THE EFFECT OF STRETCHING THE HAMSTRING MUSCLES ON LOW BACK PAIN IN CYCLISTS

By

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DEDICATION

" In the right light, study is insight".

Zack De la Rocha

This work is dedicated to my loving parents, Anne and Christopher Perkin, for being the reason I am alive - love forever.

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ABSTRACT

There have been few studies conducted to determine the effects of stretching as a therapy on its own in the treatment of low back pain. In response to this, the objective of this study was to evaluate the relative effectiveness of stretching the hamstring muscles on low back pain experienced by cyclists.

Thirty two cyclists with low back pain were screened for lumbar facet syndrome, sacroiliac syndrome and myofascial pain syndrome of the quadratus lumborum, gluteus medius and gluteus maximus muscles and randomly divided into two groups of sixteen. Detuned ultrasound was applied to the hamstring muscles of the patients in the placebo group twice a week for three weeks. Patients in the experimental group were involved in a stretching program whereby the hamstring muscles were passively stretched for three sets of thirty seconds duration, two days a week for three weeks.

Both groups were evaluated in terms of subjective clinical findings by utilising the Oswestry Low Back Pain Disability Questionnaire, the Numerical Pain Rating Scale-101, and the

short-form McGill Pain Questionnaire; and a goniometer (lumbar spine ranges of motion) and inclinometer (hamstring flexibility) were utilised to determine objective responses. This data was collected at the first and sixth treatment sessions, as well as at the one month follow-up consultation following the final treatment.

The data was statistically analysed using non-parametric test statistics, at a 95% confidence interval. The Wilcoxon Signed Ranks Test was used to analyse data within each group and the Mann-Whitney U-test was used to analyse data between each group.

In terms of the patients' subjective response to treatment, the experimental group showed a significant decrease in pain disability (Oswestry scores) as well as a decrease in pain perception (McGill and NRS-101 scores). No significant decrease in pain disability and perception were found in the placebo group, indicating that the intervention in the experimental group was effective in reducing pain perception and its associated disability.

In terms of the patients' objective response to treatment, the experimental group showed a significant increase in all ranges of the lumbar spine, except left and right lateral flexion, at the final treatment. There was also a significant difference in lumbar spine flexion at the one month follow-up consultation between the experimental and placebo groups. A significant increase in hamstring flexibility between the first and final treatments was observed in the experimental group, whereas there was no significant change within the placebo group.

Therefore, it was concluded that the stretching procedure of the hamstring muscles in this study was sufficient in improving flexibility of the hamstrings as well as being effective in the management of low back pain in cyclists in terms of objective and subjective clinical findings.

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LIST OF ABBREVIATIONS

S-F MCGILL	-	Short-form McGill Pain Questionnaire
NRS-101	-	Numerical Rating Scale-101
OSWESTRY	-	Oswestry Low Back Pain Disability Questionnaire
A.K.E TEST	-	Active-Knee-Extension test
APT	-	Anterior pelvic tilt
PPT	-	Posterior pelvic tilt
MED.	-	Median
S.D.	-	Standard deviation
S.E.	-	Standard error
P-VALUE	-	Level of significance

DEFINITION OF TERMS

FACET SYNDROME - Pain or dysfunction arising primarily from the zygapophyseal joints and their immediately adjacent soft tissues (Gatterman 1990:161).

SACRO-ILIAC SYNDROME - Sacroiliac dysfunction which may take the form of simple joint locking, or joint locking with compensatory hypermobility in adjacent articulations (Gatterman 1990:114).

MYOFASCIAL PAIN SYNDROME - Pain syndrome characterized by pain in regional muscles accompanied by trigger points that refer pain specifically to each muscle (Gatterman 1990:411).

OBJECTIVE CLINICAL FINDINGS - Those findings obtained from recording: (1) the patient's range of motion using a goniometer and (2) the patient's hamstring flexibility using an inclinometer.

SUBJECTIVE CLINICAL FINDINGS - Those findings obtained from the patient in response to the Oswestry Low Back Pain Disability Questionnaire, the short-form McGill Pain Questionnaire and the Numerical Pain Rating Scale-101.

LUMBOSACRAL - Pertaining to the lumbar vertebrae and the sacrum (Gatterman 1990:410).

ANTERIOR PELVIC TILT - Position of the pelvis in which the vertical plane through the anterior-superior iliac spines is anterior to a vertical plane through the symphysis pubis (Gatterman 1990:412).

When the anterior superior iliac spine (ASIS) is lower and the posterior superior iliac spine (PSIS) is higher on that particular side (Magee 1992:309).

POSTERIOR PELVIC TILT - Position of the pelvis in which the vertical plane through the anterior-superior iliac spines is posterior to a vertical plane through the symphysis pubis (Gatterman 1990:412).

Backward rotation of the ilium on the sacrum,where the ASIS is higher and the PSIS is lower(Magee 1992:309).

STRETCHING - Separation of the origin and insertion of a muscle or attachments of fascia or ligaments by applying constant pressure at a right angle to the fibers of the muscle or fascia (Gatterman 1990:415).

SHORT TERM/FIRST TREATMENT INTERVAL - The time period between the initial visit and the sixth consultation.

LONG TERM/OVERALL TREATMENT INTERVAL - The time period between the initial visit and the follow-up consultation.

CHAPTER ONE

1.1 INTRODUCTION:

Low back pain is reported to affect between sixty and ninety percent of the general population at some point in their lives (Kirkaldy-Willis 1991:2), but lumbar spine pain only accounts for five to eight percent of athletic injuries (Harvey and Tanner 1991). However, Mellion (1991) states that up to sixty percent of cyclists may have experienced the symptoms of neck pain and backache at some time. However, many of the continuous back problems experienced by cyclists are simply caused by tension in the lower back muscles (Westell and Martin 1991:100). The use of stretching appears to be an effective exercise in the treatment of chronic low back pain (Khalil et al. 1992). However, there is a tremendous need for studies specifying the exercise routine prescribed in order to better delineate the most effective stretching exercise in the treatment of low back pain (Dillingham and Delateur 1995).

Chronic shortening of the muscles spanning the hip and lumbar spine is thought to play a role in the pathogenesis of lumbar dysfunction and possibly contribute to the incidence of low back pain (Brier and Nyfield 1995). Westell and Martin (1991:100) state that the basic sitting position on the bicycle, coupled with the utilisation of the back muscles under effort, produces tension in the hip and low back region. However, the relationship between hip mobility and low back pain has only been studied in a few reports (Mellin 1988).

It is recommended by Altson et al. (1966) that tightness of the hamstring muscles should be carefully assessed in patients complaining of low back pain and when present, appropriate corrective measures should be administered. However, faulty biomechanics of the hamstring muscles is often an overlooked aspect in the treatment of lower back disorders (Schafer and Faye 1989:257). In an investigation by Khalil et al. (1992) it was found that patients suffering from chronic low back pain showed significant improvement in their functional abilities, as well as a significant decrease in their pain level after a two week stretching program involving the back extensor muscles, the hamstring muscles and the tensor fasciae latae. However, no reports are available that evaluate the efficacy of stretching of the hamstring muscles alone in chronic low back pain patients.

Medical management of neck pain and backache in bicyclists is based on strength and flexibility exercises for the neck, back and shoulders (Mellion 1991). However, Westell and Martin (1991:51) state that cyclists require specific suppleness or flexibility in certain areas of the body, especially the back and hips, to reduce the likelihood of the lower back condition referred to as 'cyclist's back'. Therefore, Westell and Martin (1991:101) state that a daily stretching routine should be incorporated into a cyclist's training regime as a guard against backache. The lumbar spine links the lower extremities and the torso and this important link is responsible for the coordinated transfer of power through the body in most sports (Harvey and Tanner 1991). Although most athletes are in good general condition, one cannot assume that athletes have spent sufficient time strengthening and stretching their low back, abdomen and lower extremities (Harvey and Tanner 1991).

Therefore, this study will involve stretching of the hamstring muscles in order to determine what effect an increase in hamstring extensibility has on low back pain experienced by cyclists in terms of objective and subjective clinical findings.

The results of this research may describe more clearly the role that tight hamstrings play in the aetiology of low back pain in cyclists, as well as clarify the effectiveness of stretching of the hamstring muscles as a therapeutic intervention in patients suffering from chronic low back pain.

1.2 AIM:

The purpose of this placebo-controlled investigation was to evaluate the efficacy of stretching of the hamstring muscles, in terms of objective and subjective clinical findings, in the treatment of low back pain in cyclists.

1.3 THE OBJECTIVES:

1.3.1 OBJECTIVE ONE

The first objective was to evaluate the efficacy of stretching of the hamstring muscles, in terms of objective clinical findings, in the treatment of low back pain in cyclists.

1.3.2 OBJECTIVE TWO

The second objective was to evaluate the efficacy of stretching of the hamstring muscles, in terms of subjective clinical findings, in the treatment of low back pain in cyclists.

1.3.3 OBJECTIVE THREE

The third objective was to integrate the data from the above two objectives in order to determine the efficacy of stretching of the hamstring muscles in the treatment of low back pain in cyclists.

1.4 THE HYPOTHESES:

1.4.1 HYPOTHESIS ONE

It was hypothesised that stretching of the hamstring muscles would be effective in improving the flexibility of the hamstring muscles in cyclists suffering from low back pain.

1.4.2 HYPOTHESIS TWO

It was hypothesised that stretching of the hamstring muscles would be effective in the management of low back pain in cyclists, in terms of objective and subjective clinical findings.

1.4.3 HYPOTHESIS THREE

It was hypothesised that stretching of the hamstring muscles would be more effective than a placebo treatment in the management of low back pain in cyclists, in terms of objective and subjective clinical findings.

CHAPTER TWO

2 REVIEW OF THE RELATED LITERATURE

2.1 INTRODUCTION

Harvey and Tanner (1991) state that although a low back injury is not the most common athletic injury, it may be one of the most disabling, and back pain is one of the most challenging injuries for the sports physician to diagnose and treat. Overuse injuries in cyclists are different from similar injuries in other athletes (Mellion 1991). In these other sports, medical and rehabilitative therapy are enough to deal with injuries, but with cyclists 'mechanical' as well as medical management are usually required to resolve the symptoms experienced by the athlete (Mellion 1991).

2.2 LOW BACK PAIN IN CYCLISTS

2.2.1 EPIDEMIOLOGY: INCIDENCE AND PREVALENCE

According to Weiss (1985), neck pain and backache are extremely common problems experienced by cyclists while Strickland (1992) states that eighty percent of cyclists suffer from back pain. Cycling has become a very popular sport recently, and this popularity continues to grow (Timmer 1991). This means that more individuals are susceptible to developing backache and as far as many cyclists are concerned, pain in the lower back goes with the territory (Westell and Martin 1991:100).

2.2.2 AETIOLOGY:

Many of the persistent back problems experienced by cyclists are simply due to tension in the hip and lower back muscles produced by the constant position of trunk flexion on the bicycle (Westell and Martin 1991:100). One possible explanation for the development of lumbar dysfunction in cyclists is the fact that the lumbopelvic girdle is constantly held in flexion. This may lead to chronic shortening of the muscles spanning the hip and lower spine (Brier and Nyfield 1995). Lillegard and Rucker (1993:118) state that mechanical back pain in athletes such as cyclists may be a manifestation of chronic tenderness or ligamentous strain of the spine, which is usually the result of a combination of tight hamstring muscles and lumbar ligamentous structures.

Lewit (1991:232) states that low back pain may be as a result of ligamental and muscular overstrain. In this type of low back pain, the spinal column may be functioning normally at the outset and no morphological lesion may be present. This category of low back pain may be due to work performed under conditions that induce overstrain by faulty posture or incorrect movement patterns, such as those acquired during muscular imbalance. (Lewit 1991:232)

According to Mellion (1991), the mechanism of most neck and back problems in cyclists is usually the increased load placed on the arms and shoulders when supporting the rider. These conditions are exacerbated by increased handlebar 'reach' causing hyperextension of the neck and exaggerated flexion of the lumbar spine. Dropped handlebars, as used by the majority of road cyclists, accentuate this problem (Mellion 1991).

2.2.3 SIGNS AND SYMPTOMS:

Back pain in cyclists usually starts with a dull ache in the lumbar region and also deep in the buttocks. The pain can be brought on suddenly when riding in a group or it can gradually progress in severity throughout a ride (Westell ride (Westell and Martin 1991:101). In most cases of mechanical low back pain, examination and diagnostic tests fail to identify an exact mechanism or specific anatomical site as the cause of pain, suggesting that it is a chronic inherent process rather than an acute or traumatic disorder (Lillegard and Rucker 1993:118).

According to Lewit (1991:232), discomfort and pain in patients suffering from low back pain due to ligamental and muscular overstrain are usually the result of activity, postural even more than dynamic. Often it is postural strain that is more disagreeable than movement so that if any position has to be held for a prolonged period, it is registered as a strain and the patient feels the need to change position (Lewit 1991:232). This is noteworthy since cyclists often take advantage of a quiet period during a race to sit straight up and hyperextend their backs to relieve their symptoms (Burke 1986:191).

Clinical signs in patients with ligamental and muscular overstrain consist of changes both in body statics and in faulty movement patterns. The most frequent imbalance in the lumbosacral region is between the gluteal and abdominal musculature on the one hand, and the hip flexors and back muscles on the other. The hyperactive erector spinae as well as the iliopsoas can be tender. The most frequently tender periosteal points are the spinous processes, particularly the last two lumbar vertebra and the posterior superior iliac spines. (Lewit 1991:232)

2.2.4 THERAPY:

Pathomechanical cycling injuries can be defined as overuse injuries that are a result of incompatibilities between the cyclist and the bicycle. Injuries result from differences between the fixed motion patterns of the drive mechanism of a bicycle and the complex anatomical motion patterns of the individual cyclist. A cyclist who suffers from the early signs of a pathomechanical overuse injury, such as low back pain, has only three roads to recovery. The first option is to eliminate the repetitive stress by becoming inactive but in most cases, rest is unacceptable to enthusiastic riders. The second alternative is to make mechanically acceptable adjustments to the bicycle so as to function within the constraints of the cyclist's anatomy. (Burke and Newsom 1988:6) Mechanical management includes a variety of methods to shorten the total handlebar reach such as raising the handlebars, moving the bicycle seat forward, or using handlebars with less drop (Mellion 1991). Therefore, back pain while riding may be due to poor bike fit and riders should have their position checked at a reputable bike shop (DeBenedetti 1998).

The final option, and most relevant to the clinician, for recovery from pathomechanical overuse injuries is to make anatomically acceptable changes in the human body so that the rider can conform to the motion pattern involved in cycling (Burke and Newsom 1988:7). DeBenedetti (1998) believes that to avoid back pain, the pelvis must be rotated forward to relieve pressure on the spine, which is achieved by strengthening the abdominals and stretching the hamstring and gluteal muscles. Abdominal exercises, such as crunches, and stretching of the piriformis muscles are sufficient for prevention of low back pain, but if the rider already has back pain, DeBenedetti (1998) suggests adding specific hamstring stretching to relieve the pain.

2.3 HAMSTRING MUSCLES

2.3.1 ANATOMY:

Three large femoral muscles make up the hamstring muscles, these being the biceps femoris, semitendinosus and semimembranosus muscles. The hamstring muscles have a common site of origin from the ischial tuberosity of the pelvis, deep to the gluteus maximus muscle and they insert onto the tibia and fibula. There is a significant variation in the length of these muscles, producing differences in knee range of motion between individuals. (Moore 1991:421)

2.3.2 ACTIONS:

The hamstring muscles flex the leg at the knee and, acting as extensors of the hip joint, they draw the trunk upright against gravity from the stooping position. With the knee in a semi-flexed position, the biceps femoris can act as a lateral rotator, and the semimembranosus and semitendinosus as medial rotators of the leg. The hamstring muscles are quiescent in normal symmetrical standing but any action which carries the line of body weight in front of the transverse axis of the hips is immediately accompanied by strong contraction of the hamstrings. Such actions include forward reaching, forward sway at the ankle joints, or forward bending at the hips. (Williams and Warwick 1980:604)

2.3.3 ACTIONS DURING CYCLING:

The movement of the hip joint that is most useful in cycling is hip extension (Faria and Cavanagh 1978:39). The major muscles producing hip extension are the gluteus maximus and parts of the hamstring group, which form the 'hip extensor muscle group'. Electromyographic (EMG) studies in cycling have documented specific muscle activity as well as the duration and timing of this activity during the revolution of the pedals (Timmer 1991). During the first 45° of the pedaling cycle, beginning at the 0° position of the crank (Top dead centre), the gluteus maximus acts alone to extend the hip. During the last 45° of hip extension, ending just past the 180° point of the cycle (bottom dead centre), the hamstrings work alone. The gluteus maximus and the hamstrings work together during the middle part of hip extension, which corresponds, to a crank angle of approximately 45 to 125°. (Faria and Cavanagh 1978:46)

Although knee extension is very important for the power component in cycling, the role of the hamstrings as knee flexors cannot be ignored (Timmer 1991). When the crank is at 105°, the knee extensors relax while the hamstring continue to work and the knee flexors and extensors are both active for a total of 70° of crank movement. In order to carry out their action of hip extension, the hamstrings generate a turning effect at the knee. This occurs at the 70° crank position, contrary to the dominant action of knee extension at this point in the power phase. This adds to the actual crank turning force, which is regulated by different lever lengths and muscle actions. (Faria and Cavanagh 1978:46)

Therefore, it is clear that the hamstring muscles are essential for power production during the pedal cycle since they are active through approximately 155° of the cycle, from 45 to 200°, and are active during most of the power phase (Top dead centre to bottom dead centre) of the cycle (Faria and Cavanagh 1978:47).

2.3.4 INFLUENCE OF HAMSTRING LENGTH:

The relative length of the hamstring muscles, when relaxed shows considerable variation and in some individuals the muscles are so short that they impose a serious limitation on flexion of the trunk at the hip joints when the knees are kept extended. Such movements as stooping are then largely achieved by flexion of the vertebral column. (Williams and Warwick 1980:604)

In a study done to examine the influence of hamstring length on the flexion range of motion of the lumbar angle, it was found that short hamstrings were associated with a decreased range of motion of this angle (Gajdosik et al. 1992). Because of the site of origin from the pelvis, the hamstring muscles are able to alter the forward or backward tilt of the pelvis, with the result that these muscles can increase or decrease the lumbar curve respectively (Schatz 1992:65). The length of the hamstring muscles is also considered to play an important role in the effectiveness and efficiency of basic human movements (Gajdosik 1991).

2.4 FLEXIBILITY

Flexibility can be defined as the ability of a joint to move through its normal range of motion (Burke 1986:47). The structures that can limit this range of motion are (a) the bony architecture of the joint, (b) the ligaments surrounding the joint, (c) the fibrous joint capsule, and (d) the tendons and muscles that cross the joint (Burke 1986:47). The most common cause of decreased flexibility is muscle contracture, or muscle tightness, and this cause of inflexibility is the easiest to resolve (Burke 1986:47). Since the ability of a muscle to lenghten in response to an applied load allows a single joint or series of joints to move through a full range of motion (Sanders 1990:201), a significant decrease in flexibility may be associated with an increase in stress-related injuries (Burke 1986:47).

2.4.1 FACTORS AFFECTING FLEXIBILITY:

A number of factors that contribute to the flexibility of an individual have been identified. These include gender, age, muscle size and warm-up (Wang 1993). Anatomical differences between males and females may be responsible for the fact that females are generally more flexible than males. Flexibility also tends to decrease with age due to certain changes that occur in the structure of connective tissue (Sanders 1990:216). Muscle size also affects flexibility, with large muscles usually demonstrating greater resistance to passive stretch than small muscles (Gajdosik, Giuliani, et al. 1990).

2.4.2 BENEFITS OF INCREASED FLEXIBILITY:

Improving flexibility allows the involved tissues to move easily to accommodate the stresses imposed on them, dissipate the impact of such stresses, and improve the effectiveness and effeciency of movement (Sanders 1990:202). Since the ability of connective and muscle tissues to absorb force is related to their flexibility, the greater the flexibility, the greater their ability to dissipate the applied force (Worrell and Perrin 1992).

Burke (1986:47) emphasizes the importance of having an unrestricted, normal range of motion at each joint level in the body. Increased flexibility allows for a normal range of motion at each joint level, and the body tends to become more efficient, as demonstrated by smoothness of motion and decreased fatigue. The chance of stress-related injuries decreases which translates into long-term, more effective training, which can lead to improved performance by the cyclist.(Burke 1986:48)

2.4.3 FLEXIBILITY IN CYCLISTS:

Cyclists require increased flexibility in certain areas of the body, including the back and hips, to reduce the likelihood of lower back problems (Westell and Martin 1991: 51). However, when compared with other athletes, very few cyclists stretch in order to improve their flexibilty (Westell and Martin 1991:51) and Burke (1986:47) states that flexibility has been the area that has received the least amount of attention from the United States Cycling Team.

Burke (1986:45) states that because riders spend so much time in the same position, their flexibility is frequently impaired. Therefore, an emphasis on increasing flexibility will lead to better riding, fewer injuries, and increased range of motion allowing for the use of weight-lifting exercises that appear to be a beneficial adjunct to cycling (Burke 1986:45).

2.4.4 DECREASED FLEXIBILITY AS A CAUSE OF PAIN:

By definition, overuse injuries occur when the cumulative effects of repetitive stress exceed the tolerance limits of specific anatomical structures (Burke and Newsom 1988:4). If these stresses are the result of gross motor activities, failures occur in the structures that maintain the mechanical integrity of the body, namely the musculoskeletal system (Burke and Newsom 1988:4).

The adverse effects of mechanical stresses gradually produce changes in the anatomical tissues involved, and the nervous system begins to provide feedback by registering discomfort. As the mechanical damage to the tissues becomes more marked over time, the feedback progresses into the form of pain, indicating that overuse injuries become worse over time. (Burke and Newsom 1988:6)

The ability to withstand mechanical stress depends on the individual and it is recommended that training-induced stress is increased gradually so that the compensatory increase in the resiliency of the musculoskeletal system will permit progressively greater stress to be tolerated (Burke and Newsom 1988:5). Over the short term, the likelihood of mechanical failure increases as the stress is increased. This explains why greater pain and discomfort are experienced as both mileage and cycling intensity are suddenly increased (Burke and Newsom 1988:6).

2.4.5 HAMSTRING INFLEXIBILITY AND LOW BACK PAIN:

The human body functions as a unit, and each joint must go through a specific range of motion for the body to accomplish its task. A decreased range of motion in one joint requires compensation, with other joints being forced to increase their relative motion and experience increased stress. (Burke 1986: 48). Strength training, in the absence of a regular stretching program, is believed to cause muscle hypertophy which has a negative effect on joint mobility (Wang et al. 1993). Hypertrophy of muscle produces an increase in strength of the tissue but the tissue becomes stiffer and more resistant to deformation with a resultant decrease in flexibility of the involved tissue (Sanders 1990:226). Therefore, strengthening of the hamstring muscles which is produced by the constant pedalling motion involved in cycling may result in decreased flexibility of these muscles in riders.

Tight back extensor muscles and hamstring muscles are commonly observed in symptomatic individuals with regards to low back pain (Brier and Nyfield 1995). In a study by Tafazzoli and Lamontagne (1996) conducted on eight men with mechanical low back pain and nine men without low back pain it was shown that the passive elastic moment and the stiffness of the hamstrings, as well as trunk flexion were significantly different between the two groups. The results indicated that tight hamstrings may either be the cause of, or consequent to mechanical low back pain. In either case, hamstring stretching exercises can be recommended to compensate or prevent any shortening adaptations (Tafazzoli and Lamontagne 1995).

Flexibility of the pelvis and the lower extremities plays an important role in segmental spine function and is necessary for proper body mechanics (Mayer et al. 1991:242). Inflexibility of the hamstring muscles prevents pelvic rotation at the hip anteriorly by fixing the ischium which interferes with normal lumbopelvic rhythm, often with a compensatory stretching of the posterior longitudinal ligaments of the lumbar spine (Schafer and Faye 1989:257).

Therefore, proper hamstring flexibility is necessary for smooth lumbopelvic rhythm (Mayer et al. 1991:242). Failure of the hamstring muscles to elongate normally increases the stress placed on the posterior elements of the lumbar spine, especially if the spine is in a forward flexed position, because the extensor muscles of the lower back are already elongated and cannot efficiently dissipate the applied stress (Schafer and Faye 1989:257). Burke (1986:191) states that the back's erector spinae muscles exist in a chronic state of isometric contraction during a ride, which would further aggravate the above scenario.

2.4.6 MEASURING HAMSTRING FLEXIBILITY:

Tests for measuring hamstring muscle tightness are variations of the straight-leg-raising (SLR) test. These variations include the passive bilateral SLR test, the passive toe-touch test, the active unilateral SLR test, and the passive unilateral SLR test. All of these tests measure hamstring tightness by the angle of hip flexion with the knee extended. (Gajdosik and Lusin 1983)

Some confusion exists over what limits hip flexion with SLR tests since elongation of the sciatic nerve and associated structures occurs in conjunction with stretching of the hamstring muscles. The questionable validity of the passive unilateral SLR to measure hamstring tightness led to the design of the active-knee-extension (AKE) test that measures hamstring muscle tightness by the angle of knee flexion after active knee extension while the hip is stabilized at 90 degrees flexion. This test is an objective and reliable tool for measuring hamstring tightness when conducted by one examiner under controlled conditions. (Gajdosik and Lusin 1983) It is recommended by Worrell and Perrin (1992) that the use of the straight leg raise test in assessing hamstring should be discontinued, and that clinicians use the method described by Gajdosik and Lusin (1983).

2.5 STRETCHING

Muscles which undergo strength training only become shorter, and this not only reduces their range of movement but in time makes them less efficient and more prone to injury (Westell and Martin 1991:52). The negative effect that strength training alone has on joint mobility can be counteracted by flexibility training, of which stretching is one of the most important forms (Strauss 1991:313). Restoration of flexibility is important not only for the spinal segments, but also for the pelvis and lower extremities (Mayer et al. 1991:242).

The specific aims of flexibility training in injury prevention are to improve and maintain joint mobility, to decrease the risk of joint overloading, to increase muscle and tendon strength and to adapt the musculoskeletal system to the demands of the particular sport that the athlete is involved with (Strauss 1991:314).

2.5.1 STRETCHING AND LOW BACK PAIN

Stretching, mobilization and manipulation are some of the techniques utilised by physical therapists and chiropractors in the rehabilitation of low back pain (Khalil et al. 1992). The results obtained in a controlled study by Khalil et al. (1992) showed that chronic low back pain patients undergoing a multidisciplinary program of treatment with systematic stretching maneuvers of certain muscles were able to improve their functional abilities. Muscle stretching in these patients also resulted in an immediate gain, as well as in a cumulative gain in back extension strength, trunk flexion and extension ranges of motion, and contributed to a reduction in pain levels. The muscles that were stretched included the hamstrings and the lumbar paraspinal muscles. (Khalil et al. 1992)

2.5.2 TYPES OF STRETCHING:

Three common methods used in an attempt to achieve an increase in flexibility are ballistic stretching, static stretching and proprioceptive neuromuscular facilitation (PNF) techniques (Anderson and Burke 1991).

Ballistic stretch uses bouncing or jerking movements imposed on the muscles to be stretched. The quick, jerking motion that occurs can theoretically exceed the extensibility limits of the muscle in an uncontrolled manner and cause injury. For this reason, the use of this technique has not been widely supported. (Anderson and Burke 1991)

Static stretch is a method in which the muscle is slowly elongated to tolerance and the position held with the muscle in this greatest tolerated length. Static stretching offers advantages over the ballistic stretching method. Exceeding the extensibility limits of the tissue involved is unlikely, and the technique requires less energy to perform. (Anderson and burke 1991)

Hold-relax is one of the PNF techniques used to increase joint range of motion and is based upon an isometric contraction of the shortened muscle performed against maximal resistance. The hold-relax procedure is performed at any point in the subject's range of motion where limitation is present as a result of pain, muscle spasm, or other causes. (Tanigawa 1972)

Each of these three types of stretching techniques (static, ballistic, and PNF) appears to increase the flexibility of a muscle immediately after the stretch (Anderson and Burke 1991).

Given that the ballistic stretch may pose the greatest potential for trauma and that PNF techniques require the assistance of an experienced practitioner, the most common method of stretching used to increase the flexibility of a muscle is the static stretch (Anderson and Burke 1991). Due to the fact that static stretching is also much easier to teach and to perform than PNF stretching, it is the form of stretch that is recommended for increasing hamstring flexibility (Worrell et al. 1994).

2.5.3 STATIC STRETCH OF THE HAMSTRING MUSCLES

Static hamstring stretching is performed in a standing position with the pelvis in an anterior pelvic tilt with the stretching leg on a table. The anterior pelvic tilt with shoulder retraction minimises compensation of the cervical, thoracic and lumbar regions. (Sullivan et al. 1992)

During hamstring stretching, with the pelvis maintained in an anterior pelvic tilt position, Sullivan et al. (1992) postulate that the ischial tuberosity (hamstring origin) is displaced superiorly and posteriorly to a position further from the tibial and fibular hamstring insertions. Thus, greater tension would occur within the hamstring musculotendinous structure.

The purpose of the study conducted by Sullivan et al. (1992) was to compare static stretch and PNF hamstring stretching techniques while maintaining the pelvis in two testing positions: anterior pelvic tilt (APT) or posterior pelvic tilt (PPT). Two groups of ten subjects were randomly assigned to either and APT or PPT position. Each subject performed eight sessions using PNF on one leg and static stretch on the other while maintaining the pelvis in the assigned position. The results showed that the anterior pelvic tilt position was significantly more effective than the posterior pelvic tilt position in increasing hamstring muscle length. There was no significant increase in hamstring flexibility in the subjects in the posterior pelvic tilt group. In addition, there was no significant difference between static stretch and PNF stretching technique in the anterior pelvic tilt position. It can be concluded that the anterior pelvic tilt position may be more important than stretching technique (PNF or static stretch) for increasing flexibility (Sullivan et al. 1991).

2.5.4 STRETCHING OF THE HAMSTRING MUSCLES FOR LOW BACK PAIN

Athletes who can achieve the correct position or stance in their sport will be able to dissipate forces effectively at the lumbopelvic spine, and will be efficient at their sport-task due to proper recruitment of the hip extensor mechanism (Brier and Nyfield 1995). One possible explanation for the development of lumbar dysfunction in cyclists is through the mechanical disability that is perpetuated by lumbopelvic tightness (Brier and Nyfield 1991). Therefore, the ability to achieve a biomechanically correct posture through proper utilisation of the hip extensors may alleviate the symptoms of low back pain associated with decreased flexibility of the hamstring muscles in cyclists. Thus, the research hypothesis is that stretching of the hamstring muscles will produce clinically significant improvements in the symptoms experienced by cyclists with low back pain.

2.6 SUMMARY:

Low back pain is a common disorder affecting a large proportion of the population, including athletes. Unfortunately, low back pain remains a symptom of multiple uncertain aetiology. It has been demonstrated that the presence of tight hamstring muscles is associated with syndromes of low back dysfunction (Tafazzoli and Lamontagne 1996). The effects of hamstring inflexibility may be more pronounced in cyclists due to the prolonged position of forward flexion that is a characteristic of cycling, as well as the continuous utilisation of the hamstring muscles during the pedaling cycle.

For chronic low back pain patients, stretching of certain muscles, including the hamstring muscles, improved their physical abilities and reduced their pain level. However, the exact contribution of tight hamstrings alone is not clear and it is recommended by Khalil et al. (1992) that research should be conducted to determine which single stretching maneuver would provide the most benefit for chronic low back pain patients.

Therefore, the purpose of this study is to evaluate the effects of stretching of the hamstring muscles on low back pain in cyclists, in terms of subjective and objective clinical findings.

CHAPTER THREE

3 MATERIALS AND METHODS

3.1 INTRODUCTION

This chapter deals with the methods employed in data collection, as well as the statistical methods used for the interpretation of the data.

3.2 THE DATA

The data used in this study was of two kinds: primary and secondary data. The nature of each of these two types of data shall be discussed below.

3.2.1 THE PRIMARY DATA:

The primary data consisted of the following:

Patients' lumbar spine range of motion, as determined by a goniometer.

Patients' disability, as determined by an Oswestry Low Back Pain Disability Questionnaire (Appendix D).

Patients' pain perception, as determined by a short-form

McGill Pain Questionnaire (Appendix E) and a Numerical Pain Rating Scale-101 (Appendix F).

Patients' hamstring muscle flexibility, as determined by an inclinometer.

A detailed description of the above measurements is provided later.

3.2.2 THE SECONDARY DATA:

This consisted of recognised diagnostic and evaluatory criteria as pertains to patients' perceptions of pain sensitivity, spinal range of motion, disability and pain perception. This included commonly utilised orthopaedic tests and palpation techniques, which are described later.

3.3 RESEARCH METHODOLOGY AND MATERIALS USED

The objective of this placebo-controlled investigation was to evaluate the efficacy of stretching of the hamstring muscles, in terms of objective and subjective clinical findings, in the treatment of low back pain in cyclists.

Both experimental and questionnaire design were the methods employed in the data collection process.

Patients were recruited from the greater Durban area by use of convenience sampling ie: advertisements placed in a local cycling pamphlet, *Go Cycle* and the local radio station, *East Coast Radio*. It was advertised that free treatment would be administered to cyclists suffering from low back pain for six weeks or more and who were willing to participate in this study. Upon telephonic reply, these potential patients had the exact study protocol explained to them. Any person that was over the age of 18, literate and who met with the following criteria was scheduled for an initial consultation:

1. The individual was not in a rehabilitation program for a lower extremity or lumbar spine injury and was not receiving any treatment for such.

2. The individual was not suffering from a hamstring muscle injury.

3. The individual was not involved in a stretching program of the hamstring muscles.

4. The individual was cycling a minimum of sixty kilometres per week.

At the initial consultation, potential candidates for the study underwent a full case history (Appendix A), physical examination (Appendix B) and a regional low back and pelvis examination (Appendix C). When clinically indicated, an X-ray examination of the lumbar spine and pelvis was carried out in order to exclude, or assess the relevance of, any other pathologies such as degeneration, inflammation, malformation or mechanical disturbance of the lumbar spine that may have been a cause of low back pain. Following examination, a diagnosis was determined. Individuals with demonstrable bone or disc disease involving the lumbar spine were not accepted into the study. Individuals with the following diagnostic categories, present for six weeks or more, were accepted into the study: lumbar spine facet syndrome; sacroiliac syndrome and myofascial pain dysfunction syndrome of the quadratus lumborum, gluteus maximus and gluteus medius muscles.

The orthopaedic tests utilised to diagnose facet syndrome were Kemp's test and lumbar facet joint challenge; and those used to diagnose sacroiliac syndrome were Patrick's Faber test and Gaenslen's test. Kemp's test (axial compression) is performed with the patient sitting. The examiner reaches around the patient's shoulders from behind and rotates and extends the patient. Axial compression is then applied with the patient maximally extended and rotated right and then left. Pain in the lumbar region is indicative of a positive test. (Gatterman 1990: 141.)

Lumbar facet joint challenge ('springing') is performed with the patient prone. The examiner places a thumb on the spinous process tip and pushes laterally, varying the force. This produces joint play in the neutral prone position and end-feel at the limit of range of motion. Neither is reached abruptly in a normal joint. A joint with restricted mobility has lost the springiness at the end position. It is this springiness that one palpates for when performing facet joint challenge. (Gatterman 1990: 49, 84.)

Patrick's Faber test requires that the patient lie supine, and that the examiner place the patient's test leg so that the foot of the test leg is on top of the knee of the opposite leg. The examiner then slowly lowers the test leg in abduction toward the examining table. A positive test is indicated by the test leg remaining above the opposite straight leg. The word Faber indicates flexion, abduction, and external rotation of the hip at the commencement of the test. (Magee 1992: 343.)

Gaenslen's test requires that the patient lie supine with the patient positioned so that the test hip extends beyond the edge of the table. The patient draws both legs up onto the chest and then slowly lowers the test leg down into extension. Pain in the ipsilateral sacroiliac joint is indicative of positive test. (Magee 1992: 319)

Eligible candidates were required to complete an informed consent form (Appendix G), after which they were allocated either to the experimental group (stretching) or the placebo group, by means of random allocation. Allocation had already been completed prior to patients entering the study.

This random allocation method involved dividing the population of 32 subjects into eight groups of 4, each group containing different combinations of stretching and placebo. These are presented below, with the letter T representing the stretching group and the letter t representing the placebo group. These combinations were used to further enhance the process of randomization.

Group1:TTtt

Group2:TTtt

Group3:tTTt

Group4:TtTt

Group5: tTtT

Group6: TttT

Group7:tTTt

Group8: ttTT

This resulted in two groups of 16 patients each, one group receiving stretching and the other group receiving placebo. Single blinding was utilised for the purpose of the study, with only the researcher aware of which intervention each subject was receiving.

At the first, sixth, and one month follow-up consultations, each patient was required to complete the Oswestry Low Back Pain Disability Questionnaire (Fairbank et al. 1980), the short-form McGill Pain Questionnaire (Melzack 1987) and the Numerical Pain Rating Scale-101 (Jensen et al. 1986) prior to each treatment. In addition, the following measurements were taken: patients' lumbar spine ranges of motion using the BROM II (Breum et al. 1995) and patients' knee extension using the Active-Knee-Extension test (Gajdosik and Lusin 1983), also prior to each treatment.

Subjects in the placebo group received a placebo treatment of detuned ultrasound twice a week for three weeks. The head of the ultrasound unit was applied over the hamstring muscles, but the intensity remained at zero for the three minute treatment period.

Subjects in the experimental group were involved in a stretching program two days a week for three weeks (six stretching sessions), which has been shown to be sufficient for achieving an increase in flexibility (Godges et al. 1993). Static hamstring stretching was performed in a standing position with the pelvis in an anterior pelvic tilt (Sullivan et al. 1992). At the initial treatment session, subjects were instructed on how to achieve an anterior pelvic tilt position prior to the stretching procedure. All subjects demonstrated the ability to obtain an anterior pelvic tilt in the standing position prior to the stretching procedure. Subjects were instructed to face a table or chair and place the heel of the leg to be stretched on the table or chair seat (this was determined by the subject's comfort and his/her ability to maintain an anterior pelvic tilt) and keep their hands on their hips. Subjects were then instructed to maintain their head horizontal and the stretched leg fully extended while retracting their scapulae and increasing their lumbar lordosis (Plate 3.1). Then they were asked to move their trunks forward at the pelvis until they perceived a hamstring stretching sensation without pain. (Sullivan et al. 1992) Each subject stretched both legs during the treatment session.

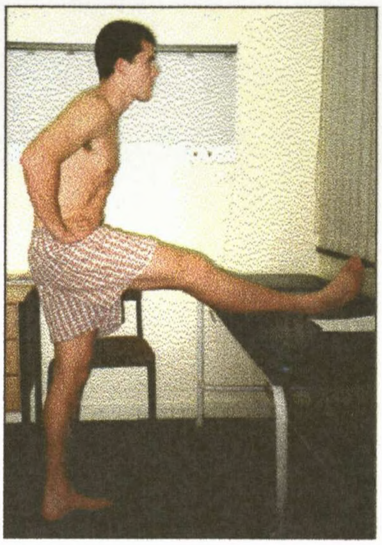


Plate 3.1 Anterior pelvic tilt stretching position.

The regimen consisted of three sets of slow, static stretching for thirty seconds, which has been shown to be an effective duration for enhancing the extensibility of the hamstring muscles (Bandy and Irion 1994), with each set being separated by 15 seconds. The duration of static stretch was directly supervised and timed with a stopwatch. Subjects were monitored during each stretching session to ensure proper performance of the stretching method. During the research period, subjects were asked to refrain from hamstring stretching activities.

The experimental design of the study involved lumbar spine ranges of motion (as determined by a goniometer) and hamstring flexibility (as determined by an inclinometer).

Lumbar spine ranges of motion were measured in flexion, extension, left lateral flexion, right lateral flexion, left rotation and right rotation, with the use of a BROM II (back range of motion) goniometer, supplied by Performance Attainment Associates (3600 LA Bore Rd, Suite 6, Saint Paul, MN 551100-4144). The BROM II has been found to be a reliable instrument in the measurement of certain planes of lumbar mobility (Breum et al. 1995). The goniometer consisted of two sets of instruments: one used for the measurement of flexion and extension (part A), and one (part B) utilised for left and right lateral flexion (with a coronal-facing compass) and left and right rotation (with a horizontal- facing compass). The method of measurements utilised is as follows:

For flexion and extension: marks were made on the skin over the S1 process below (point 1) and the T12 spinous process above (point 2). The fulcrum of part A of the goniometer was then placed over point 1, and the velcro straps secured around the patients waist, whilst the goniometer's marker was then placed at point 2. This reading was then recorded as an initial reading. The patient was then asked to bend forward as far as possible, whilst the goniometer was held firm so as to prevent any movement off the aforementioned points. At the limit of flexion, a second reading was taken. The first reading was then subtracted from this second reading in order to obtain the number of degrees for flexion. The patient was then asked to stand up straight once more and another initial reading (for extension) was taken. The patient was then instructed to bend backwards as far as possible, again whilst the goniometer was held firm so as to prevent any movement off the aforementioned points, and at this limit, the second reading for extension was taken. This reading was then subtracted from the first to obtain the number of degrees for extension.

For left and right lateral flexion: part B of the goniometer was used. A magnet was velcro strapped to the original point 2 (T12 spinous process) and the two bases of part B were placed horizontally on either side of the L4 spinous process so that the coronal-facing compass faced the researcher in the coronal plane. The goniometers compass was then allowed to point downwards and an intial reading was taken. Then the patient was asked to laterally bend to the left as far as possible, whilst the goniometer was held firmly so as to prevent any movement off the above-mentioned position. A second reading was taken and the difference between first and second readings calculated. This represented the number of degrees for left lateral flexion. This procedure was then repeated for right lateral flexion and a reading taken, which indicated the number of degrees for right lateral flexion.

For left and right rotation: part B of the goniometer was again used, with the instrument in the same position as for left and right lateral flexion. However, this time the horizontal-facing compass was used for taking readings. An initial reading was taken. The patient was then instructed to rotate as much to the left as possible and a second reading taken. The difference between the two readings represented the number of degrees for left rotation. This procedure was repeated for right rotation, and another reading taken which indicated the number of degrees for right rotation. The readings were then recorded in the patients' files.

Hamstring flexibility was measured with the use of an electronic inclinometer, supplied by Saunders Therapy Products (Bloomington, MN 551100-4144). The Active-Knee-Extension test (Gajdosik and Lusin 1983) was used to assess hamstring flexibility and was performed in the following way:

Starting position: The subject relaxed supine on an examination table for 5 minutes prior to the test. The subject was then positioned supine on an examination table with the uninvolved lower extremity secured to the table with a 75mm wide Velcro strap across the thigh. Another 75mm wide Velcro strap was placed over the anterior iliac spines of the pelvis for pelvic stabilisation. The inclinometer was placed one inch below and parallel to the fibular head (Sullivan et al. 1993). The use of an inclinometer eliminated the need to establish an axis of motion because it responded to gravity. The hip and knee angles were visually estimated at 90 degrees with the distal anterior surface of the thigh in contact with the crossbar on a metal frame. The subject was then instructed to maintain contact with the crossbar with the knee relaxed in flexion and the ankle in plantar flexion (Plate 3.2).

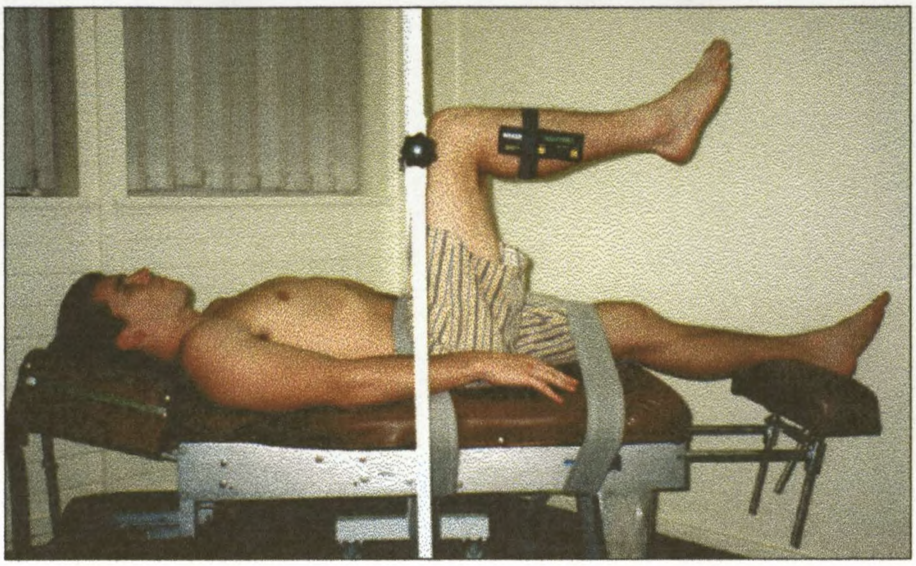


Plate 3.2 Starting position for the Active-Knee-Extension test for determining hamstring muscle length.

Movement and end point: From the above position, the subject was instructed to actively extend the knee while maintaining contact of the thigh with the crossbar. The subject was instructed to extend the knee to the point of initial, mild resistance of the hamstring muscles and not to force the leg past this point (Plate 3.3). Knee extension at this end point, which represented the degree of hamstring tightness, was then recorded once the inclinometer reading stabilized, and the average of three readings was recorded. This test was performed bilaterally and the sum of the readings divided by two and recorded.

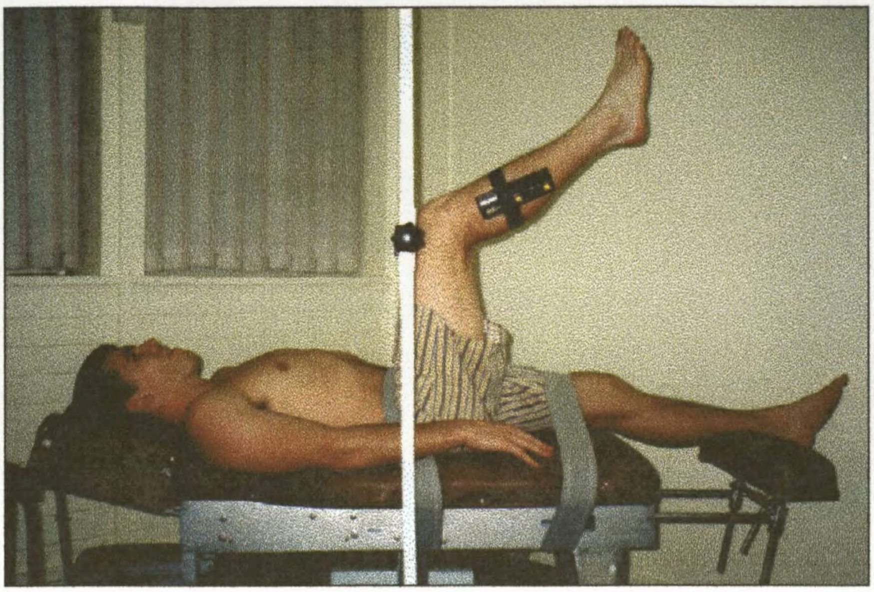


Plate 3.3 End position for the Active-Knee-Extension test for determining hamstring muscle length.

The descriptive survey design used the Oswestry Low Back Pain Disability Questionaire (Appendix D), the short-form McGill Pain Questionnaire (Appendix E) and the Numerical Pain Rating Scale-101 (Appendix F). According to McDowell and Newell (1987: 239-259), as well as Triano et al. (1993), both the Oswestry Low Back Pain Disability Questionaire and the Numerical Pain Rating Scale-101 are accepted as valid and reliable measurement criteria. Furthermore, Jensen et al. (1986) found the 101-point rating scale the most practical index when compared to six other methods of measuring clinical pain intensity.

The Oswestry Low Back Pain Disability Questionnaire consists of ten sections of six questions each. For each section, the total possible score is 5 points, with the point distribution ranging from zero (if the first statement of the respective section was marked) to five (if the sixth [last] statement was chosen). Upon completion of the questionnaire, the points for each section were added, with the maximum possible score being fifty. The final score was then converted to a percentage for each patient, for that particular consultation. In the event that one section was not completed, the highest possible score became 45 and the total score was then calculated out of 45, and then converted to a percentage. Similarly, if more than one section was not answered, the total score was then divided by five less points per section unanswered before converting to a percentage. (Fairbank et al. 1980.) These scores were calculated and recorded on the patients' files at the times of data collection.

The short-form McGill Pain Questionnaire was analysed as follows: points were allocated to each word in each column (of mild, moderate, and severe) for the sensory dimension of pain experience (ie: the first eleven words on the questionnaire). Each patient's response for each word was then added together, divided by 91,89, and then multiplied by 100 in order to obtain a percentage. (Melzack and Katz 1992: 152-167.) This was done before the first, sixth and follow-up consultations for each patient, with the results being recorded in the patients' files.

The Numerical Pain Rating Scale-101, a numerical pain intensity scale, was used to measure the subjective response of patients to treatment in terms of their perception of the pain intensity. The questionnaire instructed the patient to rate their pain at its worst and at its least on a numerical scale of zero to one hundred, with zero indicating "no pain at all" and one hundred indicating "pain as bad as it could be". This data was collected at the respective times and recorded in the patients' files. The average pain intensity was calculated by adding the values representing worst and least pain and then dividing this figure by two. (Jensen et al. 1986.) The average pain intensity experienced by each patient over the treatment and follow-up periods were then utilised for statistical analysis.

Statistical analysis was taken over two periods: viz: the treatment and the follow-up periods.

Due to the fact that the population size numbered only thirty-two, non-parametric test statistics (ie: the Wilcoxon's Sign Ranked test and the Mann-Whitney unpaired two-tailed test) were used in analysing the data. Statistical analyses therefore assume that the population is symmetric (ie: normally distributed).

The data was analysed using the computer software programme STATGRAPHICS PLUS, VERSION 6, supplied by Manugistics, Inc.

The Wilcoxon's Sign Ranked Test was used to determine whether any significant change occurred between the initial and final treatments, the initial and follow-up appointments, and between the final treatment and the one month follow-up consultation, within each study group. In each respective hypothesis test conducted, the null hypothesis (Ho) stated that no significant difference existed between for example the initial and final consultation. The null hypothesis (Ho) was rejected if the P-value was less than α and it was concluded that there was a significant difference within the group at the $\alpha = 0,05$ level of significance. Ho was accepted if P was greater than or equal to α with the conclusion that there was no significant difference within the group at the $\alpha = 0,05$

level of significance. The P-value was calculated by dividing the two-tailed probability by 2 at a 95% level of significance and was therefore expressed as statistically significant if it was equal to or less than 0.025.

The Mann-Whitney U-test was used to determine whether any significant difference existed between the two groups at the time of initial, final or follow-up consultations. Each respective hypothesis test conducted was treated similarly to that described for the Wilcoxon's Sign Ranked Test.

Summary statistics (mean, median, standard error and standard deviation) were then obtained.

Barcharts were then constructed to provide a visual summary of results obtained from the Mann-Whitney U-tests.

3.4 THE SPECIFIC TREATMENT OF EACH OBJECTIVE

3.4.1 OBJECTIVE ONE:

The first objective of this study was to evaluate the effects of stretching of the hamstring muscles, in terms of objective and subjective clinical findings, in order to determine the efficacy of this treatment approach in the management of low back pain in cyclists.

3.4.1.1 THE DATA REQUIRED:

The data required for testing the hypothesis of objective one was the response of the patients in this group to the Oswestry Low Back Pain Disability Questionnaire (Appendix D), the short-form McGill Pain Questionnaire (Appendix E), the Numerical Pain Rating Scale-101 (Appendix F), the readings obtained for lumbar spine ranges of motion and knee extension.

3.4.1.2 HOW THE DATA WAS SECURED:

All data was collected from the participating patients treated at Technikon Natal's Chiropractic Day Clinic.

This data was recorded in each patient's file at the afore-mentioned times of data collection.

All questionnaires were completed under the researcher's supervision.

3.4.2 OBJECTIVE TWO:

The second objective of this study was to evaluate the efficacy of stretching of the hamstring muscles, in terms of subjective clinical findings, in the treatment of low back pain in cyclists.

3.4.2.1 THE DATA REQUIRED:

The data required for testing the hypothesis of objective two was the response of the patients in this group to the Oswestry Low Back Pain Disability Questionnaire (Appendix D), the short form McGill Pain Questionnaire (Appendix E), the numerical Pain Rating Scale-101 (Appendix F), the readings obtained for lumbar spine ranges of motion and knee extension.

3.4.2.2 HOW THE DATA WAS SECURED:

The data required was obtained as for objective one.

3.4.3 OBJECTIVE THREE:

The third objective of this study was to integrate the data from the above two objectives in order to determine the efficacy of stretching of the hamstring muscles in the treatment of low back pain in cyclists.

3.4.3.1 THE DATA REQUIRED:

The data required for testing the hypothesis of objective three was the response of the patients in both groups to the Oswestry Low Back Pain Disability Questionnaire (Appendix D), the short-form McGill Pain Questionnaire (Appendix E), the Numerical Pain Rating Scale-101 (Appendix F), the readings obtained for lumbar spine ranges of motion and knee extension.

3.4.3.2 HOW THE DATA WAS SECURED:

The data required was recorded in the files of all participating patients during the process of securing data for objectives one and two.

CHAPTER FOUR

4 RESULTS

4.1 INTRODUCTION

This chapter deals with the results obtained after statistically analysing the data from the measurement criteria utilised, viz:

the lumbar spine ranges of motion;
the knee extension range of motion;
the short-form McGill Pain Questionnaire;
the Numerical Pain Rating Scale-101; and
the Oswestry Low Back Pain Disability Questionnaire

The results obtained for the Wilcoxon's Sign Ranked Test are tabulated below, under the non-parametric paired hypothesis tests. The tables include the level of significance (P-value), the standard deviation (S.D.), standard error (S.E.), the mean and the median (Med.).

For the Mann-Whitney U-tests, the data is presented in table form under the non-parametric unpaired hypothesis tests. The results of the Power test are tabulated below each of the above tables so as to determine whether a type I error may have occurred, which will occur 5% of the time at a 95% confidence level. Any result of 50% (i.e.0.5) or above is acceptable, but the gold standard for the Power test is usually 80% (0.8). However, with small sample sizes, and with generally used methods of data collection, power will be typically poor.

The age and gender distributions are also tabulated following the aforementioned results.

4.2 CRITERIA GOVERNING THE ADMISSIBILITY OF THE DATA

Only the data collected from patients who met with the criteria of the design of the study was used. Only responses to the Oswestry Low Back Pain Disability Questionnaire, the short-form McGill Pain Questionnaire and the Numerical Pain Rating Scale-101, completed under the researcher's supervision were utilised. Similarly, only the readings for knee extension range of motion and lumbar spine range of motion taken by the researcher were used.

4.3 NON-PARAMETRIC WILCOXON'S SIGN RANKED TESTS

4.3.1 OBJECTIVE RESULTS

Table 4.1 Statistical results of the goniometric and inclinometer measurements comparing the first and final treatments of the experimental group

	Consultation 1					Final consultation 6			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
Flexion	27.88	28.0	6.603	1.650	**0.001**	31.73	30	5.59	1.39
Extension	7.49	7.0	2.37	0.59	**0.007**	8.71	8.5	2.98	0.74
(R) rotation	20.05	21.5	5.06	1.26	**0.004**	23.35	23.5	3.70	0.92
(L) rotation	19.88	20.5	5.70	1.42	**0.001**	23.90	25.0	4.49	1.12
(R) Lat.flex.	19.59	20.5	5.02	1.25	0.036	21.45	21.5	4.93	1.23
(L) Lat.flex.	18.01	20.0	5.31	1.32	0.34	19.94	21.0	4.57	1.14
Inclinometer	44.18	44.65	8.97	2.24	**0.0001**	51.03	51.15	8.31	2.07

POWER			
FLEXION	0.226	**(R) LAT.FLEX**	0.102
EXTENSION	0.143	**(L) LAT.FLEX**	0.173
(R) ROTATION	0.401	**INCLINOMETER**	0.721
(L) ROTATION	0.440		

The null hypothesis was rejected for all readings except right and left lateral flexion, indicating improvement from first to final treatment in the experimental group.

Table 4.2 Statistical results of the goniometric and inclinometer measurements comparing the first and follow-up treatments of the experimental group

	Consultation 1					Follow-up consultation			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
Flexion	27.88	28.0	6.603	1.650	**0.0003**	32.66	31.0	5.11	1.27
Extension	7.49	7.0	2.37	0.59	**0.008**	9.80	10.0	3.45	0.86
(R) rotation	20.05	21.5	5.06	1.26	**0.005**	23.70	24.5	3.86	0.96
(L) rotation	19.88	20.5	5.70	1.42	**0.003**	24.0	24.0	4.60	1.15
(R) Lat.flex.	19.59	20.5	5.02	1.25	0.044	22.20	21.5	4.44	1.11
(L) Lat.flex.	18.01	20.0	5.31	1.32	0.15	20.44	20.5	4.77	1.19
Inclinometer	44.18	44.65	8.97	2.24	**0.0001**	51.54	51.9	8.32	2.08

POWER			
FLEXION	0.071	**(R) LAT.FLEX**	0.214
EXTENSION	0.440	**(L) LAT.FLEX**	0.974
(R) ROTATION	0.473	**INCLINOMETER**	0.952
(L) ROTATION	0.452		

The null hypothesis was rejected for all readings except right and left lateral flexion, indicating improvement from first to follow-up treatment in the experimental group.

Table 4.3 Statistical results of the goniometric and inclinometer measurements comparing the final and follow-up treatments of the experimental group

	Final consultation 6					Follow-up consultation			
	Mean	Med.	S.D.	S.E.	p-value	Mean	Med.	S.D.	S.E.
Flexion	31.73	30	5.59	1.39	0.06	32.66	31.0	5.11	1.27
Extension	8.71	8.5	2.98	0.74	**0.015**	9.80	10.0	3.45	0.86
(R) rotation	23.35	23.5	3.70	0.92	0.26	23.70	24.5	3.86	0.96
(L) rotation	23.90	25.0	4.49	1.12	0.34	24.0	24.0	4.60	1.15
(R) Lat.flex.	21.45	21.5	4.93	1.23	0.61	22.20	21.5	4.44	1.11
(L) Lat.flex.	19.94	21.0	4.57	1.14	0.54	20.44	20.5	4.77	1.19
Inclinometer	51.03	51.15	8.31	2.07	0.21	51.54	51.9	8.32	2.08

POWER			
FLEXION	0.646	(R) LAT.FLEX	0.037
EXTENSION	0.088	(L) LAT.FLEX	0.030
(R) ROTATION	0.029	INCLINOMETER	0.021
(L) ROTATION	0.025		

The null hypothesis was accepted for all readings except extension, which indicated that only lumbar spine extension demonstrated a significant statistical improvement between the final and follow-up treatments in the experimental group.

Table 4.4 Statistical results of the goniometric and inclinometer measurements comparing the first and final treatments of the placebo group

	Consultation 1					**Final consultation 6**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
Flexion	27.36	29.0	4.55	1.13	0.38	27.6	29.0	4.29	1.07
Extension	7.93	8.0	2.13	0.53	0.72	7.92	8.0	1.89	0.47
(R) rotation	20.45	21.0	4.98	1.24	0.38	20.96	21.0	5.36	1.34
(L) rotation	20.52	20.5	4.25	1.06	0.07	20.91	21.0	4.88	1.22
(R) Lat.flex.	18.39	19.0	4.16	1.04	0.26	19.19	20.0	3.66	0.91
(L) Lat.flex.	18.0	19.5	3.79	0.94	0.15	17.94	21.0	4.57	1.14
Inclinometer	48.31	48.35	10.70	2.67	0.095	49.16	48.8	10.52	2.63

POWER			
FLEXION	0.026	**(R) LAT.FLEX**	0.037
EXTENSION	0.025	**(L) LAT.FLEX**	0.035
(R) ROTATION	0.029	**INCLINOMETER**	0.038
(L) ROTATION	0.028		

The null hypothesis was accepted for all readings, which indicated that there was no significant statistical improvement between the first and final treatments in the placebo group.

Table 4.5 Statistical results of the goniometric and inclinometer measurements comparing the first and follow-up treatments of the placebo group

	Consultation 1					**Follow-up consultation**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
Flexion	27.36	29.0	4.55	1.13	0.57	27.98	28.5	3.87	0.96
Extension	7.93	8.0	2.13	0.53	0.77	8.18	8.0	1.53	0.38
(R) rotation	20.45	21.0	4.98	1.24	0.38	20.93	22.0	5.09	1.27
(L) rotation	20.52	20.5	4.25	1.06	0.14	20.94	21.0	4.16	1.04
(R) Lat.flex.	18.39	19.0	4.16	1.04	0.75	19.0	20.0	3.47	0.86
(L) Lat.flex.	18.0	19.5	3.79	0.94	1.0	17.81	19.0	3.39	0.84
Inclinometer	48.31	48.35	10.70	2.67	0.081	49.34	49.25	10.61	2.65

POWER			
FLEXION	0.035	**(R) LAT.FLEX**	0.037
EXTENSION	0.033	**(L) LAT.FLEX**	0.026
(R) ROTATION	0.029	**INCLINOMETER**	0.047
(L) ROTATION	0.029		

The null hypothesis was accepted for all readings, which indicated that there was no significant statistical improvement between the first and follow-up treatments in the placebo group.

Table 4.6 Statistical results of the goniometric and inclinometer measurements comparing the final and follow-up treatments of the placebo group

	Final consultation 6					Follow-up consultation			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
Flexion	27.6	29.0	4.29	1.07	1.0	27.98	28.5	3.87	0.96
Extension	7.92	8.0	1.89	0.47	0.44	8.18	8.0	1.53	0.38
(R) rotation	20.96	21.0	5.36	1.34	0.75	20.93	22.0	5.09	1.27
(L) rotation	20.91	21.0	4.88	1.22	0.77	20.94	21.0	4.16	1.04
(R) Lat flex.	19.19	20.0	3.66	0.91	1.0	19.0	20.0	3.47	0.86
(L) Lat. flex.	17.94	21.0	4.57	1.14	0.82	17.81	19.0	3.39	0.84
Inclinometer	59.16	48.8	10.52	2.63	0.61	49.34	49.25	10.61	2.65

POWER			
FLEXION	0.029	**(R) LAT. FLEX**	0.026
EXTENSION	0.036	**(L) LAT. FLEX**	0.029
(R) ROTATION	0.025	**INCLINOMETER**	0.025
(L) ROTATION	0.025		

The null hypothesis was accepted for all readings, which indicated that there was no significant statistical improvement between the first and follow-up treatments in the placebo group.

4.3.2 SUBJECTIVE RESULTS

Table 4.7 Statistical results of the short-form McGill Pain Questionnaire, Numerical Rating Scale-101, and Oswestry Low Back Pain Disability Questionnaire comparing the first and final treatments of the experimental group

	Consultation 1					**Final consultation 6**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
S-F McGill	24.61	26.62	10.59	2.64	0.0001	10.65	11.62	7.14	1.78
NRS-101	42.86	42.80	7.37	1.59	0.0001	16.72	15.0	7.78	1.94
Oswestry	19.0	21.0	10.95	2.73	0.0003	10.93	11.0	5.11	1.27

POWER	
SHORT-FORM MCGILL	1.00
NRS-101	1.00
OSWESTRY	0.941

The null hypothesis was rejected for all readings, which indicated that there was a significant statistical improvement between the first and final treatments in the experimental group for all the questionnaires.

Table 4.8 Statistical results of the short-form McGill Pain Questionnaire, Numerical Rating Scale-101, and Oswestry Low Back Pain Disability Questionnaire comparing the first and follow-up treatments of the experimental group

	Consultation 1					Follow-up consultation			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
S-F McGill	24.61	26.62	10.59	2.64	**0.0001**	5.2	4.91	5.49	1.37
NRS-101	42.86	42.80	7.37	1.59	**0.0005**	8.85	8.75	3.74	0.93
Oswestry	19.0	21.0	10.95	2.73	**0.008**	10.95	10.0	4.04	1.01

POWER	
SHORT-FORM MCGILL	1.00
NRS-101	0.952
OSWESTRY	1.00

The null hypothesis was rejected for all readings, which indicated that there was a significant statistical improvement between the first and follow-up treatments in the experimental group for all the questionnaires.

Table 4.9 Statistical results of the short-form McGill Pain Questionnaire, Numerical Rating Scale-101, and Oswestry Low Back Pain Disability Questionnaire comparing the final and follow-up treatments of the experimental group

	Final consultation 6					**Follow-up consultation**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
S-F McGill	10.65	11.62	7.14	1.78	**0.003**	5.2	4.91	5.49	1.37
NRS-101	16.72	15.0	7.78	1.94	**0.0003**	8.85	8.75	3.74	0.93
Oswestry	10.93	11.0	5.11	1.27	0.91	10.95	10.0	4.04	1.01

POWER	
SHORT-FORM MCGILL	0.985
NRS-101	0.873
OSWESTRY	0.247

The null hypothesis was rejected for the short-form McGill Pain Questionnaire and Numerical Rating Scale-101 readings, which indicated that there was a significant statistical improvement between the final and follow-up treatments in the experimental group for these questionnaires.

Table 4.10 Statistical results of the short-form McGill Pain Questionnaire, Numerical Rating Scale-101, and Oswestry Low Back Pain Disability Questionnaire comparing the first and final treatments of the placebo group

	Consultation 1					**Final consultation 6**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
S-F McGill	21.54	20.82	14.68	3.67	**0.001**	16.54	17.56	14.89	3.72
NRS-101	37.42	40.0	7.94	1.98	0.05	30.02	30.0	7.63	1.90
Oswestry	13.90	12.0	10.47	2.61	0.97	13.77	11.0	8.80	2.20

POWER	
SHORT-FORM MCGILL	0.712
NRS-101	0.904
OSWESTRY	0.025

The null hypothesis was rejected for the short-form McGill Pain Questionnaire readings, which indicated that there was a significant statistical improvement between the first and final treatments in the placebo group for this questionnaire. The null hypothesis was accepted for all the other readings, indicating that there was no statistical improvement for the remaining questionnaires.

Table 4.11 Statistical results of the short-form McGill Pain Questionnaire, Numerical Rating Scale-101, and Oswestry Low Back Pain Disability Questionnaire comparing the first and follow-up treatments of the placebo group

	Consultation 1					**Follow-up consultation**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
S-F McGill	21.54	20.82	14.68	3.67	0.0001	15.61	15.75	14.18	3.54
NRS-101	37.42	40.0	7.94	1.98	0.05	29.13	30.0	6.70	1.67
Oswestry	13.90	12.0	10.47	2.61	0.77	12.55	12.0	9.17	2.29

POWER	
SHORT-FORM MCGILL	0.881
NRS-101	0.973
OSWESTRY	0.062

The null hypothesis was rejected for the short-form McGill Pain Questionnaire readings, which indicated that there was a significant statistical improvement between the final and follow-up treatments in the placebo group for this questionnaire. The null hypothesis was accepted for all the other readings, indicating that there was no statistical improvement for the remaining questionnaires.

Table 4.12 Statistical results of the short-form McGill Pain Questionnaire, Numerical Rating Scale-101, and Oswestry Low Back Pain Disability Questionnaire comparing the final and follow-up treatments of the placebo group

	Final consultation 6					**Follow-up consultation**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
S-F McGill	16.54	17.56	14.89	3.72	0.09	15.61	15.75	14.18	3.54
NRS-101	30.02	30.0	7.63	1.90	0.11	29.13	30.0	6.70	1.67
Oswestry	13.77	11.0	8.80	2.20	0.13	12.55	12.0	9.17	2.29

POWER	
SHORT-FORM MCGILL	0.042
NRS-101	0.047
OSWESTRY	0.053

According to the above table there was no significant improvement within the placebo group from the final to follow-up consultations for any of the subjective questionnaires. The null hypothesis is therefore accepted for all of the above readings.

4.4 NON-PARAMETRIC MANN-WHITNEY UNPAIRED TESTS

4.4.1 OBJECTIVE RESULTS

Table 4.13 Statistical results of the goniometric and inclinometer measurements comparing the initial lumbar ranges of motion and hamstring flexibility readings of the experimental and placebo groups

	EXPERIMENTAL GROUP Consultation 1					**PLACEBO GROUP Consultation 1**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
Flexion	27.88	28.0	6.603	1.650	0.83	27.36	29.0	4.55	1.13
Extension	7.49	7.0	2.37	0.59	0.52	7.93	8.0	2.13	0.53
(R) rotation	20.05	21.5	5.06	1.26	0.90	20.45	21.0	4.98	1.24
(L) rotation	19.88	20.5	5.70	1.42	0.90	20.52	20.5	4.25	1.06
(R) Lat.flex.	19.59	20.5	5.02	1.25	0.38	18.39	19.0	4.16	1.04
(L) Lat.flex.	18.01	20.0	5.31	1.32	0.67	18.0	19.5	3.79	0.94
Inclinometer	44.18	44.65	8.97	2.24	**0.022**	48.31	48.35	10.70	2.67

POWER			
FLEXION	0.029	**(R) LAT.FLEX**	0.059
EXTENSION	0.043	**(L) LAT.FLEX**	0.025
(R) ROTATION	0.028	**INCLINOMETER**	0.66
(L) ROTATION	0.032		

The null hypothesis was rejected for hamstring flexibility, which indicated a significant difference between the groups.

Table 4.14 Statistical results of the goniometric and inclinometer measurements comparing the final lumbar ranges of motion and hamstring flexibility readings of the experimental and placebo groups

	EXPERIMENTAL GROUP Final Consultation 6					**PLACEBO GROUP Final Consultation 6**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
Flexion	31.73	30	5.59	1.39	0.04	27.6	29.0	4.29	1.07
Extension	8.71	8.5	2.98	0.74	0.41	7.92	8.0	1.89	0.47
(R) rotation	23.35	23.5	3.70	0.92	0.21	20.96	21.0	5.36	1.34
(L) rotation	23.90	25.0	4.49	1.12	0.13	20.91	21.0	4.88	1.22
(R) Lat.flex.	21.45	21.5	4.93	1.23	0.20	19.19	20.0	3.66	0.91
(L) Lat.flex.	19.94	21.0	4.57	1.14	**0.01**	17.94	21.0	4.57	1.14
Inclinometer	51.03	51.15	8.31	2.07	0.33	49.16	48.8	10.52	2.63

POWER			
FLEXION	0.494	**(R) LAT.FLEX**	0.190
EXTENSION	0.076	**(L) LAT.FLEX**	0.268
(R) ROTATION	0.190	**INCLINOMETER**	0.166
(L) ROTATION	0.291		

The null hypothesis was rejected for left lateral flexion, which indicated a significant difference between the groups.

Table 4.15 Statistical results of the goniometric and inclinometer measurements comparing the follow-up lumbar ranges of motion and hamstring flexibility readings of the experimental and placebo groups

	EXPERIMENTAL GROUP Follow-up Consultation					**PLACEBO GROUP Follow-up Consultation**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
Flexion	32.66	31.0	5.11	1.27	**0.002**	27.98	28.5	3.87	0.96
Extension	9.80	10.0	3.45	0.86	0.06	8.18	8.0	1.53	0.38
(R) rotation	23.70	24.5	3.86	0.96	0.08	20.93	22.0	5.09	1.27
(L) rotation	24.0	24.0	4.60	1.15	0.05	20.94	21.0	4.16	1.04
(R) Lat.flex.	22.20	21.5	4.44	1.11	0.04	19.0	20.0	3.47	0.86
(L) Lat.flex.	20.44	20.5	4.77	1.19	0.10	17.81	19.0	3.39	0.84
Inclinometer	51.54	51.9	8.32	2.08	0.32	49.34	49.25	10.61	2.65

POWER			
FLEXION	0.573	**(R) LAT.FLEX**	0.466
EXTENSION	0.033	**(L) LAT.FLEX**	0.289
(R) ROTATION	0.268	**INCLINOMETER**	0.233
(L) ROTATION	0.352		

The null hypothesis was rejected for flexion, which indicated a significant difference between the groups at the follow-up consultation for this range of motion.

Figure 4.1 Median values of flexion at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups

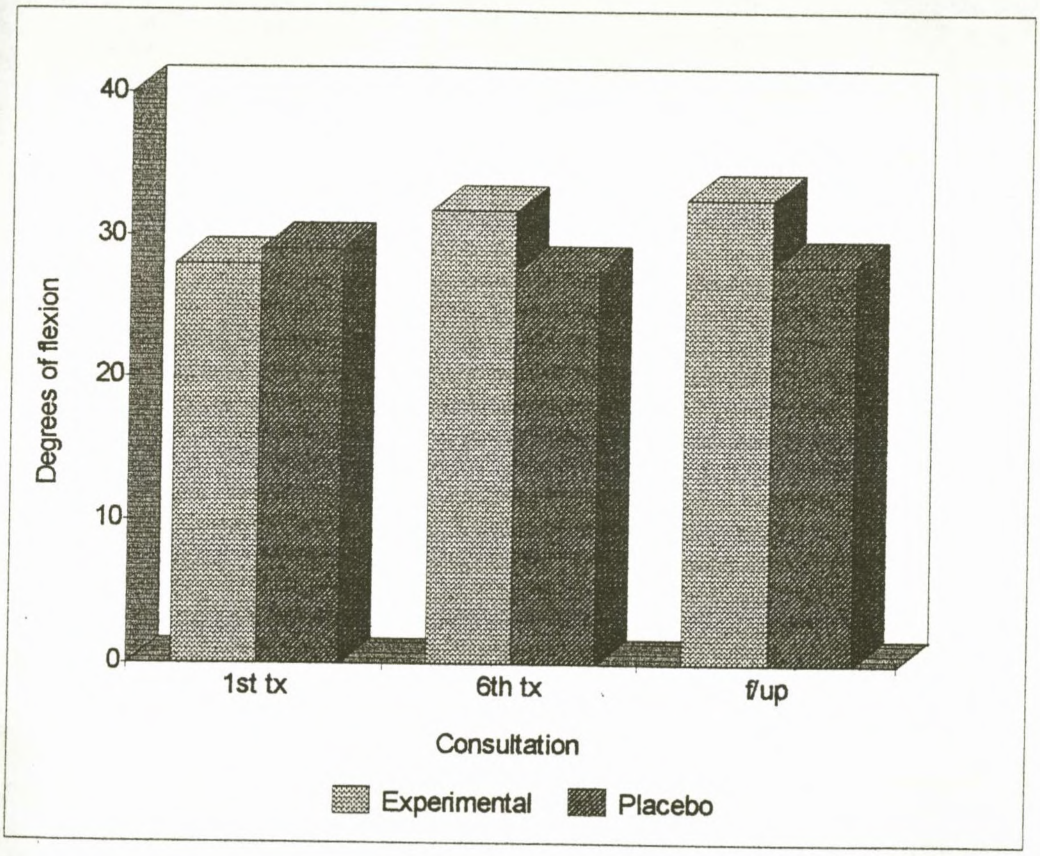


FIGURE 4.2 Median values of extension at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups

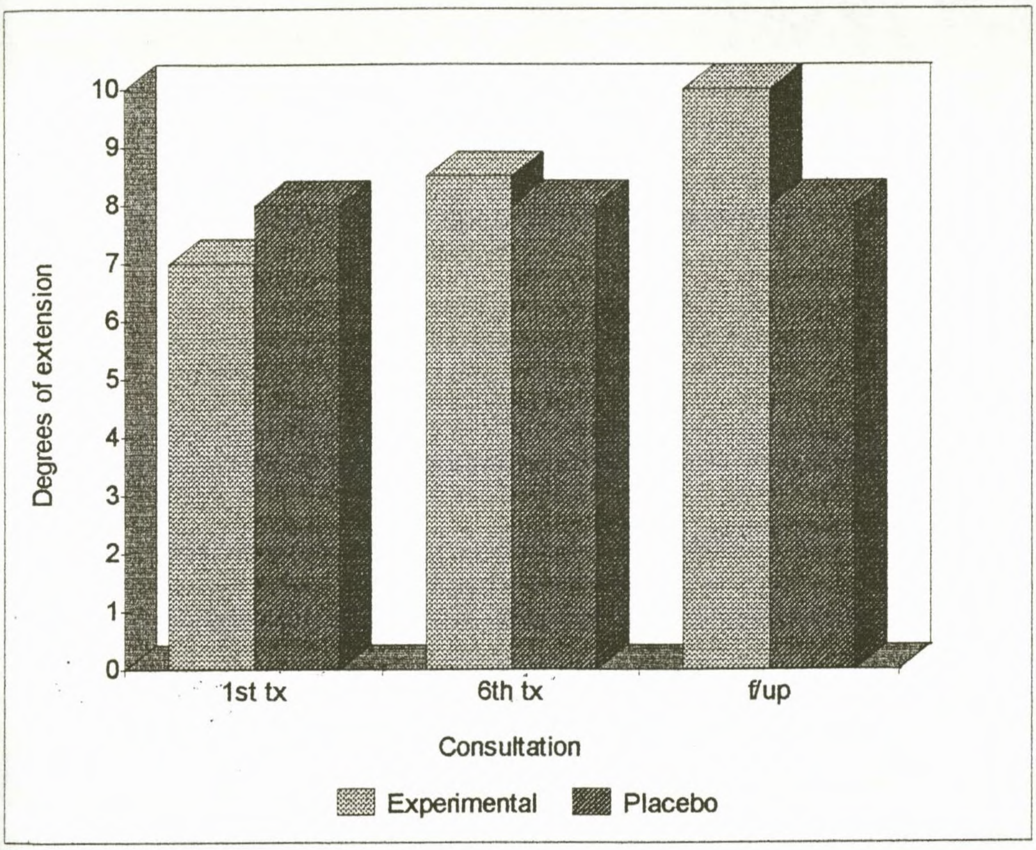


FIGURE 4.3 Median values of right rotation at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups

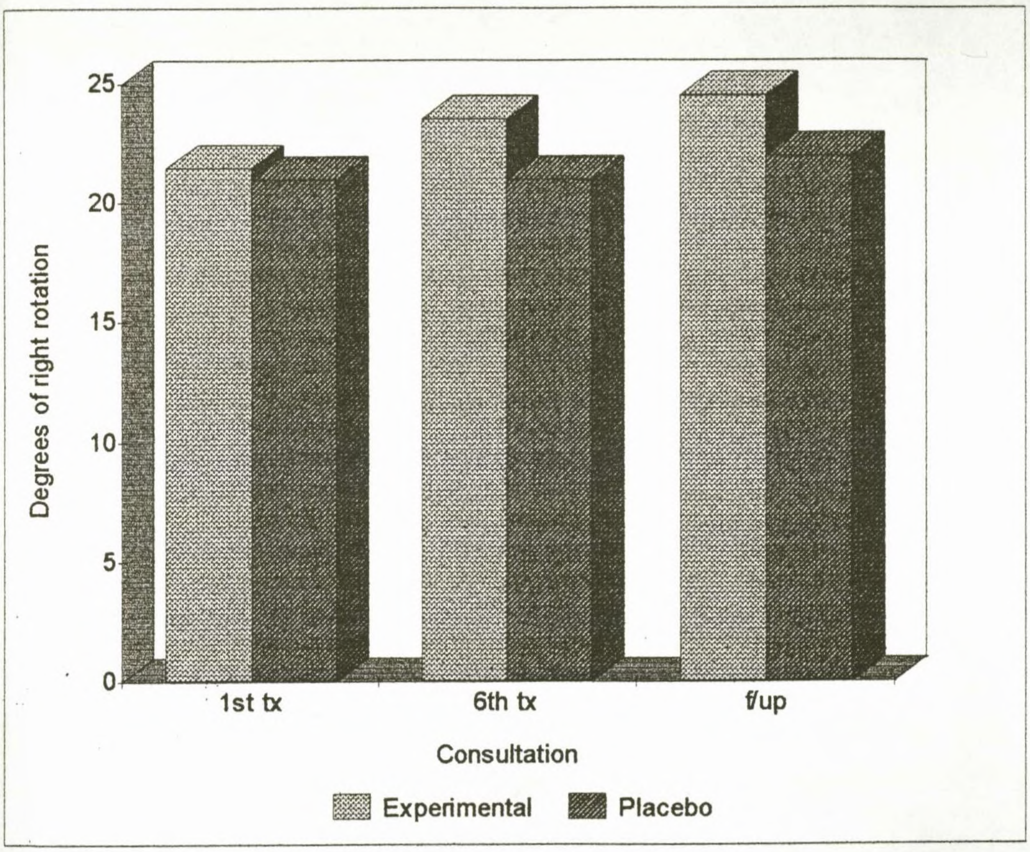


FIGURE 4.4 Median values of left rotation at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups

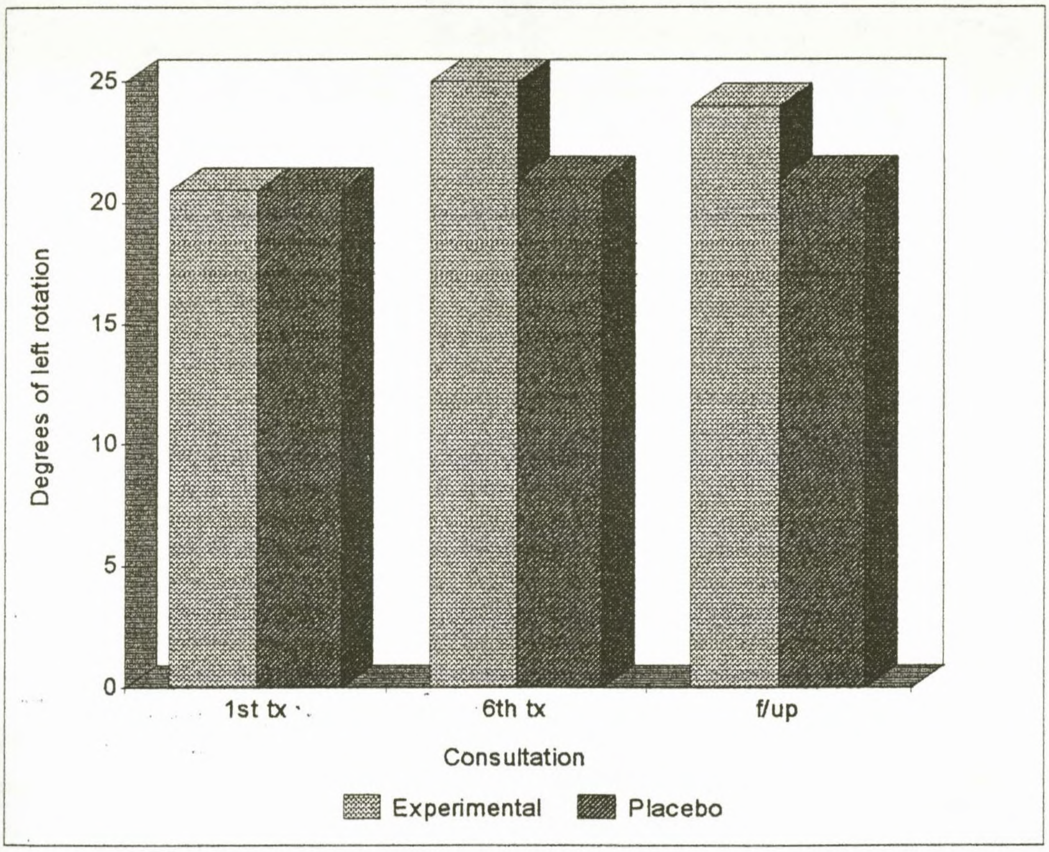


FIGURE 4.5 Median values of right lateral flexion at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups

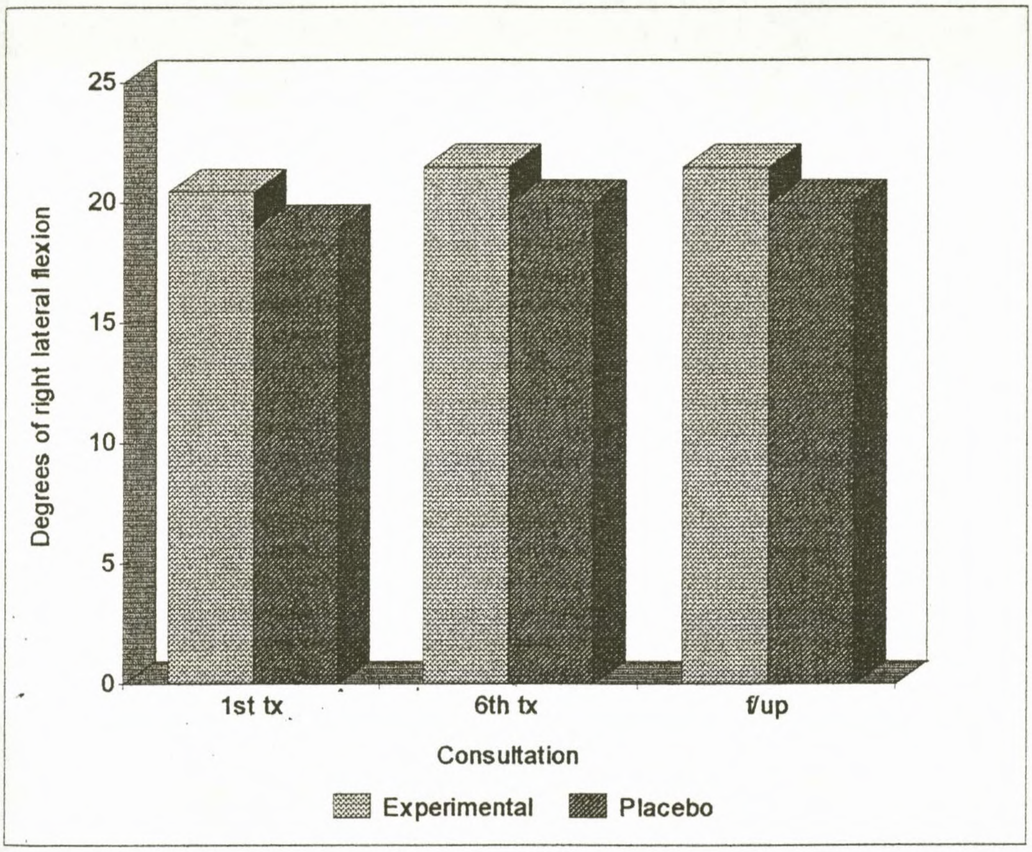


FIGURE 4.6 Median values of left lateral flexion at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups

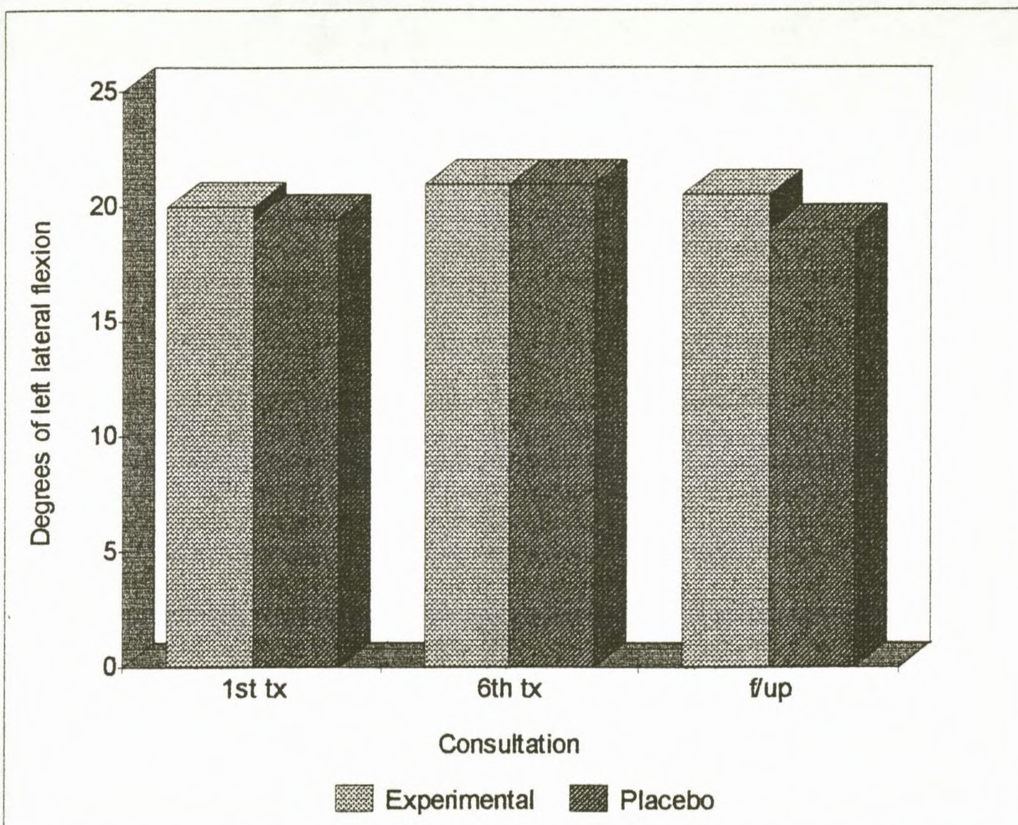
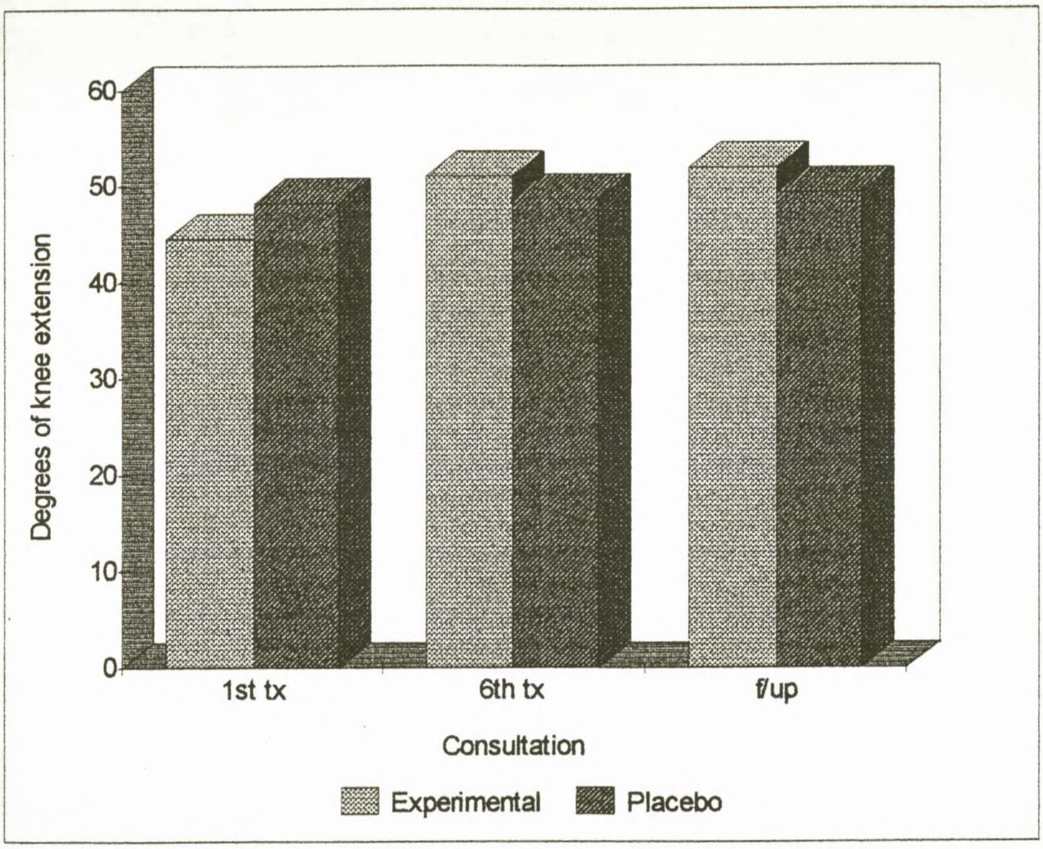


FIGURE 4.7 Median values of hamstring flexibility at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups



4.4.2 SUBJECTIVE RESULTS

Table 4.16 Statistical results of the short-form McGill Pain Questionnaire, Numerical Rating Scale-101, and Oswestry Low Back Pain Disability Questionnaire comparing the initial readings for the experimental and placebo groups

	EXPERIMENTAL GROUP Consultation 1					PLACEBO GROUP Consultation 1			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
S-F McGill	24.61	26.62	10.59	2.64	0.34	21.54	20.82	14.68	3.67
NRS-101	42.86	42.80	7.37	1.59	0.59	37.42	40.0	7.94	1.98
Oswestry	19.0	21.0	10.95	2.73	0.16	13.90	12.0	10.47	2.61

POWER	
SHORT-FORM MCGILL	0.259
NRS-101	0.033
OSWESTRY	0.716

The null hypothesis was accepted for all readings, which indicated that there was no significant difference between the groups at the first treatment for the subjective questionnaires.

Table 4.17 Statistical results of the short-form McGill Pain Questionnaire, Numerical Rating Scale-101, and Oswestry Low Back Pain Disability Questionnaire comparing the final readings for the experimental and placebo groups

	EXPERIMENTAL GROUP Final Consultation 6					**PLACEBO GROUP Final Consultation 6**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
S-F McGill	10.65	11.62	7.14	1.78	0.03	16.54	17.56	14.89	3.72
NRS-101	16.72	15.0	7.78	1.94	**0.00006**	30.02	30.0	7.63	1.90
Oswestry	10.93	11.0	5.11	1.27	0.13	13.77	11.0	8.80	2.20

POWER	
SHORT-FORM MCGILL	0.027
NRS-101	1.00
OSWESTRY	0.140

The null hypothesis was rejected for the Numerical Rating Scale-101, which indicated that there was a significant difference between the groups at the final treatment for this questionnaire.

Table 4.18 Statistical results of the short-form McGill Pain Questionnaire, Numerical Rating Scale-101, and Oswestry Low Back Pain Disability Questionnaire comparing the follow-up readings for the experimental and placebo groups

	EXPERIMENTAL GROUP Follow-up Consultation					**PLACEBO GROUP Follow-up Consultation**			
	Mean	**Med.**	**S.D.**	**S.E.**	**p-value**	**Mean**	**Med.**	**S.D.**	**S.E.**
S-F McGill	5.20	4.91	5.49	1.37	**0.0003**	15.61	15.75	14.18	3.54
NRS-101	8.85	8.75	3.74	0.93	**0.000001**	29.13	30.0	6.70	1.67
Oswestry	10.95	10.0	4.04	1.01	**0.01**	12.55	12.0	9.17	2.29

POWER	
SHORT-FORM MCGILL	0.332
NRS-101	1.00
OSWESTRY	0.449

The null hypothesis was rejected for all three questionnaires, which indicated that there was a significant difference between the groups at the follow-up treatment for these questionnaires.

FIGURE 4.8 Median values of the short-form McGill Pain Questionnaire at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups

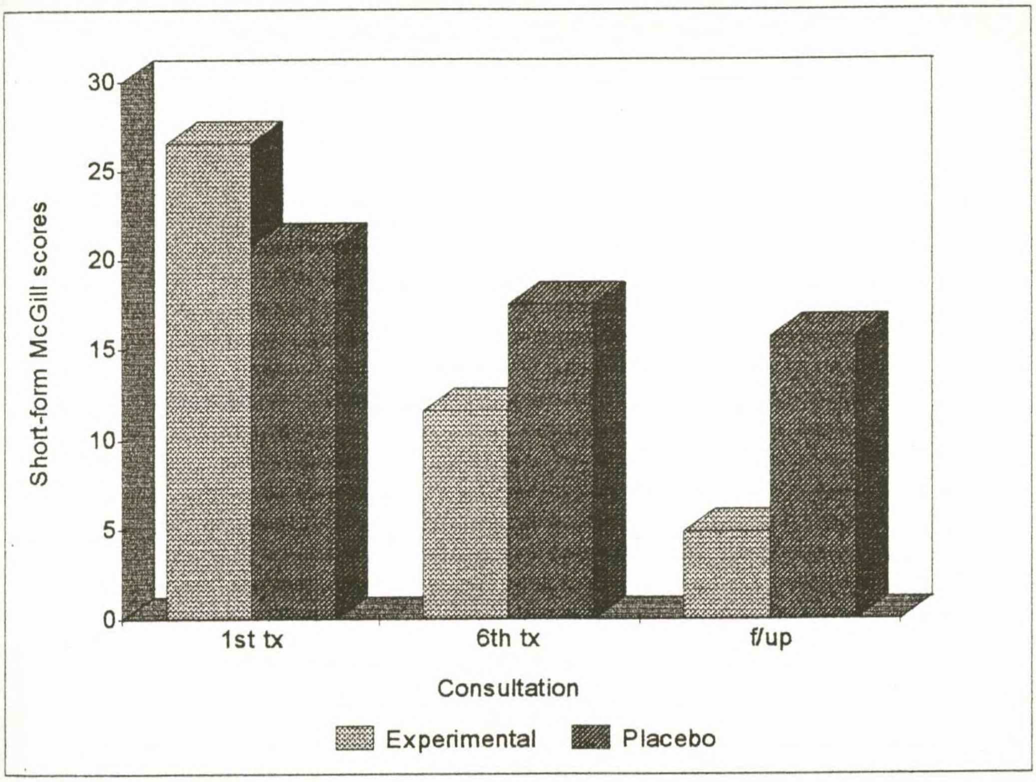


FIGURE 4.9 Median values of the Numerical Rating Scale-101 at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups

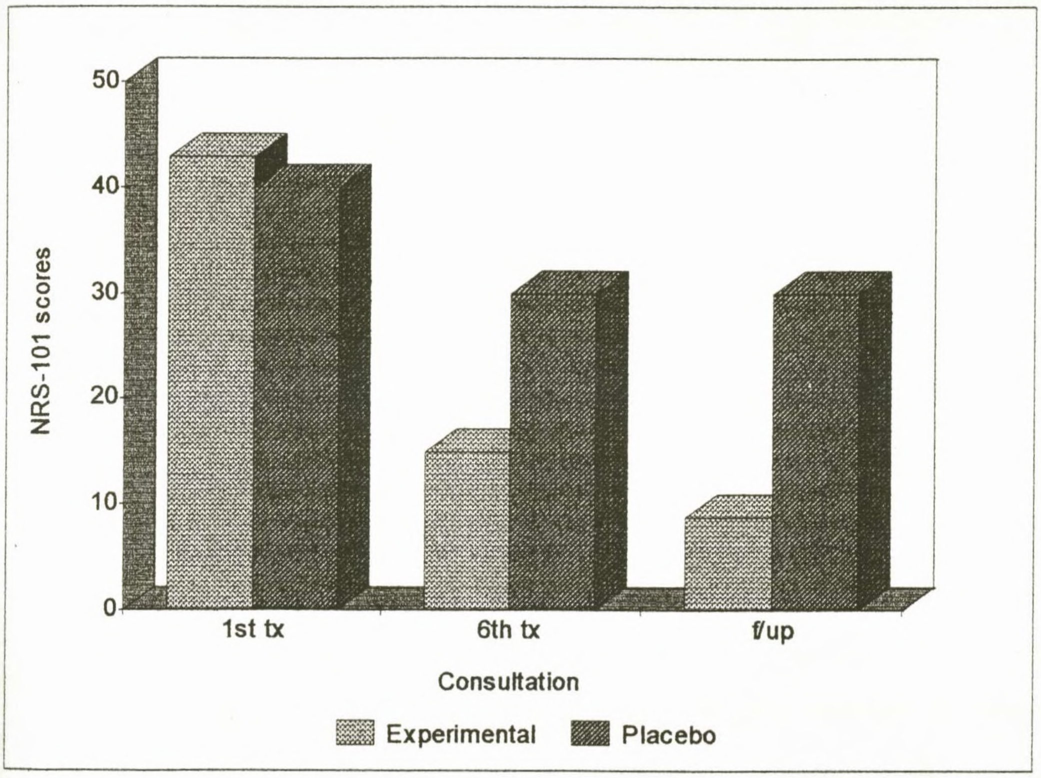
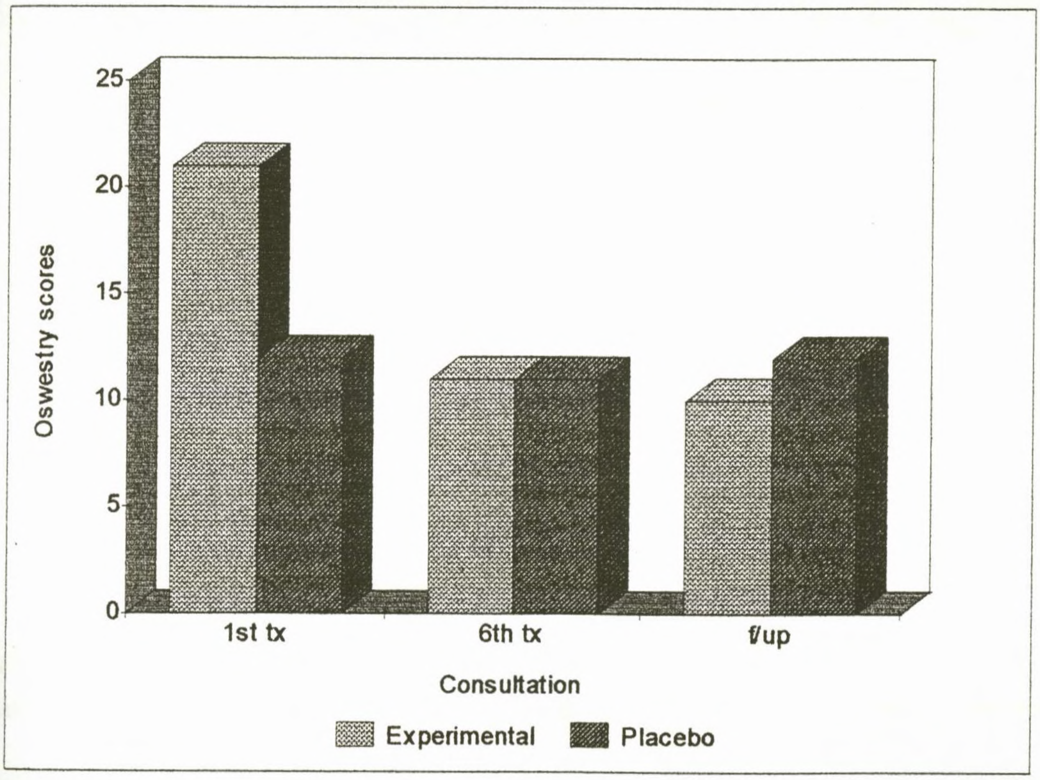


FIGURE 4.10 Median values of the Oswestry Low Back Pain Disability Questionnaire at the first treatment, final treatment and follow-up consultation comparing the experimental and placebo groups



4.5 POPULATION AGE AND GENDER DISTRIBUTION

TABLE 4.19 Table of average age, age range and gender distribution

	Experimental Group	**Placebo Group**
Average age	37.0 years	35.5 years
Age range	22-56	19-48
Males	14	13
Females	2	3

4.6 POPULATION SYNDROME DISTRIBUTION

TABLE 4.20 Table of facet syndrome, sacroiliac syndrome, facet and sacroiliac syndrome, and myofascial pain dysfunction syndrome.

	Experimental Group	**Placebo Group**
Facet	12	11
Sacroiliac	0	0
Facet+sacroiliac	4	5
Myofascial	12	10

4.7 GENERAL REMARKS

Of the 35 patients found eligible for inclusion in this study, three were non-compliant. All 32 patients completed the study, with no adverse effects to stretching occurring.

CHAPTER FIVE

5 DISCUSSION

5.1 INTRODUCTION

This chapter involves the discussion of results after statistical analysis of the data obtained from the goniometer and inclinometer readings, the short-form McGill Pain Questionnaire, the Numerical Pain Rating Scale-101, and the Oswestry Low Back Pain Disability Questionnaire.

The results are discussed in two parts, viz: objective and subjective results. Each measurement parameter is discussed, and involves both the intra-treatment and inter-treatment evaluation.

The evaluation of the intra-treatment results of the initial and follow-up treatments (overall treatment interval) gives an indication of the efficacy of the treatment program. The comparison of the initial and sixth treatments (first treatment interval), and the sixth and follow-up treatments (second treatment interval) are also evaluated so as to determine any residual benefits.

The evaluation of inter-treatment data, assessing the first treatment measurements, illustrates any differences in the objective and subjective findings between the placebo and experimental groups, in terms of signs and symptoms at the beginning of the study. Comparing sixth treatment data demonstrates any difference in the rate of improvement between the groups, and follow-up treatment comparison indicates the effectiveness of treatment over an extended time period.

5.2 OBJECTIVE DATA

5.2.1 RANGES OF MOTION

5.2.1.1 INTRA-TREATMENT COMPARISON:

The six lumbar spine ranges of motion were considered.

When the first and overall treatment intervals were evaluated, there was a significant difference in the experimental group in flexion, extension, right rotation and left rotation. No significant difference in left lateral flexion and right lateral flexion occurred in the experimental group. Furthermore, no significant difference in any of the six ranges of motion occurred in the placebo group between first and follow-up consultations. These findings suggest that overall the experimental procedure was effective in terms of increasing all ranges of motion, except for lateral flexion ranges. This supports hypotheses two, in terms of ranges of motion.

When a comparison of the second treatment interval was conducted, there was no significant difference in any of the ranges of motion of both groups. These results suggest that no significant improvement in lumbar spine range of motion in the experimental group took place after the stretching program was discontinued, and that the first treatment interval was the period with the most favourable response.

5.2.1.2 INTER-TREATMENT COMPARISON:

Statistical comparison of the initial consultations illustrated no significant differences in any of the six ranges of motion. On comparing the sixth consultations, a significant difference in left lateral flexion only was observed.

A comparison of the follow-up consultation ranges of motion revealed a significant difference in flexion between the two groups. The above findings support hypothesis three, in terms of certain ranges of motion.

5.2.2 HAMSTRING FLEXIBILITY

5.2.2.1 INTRA-TREATMENT COMPARISON:

A significant improvement was noted for the experimental group for the first and overall treatment intervals. No significant improvement was noted in the placebo group for the first, second or overall treatment intervals. These findings suggest that the treatment was effective in increasing the flexibility of the hamstring muscles, and that the first treatment interval was the period with the most favourable response. This supports hypothesis one, in terms of flexibility.

5.2.2.2 INTER-TREATMENT COMPARISON:

A significant difference was noted between the two groups at the initial treatment, with the placebo group demonstrating a four degree greater average reading for knee extension. A comparison of the final and follow-up consultations indicated no significant difference between the two groups, which suggests that stretching of the hamstring produced a significant increase in hamstring flexibility in the experimental group, with average knee extension being almost two degrees greater than that of the placebo group. This supports hypothesis one, in terms of hamstring flexibility.

5.3 SUBJECTIVE DATA

5.3.1 PAIN PERCEPTION (MCGILL)

5.3.1.1 INTRA-TREATMENT COMPARISON:

A significant difference was noted for the overall treatment interval in both the experimental and placebo groups. For the first treatment interval, significant differences were noted in both groups, but only the experimental group demonstrated a significant difference for the second treatment interval. These findings suggest that overall, both groups were effective in terms of decreasing pain perception (McGill). However, only the experimental group was effective in decreasing pain perception (McGill) between the final and follow-up consultations. This supports hypothesis two, in terms of pain perception (McGill).

5.3.1.2 INTER-TREATMENT COMPARISON:

No significant difference was noted between the experimental and placebo groups at the first treatment, which suggests a similarity between the two groups in terms of pain perception as evaluated by the short-form McGill Pain Questionnaire (Appendix E).

At the final consultation, there was no significant difference between the two groups in terms of pain perception (McGill). However, a significant difference between the two groups was noted at the follow-up consultation in terms of pain perception. These findings suggest that the experimental group was more effective in reducing pain perception (McGill) on a long-term basis. This supports hypothesis three, in terms of pain perception.

5.3.2 PAIN PERCEPTION (NRS-101)

5.3.2.1 INTRA-TREATMENT COMPARISON:

Significant differences were noted for all treatment periods within the experimental group. No significant differences were found for any treatment interval for the placebo group. These findings suggest that overall, the experimental group was effective in terms of decreasing pain perception, as measured by the Numerical Rating Scale-101 (Appendix F). This supports hypothesis two, in terms of pain perception.

5.3.2.2 INTER-TREATMENT COMPARISON:

No significant difference was noted between the experimental and placebo groups at the first treatment, which suggests a similarity between the two groups in terms of pain perception as evaluated by the Numerical Rating Scale-101 (Appendix F).

A significant difference between the two groups was noted at the final and follow-up consultations in terms of pain perception. These findings suggest that the experimental group was more effective in reducing pain perception (NRS-101). This supports hypothesis three, in terms of pain perception.

5.3.3 DISABILITY

5.3.3.1 INTRA-TREATMENT COMPARISON:

Significant improvements were noted for the first and overall treatment intervals for the experimental group. No significant difference was found in the second treatment interval for the experimental group. No significant differences were noted for any period of treatment within the placebo group. These findings suggest that the experimental group was effective in reducing disability, and that the first treatment interval was the period with the most favourable response. This supports hypothesis two in terms of disability.

5.3.3.2 INTER-TREATMENT COMPARISON:

No significant difference was noted between the experimental and placebo groups at the first treatment, which suggests a similarity between the two groups in terms of disability as measured by the Oswestry Low Back Pain Disability Questionnaire (Appendix G).

At the final consultation, there was no significant difference between the two groups in terms of disability. However, a significant difference between the two groups was noted at the follow-up consultation in terms of disability. These findings suggest that the experimental group was more effective in reducing disability on a long-term basis. This supports hypothesis three, in terms of disability.

5.4 INTERPRETATION OF CLINICAL FINDINGS

In terms of objective and subjective clinical findings:

Firstly, it was hypothesised that stretching of the hamstring muscles would be effective in improving the flexibility of the hamstring muscles in cyclists suffering from low back pain.

It was shown that the experimental procedure was effective in increasing the flexibility of the hamstring muscles for the first and overall treatment intervals. Overall, there was a 7.35 degree increase in the median values for hamstring flexibility within the experimental group. Increases in flexibility in this study are in general agreement with Sullivan et al.(1992), who reported a 9 degree increase for static stretching after eight treatment sessions, as well as with Worrell et al.(1994), who reported a 8 degree increase after 15 treatment sessions.

Secondly, it was hypothesised that stretching of the hamstring muscles would be effective in the management of low back pain in cyclists, in terms of objective and subjective clinical findings.

Hence, it was shown that the experimental group was effective in improving all ranges of motion of the lumbar spine over the short term and the long term, except for right and left lateral flexion. It was also shown that the experimental group was effective in decreasing the perception of pain and disability associated with pain, over the short term and the long term.

Thirdly, it was hypothesised that stretching of the hamstring muscles would be more effective than a placebo treatment in the management of low back pain in cyclists, in terms of objective and subjective clinical findings.

The results indicate that the experimental group was more effective in increasing lumbar spine flexion range of motion over the long term, thus demonstrating the prolonged benefits of hamstring stretching exercises in terms of objective clinical findings. The experimental group was also shown to be more effective than the placebo group in decreasing sensitivity to pain and disability due to pain, indicating both the short term and the residual benefits of hamstring stretching exercises in terms of subjective clinical findings.

5.5 AGE AND GENDER

The average ages and ranges of age distribution are tabulated in table 4.19. Of the patients accepted into the study, 84.4% were males, while 15.6% were females. These figures denote a fairly uneven distribution in terms of gender.

5.6 COMMENTS

According to the flexibility standards outlined by Burke (1986:50), cyclists should be able to extend the leg that is bent at 90 degrees all the way to 180 degrees with the foot bent at 90 degrees. This test is carried out in a similar position to the Active-Knee-Extension test, with the patient lying supine and the leg not being tested extended straight on the table (Burke 1986:50). It is interesting to note that none of the cyclists involved in the study were able to achieve this end position when performing the AKE test. Therefore, none of the subjects met with the current flexibility standards for the hamstring muscles, which are based on data in the physical therapy, physical medicine and sports medicine literature.

The above inflexibility may have accounted for the favourable response of the subjects to the stretching program, since any improvement in hamstring flexibility may have had a more pronounced effect on the restoration of motion within the lumbar spine. This is supported by the fact that there was a significant improvement in forward flexion, which continued into the one month follow-up period.

CHAPTER SIX

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

This study consisted of 32 cyclists suffering from low back pain. The patients were divided into a experimental and a placebo group. The former received a treatment of hamstring stretching exercises and the latter a placebo treatment of detuned ultrasound. Each patient received six treatments which was followed by a one month follow-up consultation.

The results indicate that the experimental group was far more effective in: (a) improving the flexibility of the hamstring muscles, (b) increasing lumbar spine flexion range of motion (long term), (c) decreasing the perception of pain (short and long term), and (d) decreasing the disability associated with pain (short and long term).

Therefore, this study supports the use of stretching of the hamstring muscles in the treatment of cyclists suffering from low back pain.

6.2 RECOMMENDATIONS

Future research in this field should aim to determine if any changes in cycling performance and efficiency occur due to alterations in the closed kinetic chain when the flexibility of the hamstring muscles is increased. Electromyographic studies of the lumbar and hamstring muscles may be utilised in order to further understand the relationship between muscle function and low back pain. In a study by Worrell et al. (1994), it was demonstrated that stretching of the hamstring muscles was an effective method for increasing selective hamstring isokinetic peak torque values in the open kinetic chain. However, the effect of increased hamstring flexibility on functional activities in the closed kinetic chain requires further study (Worrell et al. 1994).

The treatment protocol highlighted in this study should be incorporated into any rehabilitation program with the goal of reducing low back pain in cyclists. This therapeutic modality could also be applied to other endurance athletes, such as runners, and other individuals who may suffer from low back pain due to prolonged hip flexion as a result of sitting for extended periods of time.

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APPENDIX A

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:______________________________ Date: ___________________
file #:_______ X-Ray#:___________________
Age:_______ Sex:_______ Occupation:___________________
Intern:_________________________ Signature:___________________

FOR CLINICIAN'S USE ONLY
Initial visit clinician:___________________Signature:___________________

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

Case Status:

PTT: Conditional: Signed Off: Final Sign out:

Recommendations:

Intern's Case History

1. Source of History:

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

3. Present Illness:

- Location
- Onset
- Duration
- Frequency
- Pain (Character)
- Progression
- Aggravating Factors
- Relieving Factors
- Associated S & S
- Previous Occurrences
- Past Treatment and 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
- Environmental Hazards (Home, School, Work)
- Safety Measures (seat belts, condoms)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication
- 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 B

TECHNIKON NATAL

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

Patient:______________________ File#: ______________________ Date:__________
Clinician:_____________________ Signature:____________________
Intern:_______________________ Signature:____________________

1. VITALS

Pulse rate:
Respiratory rate:
Blood pressure: R L
Temperature:
Height:
Weight:

2. GENERAL EXAMINATION

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

Urinalysis:

3. CARDIOVASCULAR EXAMINATION

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

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

Palpation:
- Apex Beat (character + location):
- Right or left ventricular heave:
- Epigastric Pulsations:
- Palpable P2:
- Palpable A2:

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

Percussion: - borders of heart

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

4. RESPIRATORY EXAMINATION

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

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

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

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

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

5. ABDOMINAL EXAMINATION

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

Inspection - Shape:
- Scars:
- Hernias:

Palpation - Superficial:
- Deep = Organomegally:

- Masses (intra- or extramural)
- Aorta:

Percussion - Rebound tenderness:
- Ascites:
- Masses:

Auscultation - Bowel sounds:
- Arteries (aortic, renal, iliac, femoral, hepatic)

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

6. G.U.T EXAMINATION

External genitalia:
Hernias:
Masses:
Discharges:

7. NEUROLOGICAL EXAMINATION

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

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

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

Evidence of head trauma:

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

Cranial Nerves:

I Any loss of smell/taste:
Nose examination:

II External examination of eye:
- Visual Acuity:
- Visual fields by confrontation:

- Pupillary light reflexes = Direct:
  = Consensual:
- Fundoscopy findings:

III Ocular Muscles:
Eye opening strength:

IV Inferior and Medial movement of eye:

V a. Sensory - Ophthalmic:
- Maxillary:
- Mandibular:
b. Motor - Masseter:
- Jaw lateral movement:
c. Reflexes - Corneal reflex
- Jaw jerk

VI Lateral movement of eyes

VII a. Motor - Raise eyebrows:
- Frown:
- Close eyes against resistance:
- Show teeth:
- Blow out cheeks:
b. Taste - Anterior two-thirds of tongue:

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

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

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

XII Inspection of tongue (deviation):

Motor System:

a. Power
- Shoulder = Abduction & Adduction:
  = Flexion & Extension:
- Elbow = Flexion & Extension:
- Wrist = Flexion & Extension:

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

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

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

Sensory System:

a. Dermatomes
- Light touch:
- Crude touch:
- Pain:
- Temperature:
- Two point discrimination:

b. Joint position sense
- Finger:
- Toe:

c. Vibration:
- Big toe:
- Tibial tuberosity:
- ASIS:
- Interphalangeal Joint:
- Sternum:

Cerebellar function:

Obvious signs of cerebellar dysfunction:

= Intention Tremor:

= Nystagmus:

= Truncal Ataxia:

Finger-nose test (Dysmetria):
Rapid alternating movements (Dysdiadochokinesia):
Heel-shin test:
Heel-toe gait:
Reflexes:
Signs of Parkinsons:

8. **SPINAL EXAMINATION:**(See Regional examination)

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

9. **BREAST EXAMINATION:**

Summon female chaperon.

Inspection
- Hands rested in lap:
- Hands pressed on hips:
- Arms above head:
- Leaning forward:

Palpation
- masses:
- tenderness:
- axillary tail:
- nipple:
- regional lymph nodes:

APPENDIX C

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC
REGIONAL EXAMINATION - *LUMBAR SPINE AND PELVIS.*

PATIENT: ____

FILE #: ____________________ DATE: ______________

INTERN/RESIDENT: ________________________________

SUPERVISING CLINICIAN: ___________________________

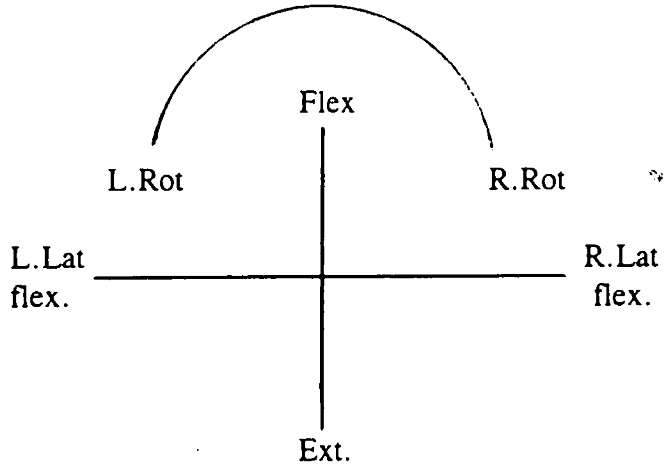
STANDING:

Posture
Minor's Sign
Skin
Scars
Discoloration
Muscle Tone
Bony & Soft Tissue Contours

Spinous Percussion
Schober's Test (6cm)
Treadmill
Body Type
Attitude

RANGE OF MOTION

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



SUPINE:

Skin
Hair
Nails
Palpate Abdomen/groin
Pulses (abdomen)

Observe abdomen
Fasciculations
Abdominal Reflexes

Pulses (extremities)
SLR
Bowstring
Plantar Reflex
Circumference (thigh, calf)
Leg Length:
- actual
- apparent

Sciatic Notch
Patrick FABERE
Gaenslen's Test
Gluteus Maximus Stretch
Hip Medial rotation
Psoas Test
Thomas' Test:
- hip joint
- Rectus Femoris

LATERAL RECUMBENT

S-I Compression
Ober's Test
Femoral Nerve stretch
Myotomes:
- QL
- Gluteus Medius

NON ORGANIC SIGNS

Pin Point Pain
Axial Compression
Trunk Rotation
Burn's Bench Test
Flip Test
Hoover's Test
Ankle Dorsiflexion Test.

GAIT

Rhythm
On toes (standing)
On Heels (standing)
Half squat on one leg

PRONE

Gluteal skyline
Skin rolling
Iliac crest compression
Facet joint challenge
S-I tenderness
Erichson's Test
Pheasant's Test
Myotome:
- Glut. Max

Active MF Trigger Pts:
- QL
- Glut. Med
- Glut. Min
- Glut. Max
- Piriformis
- Hamstrings
- TFL

NEUROLOGICAL EXAMINATION

DERMATOMES			MYOTOMES			REFLEXES		
	L	R		L	R		L	R
T12			Hip Flex			Pat.		
L1			Hip int rot			Achil		
L2			Hip ext rot			H/S		
L3			Hip abd					
L4			Hip add					
L5			Knee flex					
S1			Knee ext					
S2			Dorsiflex					
S3			Plantarflex					
			Eversion					
			Ext.hal.long					

Tripod
Kemp's Test

MOTION PALPATION and JOINT PLAY:

LEFT: Upper Thoracics:
Lumbar Spine:
Sacroiliac Joint:

RIGHT: Upper Thoracics:
Lumbar Spine:
Sacroiliac Joint:

Basic Exam: Hip
Case History:

ROM: Active:
Passive:
RIM:
Orthopaedic/Neuro/
Vascular:

Observ/Palpation:

Basic Exam: Thoracic Spine
Case History:

ROM: Motion Palp:
Active:
Passive:
Orthpaedic/Neuro/
Vascular:

Observ/Palpation:

APPENDIX D

OSWESTRY BACK DISABILITY INDEX

PATIENT NAME:______________________________ FILE 0:______ DATE:________

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

Section 1 - Pain Intensity
- ☐ I have no pain at the moment.
- ☐ The pain is very mild at the moment.
- ☐ The pain is moderate at the moment.
- ☐ The pain is fairly severe at the moment.
- ☐ The pain is very severe at the moment.
- ☐ The pain is the worst imaginable at the moment.

Section 2 - Personal Care (Washing, Dressing, etc.)
- ☐ I can look after myself normally without causing extra pain.
- ☐ I can look after myself normally but it causes extra pain.
- ☐ It is painful to look after myself and I am slow and careful.
- ☐ I need some help but manage most of my personal care.
- ☐ I need help every day in most aspects of self care.
- ☐ I do not get dressed, I wash with difficulty and stay in bed.

Section 3 - Lifting
- ☐ I can lift heavy weights without extra pain.
- ☐ I can lift heavy weights but it gives extra pain.
- ☐ Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, for example on a table.
- ☐ Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned.
- ☐ I can lift very light weights.
- ☐ I cannot lift or carry anything at all.

Section 4 - Walking
- ☐ Pain does not prevent me walking any distance.
- ☐ Pain prevents me walking more than 1 mile (2.2 km).
- ☐ Pain prevents me walking more than 1/2 mile (1.1 km).
- ☐ Pain prevents me walking more than 1/4 mile (0.5 km).
- ☐ I can only walk using a stick or crutches.
- ☐ I am in bed most of the time and have to crawl to the toilet.

Section 5 - Sitting
- ☐ I can sit in any chair as long as I like.
- ☐ I can only sit in my favorite chair as long as I like.
- ☐ Pain prevents me from sitting more than 1 hour.
- ☐ Pain prevents me from sitting more than 1/2 hour.
- ☐ Pain prevents me from sitting more than 10 minutes.
- ☐ Pain prevents me from sitting at all.

Section 6 - Standing
- ☐ I can stand as long as I want without extra pain.
- ☐ I can stand as long as I want, but it gives me extra pain.
- ☐ Pain prevents me from standing for more than one hour.
- ☐ Pain prevents me from standing for more than 30 minutes.
- ☐ Pain prevents me from standing for more than 10 minutes.
- ☐ Pain prevents me from standing at all.

Section 7 - Sex Life
- ☐ My sex life is normal and causes no extra pain.
- ☐ My sex life is normal but causes some extra pain.
- ☐ My sex life is nearly normal but it is very painful.
- ☐ My sex life is severely restricted by pain.
- ☐ My sex life is nearly absent because of pain.
- ☐ Pain prevents any sex life at all.

Section 8 - Social Life
- ☐ My social life is normal and gives me no oxta pain.
- ☐ My social life is normal but increases the degree of pain.
- ☐ Pain has no significant effect on my social life apart from limiting my more energetic interests, for example, dancing.
- ☐ Pain has restricted my social life and I do not go out as often.
- ☐ Pain has restricted my social life to my home.
- ☐ I have no social life because of pain.

Section 9 - Sleeping
- ☐ I have no trouble sleeping.
- ☐ I can sleep well only by using pills.
- ☐ Even when I take pills I have less than six hours sleep.
- ☐ Even when I take pills I have less than four hours sleep.
- ☐ Even when I take pills I have less than two hours sleep.
- ☐ Pain prevents me from sleeping at all.

Section 10 - Travelling
- ☐ I can travel anywhere without extra pain.
- ☐ I can travel anywhere but it gives me extra pain.
- ☐ Pain is bad but I manage trips over two hours.
- ☐ Pain restricts me to trips of less than one hour.
- ☐ Pain restricts me to trips under 30 minutes.
- ☐ Pain prevents me from travelling, except to the doctor or hospital.

APPENDIX E

SHORT-FORM McGILL PAIN QUESTIONNAIRE

RONALD MELZACK

PATIENT'S NAME: ______________________ DATE: ____________

	NONE	MILD	MODERATE	SEVERE
THROBBING	0) ____	1) ____	2) ____	3) ____
SHOOTING	0) ____	1) ____	2) ____	3) ____
STABBING	0) ____	1) ____	2) ____	3) ____
SHARP	0) ____	1) ____	2) ____	3) ____
CRAMPING	0) ____	1) ____	2) ____	3) ____
GNAWING	0) ____	1) ____	2) ____	3) ____
HOT-BURNING	0) ____	1) ____	2) ____	3) ____
ACHING	0) ____	1) ____	2) ____	3) ____
HEAVY	0) ____	1) ____	2) ____	3) ____
TENDER	0) ____	1) ____	2) ____	3) ____
SPLITTING	0) ____	1) ____	2) ____	3) ____

APPENDIX F

NUMERICAL RATING SCALE -101 QUESTIONNAIRE

Patient Name :____________ File No. :____ Date :_______

Please indicate on the line below , the number between 0 and 100 that best describes the pain you experience <u>when it is at its worst.</u> A zero (0) would mean "no pain at all", and one hundred (100) would mean "pain as bad as it could be". Please write only one number

____

Please indicate on the line below , the number between 0 and 100 that best describes the pain you experience <u>when it is at its least</u>.A zero (0) would mean "no pain at all", and one hundred (100) would mean "pain as bad as it could be". Please write only one number .

____

APPENDIX G

INFORMED CONSENT FORM

(To be completed in duplicate by patient/subject*) *Delete whichever is not applicable.

TITLE OF RESEARCH PROJECT

____

____

NAME OF SUPERVISOR

____

NAME OF RESEARCH STUDENT

____

PLEASE CIRCLE THE APPROPRIATE ANSWER

1. Have you read the research information sheet? YES/NO

2. Have you had an opportunity to ask questions regarding this study? YES/NO
3. Have you received satisfactory answers to your questions? YES/NO

4. Have you had an opportunity to discuss this study? YES/NO
5. Have you received enough information about this study? YES/NO

6. Who have you spoken to? ______________________________

7. Do you understand the implications of your involvement in this study? YES/NO

8. Do you understand that you are free to withdraw from this study? YES/NO
   a) at any time
   b) without having to give a reason for withdrawing, and
   c) without affecting your future health care.

9. Do you agree to voluntarily participate in this study? YES/NO

PATIENT/SUBJECT* Name____________________ Signature____________________
(in block letters)

PARENT/GUARDIAN* Name____________________ Signature____________________
(in block letters)

WITNESS Name____________________ Signature____________________
(in block letters)

RESEARCH STUDENT Name____________________ Signature____________________
(in block letters)