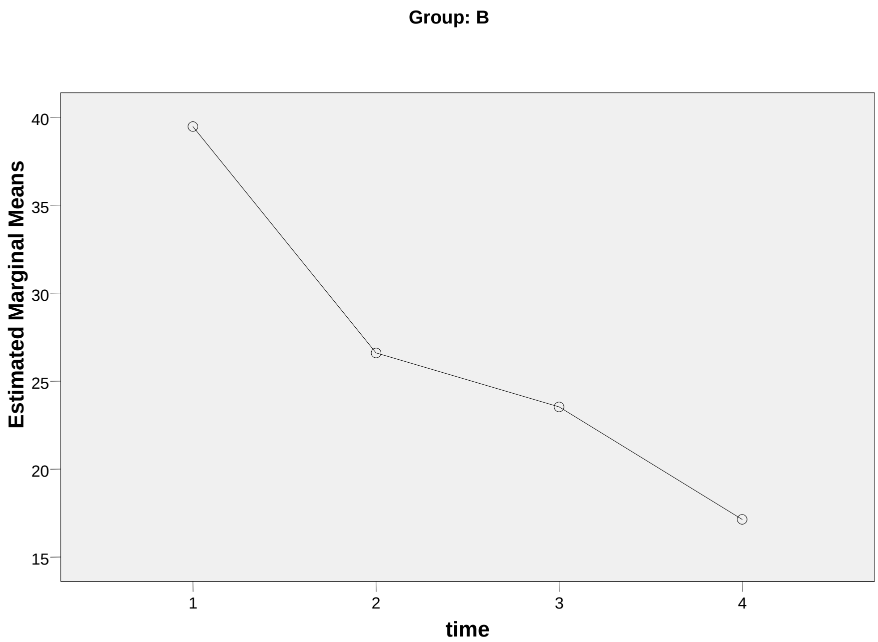


Figure 4.10: Mean QDS over time in Group B

4.5.2.2.1 Discussion

These findings correlate with previous studies, strengthening spinal stability muscles or increasing stability decreases pain during functional tasks (Jull and Richardson, 2000; Chok, lee, Latimer and Tan, 1999 and Mens, Damen, Snijders and Stam, 2005). However, the Hawthorne effect cannot be eliminated due to the subjective nature of the assessment (Boon *et al.,* 2006).

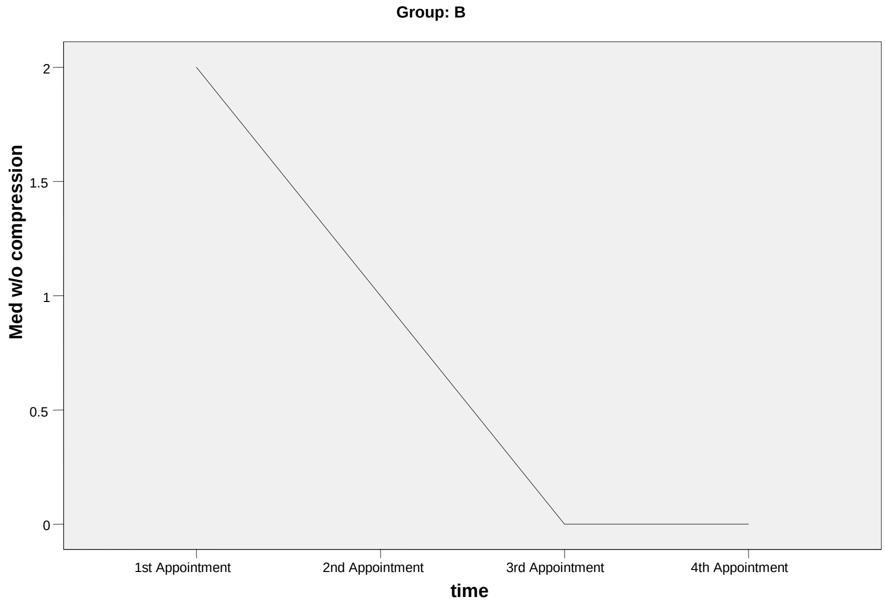
4.5.2.3. ASLR- subjective outcome

4.5.2.3.1. Without compression

There was a highly significant decrease in values over time in this group for ASLR values without compression (*p*<0.001).

Table 4.12: Friedman test to compare median ASLR value without compression over time in Group B

Effect	Statistic	*p* value
Time	Friedman Chi square=40.5	<0.001



<u>Figure 4.11: Median ASLR without compression over time in Group B</u>

4.5.2.3.2. With compression

There was no significant change over time in this group for ASLR values with compression (*p*=0.934).

Table 4.13: Friedman test to compare median ASLR value with compression over time in Group B

Effect	Statistic	*p* value
Time	Friedman Chi square=0.429	0.934

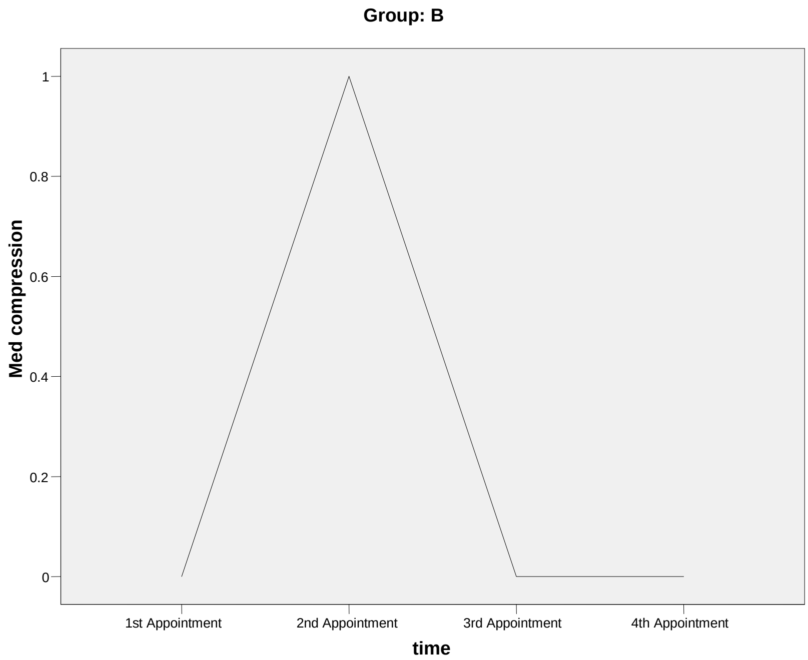


Figure 4.12: Median ASLR with compression over time in Group B

4.5.2.3.3. Discussion

This study correlates with the results of Beales, O'Sullivan and Briffa's (2009) research which highlighted that patients with decreased force closure found it easier to lift their leg when manual compression was applied to their pelvis. Furthermore, this study supports Jull and Richardson (2000) that strengthening of the spinal stability muscle over time is important in restoring normal synergistic motion (Figure 4.11).

This study supported Heller's (2006) concept that the use of an SI belt in a spinal stability programme may be favourable as it reinforces and retrains the needed motion over time (Figure 4.11).

The results from this study contradicts O'Sullivan and Beales (2007) findings, that strengthening the spinal stability muscles and increasing the force closure usually produces a negative ASLR and when manual compression is applied the ASLR is more difficult. However there is lack of consensus on how long a spinal stability programme should be implemented until desired benefits are attained. Due to time constraints and literature suggesting benefits could be attained within four weeks (Chok *et al.,* 1999) this short time-line was implemented for this research. While Jull and Richardson (2000) believe benefits will be noticed at 10 weeks and Airaksinen *et al.,* (2004) suggested 3-6 months. Therefore a longer treatment intervention may have produced different results.

Initially the graph (Figure 4.12) concurs with the findings of O'Sullivan and Beales (2007) that excessive force closure produces a provocative ASLR, but with time the graph deviates. Hence questions need to be asked about the flexibility and rigidity of the standard SI Belt.

Lastly the Hawthorne effect cannot be eliminated due to the subjective nature of the assessment (Boon *et al.,* 2006).

4.5.2.4. Biofeedback device- objective outcome

4.5.2.4.1 Time prone (seconds)

There was a non significant change in time prone over time in Group B (p=0.063).

Table 4.14: Effect of time on Time prone in Group B

Effect	Statistic	*p* value
Time	Wilk's lambda =0.556	0.063

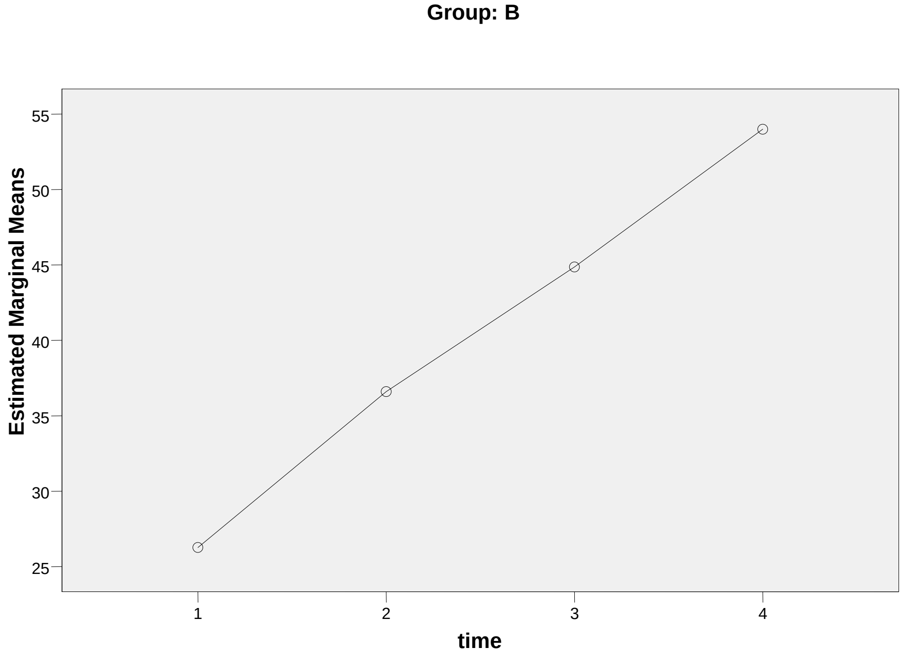


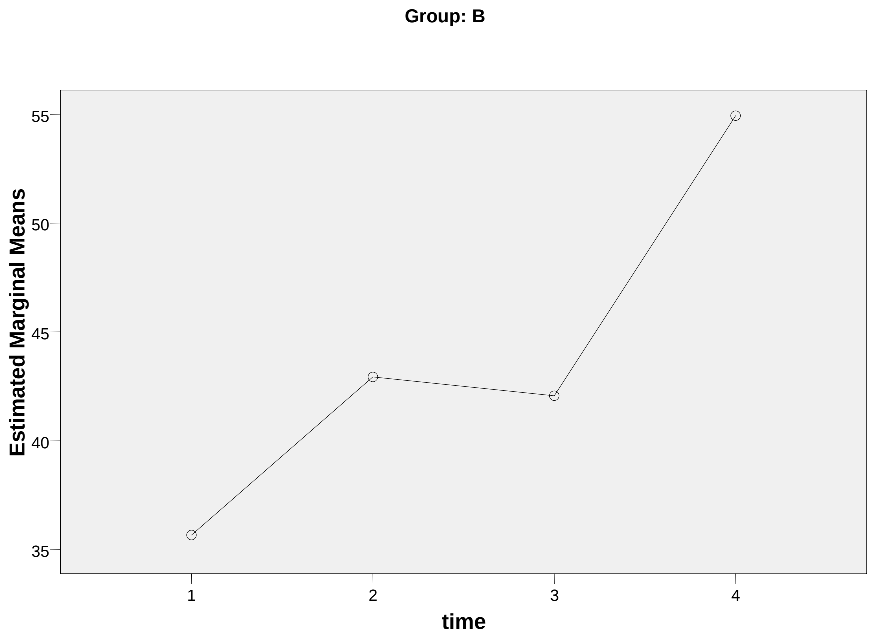
Figure 4.13: Mean time prone over time in Group B

4.5.2.4.2. Time supine (seconds)

There was a non significant change in time supine over time in Group B (*p*=0.079).

Table 4.15: Effect of time on Time supine in Group B

Effect	Statistic	*p* value
Time	Wilk's lambda =0.580	0.079



<u>Figure 4.14: Mean time supine over time in group B</u>

4.5.2.4.3. Discussion

This research displays a slight correlation (Figure 4.13 and Figure 4.14) with previous literature suggesting that strengthening the transverse abdominus and multifidus allows the patients to progressively hold the draw-in contraction for longer (Cairns *et al.,* 2000).

The initial co-contraction in a spinal stability programme is so important, if progression occurs to more challenging exercises before mastering these fundamentals, patients negate the benefits of performing these exercises (Hallam, 2004). Therefore, insisting patients demonstrate the fundamentals of a spinal stability programme, which are usually taken for granted, may have produced different results. Furthermore, patient compliance cannot be taken for granted and they may have abstained from performing their exercises at home.

Chronic back pain suffers experience pain cycles, with their pain fluctuating over a six week period (Morris, 2006). This fact was not considered when this research was undertaken. So allowances in this regard need to be taken into consideration as this may produce pain inhibition and undesirable results.

4.5.2.5. Static trunk extensor endurance- objective outcome

There was a significant increase in this outcome over time in Group B.

Table 4.16: Effect of time on static trunk extensor endurance in Group B

Effect	Statistic	*p* value
Time	Wilk's lambda =0.265	0.001

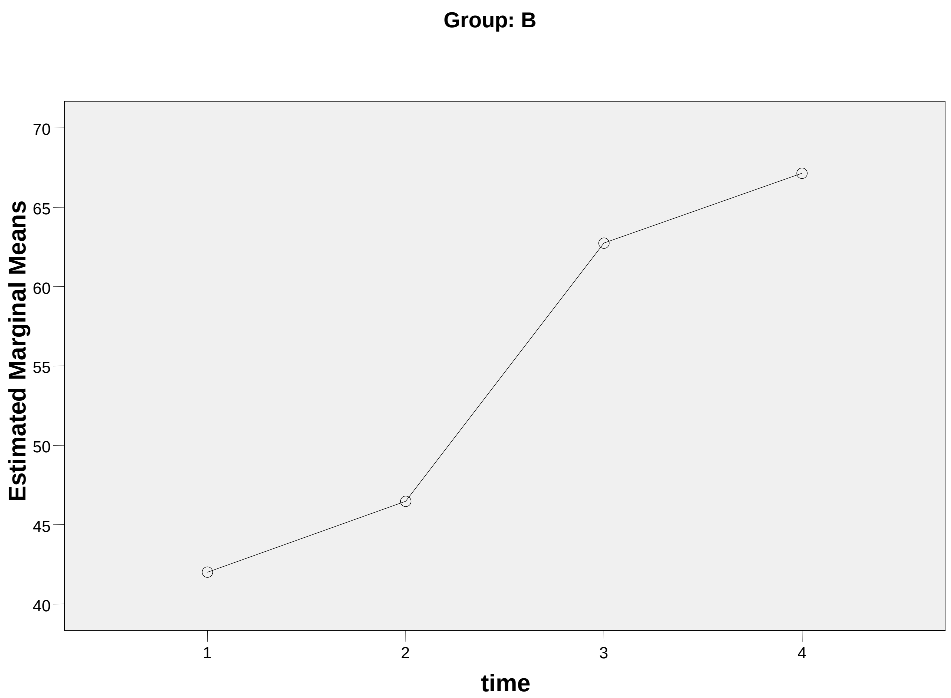


Figure 4.15: Mean static trunk extensor endurance over time in group B

4.5.2.5.1 Discussion

This study agrees with the research conducted by Chok *et al.,* (1999) that the endurance capabilities of muscles improved when a spinal stability programme was implemented (Figure 4.15).

4.5.3. Objective Three

To determine the effectiveness of a spinal stability programme on patients who are known to have a decreased force closure in terms of objective and subjective findings.

4.5.3.1. Numerical pain rating scale- subjective outcome

There was no significant decrease over time in Group C for pain.

Table 4.17: Effect of time on NRS in Group C

Effect	Statistic	*p* value
Time	Wilk's lambda =0.653	0.151

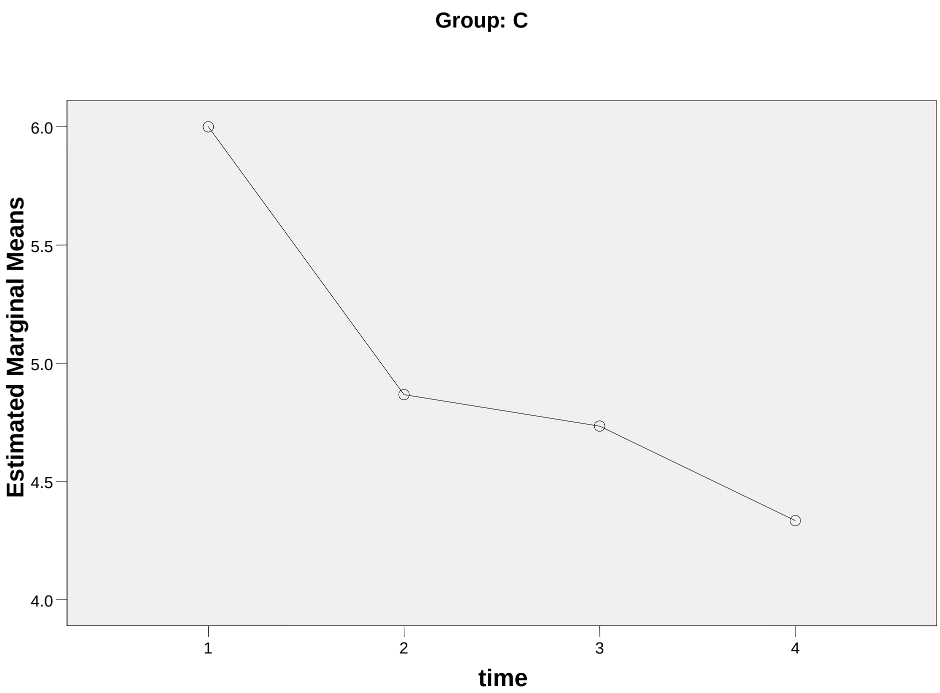


Figure 4.16: Mean NRS over time in Group C

4.5.3.1.1. Discussion

This research cannot validate the results from Lederman (2008) and Chok *et al.,* (1999) study that strengthening spinal stability muscles can reduce LBP.

The initial co-contraction in a spinal stability programme is so important, if progression occurs to more challenging exercises before mastering these fundamentals, patients negate the benefits of performing these exercises (Hallam, 2004). Therefore insisting patients demonstrate the fundamentals of a spinal stability programme, which were taken for granted, may have produced different results. Furthermore patient compliance cannot be taken for granted and they may have abstained from performing their exercises at home.

However the Hawthorne effect cannot be eliminated due to the subjective nature of the assessment (Boon *et al.,* 2006).

4.5.3.2. Quebec disability scale- subjective outcome

There was a significant decrease over time in Group C for disability.

Table 4.18: Effect of time on QDS in Group C

Effect	Statistic	*p* value
Time	Wilk's lambda =0.293	0.002

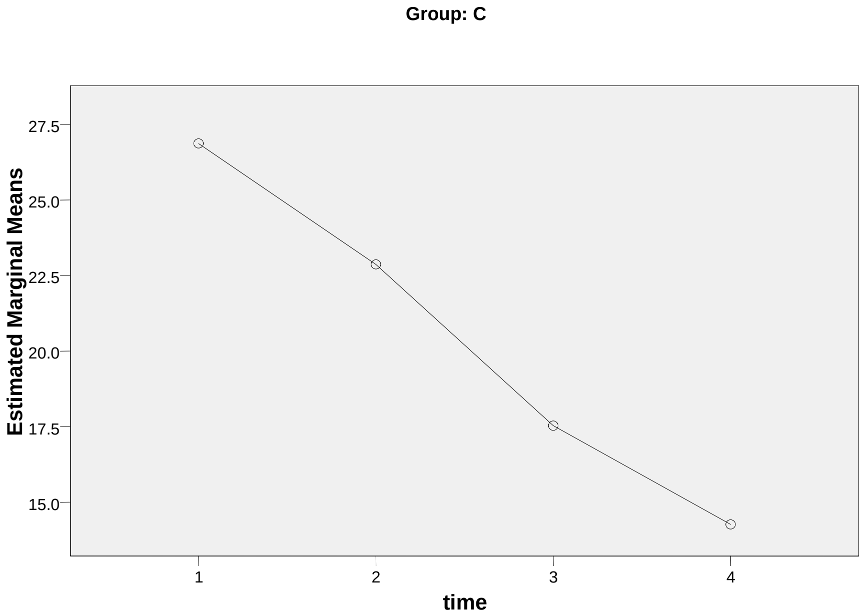


Figure 4.17: Mean QDS over time in Group C

4.5.3.2.1. Discussion

This study correlates with the results of Chok *et al.,* (1999) research that the endurance capabilities of muscles improved when a spinal stability programme was implemented (Figure 4.17).

This group has shown to have a high pain tolerance during activities, as all three groups have similar NRS starting points but Group C's starting point for QDS was much lower than the other two groups.

4.5.3.3. ASLR- subjective outcome

4.5.3.3.1. Without compression

There was a highly significant decrease in values over time in this group for ASLR values without compression (p<0.001).

Table 4.19: Friedman test to compare median ASLR value without compression over time in Group C

Effect	Statistic	*p* value
Time	Friedman Chi square=32.105	<0.001

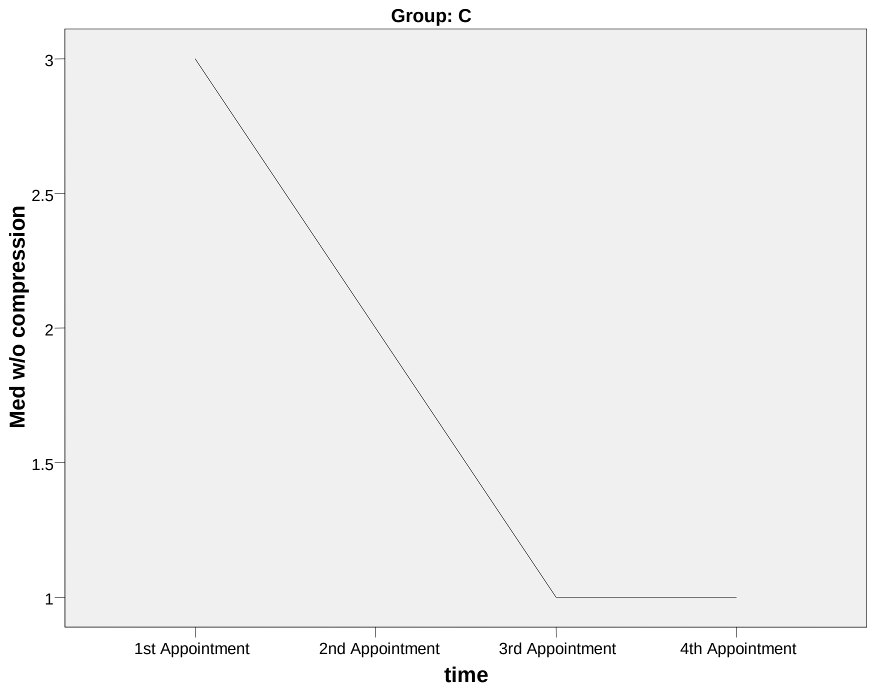


Figure 4.18: Median ASLR without compression over time in Group C

4.5.3.3.2. With compression

There was no significant change over time in this group for ASLR values with compression (p=0.808).

Table 4.20: Friedman test to compare median ASLR value with compression over time in Group C

Effect	Statistic	*p* value
Time	Friedman Chi square=0.974	0.808

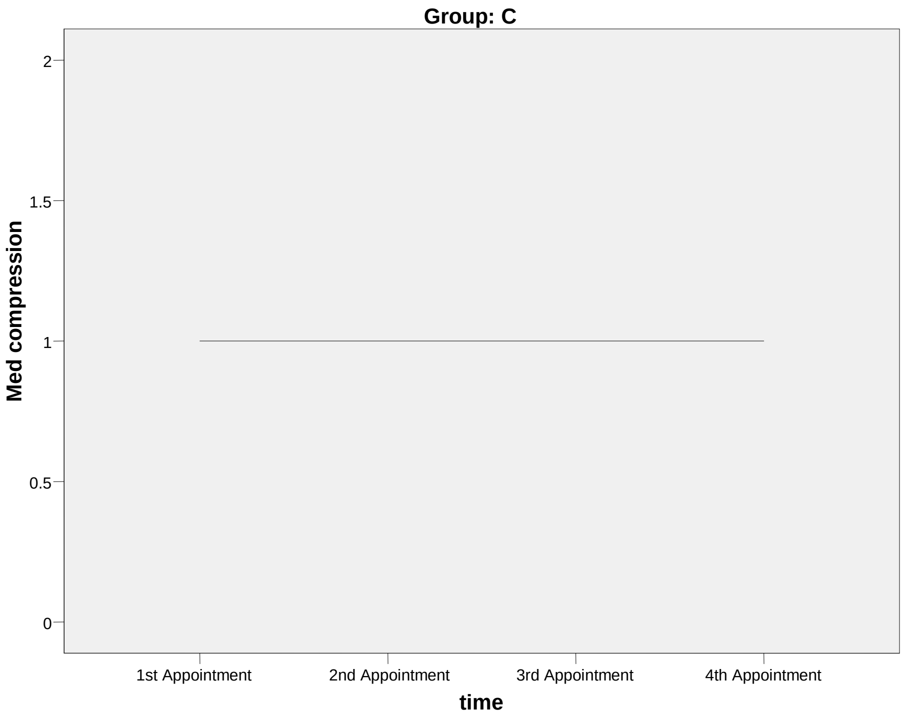


Figure 4.19: Median ASLR with compression over time in group C

4.5.3.3.3. Discussion

This study correlates with Beale, O'Sullivan and Briffa's (2009) results showing that patients with decreased force closure found it easier to lift their leg when manual compression was applied to their pelvis. Furthermore, this study supports Jull and Richardson (2000) that strengthening of the spinal stability muscle over time is important in restoring normal synergistic motion, (Figure 4.18).

The results from the study contradicts O'Sullivan and Beales (2007) findings, that strengthening the spinal stability muscles and increasing the force closure usually produces a negative ASLR and when manual compression is applied the ASLR is more difficult. However there is lack of consensus on how long a spinal stability programme should be implemented until desired benefits are attained. Due to time constraints and literature suggesting benefits could be attained within four weeks (Chok *et al.,* 1999) this short time-line was implemented for this research. While Jull and Richardson (2000) believe benefits will be noticed at 10 weeks and

Airaksinen *et al.,* (2004) suggested 3-6 months. Therefore a longer treatment intervention may have produced different results.

The flat line associated with Figure 4.19 may be due to the athletic nature of the group and their high pain tolerance during activities.

Lastly the Hawthorne effect cannot be eliminated due to the subjective nature of the assessment (Boon *et al.,* 2006).

4.5.3.4. Biofeedback device- objective outcome

4.5.3.4.1. Time prone (seconds)

There was a significant change in time prone over time in Group C (p=0.014).

Table 4.21: Effect of time on Time prone in Group C

Effect	Statistic	*p* value
Time	Wilk's lambda =0.427	0.014

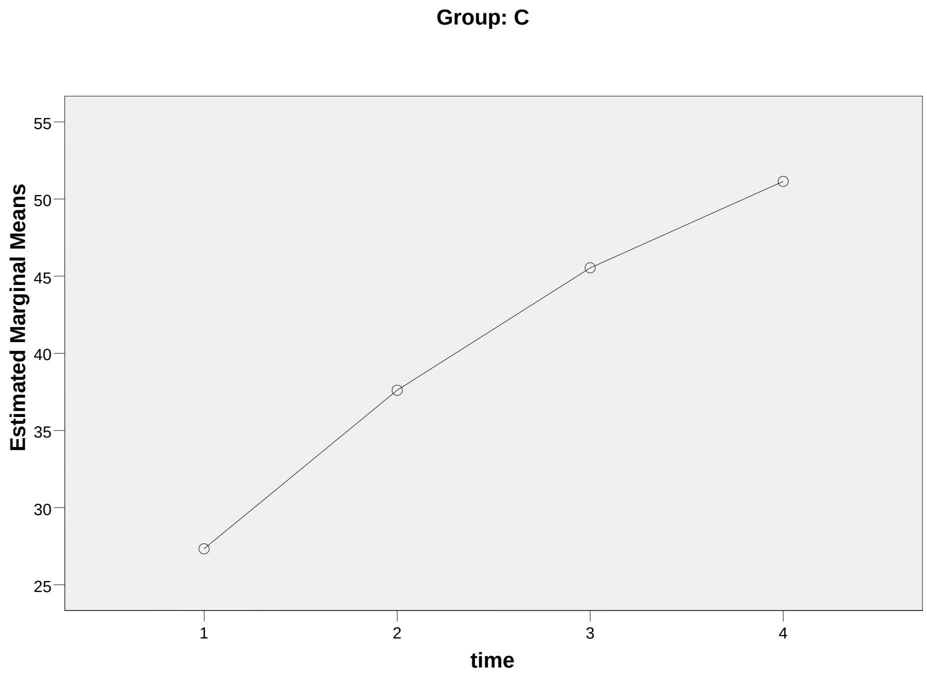


Figure 4.20: Mean time prone over time in Group C

4.5.3.4.2. Time supine (seconds)

There was a significant change in time supine over time in Group C (*p*=0.015).

Table 4.22: Effect of time on Time supine in Group C

Effect	Statistic	*p* value
Time	Wilk's lambda =0.429	0.015

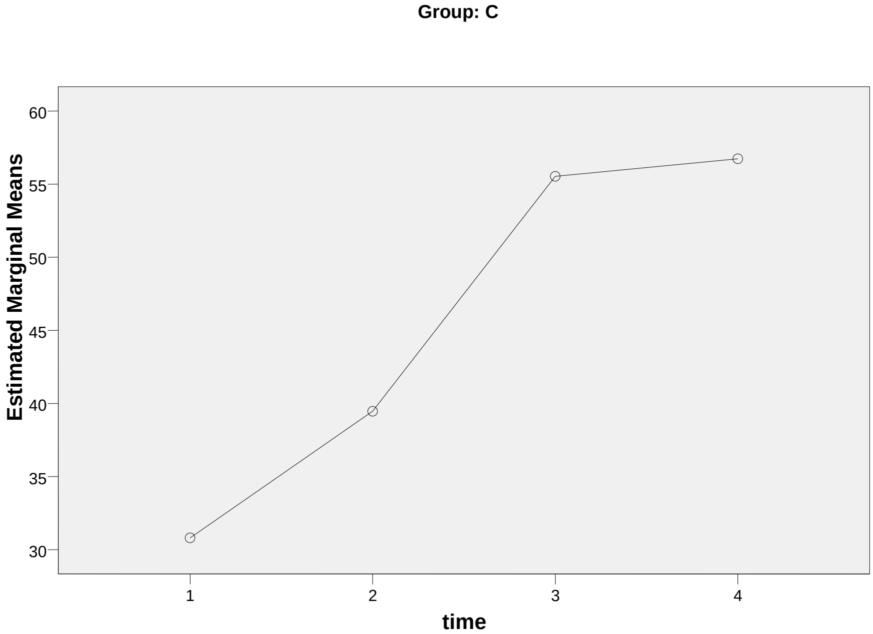


Figure 4.21: Mean time supine over time in Group C

4.5.3.4.3. Discussion

The results indicated in Figures 4.20 and Figure 4.21 correlate with Cairns *et al.,* (2000) study that strengthening of the transverse abdominus and multifidus enables the patient to progressively hold the draw-in contraction for longer.

Depicted in the other assessments of this group, pain inhibition is not very prominent, which could have also produced similar findings.

Lastly, the competitive nature of athletes always trying to better themselves cannot be eliminated.

4.5.3.5. Static trunk extensor endurance

There was a significant increase in this outcome over time in Group C.

Table 4.23: Effect of time on Static Trunk Extensor Endurance in Group C

Effect	Statistic	*p* value
Time	Wilk's lambda =0.431	0.015

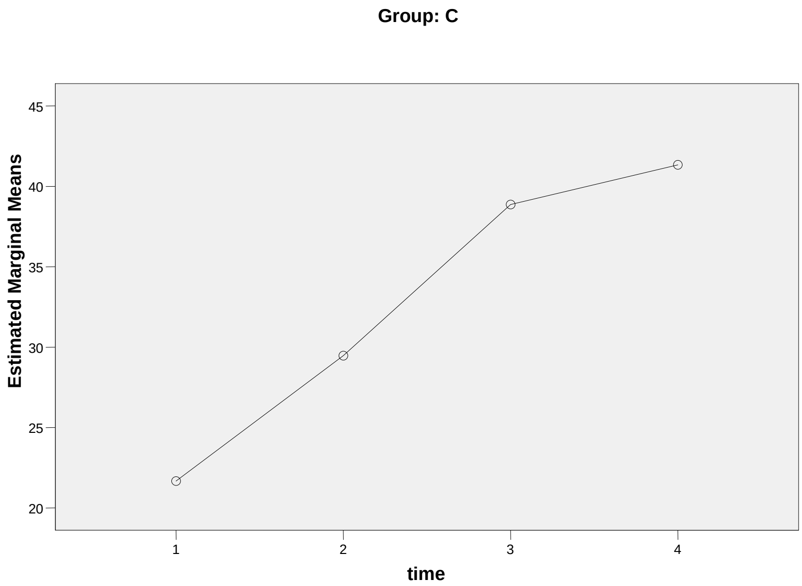


Figure 4.22: Mean static trunk extensor endurance over time in Group C

4.5.3.5.1. Discussion

This study agrees with the findings of Chok *et al.,* (1999) research that the endurance capabilities of muscles improved when a spinal stability programme was implemented (Figure 4.22).

However, the competitive nature of athletes cannot be ruled out and the high pain tolerance during activities cannot be ruled out.

4.5.4. Objective Four

To compare the relative effectiveness of the three treatment interventions against one another in order to verify or disprove the Groovi-SI-Belt® manufacturer's claims to the product.

4.5.4.1. Numerical pain rating scale- subjective outcome

There was a marginally non significant treatment effect for NRS (*p*=0.057), although all groups experienced a significant decrease in pain over time (*p*<0.001). Figure 4.23 shows that there was a trend towards Group A showing a faster decrease than the other two groups, but this difference was not quite statistically significant.

Table 4.24: Within and Between subjects effects for NRS

Effect	Statistic	*p* value
Time	Wilk's lambda =0.303	<0.001
Time*group	Wilk's lambda =0.748	0.057
Group	F=1.906	0.161

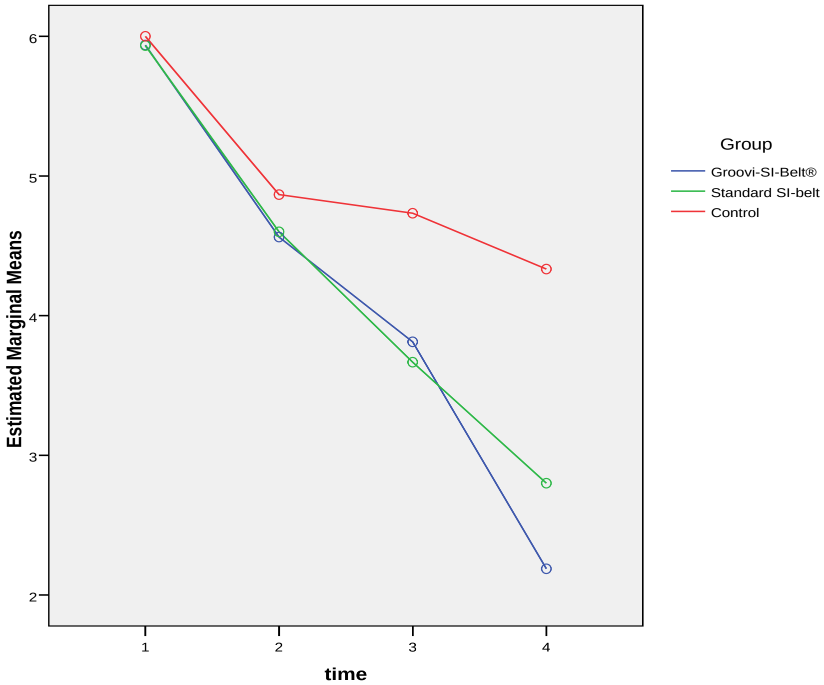


Figure 4.23: Mean NRS by treatment group and time

4.5.4.1.1. Discussion

Figure 4.23 shows how significant Group A and B were compared to Group C. This shows the importance of brace aided pelvic stabilization (SI belt) for chronic low back pain patients as a successful treatment intervention.

Therefore, Bell's (2008) claim that a SI belt acts as an adjunct to the restoration of force closure stands true. However, patients wearing the Groovi-SI-Belt® had a slightly higher improvement rate than the standard SI belt. This may have been due to size difference. With the width of the Groovi-SI-Belt® being superior thus stimulating more afferent fibres and nullifying the nociceptors or it may have been due to the fact the compression could by adjusted by the use of the power straps.

4.5.4.2. Quebec disability scale- subjective outcome

There was a marginally non significant treatment effect for QDS (p=0.061), although all groups experienced significant decrease in disability over time (p<0.001). Figure 4.24 shows that there was a trend towards group A showing a faster rate of decrease than the other two groups but this difference was not quite statistically significant.

Table 4.25: Within and Between subjects effects for QDS

Effect	Statistic	*p* value
Time	Wilk's lambda =0.355	<0.001
Time*group	Wilk's lambda =0.750	0.061
Group	F=1.707	0.193

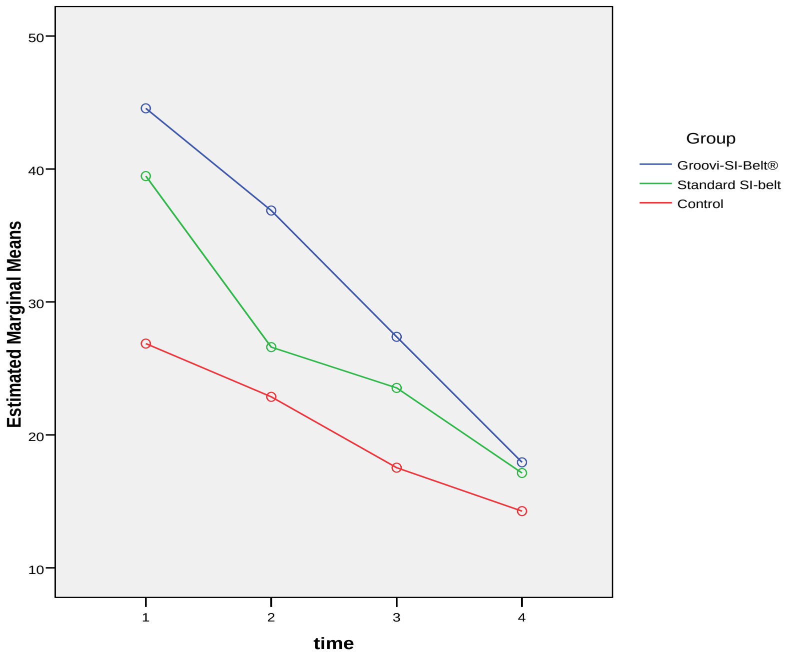


Figure 4.24: Mean QDS by treatment group and time

4.5.4.2.1. Discussion

Figure 4.24 shows that patients from all three groups improved significantly. Therefore, a spinal stability programme along with brace aided pelvic stabilization (SI belt) would be an excellent treatment intervention.

However, this research did show that Group C had a greater pain tolerance. This made it difficult to draw a conclusion from the control group. Further questions therefore need to be investigated on how important a spinal stability programme alone is in comparison to a spinal stability programme combined with the use of an SI belt.

Though there is evidence to show that the combined treatment intervention with the use of the Groovi-SI-Belt® is more beneficial that the standard SI belt (Figure 4.24). This further strengthens Bell's (2008) argument that by adjusting the compression of an SI belt in accordance to the weakened force closure may be more beneficial in alleviating the patients' symptoms.

4.5.4.3. ASLR- subjective outcome

There was no significant difference between the treatment groups with regard to change in ASLR variables over time.

Table 4.26: Comparison of mean change in ASLR between baseline and visit 4 between the treatment groups.

Group		Change in ASLR without compression	Change in ASLR with compression
Groovi-SI-Belt®	Mean	-2.1250	-.1875
	N	16	16
	Std. Deviation	.88506	1.32759
Standard SI belt	Mean	-1.8667	.0000
	N	15	15
	Std. Deviation	.74322	.75593
Control	Mean	-1.7333	.0000
	N	15	15
	Std. Deviation	1.03280	.84515
Total	Mean	-1.9130	-.0652
	N	46	46
	Std. Deviation	.89010	.99782
P value		0.468	0.838

4.5.4.3.1. Discussion

All three treatment interventions showed that without compression normal synergistic motion returned. Group B and Group C had a faster rate of improvement than Group A. The only plausible explanation could be that patients in group A relied more on the Groovi-SI-Belt® and put less emphasize on the spinal stability programme. This could have been due to the patients' perception of the Groovi-SI-Belt®.

Table 4.26 shows that all three groups were non significant when compression was applied. They contradicted O'Sullivan and Beales (2007) results, that strengthening the spinal stability muscles and increasing the force closure usually produces a negative ASLR and when manual compression is applied the ASLR is more difficult. However, there is lack of consensus on how long a spinal stability programme should be implemented until desired benefits are attained. Due to time constraints and literature suggesting benefits could be attained within four weeks (Chok *et al.,* 1999) this short time-line was implemented for this research. While Jull and Richardson (2000) believe benefits will be noticed at 10 weeks and Airaksinen *et al.,* (2004) suggested 3-6 months. Therefore a longer treatment intervention may have produced different results.

Due to the graphs produced in Figure 4.5 and Figure 4.12 questions about both belts flexibility, rigidity and durability need to be investigated. Due to the fact both graphs produced were haphazard in terms with the findings of O'Sullivan and Beales (2007) research.

No conclusions can be drawn from Group C due to the nature of the graph (flat line).

4.5.4.4. Biofeedback device- objective outcome

4.5.4.4.1. Time prone (seconds)

There was no evidence of a differential treatment effect for this outcome (p=0.443) although all three groups experienced a significant change in seconds over time. Figure 4.25 shows that the time increased for all groups at a similar rate but there was a slight trend towards a faster rate of increase in Group A compared with the other two groups. However, this difference was not statistically significant.

Table 4.27: Within and Between subjects effects for time prone

Effect	Statistic	*p* value
Time	Wilk's lambda = 0.434	<0.001
Time*group	Wilk's lambda = 0.870	0.443
Group	F=0.991	0.379

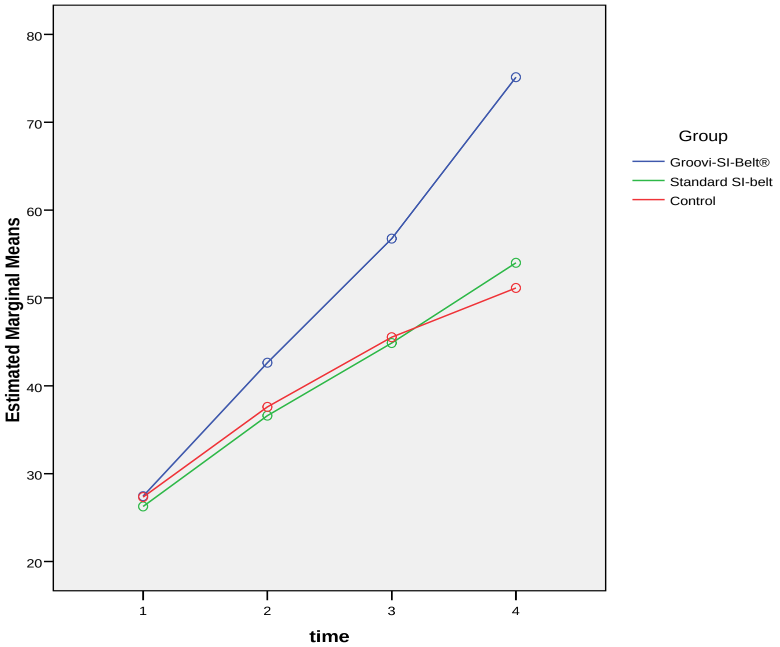


Figure 4.25: Mean time prone (seconds) by treatment group and time

4.5.4.4.2. Time supine (seconds)

There was no evidence of a differential treatment effect for this outcome (p=0.243) although all three groups experienced a significant change in seconds over time (p<0.001). Figure 4.26 shows that the time increased for all groups but there was a slight trend towards a faster rate of increase in Group A compared with the other two groups. However, this difference was not statistically significant.

Table 4.28: Within and Between subjects effects for time supine

Effect	Statistic	*p* value
Time	Wilk's lambda =0.601	<0.001
Time*group	Wilk's lambda =0.828	0.243
Group	F=0.324	0.725

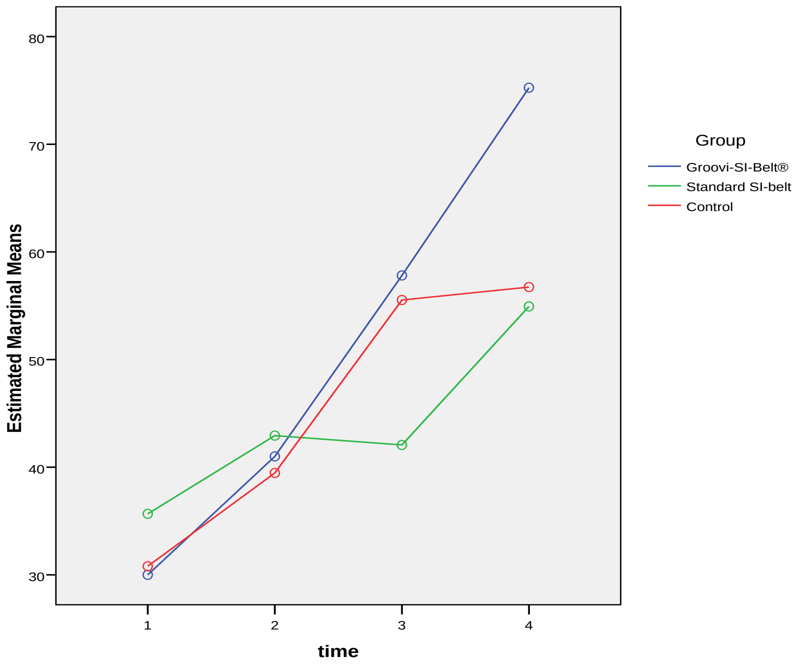


Figure 4.26: Mean time supine (seconds) by treatment group and time

4.5.4.4.3. Discussion

The results shown in Figure 4.25 and Figure 4.26 compares favourably with previous literature suggesting that strengthening the transverse abdominus and multifidus allows the patients to progressively hold the draw-in contraction for longer (Cairns *et al.,* 2000).

The initial co-contraction in a spinal stability programme is so important, if progression occurs to more challenging exercises before mastering these fundamentals, patients negate the benefits of performing these exercises (Hallam, 2004). Therefore insisting patients demonstrate the fundamentals of a spinal stability programme, which are usually taken for granted, may have produced different results.

Chronic back pain suffers experience pain cycles, with their pain fluctuating over a six week period. This fact was not considered when this research was undertaken.

So allowances in this regard need to be taken into consideration as this may produce pain inhibition and undesirable results. This fact is pertinent to Group B due to the fact Group C had a high pain tolerance. Insisting on stricter inclusion criteria in respect with the patients' pain may have rendered different results.

However the Groovi-SI-Belt® showed a greater improvement, consolidating Bell's (2008) claim that alleviating the compression of a SI belt during a spinal stability programme is crucial. This is because it facilitates the relearning of inhibited muscles along with strengthening the spinal stability muscles.

4.5.4.5. Static trunk extensor endurance- objective outcome

There was a statistically significant treatment effect for this outcome over time (*p*=0.005). Figure 4.27 shows that the rate of increase over time was faster in Group A than in the other two groups. The effect of the Groovi-SI-Belt® was a linear increase while the other two groups showed increases which were much less rapid.

Table 4.29: Within and Between subjects effects for Static trunk extensor endurance (s)

Effect	Statistic	*p* value
Time	Wilk's lambda =0.295	<0.001
Time*group	Wilk's lambda =0.646	0.005
Group	F=1.377	0.263

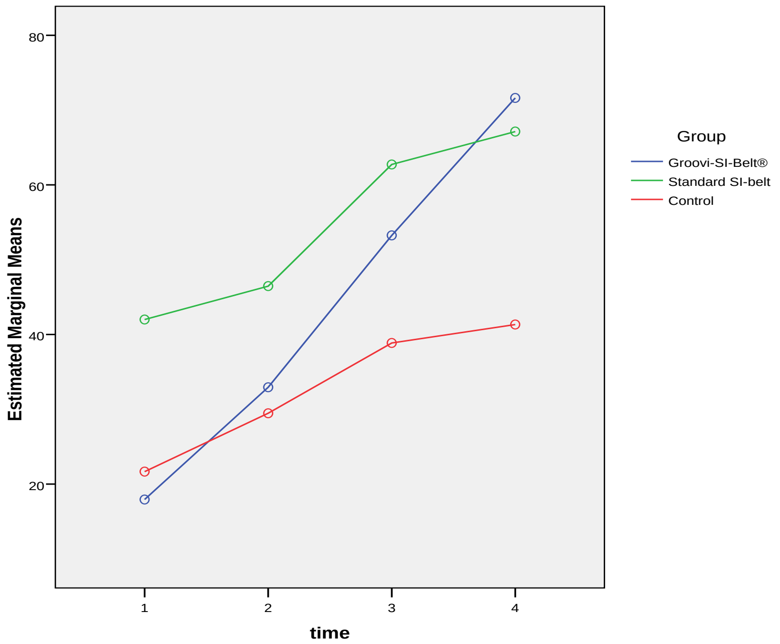


Figure 4.27: Mean static trunk extensor endurance (seconds) by treatment group and time

4.5.4.5.1. Discussion

All three groups showed significant improvement (Figure 4.27).

However, this research showed that the endurance capabilities between the groups were higher with the use of the Groovi-SI-Belt®. Either due to the fact compression could be adjusted by use of the power straps allowing for greater spinal stability strength gains. Alternatively, through the sensory input offered by the belt as this allows for muscle activation through nullifying pain inhibition (Leach, 2003).

4.5.5. Objective Five

To determine the possibility of any adverse effects of the Groovi-SI-Belt®.

4.5.5.1. Discussion

No adverse effects were reported by any of the patients.

<u>In summary:</u>

This study showed that brace aided pelvic stabilization combined with a spinal stability programme was a beneficial treatment intervention for patients suffering from chronic low back pain. The Groovi-SI-Belt® showed a significant improvement with all the subjective and objective assessments except for the ASLR with compression but this reading was inconclusive in all three groups. The patients using the standard SI belt, showed significant improvement in the NRS; QDS; ASLR (without compression) and the static trunk extensor endurance test. However, the Groovi-SI-Belt® showed non significant trends of faster rates of improvement but the mechanism of action could not be determined in this study.

The improvement may have been due to the fact the compression could be adjusted by use of the power straps allowing for greater spinal stability strength gains.

Alternatively the improvement may have been due to the vast surface area of the body with which the Groovi-SI-Belt® made contact with. The body could have interpreted this sensory input and nullified the nociceptors improving pain inhibition and facilitating spinal stability strength gains.

CHAPTER FIVE
RECOMMENDATIONS

5.1. Introduction

The research conducted in this study utilized the most reliable and one of the best possible research protocol and statistical package. However, general trends were observed in this study which could have altered the results.

5.2. Suggestions

The sample size of this study was limited to forty six patients. This relatively small population group was used with a statistical package, which yielded statistically significant results, but trends observed within the study may allow for recommendations of a larger sample size in the future.

Limiting financial constraints would allow the researcher more freedom in conducting a more efficient and valuable study. This would allow for a larger sample size giving a true reflection of the demographics of South Africa. This information would be crucial because it would give further insight in regards to what treatments work within certain communities or ethnic groups.

Inclusion criteria must be more specific in selecting chronic low back pain patients due to the general pain fluctuations these patients experience over a six week period. The age groups should also be more specific and smaller in forthcoming studies to take into consideration the physiological change which occurs in the body.

General recommendations regarding the duration of the spinal stability programme should be amended with the minimum duration exceeding ten weeks. Examiners must insist patients are capable of performing the fundamentals of a spinal stability programme otherwise data becomes null avoid.

Further questions need to be investigated about the Groovi-SI-Belt® in regard to its flexibility, rigidity and durability of the product. This would require different forms of assessments as well as a longer timeline for data collection. Furthermore, this study could also focus on the patients' perception of the product.

REFERENCES

Airaksinen, O., Hildebrandt, J., Mannion, A., Ursin, H., Brox, J., Klaber-Moffett, J., Reis, S., Zanoli, G., Cedraschi, C., Kovacs, F. and Staal, J. 2004. *European guidelines for the management of chronic nonspecific low back pain.* Spine, 15(2): 192-300.

Akuthota, V. and Nadler, S. 2004. *Core Strengthening*. American Academy of Physical Medicine and Rehabilitation, 85(1): 86-92.

Aldous, S. 2003. The sacroiliac joint. [online] Available from: http://www.vancouveryoga.com/anatomy_sacroilliac.html [Accessed 29 October 2010].

Andersson, G. 1999. *Epidemiological features of chronic low back pain*. Lancet, 354: 581-585.

Beales, D., O' Sullivan, P. and Briffa, N. 2009. *The effect of manual pelvic compression on trunk motor control during an active straight leg raise in chronic pelvic girdle pain subjects.* Manual Therapy, 1-10.

Bell, T. 2008. The Groovi-SI-Belt®, Information for practitioner. [online] Available from:http://www.groovi-products.co.za/downloads/GrooviSIbelt%20practitioner.pdf [Accessed 19 November 2009].

Boon, N., Colledge, N., Walker, B. and Hunter, J. 2006. *Davidson's principles and practice of medicine.* 20th ed. London: Elsevier.

Borenstein, D.G., Wiesel, S.W. and Boden, S.D. 1995. *Epidemiology of low back pain and sciatica*. In Borenstein, D.G., Wiesel, S.W. and Boden, S.D. ed. *Low back pain: Medical diagnosis and comprehensive management. 2nd ed.* 22 – 27p. Philadelphia: W.B. Saunders Company. 732p.

Buchthal, H. 1957. Miniature Painting in the Latin Kingdom of Jerusalem, Oxford.

Cairns, M., Harrison, K. and Wright, C. 2000. *Pressure Biofeedback: A useful tool in the measurement of abdominal muscular dysfunction?*. Physiotherapy, 86(3): 127.138

Chok, B., Lee, R., Latimer, J. and Tan, S.B. 1999. *Endurance Training of the Trunk Extensor Muscles in People with Sub-acute Low Back Pain*. Physical Therapy, 79 (11): 1032-1042.

Diaz-Ledezma, C., Urrutia, J., Romeo, J., Chelen, A., Gonzalez-Wilhelm, L. and Lavarello, C. 2009. *Factors associated with variability in length of sick leave because of acute low back pain.* Spine, 9:1010-1015.

de Groot, M., Pool-Goudzward, A., Spoor, C. and Snijders, C. 2006. *The active straight leg raise (ASLR) in pregnant woman: Differences in muscle activity and force between patients and healthy subjects.* Manual Therapy, doi:10.1016/j.math.2006.08.006

Esterhuizen, T. (Private communications), 3 May 2010, 14:06 PM.

Flaherty, E. 2007. Pain assessment for older patients. New York University College of Nursing. Issue No. 7.

Goldstein, S. 2002. SI joint dysfunction and low back pain assessment and treatment protocols using algorithm method for differential diagnosis and treatment. [online] Available from: http://www.terrarosa.com.au/dvd/sijoint_notes.pdf [Accessed 24 May 2010].

Hallam, E. 2004. The Core Issue. [online] Available from: http://www.backcare.org.uk [Accessed 15 December 2009].

Heller, M. 2006. Assessing Core Stability: Basic Evaluation, Basic Exercises. [online] Available from: http://www.marchellerdc.com/pro_resources/Articles/DC_42_Core_Stability.pdf [Accessed 10 December 2009].

Hodges, P., Holm, AK., Holm, S., Ekstro¨, m L., Cresswell, A. and Hansson, T. 2003. *Intervertebral stiffness of the spine is increased by evoked contraction of transversus abdominis and the diaphragm: in vivo porcine studies*. Spine: 28(23):2594–2601.

Hyatt, G. and Cram, C. 2003. Prenatal and Postpartum Exercise Design. [online] Available from: http://exercise.about.com/library/blpostpartumabs1.htm [Accessed 7 February 2010].

Huntoon, E. and Huntoon, M. 2004. *Differential Diagnosis of Low Back Pain*. Elsevier, 2:138-144.

Huguelet, M.C. 2003. What is a sacroiliac belt. [online] Available from: http://www.wisegeek.com/what-is-a-sacroiliac-belt.htm [Accessed 1 June 2010].

Jull, G. and Richardson, C. 2000. *Motor Control Problems in Patients with spinal Pain: A New Direction for Therapeutic Exercize*. Manipulative and Physiological Therapeutics, 23(2):115-117.

Kirkaldy-Willis, W.H. and Burton, C.V. 1992. *Managing low back pain.* 3rd Edition. New York USA: Churchill Livingstone Inc.

Kopec, J., Esdaile, J., Abrahamowicz, A., Abenheim, L., Wood-Dauphine, S., Lamping, D. and Williams, J. 1995. *The quebec back pain disability scale*. Spine, 20(3):341-352.

Leach, R. 2003. *Experimental and clinical evidence of the subluxation complex model. 4*th ed. U.S.A: Lippincott Williams and Wilkins.

Lederman, E. 2008. *The myth of core stability.* Bodywork and Movement Therapies, 14:84-98.

Lee, D. 2005. Recent advances in the Assessment and Treatment of Sacroiliac joint-stability and the role of motor control. [online] Available from: http://dianelee.ca/articles/articlesPro.php [Accessed 10 November 2009].

Liebenson, C. 2007. *Rehabilitation of the spine*: *A Practitioner's Manual*. 2nd ed. Philadelphia: Lippincott Williams and Wilkins.

Liebenson, C. 2004. *The relationship of the sacroiliac joint, stabilization musculature, and lumbo-pelvic instability*. Bodywork and Movement Therapies, 8:43-45.

Lin, L., Jen-Hwa Hu, P. and Liu Sheng, O. 2005. *A decision support system for lower back pain diagnosis: Uncertainty management and clinical evaluations*. Decisions Support System, 42:1152-1167.

Mens, J.M., Vleeming, A., Stoeckart, R., Stam, H. and Snijders, C. 1996. *Understanding peripartum pelvic pain*. Spine, 21:1363-1370.

Mens, J.M., Vleeming, A., Snijders, CJ., Stam, HJ. and Ginai, AZ. 1999. *The active straight leg raising test and mobility of the pelvic joints*. European Spine Journal, 8(6):468–474.

Mens, J.M., Vleeming, A., Snijders, C.J., Koes, B.W. and Stam, H.J. 2001. *Reliability and validity of the active straight leg raise test in posterior pelvic pain since pregnancy.* Spine, 26(10):1167–71.

Mens, J.M., Damen, L., Snijders, C. and Stam, H. 2005. *The mechanical effect of a pelvic belt in patients with pregnancy-related pelvic pain*. Clinical Biomechanics, 21: 122-127.

Melzack, R. and Wall, P. 1965. *Pain mechanisms: a new theory.* Science, 150(699):971-979.

Morris, C. 2006. *Low back syndromes: Integrated clinical management.* 1st ed. United States: The McGraw-Hill Companies.

Mouton, J. 1996. *Understanding social research*. 3rd ed. Pretoria: Van Shaik Publishers.

O'Sullivan. P.B. 2005. 'Clinical Instability' of the lumbar spine: its pathological basis, diagnosis and conservative treatment. In: Jull GA, Boyling JD editors. Grieve's Modern Manual Therapy, 3rd edn. Edinburgh: Churchill Livingstone.

O'Sullivan, PB. and Beales, DJ. 2007. *Diagnosis & classification of pelvic girdle disorders – Part 1: A mechanism based approach within a biopsychosocial framework.* Manual Therapy, 12: 86-97.

Panjabi, M. 2003. *Clinical spinal instability and low back pain*. Journal of Electromyography and Kinesiology, 13:371–379.

Panjabi, MM. 1992. *The stabilizing system of the spine. Part II. Neutral zone and instability hypothesis.* Journal Spinal Disorders, 5:390-397.

Pool-Goudzwaard, A., Hoek van Dijke, G., van Gurp, M., Mulder, P., Snijders, C. and Stoeckart, R. 2004. *Contribution of the pelvic floor muscles to stiffness of the pelvic ring.* Clinical Biomechanics, 19:564-571.

Pope, M., Muffroid, M., Haugh, L., Haig, A. and Henry, S. 1993. *Endurance Training of Trunk Extensor Muscles.* Physical Therapeutic, 73:3-10.

Poul, J., West, J., Buchannan, N. and Grahame, R. 1993. *Local action transcutaneous Flurbiprofen in treatment of soft tissue rheumatism.* British Journal of Rheumatology, 32:1000-1003.

Praemer, A., Furnes, S. and Rice, D. 1992. Musculoskeletal conditions in the United States. Rosemont: AAUS, 1-99.

Price, D., Bush, F., Long, S. and Harkins, S. 1994. *A comparison of pain measurement characteristics of mechanical visual analogue and simple numerical rating scale.* Pain, 56:217-226.

Roelofs, J., Swinkels-Meewisse, I., Oostendorp, R., Verbeek, A. and Vlaeyen, J. 2005. *Acute low back pain: Pain-related fear and pain catastrophizing influence physical performance and perceived disability*. Pain, 120:36-43.

Seth, S.D. 1999. *Textbook of Pharmacology.* 2nd ed. Churchill Livingstone. Pg 174.

Silfies, S., Squillante, D., Maurer, P., Westcott, S. and Karduna, A. 2004. *Trunk muscle recruitment patterns in specific chronic low back pain populations.* Clinical Biomechanics, 20:465-473.

Snijders, C.J., Vleeming, A. and Stoeckart, R., 1993a. *Transfer of lumbosacral load to iliac bones and legs. Part I: biomechanics of self-bracing of the sacroiliac joints and significance for treatment and exercise.* Clinical Biomechanics. 8, 285–294.

Stevens, V., Witvrouw, E., Vanderstraeten, G., Parlevliet, T., Bouche, K., Mahieu, N. and Danneels, L. 2006. *The relevance of increasing resistance on trunk muscle activity during seated axial rotation*. Physical Therapy in Sport, 8:7-13.

University of Auckland, Bioengineering Institute [online]. Available at www.auckland.ac.nz, [Accessed 4 October 2010].

van der Hulst, M., Vollenbroek-Hutten, M., Rietman, J. and Hermens, H. 2009. *Lumbar and abdominal muscle activity during walking in subjects with chronic low back pain: support of the guarding hypothesis*. Journal of Electromyography and Kinesiology, 20;31-38.

Van Tulder, M.W., Koes, B.W. and Bouter, L.M. 1997. *Conservative Treatment of Acute and Chronic Non-Specific Low Back Pain. A Systemic Review of Randomised Controlled Trials of the Most Common Interventions*. Spine, 22(18): 2128-2156.

Vleeming, A. 1997. Movement stability and Low Back Pain. [online] Available from: http://www.thelondonmassagecompany.com/pdf/conference/SacroiliacJoint_Notes.pdf [Accessed 17 December 2009].

Walker, B.F. 1997. *The epidemiology of low back pain. The magnitude of the problem. Australasian Chiropractic and Osteopathy*. 6(3): 95 – 96.

Wegner, T. 2007. *Applied business statistics: Methods and excel-based application.* 2nd ed. South Africa: Juta&co.Ltd.

Wolff, M., Weinik, M. and Maitin, I. 2003. Bracing for low back pain. In Cole, A., Herring, S. (ed.) The Low Back Pain Handbook. Philadelphia: Hanley and Belfus, Inc. pp. 201-218.

Wong, E. and Deyo, R. 2001. *Acute low back pain.* Elsevier, 8:171-174.

Appendix A

Suffering from Chronic Low Back Pain aged between 18-45?

Be part of the research which is being conducted at the Durban University of Technology, if you meet the criteria and are eligible for the research you will receive free treatment for your low back pain

Contact:
Ricardo Marques- 0833515679
D.U.T Chiropractic clinic: 031-3732205

APPENDIX B

LETTER OF INFORMATION

Date:

Dear Participant, welcome to my research project.

Title of Research: Relative effectiveness of three treatment protocols with and without brace aided pelvic stabilization in patients with chronic low back pain.

Name of student: Ricardo Marques

Name of supervisor: Dr. V. Boodhoo **(M. Tech.: Chiro.)**
Contact number: 031-2077968

You have been selected to be part of the research programme. This research programme will determine the effectiveness of the new Groovi-SI-Belt® on individuals suffering from chronic low back pain.

Groovi-SI-Belt®: is a light fabric which is wrapped around the pelvic girdle and secured with velcro, further compression is provided by two Power straps (separate strong elastic bands), each with a central velcro attachment, so that the Power strap is then stretched from the central point in two different directions

Standard SI-Belt: Is a device which supports and stabilizes the SI joints. Composed normally of nylon or elastic bands which fit tightly around the hips by velcro fasteners. If applied correctly can alleviate certain forms of LBP

Forty-five people will be required to complete this study.

To be part of this study you must

- You must also be diagnosed to have decreased force closure by the use of the active straight leg raise (ASLR). Following this the compression test and biofeedback device must show relevant weakness in either the transverse abdominus or multifidus.

You will not be eligible to take part in this study if you

- If you are contraindicated to exercise therapy; if you are known to have nerve root compromise and lastly if you are receiving medication other than analgesic's and non-steroidal anti-inflammatory medication.

Research procedure

- You will be required to attend one treatment a week for four weeks.
- You will be required to perform the allocated exercises three times a week and record the dates that these exercises are performed.
- If you find yourself in the Groovi-SI-Belt ® or the standard SI belt group, you will be required to wear the belts whenever you are active.

Benefits to the participant

- You will be taught and shown a spinal stability programme, which they can implement in their daily lives or even teach it to others.
- You will be randomly placed into the allocated groups and thirty of the forty-five subjects will be receiving either a free Groovi-SI-Belt® or a standard sacro-iliac (SI) belt.
- After the duration of the study, you may have also noticed a decrease in your low back pain.

Reason/s why the subject may be withdrawn from the study

- If you are non-compliant of what is expected of you on a daily basis.
- You become terribly ill, which could be detrimental to yourselves as well as the people you are around.

If the following issues do occur, you will just be asked to return either the Groovi-SI-Belt® or the standard SI belt. If you are released during the research process no adverse reactions will be noticed by the subject.

Confidentiality

All personal details and relevant information gathered through the research process will only be accessible by the researcher (Ricardo Marques) and supervisor (Dr. Vilash Boodhoo). Once all the relevant data has been gathered and analyzed, it will be disposed of in a professional manner, not being made available to the general public.

Persons to contact in the event of any problems or queries

Myself: Ricardo Marques
Contact details: 0833515679

Supervisor: Dr V. Boodhoo (M-Tech.: Chiro.)
Contact details: Work: **031-2077968**

Faculty of Health, Research coordinator: Mr V. Singh
Contact details: **031-3732701**

I…………………………………… (Subjects full name) ………………………… (ID number), have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by Ricardo Marques to my satisfaction. Furthermore, I fully understand that I may withdraw from this study without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in the study.

Subject's name(print)………………………Signature ……………...Date……….

Researcher's name…………………………Signature ………………Date ……..

Witness name ………………………………Signature ………………Date ………

APPENDIX C
DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:______________________________ Date:__________

File # : __________ Age: __________

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 ***PHYSICAL EXAMINATION: SENIOR***
Patient Name : **File no :** **Date :** **Student :** **Signature :**

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

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

SYSTEM SPECIFIC EXAMINATION:
CARDIOVASCULAR EXAMINATION
RESPIRATORY EXAMINATION
ABDOMINAL EXAMINATION
NEUROLOGICAL EXAMINATION
COMMENTS

Clinician: **Signature :**

REGIONAL EXAMINATION - LUMBAR SPINE AND PELVIS

DURBAN UNIVERSITY of TECHNOLOGY

Patient:_______________________________File#:______Date:_________

Intern\Resident:______________________________ Clinician:_____________________

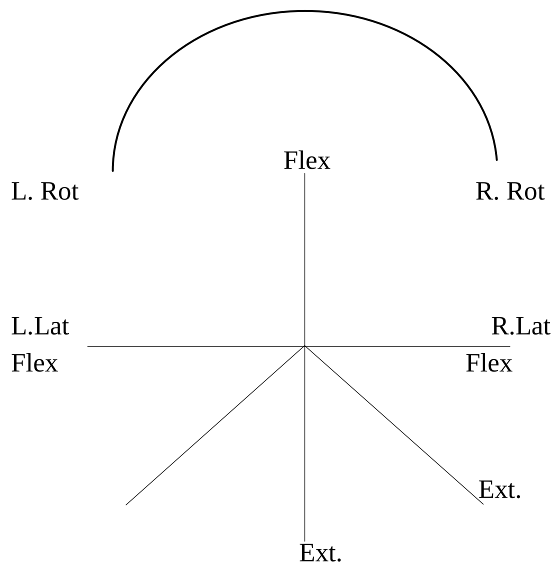
STANDING:

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
Lhermitte

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

Slump 7 test	L										
	R										

LATERAL RECUMBENT:

	L	R
Ober's		
Femoral n. stretch		
SI Compression		

PRONE:

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

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

NON ORGANIC SIGNS:

Pin point pain
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 extension	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		

Appendix F

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 ☐

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:**

Clinician: **Signature :**

APPENDIX G

Patient Name: Date of initial visit:

Occupation:

Age:

File no:
NRS- Numerical Pain Rating Scale

1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**

No pain
Excruciating

1st consult: Date

1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**

No pain
Excruciating

2nd consult: Date

1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**

No pain
Excruciating

3rd consult: Date

1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**

No pain
Excruciating

4th consult: Date

APPENDIX H

Patient Name: Date of initial visit:

Occupation: Age:

File no:

ASLR- Active straight leg raise
Categories:

0- Not difficult
1- Minimally difficult
2- Somewhat difficult
3- Fairly difficult
4- Very difficult
5- Unable to perform

ASLR (without compression)	
ASLR (with compression)	

1st consult: Date

ASLR (without compression)	
ASLR (with compression)	

2nd consult: Date

ASLR (without compression)	
ASLR (with compression)	

3rd consult: Date

ASLR (without compression)	
ASLR (with compression)	

4th consult: Date

APPENDIX I

Biofeedback mechanism

1. The prone test:

- A 3-chamber pressure cell is placed centrally under the abdomen, with the umbilicus in the centre of the inflatable sleeve, and inflated to a baseline of 70mmHg.
- The subject is then instructed to draw the abdominal wall up and in, without moving the spine or pelvis.
- The pressure reading should decrease by 6-10mmHg.
- A variation of 2mmHg is allowed for the normal breathing pattern.
- The measurement is taken at the time at which the patient can no longer hold the contraction at the baseline level (70mmHg- 6 to 10mmHg).

2. The supine test:

- A 3-chamber pressure cell is placed centrally under the lumbar spine with the bottom of the sleeve in line with the posterior superior iliac spines (PSIS), and inflated to a baseline of 40mmHg.
- The subject is instructed to draw in the abdominal wall without moving the spine or pelvis.
- The pressure reading should remain at 40mmHg.
- A variation of 2mmHg is allowed for the normal breathing pattern.
- The measurement is taken at the time at which the patient can no longer hold the contraction at the baseline level (40mmHg).

APPENDIX J

Patient Name: Date of initial visit:

Occupation: Age:

File no:

Biofeedback mechanism

Prone test

Time:	mmHg:

1st consult: Date

Time:	mmHg:

2nd consult: Date

Time:	mmHg:

3rd consult: Date

Time:	mmHg:

4th consult: Date

Supine test

Time:	mmHg:

1st consult: Date

Time:	mmHg:

2nd consult: Date

Time:	mmHg:

3rd consult: Date

Time:	mmHg:

4th consult: Date

APPENDIX K

Patient Name: Date of initial visit:

Occupation: Age:

File no:

Static Trunk Extensor Endurance Test:
Patient is prone their ASIS (anterior superior iliac spine) on the end of the table. Arms at the side, thighs and ankles are fixed to the table by straps. Patients are then asked to maintain the horizontal position for as long as they can, for a maximum of 240 seconds, timing begins once they maintain the horizontal position unsupported. Patient is allowed one additional chance if they drop below the horizontal position but if they drop twice the time is recorded. If patient reports cramping in the legs or LBP, the test is stopped and the time is recorded (Liebenson, 2007).

1st consult: Date

Time:

2nd consult: Date

Time:

3rd consult: Date

Time:

4th consult: Date

Time:

Appendix L

Name: _________________________. Age: ______. Date: ____________. Score:

This questionnaire determines what effect your back pain has on your daily activities. We would like to know if the following activities are difficult to perform on a scale from 0 to 5 (0=normal and 5=severe). Do not skip any of the activities and check the corresponding box.

Today, do you find it difficult to perform the following activities because of your back	**0**	**1**	**2**	**3**	**4**	**5**
1. Get out of bed.						
2. Sleep through the night (sleep atleast 6 hours).						
3. Turn over in bed.						
4. Ride in a car (travel 1 hour in a car).						
5. Stand up for 20-30 minutes.						
6. Sit for 4 hours in a chair.						
7. Climb 1 flight of stairs.						
8. Walk a few blocks (300-400m).						
9. Walk several miles.						
10. Reach up to high shelves.						
11. Throw a ball.						
12. Run two blocks (about 200m)						
13. Take food out of the refrigerator.						
14. Make your bed.						
15. Put on socks (panty hose).						
16. Bend over a sink for 10 minutes.						
17. Move a chair.						
18. Pull or push heavy doors.						
19. Carry two bags of groceries.						
20. Lift and carry a heavy suitcase (or 40 pounds)						
Sub-total						
Total score						

Appendix M

Sahrmann Exercise #1
Lie on the floor with the knees bent. Perform the Basic Breath and, keeping one knee bent, slowly slide the other leg out until it's parallel and just a few inches off the floor. Bring the leg back and repeat on the other leg. Once you're able to complete 20 reps on each leg, without losing the abdominal contraction, move to the next exercise.

Sahrmann Exercise #2
Lie on the floor with the knees bent. Perform the Basic Breath and lift one knee towards the chest. Straighten the leg so that it is parallel and about 2-3 inches off the floor. Bring the leg back to start and repeat with the other leg for 5 or more reps. Once you're able to complete 20 reps on each leg, without losing the abdominal contraction, move to the next exercise.

Sahrmann Exercise #3
Perform the Basic Breath as you bring the knees up to a 90-degree angle. Keep one leg bent and lower the other leg towards the floor, tapping the floor with your toe. Complete 1-5 reps on the same leg and then switch sides. Once you're able to complete 20 reps on each leg, without losing the abdominal contraction, move to the next exercise.

Sahrmann Exercise #4
Perform the Basic Breath as you bring the knees up to a 90-degree angle. Keep one leg bent and extend the other leg out until it's parallel, but not touching the floor. Repeat on the other leg, working up to 10 reps on each side. Once you're able to complete 20 reps on each leg, without losing the abdominal contraction, move to the next exercise.

Sahrmann Exercise #5
Perform the Basic Breath and bring the legs into the chest. Straighten both legs so that they're perpendicular to the floor. Slowly lower both legs towards the floor, going as far as you can without arching the back. Repeat for 5-10 reps, working up to 20 reps.