AN INVESTIGATION TO IDENTIFY CHANGES IN POWER OF THE KAYAKING STROKE FOLLOWING MANIPULATION OF THE CERVICAL SPINE IN ASYMPTOMATIC KAYAKERS.

A dissertation in partial compliance with the requirements for a Master's Degree in Technology: Chiropractic, submitted to the Faculty of Health at the Durban University of Technology.

By

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I, Neil Cuninghame, solemnly declare this work to be my own in compilation and execution.

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DEDICATION

It is with great pleasure that I dedicate this dissertation to the following people, without them this would not have been as sweet:

My parents, Bryan and Gail, who have loved and supported me unconditionally throughout my life and have always been there for me. You have supported my every decision without question and will continue to be my guidance and pillar of strength throughout my life. I will be eternally grateful for the life lessons you have taught me and the support you have shown me.

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ABSTRACT

Introduction

Although kayaking is an Olympic sport and said to be one of the top ten growth sports in America, relatively little literature has been written on it by sports scientists and there is a paucity of available literature. Previous research has described the effects of spinal manipulation on muscles at distant sites to the joint being manipulated, and there have been trends which have shown a positive increase in strength and in muscle activity at these sites. There has, however, been a lack of literature to show that these positive trends would influence sporting performance in any way.

30 volunteer kayakers, who train and compete on a regular basis, were actively recruited and randomly allocated into one of three groups. Group 1 received manipulation on a fixated cervical segment, group 2 on a non-fixated cervical spine segment, and group 3 received placebo laser to the posterior cervical area. Subjects were then required to complete two 200m sprint tests on a kayak ergometer. Measurements were taken pre and post manipulation and included maximum watts recorded for the duration of the sprint test and time taken to complete 200m.

Although no statistically significant results were found between the groups, trends revealed that in group 1, which received spinal manipulation on a fixated joint, there was an increase in the mean peak watts post manipulation, as compared to the placebo and non-fixated groups which showed a decrease in peak watts post manipulation.

Group 1 also demonstrated a mean decrease in time taken to complete the second 200m sprint test. Group 2 and 3 again showed an increase in time taken to complete the second sprint test post manipulation.

It is, therefore, concluded that manipulation of a fixated cervical joint in asymptomatic kayakers results in an increase in performance, although it must be noted that these were only trends and that there was no statistical significance in these results. This research has, furthermore, opened the door to future studies which may test the performance enhancing benefits of competitive sports such as kayaking.

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CHAPTER 1

INTRODUCTION

Adjustment or manipulation has been defined as a low amplitude, high velocity thrust in which the joint fixation or subluxation (defined by the American Chiropractic Association as "a motion segment in which alignment, movement integrity, and/or physiologic function are altered, although contact between the joint surfaces remains intact") being manipulated is taken into the paraphysiological range of motion (Chapman-Smith, 2000). The effects of a single chiropractic adjustment or manipulation include an increase in a joint's range of motion, increased skin pain tolerance levels and consistent, repeatable reflex responses in muscles in the spine and limbs, to mention a few (Chapman-Smith, 2000).

Hertzog *et al.* (1999) were the first to show that there were electromyographic reflex responses in back and limb muscles during spinal joint treatments and discussed that it had previously been hypothesised that certain reflex responses following manipulation have an increased effect on functional ability of the patient and inhibition of hypertonic muscles, although Herzog *et al.* (1999) pointed out that increased functional ability may have a series of origins other than reflex activation of muscles. They describe these reflexes as spatially and temporally non-synchronised motor unit action potentials.

Following on from work by Rebechini-Zasadny *et al.* (1981), Wyke (1985), Herzog *et al.* (1999), and Suter and McMorland (2002), Dixon (2005) and Naidoo (2002) found that there was an increase in power and strength respectively, of the specific muscle groups, following manipulation of the cervical spine, for which they were testing.

The research by Dixon (2005) and Naidoo (2002) demonstrates that specific groups of muscles have increased power after manipulation of the cervical spine, regardless of the level manipulated; and in the case of Dixon's (2005) study, regardless of whether or not they have a fixation. Naidoo's (2002) study demonstrated an increase in forearm muscle strength on grip strength but this research does not demonstrate whether that increased strength in an isolated movement would translate into increased strength of a coupled movement and an increased strength in multiple muscle groups such as during a sporting activity. Dixon's (2005) study suggested that a non-fixated joint which is manipulated may produce similar if not the same reactions as a manipulated fixated joint and that further research should be done in this area to assess the effects of such manipulations.

It is therefore important to test these proposed changes and theories in a sport such as kayaking, which may gain from the proposed changes in reflexes and muscle strength and to do it in such a way that the specific action of the sport may be reproduced and the effects of the spinal manipulation recorded.

There can be no argument that athletes are in constant pursuit of improving performance and in gaining those valuables centimetres and seconds (sometimes milliseconds) in their respective sporting disciplines which may help them to triumph over their rivals. This is made strikingly evident in sport events as performance enhancing drugs have become an everyday occurrence at a wide variety of events. Event after event we see that one or other high profile professional sports person has been tested positive for "doping". Kayaking is no different and there have been numerous doping bans handed out over the years. Most notably after the 2004 Olympics when a world champion and Olympic medallist was banned for life for using performance enhancing drugs. South Africa has not been without its problems as was seen in 1999 when a high profile South African kayaker was suspended for two years after a positive dope test during the Dusi Canoe Marathon (McLeod, 1999).

In kayaking, seconds determine the outcome of the race and to gain a second over a 200m or 500m event could result in winning a world championship event. The times displayed in the 34th International Canoe Federation (ICF)

Flatwater Racing World Championships in 2005, demonstrate that there was less than a second which separated athletes in the 1000m, 500m and 200m events (34^{th} ICF Flatwater Racing World Championships results, 2005). The recent Flatwater World Racing Championships (canoe 09, 2009) held in Canada demonstrated even less winning margins. For example, in the men's 500m K1 final, first and second were separated by 0.074s with third being a further 0.546s back. The 200m men's K1 final saw 2^{nd} to 5^{th} being separated by a mere 0.164s with first place winning by only 0.516s (canoe 09, 2009). Even closer was the men's K2 500m final, in which first and second were only separated by 0.031s and the men's K2 200m final was won by 0.002s (canoe 09, 2009). This is a clear indication that even a slight increase in performance could yield a very significant result on the water.

Kayaking has been an Olympic sport since 1924 and is characterised by an athlete sitting in a craft and paddling on both sides (Fry and Morton, 1991; Pelham *et al.,* 1995). The kayaking stroke has been divided into three phases and it has been shown that in phase 1 of the kayak stroke, the kayak is propelled forward and that the peak boat horizontal velocity is achieved (Mann and Kearney, 1980; Trevithick *et al.,* 2007). This horizontal velocity has been shown to be produced by a specific group of muscles which are active or major movers of the upper limb during the kayak stroke, namely the Lattisimus Dorsi, Pectoralis Major, Supraspinatus and upper Trapezius muscle (Moore and Dalley, 1999; Trevithick *et al.,* 2007).

The research by this author, therefore, aimed to determine whether there was an effect following cervical spine manipulation on upper limb peripheral musculature by measuring the power produced by the athlete during a kayak stroke by using a kayak ergometer - which has been shown to reproduce the feel of open water paddling in a kayak (van Someren *et al.*, 2000).

Objectives

The purpose of this study was to ascertain whether or not spinal manipulative therapy to the C4-C7 spinal segments would increase the power of the kayak stroke and, therefore, increase speed of a kayaker with and/or without asymptomatic restrictions at these levels.

The following were the objectives of the study:

Objective 1: The first objective was an intra-group analysis (manipulation of fixated joint vs. non-fixated joint vs. placebo laser) with respect to objective findings (time taken to travel 200m and peak power recorded).

Objective 2: The second objective was an inter-group analysis (manipulation of fixated joint vs. non-fixated joint vs. placebo laser) with respect to objective findings (time taken to travel 200m and peak power recorded).

Hypothesis: It was hypothesised that manipulation of the cervical spine would result in an increase in the power of the kayak stroke and that it would be regardless of whether the cervical segment being manipulated was fixated or not.

In the remaining chapters, the researcher will review the literature on the effects of manipulation and literature on kayaking (Chapter 2); describe in detail the methodology of this study (Chapter 3) and present the statistics (Chapter 4); the results (Chapter 5) and the subsequent conclusions and recommendations (Chapter 5).

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Introduction

This literature review aims at informing the reader of the relevant anatomy of the cervical spine and the primary muscles involved in the kayaking stroke, as well as the relationship between the two and the relative effects that manipulation has on these muscles. This chapter will end with a review of literature describing kayaking specifically, as well as the similarities between open water kayaking and kayak ergometry.

2.2 Anatomy

2.2.1 Upper Body Musculature

In a study by Trevithick *et al.* (2007) into the recruitment patterns of eight muscles of the shoulder during a kayak stroke, it was noted that there were three muscles which showed a consistent pattern of activity in phase one (or pull-through phase) of the kayaking stroke – defined as the paddle position of the tested arm while moving from the most forward to the most backward position (Trevithick *et al.*, 2007).

Trevithick *et al*. (2007) tested 9 skilled recreational paddlers, none of which had any pain in their shoulders while paddling. Fine wire intramuscular electrodes where used on the Subscapularis, Supraspinatus, Infraspinatus, Serratus anterior, Rhomboid major and Lattisimus Dorsi and surface electrodes where placed on the middle Deltoid and upper Trapezius. Testing was done on a kayak ergometer.

In this study, the Supraspinatus, upper Trapezius and Lattisimus Dorsi muscles demonstrated a consistent recruitment pattern throughout the pull-through phase of the kayaking stroke (Trevithick *et al.*, 2007).

In another study by Yoshio *et al.* (1974), it was also shown that the Lattisimus Dorsi muscle was active during the pull through phase of kayaking.

Moore and Dalley (1999) state that the contraction of the Lattisimus Dorsi and Pectoralis major muscles in combination, result in powerful adduction of the humerus. They describe this movement as a movement which is used when paddling a kayak.

For the purpose of this study, these 3 muscles identified above will be known as the primary musculature. Due to its innervation, the upper Trapezius muscle will not form part of this study.

2.2.1.1 Attachments of primary musculature

Attachments of primary musculature involved in the pull-through phase of the kayaking stroke are summed up in table 2.1 below.

Table 2.1 Attachments of primary muscles

Muscle	Proximal Attachment	Distal Attachment
Pectoralis Major	Anterior surface of medial half of clavicle, anterior surface of sternum, superior six costal cartilages, and aponeurosis of external oblique muscle	Lateral lip of intertubercular groove of humerus
Lattisimus Dorsi	Spinous processes of inferior 6 thoracic vertebrae,	Floor of intertubercular groove of humerus

	thoracolumbar fascia, iliac crest, and inferior 3 or 4 ribs	
Supraspinatus	Supraspinatus fossa of scapula	Superior facet on greater tubercle of humerus

(Table abridged from Moore and Dalley, 1999)

2.2.1.2 Actions and innervation of primary musculature

Table 2.2 below outlines the main action of the primary muscles involved in the kayak stroke, as well as the relevant innervation of each of these muscles.

Table 2.2 Actions and innervation of primary muscles

Muscles	Main Action	Innervation
Pectoralis Major	Adducts and medially rotates humerus: draws scapula anteriorly and inferiorly	Lateral and medial pectoral nerves (C5, **C6, C7, C8,** and T1)
Lattisimus Dorsi	Extends adducts and medially rotates humerus	Thoracodorsal nerve (**C6, C7,** and C8)
Supraspinatus	Initiates and assists deltoid in abduction of arm	Suprascapular nerve (C4, **C5,** and C6)

Boldface indicates main segmental innervation.
(Table abridged from Moore and Dalley, 1999)

2.2.2 The cervical spine

2.2.2.1 Bony anatomy

The cervical spine is commonly divided into the upper (occiput through C1-2) and lower (C2-3 and below) cervical spine (Edmond, 2006).

The vertebrae of C3 – C6 are classified as typical vertebrae and differ from C7, which is classified as an atypical vertebra in many ways. Some of the differences are: the size of the vertebral foramen, which in C7 is smaller and does not allow passage of the vertebral artery. The spinous processes of C3-C6 are also usually bifid, whereas, C7 spinous process is long and prominent (Moore and Dalley, 1999, Cramer and Darby, 2005).

Spinal vertebrae are divided into two basic regions; a vertebral body and a posterior arch (vertebral arch). The posterior arch has several unique structures, namely; the pedicles, laminae, spinous process, transverse process, and the superior and inferior articular processes (Cramer and Darby, 2005).

Of most importance to this study, are the superior and inferior articular processes.

2.2.2.1.1 Superior and inferior articular processes

The superior and inferior articular processes arise from the pediculolaminar junction on the posterior arch. The superior articular process projects superiorly, posteriorly and slightly medially. The inferior articular processes project inferiorly and face anteriorly. The articulation between the superior and inferior process is known as the zygapophysial joints (or Z joints) and lie at a 65 degree angle to the horizontal plane in the lower cervical spine (Cramer and Darby, 2005).

2.2.2.1.2 Zygapophysial joints

The Z joints are classified as synovial, plannar joints and the articular surface of each process is covered with a thin layer of hyaline cartilage. This portion of the superior and inferior processes is known as the articular facet. These joints are also known as facet joints or interlaminar joints (Cramer and Darby, 2005).

2.3 The neurological link between the cervical spine and the primary muscles involved in kayaking.

2.3.1 Innervation of muscles

The motor neurons in spinal nerves are responsible for innervation of skeletal muscle. Cervical spinal nerves C1-C7 exit above their respective vertebral bodies, from the vertebral canal, and C8 spinal nerve exits below the C7 vertebrae. Thus, for example, C6 spinal nerve exits between C5 and C6 vertebrae (Crossman and Neary, 1998).

The medial and lateral pectoral nerves, the thoracodorsal nerves, and the suprascapular nerve all form part of the brachial plexus of the upper limb. The brachial plexus is formed by the union of the ventral rami of C5 through C8 nerves and the greater part of the ventral ramis of T1. These unite to form three trunks; the superior, middle, and inferior trunk. These trunks further divide into an anterior and a posterior compartment which form three cords; the lateral, medial, and posterior cord of the brachial plexus (Moore and Dalley, 1999).

The brachial plexus is further divided into the supraclavicular and infraclavicular parts by the clavicle. The supraclavicular branches of the brachial plexus arise from the roots and trunks of the brachial plexus, whilst the infraclavicular branches arise from the cords of the brachial plexus (Moore and Dalley, 1999).

2.3.1.1 The medial and lateral pectoral nerves

The lateral pectoral nerve originates in the lateral cord of the brachial plexus, receiving fibres from C5-C7, and pierces the clavipectoral fascia to reach the deep surface of the pectoral muscle (Moore and Dalley, 1999).

The medial pectoral nerve originates from the medial cord of the brachial plexus, receiving fibres from C8 and T1, and passes between the axillary artery and vein to reach the deep surface of the pectoral muscle (Moore and Dalley, 1999).

2.3.1.2 The thoracodorsal nerve

The thoracodorsal nerve is a branch of the posterior cord of the brachial plexus and receives fibres from C6-C8. It passes inferolaterally along the posterior axillary wall to the Lattisimus Dorsi muscle (Moore and Dalley, 1999).

2.3.1.3 The suprascapular nerve

The suprascapular nerve originates in the superior trunk of the brachial plexus and receives fibres from C5 and C6 and often from C4. It travels laterally across the posterior triangle of the neck, through the scapular notch and then under the superior transverse scapular ligament (Moore and Dalley, 1999).

2.3.2 Innervation of cervical spine facet joints

All synovial joints, such as the Z joints, are innervated by four different varieties of neuroreceptors. All these are derived from the dorsal and ventral rami, as well as the recurrent meningial nerve at each spinal segment. In addition to segmental innervation, these joints also receive innervation from segments above and below and thus, it can be said that Z joint innervation is multilevel. It has also been noted that the cervical spine has a denser innervation of mechanoreceptors than the lumbar or thoracic spine (Wyke, 1985, Bergmann *et al*, 1993, McLain and Pickar, 1998, Cramer and Darby, 2005).

Wyke (1985) classified these various sensory receptors in terms of their function and categorized them as follows:

Type I: Found in the superficial layers of the fibrous capsules of joints.
Stimulated by active or passive joint movements.
Static and dynamic mechanoreceptors which have a low threshold and are slowly adapting.

Type II: Found in deeper sub synovial layers of fibrous capsules of joints.
Stimulated by active or passive joint movements.
Dynamic mechanoreceptors with a low threshold and rapidly adapting.

Type III: Applied to surfaces of joints and ligaments.
Dynamic mechanoreceptors with a high threshold and slowly adapting.

Type IV: Found in fibrous capsule of joint and on joint ligaments.
Nociceptive mechanoreceptors with a very high threshold and non adapting.

Any manipulative procedure which is applied to the cervical spine has an effect on the level manipulated and there will, thus, be a mechanoreceptor effect at those levels (Wyke, 1985). Furthermore, due to the intersegmental distribution of the collateral branches given off by the articular mechanoreceptors, there will not only be an effect in the muscles over that joint but also in more remote muscles and musculature of all four limbs (Wyke, 1985).

According to Wyke (1985), there are central effects of articular mechanoreceptor activity, such as reflexogenic effects, perceptual effects and pain suppression. Of particular interest to this study, are the reflexogenic effects which may be produced. Wyke asserts that the articular

mechanoreceptors exert reciprocally coordinated reflexogenic influences on muscle tone and on excitability of stretch reflexes in all striated muscles.
Suter *et al.* (2000) and Bergmann *et al.* (1993) also suggest that a manipulation applied in the form of a low amplitude, high velocity thrust results in activation of mechanoreceptors around the joint and this input causes changes in the motor neuron excitability at the level of manipulation.

2.4 Manipulation

2.4.1 Definition

Manipulation is defined by Bergmann *et al.* (1993), as a therapeutic application of manual force. Edmond (2006) further defines manipulation as a specific technique in which the articular capsule is passively stretched by delivering a small amplitude, high velocity thrust. According to Edmond (2006), manipulation is considered by many to be a particular type of mobilization.

2.4.2 The effects of manipulation on peripheral limb musculature

Herzog *et al.* (1999) were the first to demonstrate reflex activation of upper and lower limb muscles during spinal treatments and found that there was a consistent reflex response in a target specific area associated with spinal manipulation. The study comprised 10 healthy males who were all asymptomatic. Each subject received 11 spinal manipulations in a set order ranging over the cervical, thoracic, lumbar, and sacroiliac joints. There were general electromyographic (EMG) responses in most muscles in the back and neck following cervical spine manipulation (C2-C3) and a 100% response in the Trapezius muscle during manipulation in the cervical spine. Among the muscles tested were the Lattisimus Dorsi and Deltoid muscles, although the Deltoid muscle showed no systematic electromyographic responses during manipulation of the cervical spine.

In attempting to answer the question of whether or not reflex responses were limited to local responses - as exhibited in previous research - or whether or not these responses would also be elicited more systemically as proposed by Wyke (1985), Herzog *et al.* (1999) concluded that manipulative procedures elicited a repeatable and largely systemic electromyographic response and that this response extended beyond the immediate area of manipulation in all treatments. Herzog *et al's* (1999) research is one example of how cervical spine manipulation may improve the performance of a kayaker as they have shown that there are reflex responses following cervical spine manipulation in two of the major muscles active during the kayaking stroke identified by Trevithick *et al* (2007), namely the Trapezius muscles and the Lattisimus Dorsi muscles.

Rebechini-Zasadny *et al.* (1981) demonstrated that 12 out of the 12 subjects tested in their study showed increased muscle strength in the first interosseous muscle of the hand, following cervical spinal manipulative therapy. In order to test changes in the interosseous muscle strength, a surface EMG was applied to the muscle and three readings were taken, the first prior to intervention, the second after passive cervical spine movement, and the third after cervical index manipulation. Their research supports the statements made by Wyke (1985) and Herzog (1999), that there are indeed reflexogenic influences in muscle tone at distant sites to the joint being manipulated. However, Rebechini-Zasadny *et al.* (1981) had a small sample size and the muscle strength was measured by using a surface EMG, which measures the activity of a muscle and cannot be assumed to show an increase in muscle strength. Rebechini-Zasadny *et al.* (1981) did not specify the levels which were manipulated or whether the subjects had fixations or not, or whether they were symptomatic or asymptomatic.

Suter and McMorland (2002) studied the effect of cervical manipulation in 16 subjects with chronic neck pain. They found that in addition to a decrease in elbow flexor inhibition, there was also an increase in elbow flexor force and in the corresponding biceps EMG. Subjects in this study demonstrated restricted joint mobility at C5/6 and C6/7 and, in accordance with this, were manipulated at those levels. Suter and McMorland (2002) go on to state that these changes may be due to the effect the change in sensory input has on the afferent pathways at these segmental levels and that this change in afferent input elicited by spinal manipulation may help to restore excitatory function of upper limb muscles. These findings were in line with previous research findings by Suter *et al*. (2000), in which they investigated whether conservative lower back treatment reduces lower limb muscle inhibition. This study involved two groups; one control and one treatment group. Although the changes did not reach statistical significance, there was an increase in knee extensor movement and total EMG values following manipulation of the sacroiliac joint.

Although previous research has been done regarding grip strength (Naidoo, 2002) and rotator cuff strength (Dixon, 2005), this was isolating a specific group of muscles - namely the forearm muscles and grip strength in Naidoo's (2002) study and the rotator cuff muscles in Dixon's (2005) study.

Naidoo (2002) measured the optimising effects of removing cervical spine dysfunction in grip strength using a grip dynamometer and summarized that there was a significant increase in grip strength, regardless of the level of cervical involvement. Naidoo's (2002) study was the first of its kind. However, he did not compare the sample group to a control group and thus, the surface EMG readings could be considered potentially inaccurate.

In Dixon's (2005) study, it was noted that the power of the rotator cuff muscles in the four measured movements (abduction, adduction, internal and external rotation) increased post manipulation in all movements in the group which had fixations and was given random manipulations, as well as in the group which had fixations and were manipulated between C4-C5. Dixon (2005) also noted that there was a statistically insignificant improvement in the asymptomatic non-fixated group versus the asymptomatic fixated group and concluded that a fixation would not necessarily have to be present for manipulation to raise the peak torque, and that manipulation of specific levels would not raise peak torque of specific muscles innervated by those levels. Dixon (2005) suggested that research be performed to ascertain the effect of spinal manipulation on the performance of an athlete.

When performing a manipulation in the lower cervical spine (C2 to C7), a specific contact point is taken on the articular pillars on the level of the fixated joint, i.e., between C4 and C5 for example, thus, the aim is to induce a maximal effect in that specific joint. This is, however, highly unlikely as the spine is a closed kinematic chain and any manipulative thrust will have some effect on the joints above and below the contacted vertebrae (Peterson and Bergmann, 2002). This may explain why Dixon (2005) and Naidoo (2002) found an increase in strength of their subjects regardless of the level of cervical manipulation.

Sandoz (1976) describes the nature of a joint manipulation with respect to where in the arc of the motion of a joint manipulation is proposed to take place. Sandoz (1976) identifies several phases of a joint's total motion, which includes active range, passive range and paraphysiological space. This paraphysiological range was described by Sandoz (1976) to be beyond the passive range but less than the anatomic limit of the joint. The end of the paraphysiological range is said to be the limit of anatomical integrity and the point beyond which injury would occur. Sandoz (1976) describes the adjustment of a normal vertebral segment to occur in this para-physiological space and hypothesised that the stretching of the articular capsule to the limit of the anatomical space most likely results in an intense stimulation of the joint proprioceptors, an action Sandoz (1976) says could hardly be without consequences. Vernon and Mrozek (2005) describe this space as one in which manipulation occurs and refer to it as a zone of elasticity at the end of normal range of motion. They also say that in a joint which has lost some of its flexibility, this zone may be decreased - the clinical term commonly referred to as a fixation, and refers to a notion of hypo mobility.

Vernon and Mrozek (2005) state that the afore-mentioned theory is only applicable to normal joints and suggest should be revised to state in which physiological range of motion joint dysfunction would more accurately be described. They also state that if hypo-mobility is the joint state associated with joint dysfunction, then by definition, manipulation must be administered to a joint with less than normal mobility, which is not at the end range of motion and does not enter the paraphysiological range as proposed by Sandoz (1976) in describing manipulation of a normal joint. As previously stated, Sandoz (1976) hypothesised that intense stimulation of the joint proprioceptors occurred in the para-physiological range and that if the revised definition of manipulation by Vernon and Mrozek (2005) states that a joint with 'joint dysfunction' does not reach this para-physiological space, then it must be questioned whether the same degree of joint stimulation occurs, as the articular capsule is theoretically not stretched to the same degree as a normal joint and it could be hypothesised that manipulation of a normal joint should have a greater degree of neurological stimulation of the surrounding tissue, as compared to the manipulation of a joint associated with joint dysfunction.

This may also be true for Leach (2004), who states that a fixation results in immobilization of a joint, thickening of the joint capsule and dehydration; thus, causing the formation of adhesions. This results in a further decrease in motion of a joint and possibly the inability of that joint to move into the para-physiological space, as described by Sandoz (1976).

The above theories may support the notion that manipulation of a non-fixated joint will produce greater reflexogenic influences on peripheral muscles than manipulation of a fixated joint, and help to explain the trend found in Dixon's (2005) study in which asymptomatic subjects without joint dysfunction or fixations in the cervical spine showed an improvement in the power of the rotator cuff muscles post manipulation of the cervical spine.

2.5 The Hawthorne and Placebo effects

2.5.1 The Hawthorne effect

McCarney *et al.* (2007) found that many patients appeared to respond better to treatment than those in normal practices, purely due to the fact that they were participating in a clinical trial. This means that patients may change their behaviour when they know they are being observed/treated. This is known as the Hawthorne effect and was first described in the 1920's and 1930's when Chicago's Western Electrical Company's Hawthorne Works conducted an extensive research programme, investigating methods of increased productivity (Roethlisberger and Dickson, 1939, Mayo, 1993). It was noted that there was an increase in productivity regardless of the changes made to the working environment and was defined by Franke and Kaul (1978) as "an increase in worker productivity produced by the psychological stimulus of being singled out and made to feel important". McCarney *et al.* (2007), describe that although this phenomenon was first reported in industrial research, it may have implications for clinical research and general practice.

The Hawthorne effect may then result in an inflated description of the effect size by over-estimating response in all research groups, although it should not affect the assessment of the difference between intervention and control (McCarney *et al,* 2007).

2.5.2 Placebo

Wall and Wheeler (1996) describe the placebo affect as being derived from the term, "I shall please", and define it as a "harmless, unmedicated treatment, used for its psychological effect, often as a comparison with other treatments". Placebo can, therefore, be described as a treatment which is given to patients to please them rather than to directly benefit them.

In the case of joint manipulations, there is also a perceived effect or placebo effect that needs to be taken into consideration. This may be due to the patient feeling that the joint has been returned to its normal position or a notion that the cracking sound indicates effectiveness (Maigne and Vautravers, 2003). Due to the possible placebo effect, it is vital that a control group be established in any research programme. The placebo effect can be used in "blind" trials, in which the participants don't know whether they are getting the active treatment or not (Draper, 2002).

According to Sood (2008), both the Hawthorne effect and Placebo cause an effect when the material intervention has no effect and both effects are created by the participant's reactions and perceptions. The Hawthorne effect, however, brings out the participant's response to being studied, whereas the placebo effect brings out their response to new methods and equipment. According to Draper (2002), the deception by the researcher to make the participant believe in the efficacy of the treatment being administered, plays a more important role in the placebo effect than in the Hawthorne effect, and that usually placebo studies are conducted to determine the efficacy of an intervention.

2.6 Kayaking

Kayaking has been around for thousands of years but it was only in 1924 that flatwater sprint kayaking was introduced to the Olympic Games as a demonstration sport and as an official Olympic sport in 1936 at the Berlin Olympics. Flatwater kayaking is raced over 3 distances at a world championship event, namely; the 200m (introduced in 1994), 500m, and 1000m events. In a kayak, the paddler is seated and uses a two blade paddle (Australian Broadcasting Corporation, 1999, International Canoe Federation, 2006). In the United States, competitive kayaking is among the top 10 fastest growing sports and known generally worldwide as a growth sport, although very little research has been done on it (Gomes and Mars, 2003; Hagemann *et al.*, 2004).

Kayaking is a sporting activity characterised by exceptional demands on upper body performance and elite kayakers are characterised by exhibiting great strength and endurance in those muscles responsible in propelling the kayak (Tesch, 1983, Formby, 2004). Great muscle strength is demanded in the arm, shoulder and back muscles to overcome the physiological stress imposed on these athletes (Tesch, 1983). According to Pickard and Pyke (1981), muscular strength, as in arm-oriented sports such as kayaking, is important in accelerating the craft and if there is high muscular strength, then a lower percentage of maximum force should be exerted per stroke and thus, the kayaker will keep paddling for a longer period of time. Tesch (1983) demonstrated that kayakers exhibited great muscular strength when performing single or repeated shoulder extensions, and found that muscular endurance was higher in kayakers than in other athletes who exhibited equal baseline strength.

Kayaking is characterised by an athlete sitting in a craft and paddling on both sides of the craft, as opposed to canoeing in which the athlete paddles on one side of the craft while supported on one knee (Pelham *et al,* 1995). Mann and Kearney (1980) have previously described the kayak stroke as a bilateral paddling action dedicated to using the "power position" of the stroke to efficiently maintain horizontal velocity, and describe one stroke as starting with initial blade contact in the water and continuing until the opposite blade achieves water contact; thus, a kayak stroke has an air and water phase. According to Mann and Kearney (1980), position one of the kayak stroke is when the blade is first in contact with the water, position two is when the paddle shaft is at a vertical position ("power position") with reference to the horizontal, and position three is the dissociation of the blade from the water. The final phase is the recovery phase, which is when the paddle is in the air (Mann and Kearney, 1980). Trevithick *et al.* (2007) have also described the kayaking stroke as follows: the pull-through phase (phase1; paddle position of the tested arm while moving from the most forward to most backward position), exit phase (phase 2; from most backward position until paddle reaches a horizontal position), and recovery phase (phase 3; from the horizontal position of the paddle to the most forward position). Phase 1 of the kayaking stroke, as described by Trevithick *et al.* (2007), can be likened to positions one and two, as described by Mann and Kearney (1980); phase 2 to position three, and phase 3 to the recovery phase.

In research by Mann and Kearney (1980), into the biomechanical analysis of the Olympic-style flatwater kayak stroke, it was found that the boat's horizontal velocity decreases prior to blade entry. Horizontal acceleration then begins immediately prior to position two of the blade being achieved and continues through position two, with the boat reaching peak horizontal velocity between position two and three of the stroke. The boat then decreases in horizontal velocity from before position three through the paddle exit and recovery phase.

Mann and Kearney (1980) describe position two of the kayak stroke as the most effective phase of kayaking, as the maximum horizontal boat acceleration occurs at this time and that this maximum occurs at and around the vertical paddle position (i.e., when the shaft of the paddle is perpendicular to the water). It was also noted in the above study, that the mean percentage of the time that the blade was in the water was 71.5 percent of the total stroke time (Mann and Kearney, 1980).

Thus, maximum boat velocity would be achieved during phase 1 of the kayak stroke and 71.5 percent of the stroke occurs during this phase, as described by Trevithick *et al.* (2007).

In phase 1, or pull-through phase, the attacking arm is stretched forward whilst the opposite arm is in an extended, externally rotated and abducted position, in order to immerse the paddle in the water (Pelham *et al.,* 1995). As the kayaker initiates the stroke, the lead arm is then pulled into an adducted position until the forearm reaches a minimum of 90 degrees. The propulsion of the kayak is achieved by the ipsilateral musculature, as the blade is pulled backward in the water. The arm is then externally rotated, extended and abducted to ensure the smooth exit of the blade from the water, as the kayak stroke enters phase 2, or exit phase (Pelham *et al.,* 1995; Hagemann *et al.*, 2004; Trevithick *et al.,* 2007).

Also in phase 1, the abducted shoulder joint extends and internally rotates against the resistance of the kayak blade in the water (Trevithick *et al.,* 2007). The role of the Lattisimus Dorsi as a prime mover of the shoulder is exhibited here, as the shoulder extends and internally rotates. According to Hagemann *et al.* (2004), during the kayak stroke, the rotator cuff muscles are intimately involved in controlling and stabilising the humeral head in the glenoid and provide the forces to generate movement in the shoulder. The Supraspinatus muscle provides a medial force to the humeral head, which resists the shearing forces produced by the prime movers, as they produce unwanted translation of the humeral head on the glenoid fossa (Trevithick *et al.*, 2007). During phase 1 a consistent pattern of activity has been demonstrated in the Supraspinatus, upper Trapezius, and Lattisimus Dorsi muscles (Trevithick *et al.*, 2007). This would indicate that these muscles are among the major muscles responsible for propulsion of the kayak in this maximum velocity phase. It must be noted that the above description of the kayak stroke refers to on the water kayaking and may not be identical in kayak ergometry.

The postural factors and kinesiology involved in kayaking must not be forgotten and are certainly important in performing this study. However, the literature on these subjects relevant to kayakers is sparse and there is no literature to the researcher's knowledge which details these factors.

In order to properly test the fitness of a kayaker, the correct action must be used for the profile. This is done in order to reflect the athlete's ability to coordinate the appropriately trained muscle groups involved in the development of power. It is, therefore, vital to assess the kayaker's performance profile from an exercise involving the trained motor pattern and to test the athlete in the exercise mode in which he is competing. The testing of kayakers must, therefore, involve the subjects executing the kayak stroke (Telford, 1980, Fry and Morton, 1991). This, according to Draper *et al.* (1991), is the reason why the kayak ergometer was designed.

2.7 The Kayak ergometer versus open water paddling

Kayak ergometers are said to mimic open water paddling and have been used by professional and amateur kayakers alike, to train on and improve technical aspects of the stroke. During winter months, these ergometers have become vital aids in training.

According to van Someren *et al.* (2000), the Kayak ergometer is a valid measurement tool, in terms of reproducing and imposing the actual physiological demands of open water kayaking on the athlete and repeated trials done by van Someren *et al.* (2000) of high intensity, short duration exercise; showed that the Kayak ergometer was valid in terms of physiological assessment of kayakers. van Someren *et al's.* (2000) trial consisted of nine well-trained male kayakers and results showed that there was no difference between open water (OW) kayaking and kayak ergometry in terms of peak oxygen uptake (VO2), carbon dioxide production (VCO2), or carbohydrate oxidation (CHO-ox). Minute ventilation was, however, higher at 60 and 90 seconds in OW kayaking.

In another trial by van Someren and Oliver (2002) into the efficacy of ergometry determined heart rates for flatwater kayak training, it was found that similar blood lactate levels were observed during kayak ergometry and OW kayaking performed at HR-LT[1] (the power output at which blood lactate concentration increased by $\geq$ 1mmol x L^{-1} and the associated heart rate) in all three of the research groups. This trial consisted of an ergometry group, a K1 (single seater kayak) group, and a K4 (four-seat Kayak) group. It was also observed by van Someren and Oliver (2002) that there was no significant difference in stroke rates between the 3 groups.

Pickard and Pyke (1981), after their study on the assessment of the strength and endurance of surf-ski paddlers, summarised that maximal oxygen uptake, anaerobic threshold, and time taken to exhaustion - measured on the kayak ergometer - related significantly to paddling performance, whereas poor correlations were found between “non-specific” treadmill endurance tests and strength tests, when compared to paddling performance. They went on to reiterate the importance of testing to be specific to the task and, therefore, involve the trained muscle groups.

The KayakPro ergometer was the official supplier to the Athens 2004 Olympic Games, 2006 Asian Games, and the 2008 Beijing Olympic Games. In 2007, five of the six World champions and the reigning Olympic K1 500m champion all used the KayakPro ergometer to train on (Newswire.com, 2008).

CHAPTER 3

METHODOLOGIES

3.1 Introduction

This chapter gives an overview of how the study was conducted. Included here are the study designs, the subjects (patients) used, the interventions (treatment) the subjects received, as well as a discussion of the collected data and the statistical procedures performed on that data. This study obtained ethics clearance through the faculty of health sciences' research committee at the Durban University of Technology and an ethics clearance certificate (no. 029/08, appendix G) was issued. The following is the order in which the study took place:

Make contact with kayakers

↓

Schedule appointment

↓

Explanation of procedure

↓

Signing of informed consent form

↓

Case history, physical examination and cervical regional performed
Which included recording of levels of fixations if any present

↓

Participant included or excluded

↓

If included

↓

Participant included into group 1, 2 or 3

↓

SOAPE note completed

↓

Kayak ergometer settings verified with participant

↓

10 minute warm-up

↓

Maximum power (Watts) and time taken over 200m recorded

↓

4 minute rest

↓

Manipulate/Placebo laser, according to group chosen

↓

Maximum power (Watts) and time taken over 200m recorded.

Figure 3.1 Flowchart illustrating overview of experimental chronology
(6 weeks for running experiment)

3.2 Study Design

This study was a pre and post stratified experimental clinical trial.

3.2.1 Objective of the study

The objective of this study was to determine whether or not spinal manipulative therapy to the C4-C7 spinal segments would increase the power of the kayaking stroke and, therefore, increase speed of asymptomatic kayakers with and/or without restrictions at those levels.

3.2.2 Sampling

Participants were recruited by direct contact at kayaking and lifesaving clubs in and around Durban, as well as by word of mouth at these venues.

To those who were interested, an initial interview was conducted with the researcher, at time of contact, to determine whether or not the patient was suitable for the study. The patients had to be males (for sample homogeneity) between the ages of 20 – 40 (to reduce the possible effects of chronic degenerative diseases) and currently training (kayaking specifically) at least 3 times per week or 4 hours per week (to ensure a minimum level of fitness throughout participants).

Once suitability was established, applicants were screened for inclusion into the study at an initial consultation. During this consultation, the participant received a short description of the study (letter of information - Appendix A) and was requested to complete an informed consent form (Appendix B) prior to being included in the study.

A standard Case History (Appendix C), Physical Examination (Appendix D) and cervical regional examination (Appendix E) were then performed in order to ensure suitability for the study and to ensure that the applicant would comply with the inclusion and exclusion criteria, listed below, before participating in the study. A SOAPE note (Appendix F) was also completed and all completed forms were signed off by a senior clinician.

In order to identify fixations and make note of subjects with and without fixations, motion palpation of the cervical spine was performed during the cervical regional examination. According to Schafer and Faye (1990), the objectives of dynamic motion palpation are to note normal and abnormal segmental motion as well as motion restrictions in each segment.

A general survey of the cervical spine was performed first by placing the thumb and middle finger of the examining hand on the lamina of each segment and moving upward from C7 to the occiput in a smooth motion, pushing forward, then relaxing the examining hand and sliding upward to the next segment (Schafer and Faye, 1990). This general scan was then followed by specifically palpating each cervical motion segment in flexion, extension, rotation and lateral flexion, checking for joint play at the end range of motion as well as palpable asymmetry between sides (Schafer and Faye, 1990).

Any fixations found on motion palpation were noted on the cervical regional and SOAPE note.

3.2.3 Sample size

This study employed a convenience sample. As the number of registered kayakers in South Africa is relatively small - 2560 in KwaZulu-Natal and 4788 nationally, 85 percent of which are male (Whitfield, 2006) - sample group size was limited to 30 kayakers, and as such, the first thirty patients who complied with the inclusion and exclusion criteria were invited to participate in the study.

3.2.4 Sample allocation

Table 3.1 indicates the sample allocation into the 3 groups.

Table 3.1 Sample allocation

	Group 1	**Group 2**	**Group 3**
Criteria	Fixation present between C4-C7	No fixation present between C4-C7	Patients with or without fixations between C4-C7
Intervention	Manipulation between C4-C7 where fixations were present according to clinical findings	Manipulation between C4-C7 where no fixations were present according to clinical findings	Sham laser

Sample size	10	10	10

Bergmann *et al.* (1993) explains that a large percentage of joint dysfunction is self-limiting, or in fact so minor that the individual adapts and compensates to the change with limited structural and functional alteration. Therefore, although a fixation is present, the patient is asymptomatic. This asymptomatic patient was the subject group selected for this study.

When performing a manipulation in the lower cervical spine (C2 to C7), a specific contact point is taken on the articular pillars on the level of the fixated joint, i.e., between C4 and C5 for example, thus, the aim is to induce a maximal effect in that specific joint. This is, however, highly unlikely as the spine is a closed kinematic chain and any manipulative thrust will have some effect on the joints above and below the contacted vertebrae (Peterson and Bergmann, 2002), which is why manipulations occurred at random levels between C4-C7 and not on a specific vertebrae. Dixon (2005) and Naidoo (2002) also showed this in their respective studies, when they showed an increase in muscle strength independent of levels manipulated. Dixon (2005) also observed no significant differences between fixated groups and non-fixated groups.

3.2.5 Inclusion and exclusion criteria

3.2.5.1 Inclusion criteria

- All subjects chosen were between the ages of 20 and 40. This was to reduce the risk of chronic degenerative diseases (Dixon, 2005; Naidoo, 2002).

- For sample homogeneity, only male kayakers in the greater Durban area were used in the study.
- To maintain a level of fitness throughout the study, subjects must have been training at least 3 times per week or 4 hours per week over the last 3 months.
- All subjects accepted into the study received a letter of information (Appendix A) and were required to complete and sign an informed consent form (Appendix B) agreeing to all documentation provided.

3.2.5.2 Exclusion criteria

Patients were excluded from the study if they presented with:

- A history of trauma or surgery to the cervical spine region.
- Any relevant relative contra-indications to manipulation including:
    - Arteriosclerosis
    - Vertebrobasilar insufficiency
    - Spinal fractures
    - Severe spinal sprains
    - Osteoarthritis
    - Clotting disorders
    - Osteoporosis
    - Other arthritides
    - Severe trauma

    (Gatterman, 1990, Peterson and Bergmann, 2002).
- Inaudible cavitation (According to Vernon and Mrozek (2005), a successful cavitation is signalled by an audible crack).
- Hypertensive patients (Bergmann *et al.* 1993).
- All patients who failed to complete the informed consent form.

3.3 Clinical Intervention

The consultation took place at the Chiropractic Day Clinic on the Durban University of Technology campus and included applicant screening and establishment of suitability for the study. The patient's history, physical examination, and cervical regional examination were discussed with the clinician on duty and once both the clinician and the researcher were satisfied that the patient met the requirements for the study, the relevant documentation was signed and the study was permitted to continue. By the clinician signing off a patient, he/she acknowledges that the patient is suitable for the clinical trial and that they have undergone all the criteria listed in order to participate in the study. The patients were then tested on the kayak ergometer and their peak power and time taken to complete 200m was measured.

3.3.1 Measurements

3.3.1.1 Patient and testing procedure

The patients were seated on the kayak ergometer and the footrest was set according to the desired leg length required by the patients to simulate their regular kayaking position. The patients then underwent a ten minute warm-up, as detailed under the guidelines set out in the Canoe and Kayak Handbook (Ferrero, 2002), which also allowed for familiarization of the kayak ergometer.
Once the warm-up was completed, the patients began the first of their two 200m sprint tests.
The Paddle Monitor software was programmed such that as the patient took his first stroke for the 200m test, the clock began and the measurements were recorded. The software went immediately into the four minute rest as the 200m mark was reached and only when the patient took his first stroke for the second 200m test did the recordings start again. The intervention was administered during the four minute rest period and not more than one minute was allowed to elapse between the time of the adjustment being administered and the commencement of the second test (Bonci *et al.* 1990).

Each patient received verbal encouragement from the researcher to ensure maximal effort was achieved throughout the testing.

3.4 The data

The data in this study consisted of both primary and secondary data.

3.4.1 The primary data

The patient's maximum stroke power (measured as peak watts by a sensor on the flywheel of the kayak ergometer and connected to a desktop computer) and time taken to cover a 200m distance was measured. One set of readings was recorded prior to the intervention and another following the intervention.
A record was kept of where the fixation was located prior to the intervention and it was also noted if the cavitation following manipulation was audible. If the cavitation was inaudible, the patient was excluded from the study at that point. Only audible cavitations were considered successful, as described by Vernon and Mrozek (2005).

3.4.1.1 Kayak ergometer testing

A kayak ergometer was used to obtain the primary data as it simulates the feel of open water paddling (Formby, 2004). The data was captured by Paddle Monitor software which recorded the data on the desktop computer. The kayak ergometer is designed as a training aid for all levels of kayakers and is widely used by professionals to supplement everyday training. According to van Someren *et al.* (2000), the Kayak ergometer is a valid measurement tool in terms of reproducing and imposing the actual physiological demands of open water kayaking on the athlete and repeated trials done by van Someren *et al.* (2000) of high intensity, short duration exercise showed that the Kayak ergometer was valid in terms of physiological assessment of kayakers. The Paddle Monitor software recorded the maximum watts exerted over the 200m period, as well as the exact time taken to complete the two 200m sprint tests.

3.4.2 The secondary data

This consisted of the literature review, which incorporated literature sourced from current journal articles, books and the internet.

3.5 Interventions

Groups 1 and 2 received manipulation, whilst group 3 received sham laser therapy.

3.5.1 Manual thrust

Groups 1 and 2 both received standard, high velocity, low amplitude manual thrust, to the cervical spine, following the techniques set out by Schafer and Faye (1990) below:
Fixations were located while the patient was seated. Contact was then taken with the thumb of the contact hand on the side of the fixation. The contra lateral side was supported by the stabilizing hand at the level of the fixation. The patient's head was then rotated away from the fixation and extended slightly. Tissue slack is then taken up with the contact as the neck is rotated further, until firm resistance was felt. A quick, short impulse was then delivered to the fixation along the plane of the articulation.

Group 2 received manipulation on non-fixated joints and the above procedure was performed as previously stated, except that joints without fixations were located as opposed to joints with fixations (as in Group 1). This was important in order to determine which levels could be manipulated in Group 2.

3.5.2 Sham laser therapy

Group 3 received sham laser therapy over the entire posterior cervical region, following the techniques set out by Kitchen and Bazin (1998) and in lecture notes by Liggins (2005). Subjects remained seated whilst sham laser was administered in the last 2 minutes of the rest period. The laser was turned on and the patient was shown that the laser was working - by briefly pointing it at the examiner's hand. The laser was then turned off and held approximately 1cm from the patient's posterior cervical region, while the probe was moved in a wave-like motion to cover the entire posterior cervical region. This was done in order to investigate whether it was the mechanical effect of the spinal manipulation, which may have influenced the outcome of the study. McCarney *et al.* (2007) found that many patients appeared to respond better to research treatment than those in normal practice, purely due to the fact that they were participating in a clinical trial. This meant that patients may have changed their behaviour when they knew they were being observed/treated. This is known as the Hawthorne effect and is the reason why sham laser was used in a control group (group 3).

3.6 Statistical methods

Data was captured in MS Excel and exported into SPSS (Statistical Package for Social Sciences) version 12 (SPSS inc. Chicago, Ill) for analysis. Descriptive analysis for categorical variables was achieved by frequency tabulations. In the case of quantitative variables, the assumption of normality was checked using the skewness statistic and its standard error. Although the sample size was small, the quantitative variables all passed the normality test, and were thus, represented by means and standard deviations.

3.7 Statistical analysis

Comparison of categorical variables between independent groups: chi-square or Fisher's exact tests where appropriate. Comparison of quantitative variables between independent groups: t-test in the case of two groups, and ANOVA with Bonferroni post hoc tests for more than two groups, were used.

SPSS version 15.0 (SPSS Inc., Chicago, Illinois, USA) was used to analyse the data. A p value <0.05 was considered as statistically significant.

Normal distribution testing was completed using the One-Sample Kolmogorov-Smirnov Test. This was done to justify the use of parametric testing.

Descriptive statistics, including frequency tables and summary statistics, was computed in the case of demographic variables.

The effects of spinal manipulation therapy on time travelled and power of the kayaking stroke were determined using repeated measures analysis of variance (ANOVA) generalized linear models. Profile plots were generated to compare the trends visually.

CHAPTER 4

STATISTICAL METHODS AND RESULTS

4.1 Results

The sample comprised 30 subjects divided into three treatment groups. The first group included 10 subjects who had SMT on fixated joints, the second group of 10 subjects had SMT on non-fixated joints and the third group of 10 subjects had Placebo laser.

All subjects were White males.

Table 1, below, reflects the occupational categories of the 30 subjects. A total of 40% of the subjects were students, 10% were Engineers, 10% were athletes and the remaining 40% were from varied occupational categories.

Table 4.1 Distribution of Occupation of subjects

Occupation	**SMT on fixated joints (n=10)**		**SMT on non-fixated joints (n=10)**		**Placebo laser (n=10)**		**Total (n=30)**	
	n	%	n	%	n	%	n	%
Accountant	0	.0%	1	3.3%	0	.0%	1	3.3%
Athlete	1	3.3%	2	6.7%	0	.0%	3	10.0%
Builder	1	3.3%	0	.0%	0	.0%	1	3.3%
Business Owner	1	3.3%	0	.0%	1	3.3%	2	6.7%
Coach	0	.0%	0	.0%	1	3.3%	1	3.3%
Construction	0	.0%	1	3.3%	0	.0%	1	3.3%
Engineer	1	3.3%	2	6.7%	0	.0%	3	10.0%
Fish wholesaler	1	3.3%	0	.0%	0	.0%	1	3.3%
IT Consultant	0	.0%	0	.0%	2	6.7%	2	6.7%

Manager	0	.0%	1	3.3%	0	.0%	1	3.3%
Manufacturer	0	.0%	0	.0%	1	3.3%	1	3.3%
Student	4	13.3%	3	10.0%	5	16.7%	12	40.0%
Transport Logistics	1	3.3%	0	.0%	0	.0%	1	3.3%
Total	**10**	**33.3%**	**10**	**33.3%**	**10**	**33.3%**	**30**	**100.0%**

The results of the Kolmogorov-Smirnov test in Table 2 reflect that the dependent variables follow a normal distribution.

Table 4.2 One-Sample Kolmogorov-Smirnov Test

	N	Kolmogorov-Smirnov Z	p
Reading 1 Time(s)	30	.763	.605
Reading 2 Time (s)	30	.593	.874
Reading 1 Max Power(watts)	30	.418	.995
Reading 2 Max Power (watts)	30	.781	.575

4.1.1 Comparison of demographics and pre-adjustment values between treatment groups

Table 4.3 reflects that the mean age of subjects was not significantly different between the three treatment groups (p=0.922).

Table 4.3 Comparison of mean age between treatment groups

		N	Mean	Std. Deviation	Std. Error	F	p
Age	SMT on fixated joints	10	26.10	3.985	1.260	.082	.922
	SMT on non-fixated	10	27.10	4.306	1.362		

	joints						
	Placebo laser	10	26.80	7.885	2.494		

Table 4.4 reflects that the mean height of subjects was not significantly different between the treatment groups (p=0.868).

Table 4.4 Comparison of mean height between treatment groups

		N	Mean	Std. Deviation	Std. Error	F	p
Height (m)	SMT on fixated joints	10	1.8460	.09823	.03106	.142	.868
	SMT on non-fixated joints	10	1.8270	.07761	.02454		
	Placebo laser	10	1.8470	.10552	.03337		

Table 4.5 reflects that the mean weight of subjects was not significantly different between the treatment groups (p=0.906).

Table 4.5 Comparison of mean weight between treatment groups

		N	Mean	Std. Deviation	Std. Error	F	p
Weight (kg)	SMT on fixated joints	10	83.90	8.293	2.622	.099	.906
	SMT on non-fixated joints	10	84.90	9.746	3.082		
	Placebo laser	10	83.10	9.110	2.881		

The results in Table 4.6 reflect that pre-adjustment values for Time and Max Power were not significantly different between the three treatment groups (p>0.05).

Table 4.6 Comparison of pre-adjustment values between treatment groups

		N	Mean	Std. Deviation	Std. Error	F	p
Reading 1 Time(s)	SMT on fixated joints	10	54.138	4.3811	1.3854	.041	.960
	SMT on non-fixated joints	10	53.922	4.3929	1.3892		
	Placebo laser	10	54.448	3.5349	1.1178		
Reading 1 Max Power(watts)	SMT on fixated joints	10	203.440	50.1233	15.8504	.344	.712
	SMT on non-fixated joints	10	198.840	53.9796	17.0698		
	Placebo laser	10	186.270	38.2832	12.1062		

4.1.2 Intra-group analysis

Intra-group analysis of the ‘SMT on fixated joints’ group, in terms of the effect on time travelled, showed no significant change over time (p=0.652).

Table 4.7 Intra-group comparison of the effect of manipulation of fixated joints of the cervical spine on time travelled

Effect	Statistic	Value	F	p
Time	Wilks' Lambda	.976	.218	.652

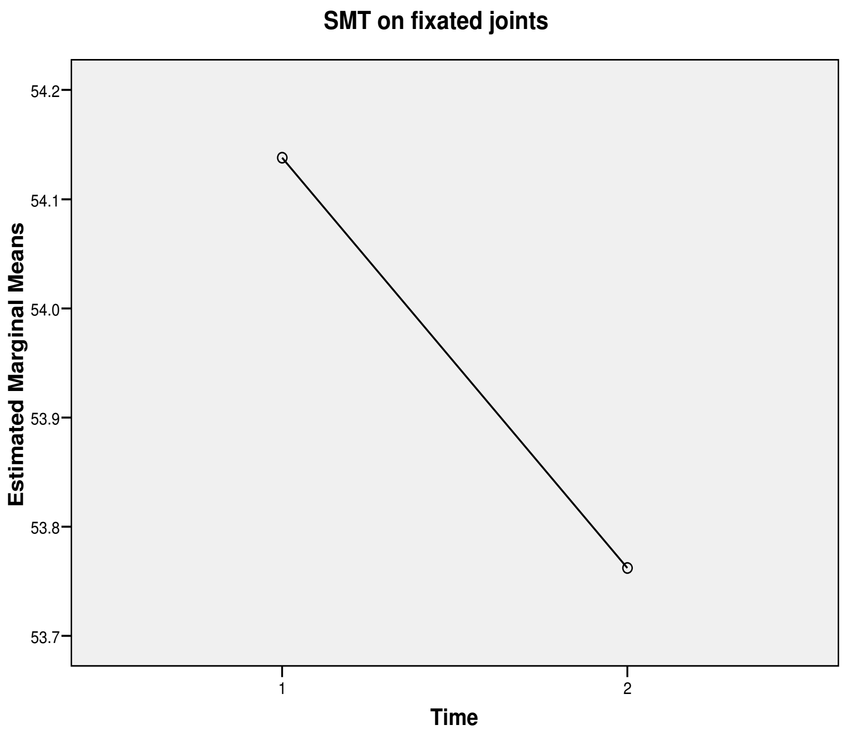


Figure 4.1 Mean time travelled in the ‘SMT on fixated joints’ group

Intra-group analysis of the ‘SMT on non-fixated joints’ group, in terms of the effect on time travelled, showed no significant change over time (p=0.930).

Table 4.8 Intra-group comparison of the effect of manipulation of non-fixated joints of the cervical spine on time travelled

Effect	Statistic	Value	F	Sig.
Time	Wilks' Lambda	.999	.008	.930

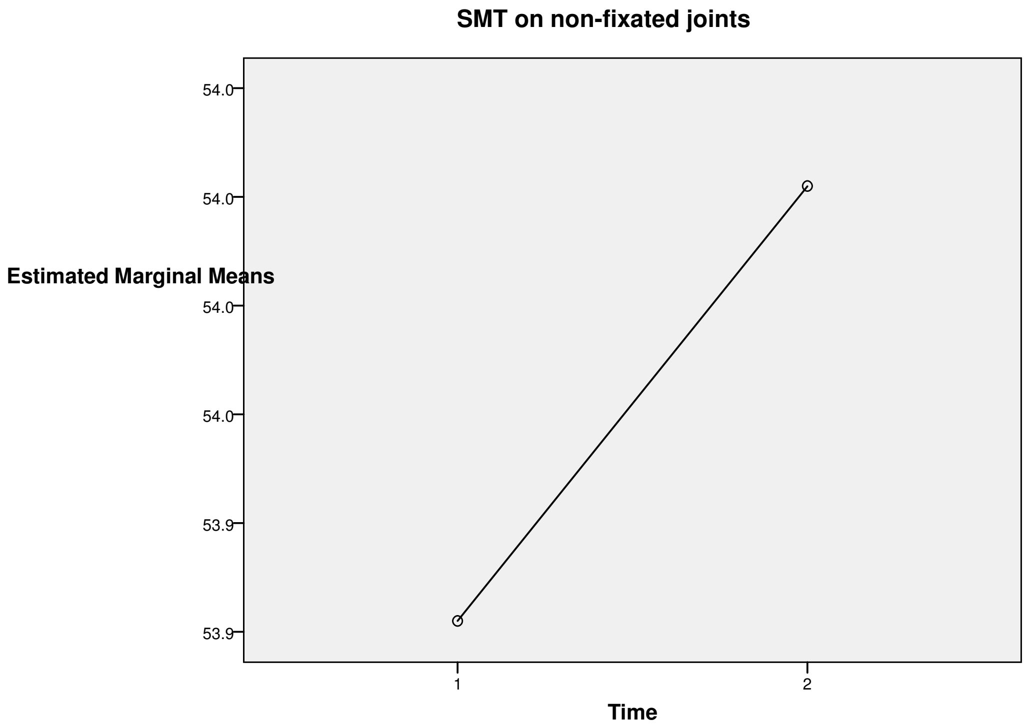


Figure 4.2 Mean time travelled in the ‘SMT on non-fixated joints’ group

Intra-group analysis of the 'Placebo laser' group, in terms of the effect on time travelled, showed no significant change over time (p=0.378).

Table 4.9 Intra-group comparison of the effect of Placebo laser of the cervical spine on time travelled

Effect	Statistic	Value	F	p
Time	Wilks' Lambda	.913	.859	.378

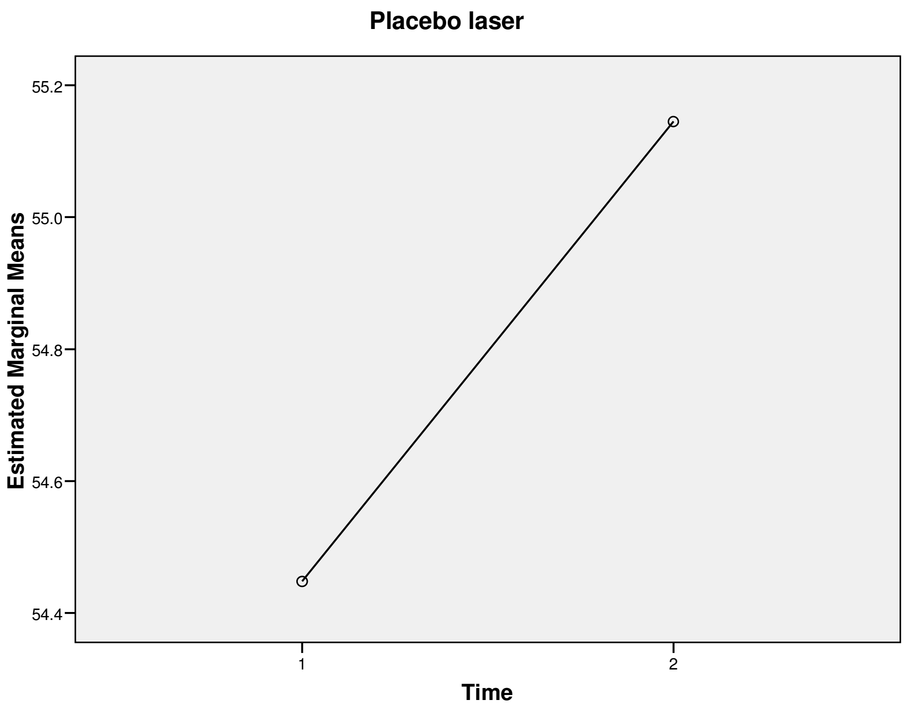


Figure 4.3 Mean time travelled in the 'Placebo laser' group

Intra-group analysis of the ‘SMT on fixated joints’ group, in terms of the effect on power of the kayaking stroke, showed no significant change over time (p=0.347).

Table 4.10 Intra-group comparison of the effect of manipulation of fixated joints of the cervical spine on the max power of the kayaking stroke

Effect		Value	F	p
Max Power	Wilks' Lambda	.902	.983	.347

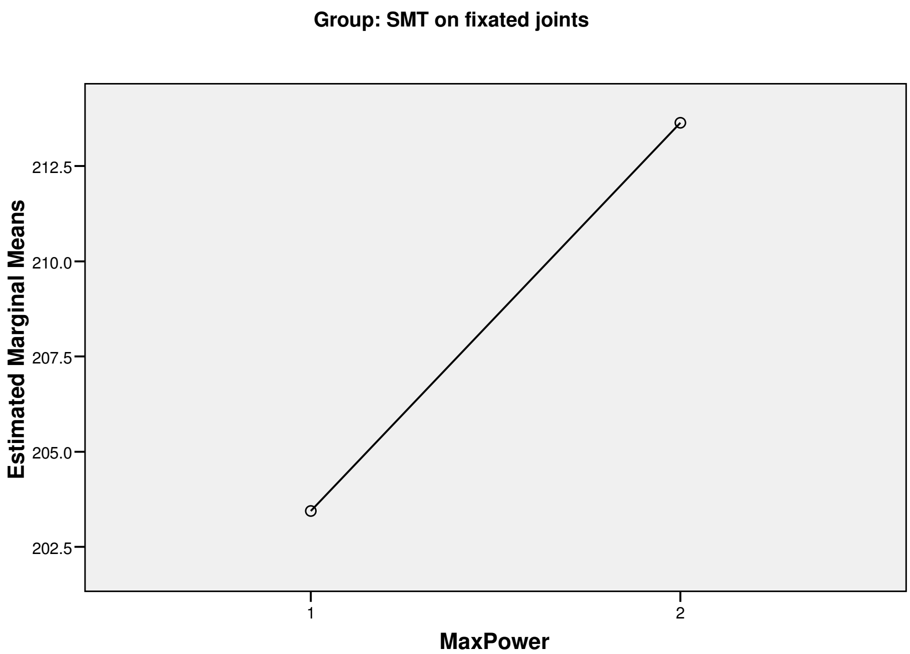


Figure 4.4 Mean max power in the ‘SMT on fixated joints’ group

Intra-group analysis of the 'SMT on non-fixated joints' group, in terms of the effect on power of the kayaking stroke, showed no significant change over time (p=0.758).

Table 4.11 Intra-group comparison of the effect of manipulation of non-fixated joints of the cervical spine on the max power of the kayaking stroke

Effect	Statistic	Value	F	p
Max Power	Wilks' Lambda	.989	.101	.758

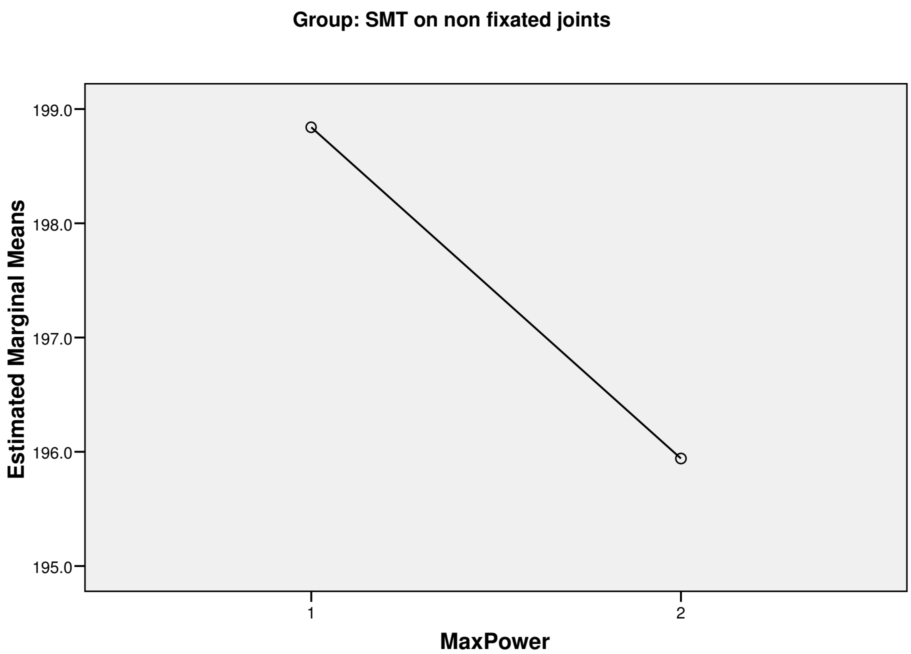


Figure 4.5 Mean max power in the 'SMT on non-fixated joints' group

Intra-group analysis of the 'Placebo laser' group, in terms of the effect on power of the kayaking stroke, showed no significant change over time (p=0.406).

Table 4.12 Intra-group comparison of the effect of placebo laser of the cervical spine on the max power of the kayaking stroke

Effect		Value	F	p
Max Power	Wilks' Lambda	.922	.761(a)	.406

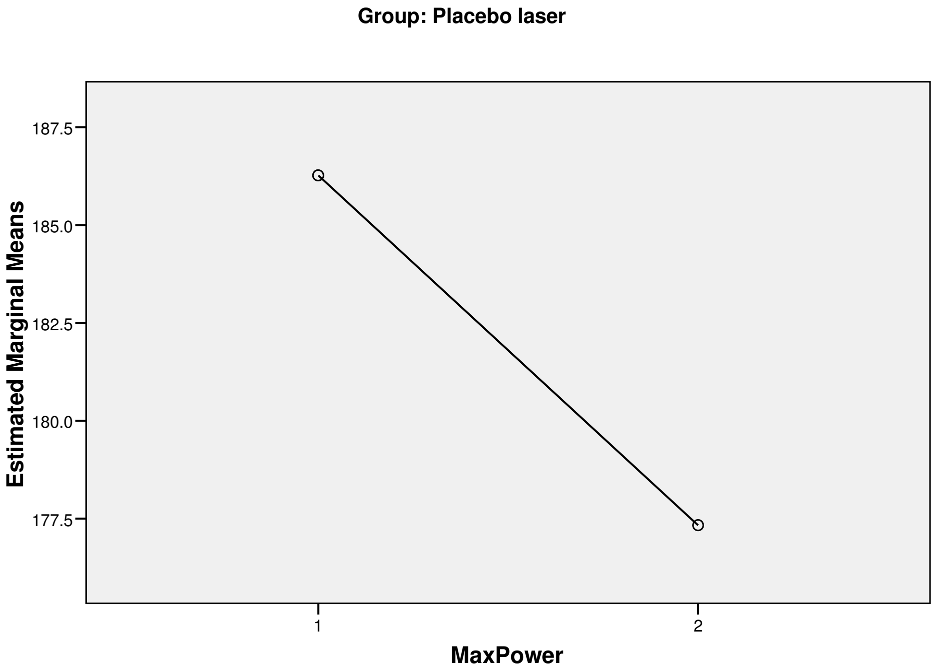


Figure 4.6 Mean max power in the 'Placebo laser' group

4.1.3 Inter – Group analysis

The results in Table 4.13 reflect that in terms of time travelled, there was no evidence of a differential treatment effect between the three groups (p=0.653).

Figure 4.7 shows changes for all three groups. In particular, an upward trend for SMT on non-fixated joints and Placebo laser, while SMT on fixated joints reflects a downward trend. However, the changes are not statistically significant.

The results of the Bonferonni post-hoc tests in Table 4.14 reflect no significant changes between group pairs (p>0.05).

Table 4.13 Inter-group comparison of the effects for time travelled

Effect	Statistic	Value	F	p
Time	Wilks' Lambda	.997	.080	.779
Time * Group	Wilks' Lambda	.969	.433	.653
Group	Between subjects		.161	.852

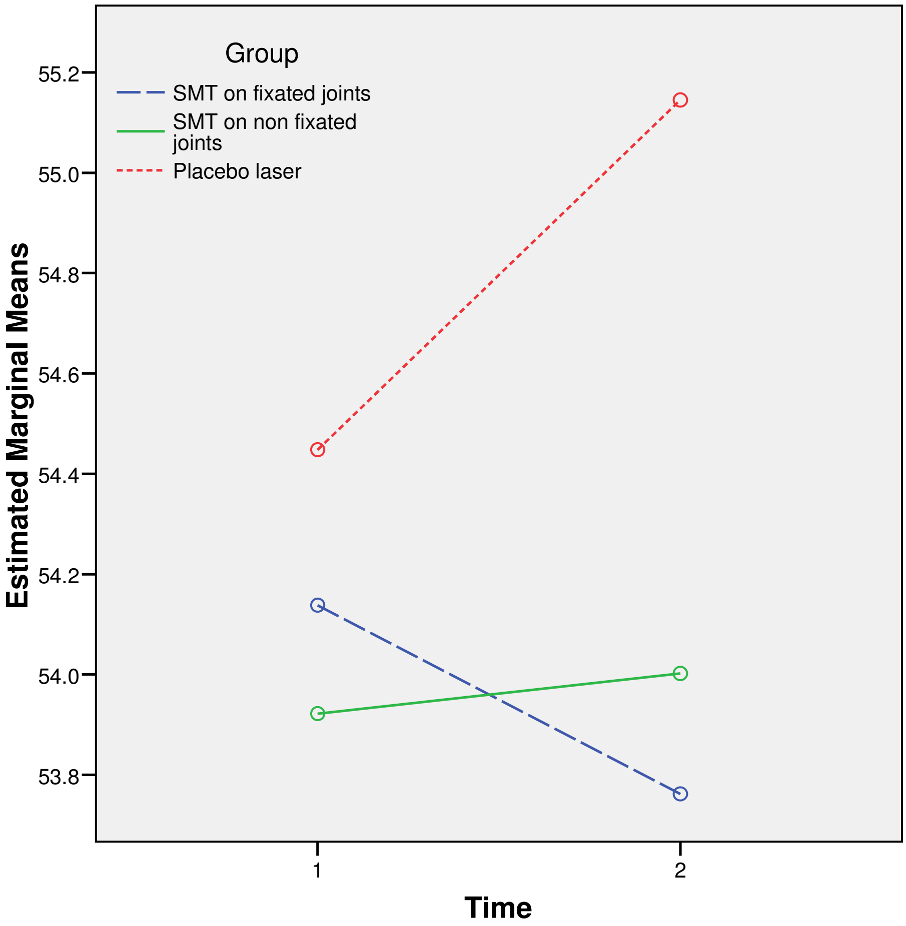


Figure 4.7 Mean time travelled by time and group

Table 4.14 Bonferonni Multiple Comparisons for Time

Group	Group	p
SMT on fixated joints	SMT on non-fixated joints	1.000
	Placebo laser	1.000
SMT on non-fixated joints	SMT on fixated joints	1.000
	Placebo laser	1.000
Placebo laser	SMT on fixated joints	1.000
	SMT on non-fixated joints	1.000

The results in Table 4.15 reflect that in terms of Max Power, there was no evidence of a differential treatment effect between the three groups (p=0.390).

Figure 4.8 shows changes for all three groups. In particular, an upward trend for SMT on fixated joints and downward trends for SMT on non-fixated joints and Placebo laser. However, the changes are not statistically significant.

The results of the Bonferonni post-hoc tests in Table 4.15 reflect no significant changes between group pairs (p>0.05).

Table 4.15 Inter-group comparison of the effects for power of the kayaking stroke

Effect	Statistics	Value	F	p
Time	Wilks' Lambda	1.000	.009	.925
Time * Group	Wilks' Lambda	.933	.975	.390
Group			.960	.395

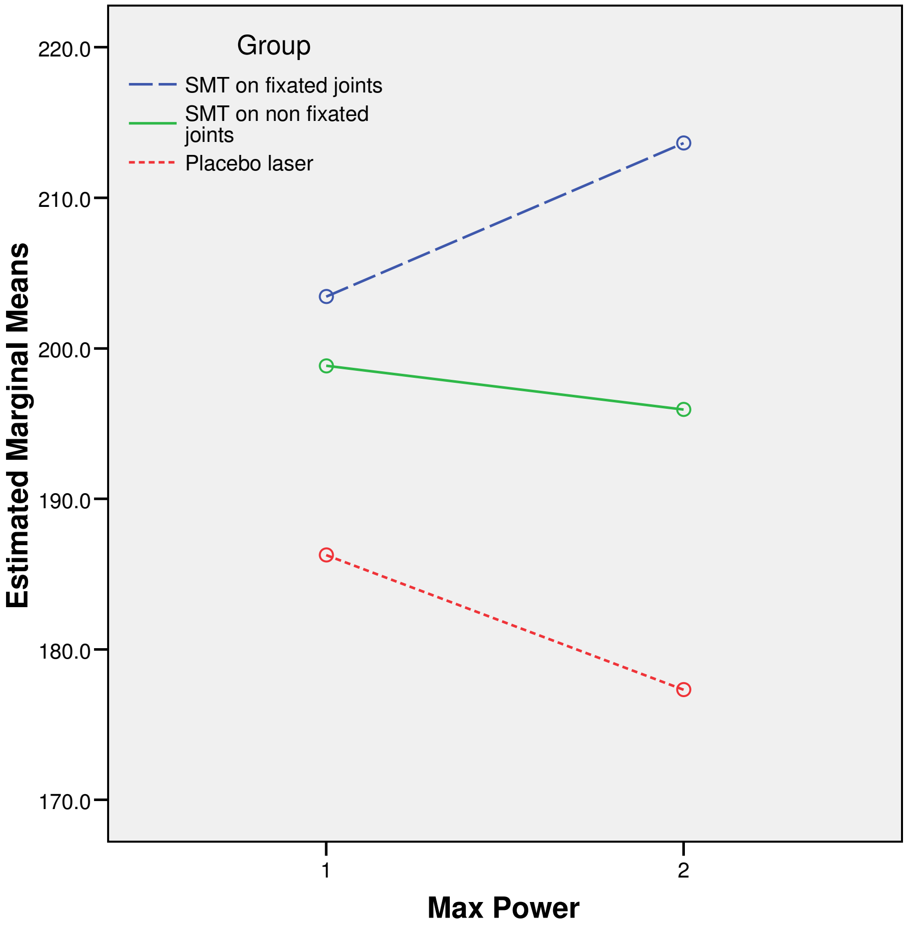


Figure 4.8 Mean Max Power by time and group

Table 4.16 Bonferonni Multiple Comparisons for Max Power

Group	Group	p
SMT on fixated joints	SMT on non-fixated joints	1.000
	Placebo laser	.537
SMT on non-fixated joints	SMT on fixated joints	1.000
	Placebo laser	1.000
Placebo laser	SMT on fixated joints	.537
	SMT on non-fixated joints	1.000

4.2 Summary and conclusion

The pre-adjustment values for both time travelled and Max Power were not statistically different between the three treatment groups**.**

The intra-group changes over time were not significant for all three treatment groups.

The inter-group changes over time also revealed no significant effect for all three treatment groups.

CHAPTER 5

DISCUSSION

5.1 Introduction

This chapter will discuss the outcomes of this research and methodological issues.

The sample utilised for this study consisted of 30 subjects out of a research population of approximately 2500 in Kwazulu/Natal. Statistical analysis can, therefore, be deemed relatively accurate and representative of a normal distribution curve. Of the 34 patients that volunteered for the study, 3 did not fulfil their commitment to the appointment and 1 did not comply with the age criteria for the study.

Data collection took place whilst the patients were performing their 200m sprint tests, pre and post manipulation.

It is important to remember the following:

1. All patients in the study were asymptomatic.
2. One group received manipulation on fixated joints, one group on non-fixated joints and one group received placebo laser.
3. Measurements were recorded on Paddle Monitor software. Maximum power (measured in Watts) and time taken to complete 200m were recorded.
4. Although the researcher attempted to maintain a homogenous sample group, the subjects who participated in this study were varied in terms of the level of experience and representation. Some subjects were national kayakers, whilst others were provincial kayakers and social kayakers. Included in the national kayakers, were 3 current and former world champions and one Olympian. 40% of the subjects have

consistently either won or been placed in the top ten in major national races. In a study by Fry and Morton (1991), it was noted that 7 of the 38 subjects tested were Australian state representative kayakers and that they exhibited greater strength, muscular girth, and maximal oxygen uptake during testing.

5.2 Demographics

85% of the 2560 registered kayakers in KwaZulu-Natal are males and as such, in order to maintain a homogenous sample group, the study was limited to males only (Whitefield, 2006). The average age of the patients who participated in the study was twenty-seven years, with 73% of patients being between the ages of twenty to thirty years and 27% being between the ages of thirty to forty years.

With reference to Table 4.1, it must be noted that 40% of the subjects were students. This may have had an effect on the outcome of the study, as the field of study and amount of additional time which the subject may or may not have had to train in as well as the amount of additional training and cross training done by the subject, may have affected the power of those particular subjects in the study. It must be noted, however, that there was a relatively even distribution of students between groups and that if there was an influence as described above, it should have been split among the groups. It must also be noted that professional athletes only numbered three and that two of them were in group 2.

It is relevant to note one of the limitations of this study, which was the lack of homogeneity between paddlers - which varied between marathon, sprint and social paddlers. To the researchers' knowledge, there were only two of the thirty subjects which were strictly sprinters and did not compete in any other form of kayaking. Eight other subjects competed regularly in both the national sprint and marathon seasons. The rest of the subjects competed mainly in local marathons and/or socially. These factors may have influenced the outcome of the results, as the majority of the subjects were not specialist sprint kayakers. If the group consisted strictly of sprinters, results may have been more accurate and consistent. These limitations could however not be avoided as there would not have been enough full time sprinters in the country to participate in this study. The majority of the kayaking which occurs in South Africa is marathon orientated and due to financial distribution, this is also where the majority of the funds are allocated. This study would have been better conducted in another country such as Germany or Hungary, where sprint kayaking is the major form of kayaking.

5.3 Assessment of the treatment effect

5.3.1 Time

Time taken to complete a 200m sprint distance, pre and post manipulation, was recorded using Paddle Monitor software.

Although not statistically significant, there was a visual trend which showed a decrease in mean time taken to complete the 200m in the fixated group (Fig 4.1). The non-fixated (Fig 4.2) and placebo groups (Fig 4.3) on the other hand, showed no change and a mean increase in time respectively over the set distance. These changes are in line with the findings by Naidoo (2002) and Dixon (2005), although they do not confirm the trends noticed by Dixon (2005), in which the asymptomatic, non-fixated group improved post manipulation. It must also be noted that Naidoo's (2002) study was conducted on symptomatic patients, whereas the study by this researcher was conducted on asymptomatic patients.

Fig 4.1 indicates that there was a decrease in mean time taken to complete the 200m sprint after manipulation of a fixated joint in the cervical spine. The mean time ranged from approximately 54.15s to approximately 53.75s. As discussed in the introduction to this dissertation, these changes in times may be considered extremely relevant. It was previously noted that the winning margins at the 2009 World Flatwater Racing Championships were consistently less than one second with numerous finals displaying winning margins of less than 0.1s and one final even going as low as 0.002s between first and second. Although these findings have been shown to be statistically insignificant, they cannot be ignored. These results must be taken into the context of the sport being researched, namely sprint kayaking, and the extremely narrow margins by which races are won in this discipline.

Figure 4.2 shows a mean increase in time of less than 0.1s and based on the improvements shown in Group 1, it could be argued that there is no improvement in performance of a kayaker after manipulation of a non-fixated cervical spine segment. More research with greater numbers of asymptomatic kayakers with no fixations would need to be performed in order to confidently state this.

Group 3 showed similar margins of change as in group 1 in that there was a difference in times post placebo intervention of approximately 0.8s, with group three subjects times increasing in the second test. These changes demonstrate that the placebo group worsened after the placebo laser intervention.

Comparing group 1 and group 3 results, it must be noted that there is a difference between the groups in the second sprint time post intervention, of approximately 1.2s with group 1 increasing time by approximately 0.8s and group 3 decreasing time by approximately 0.4s. This shows a trend in which the group which was manipulated on a fixated segment in the cervical spine actually improved greatly when compared to the placebo laser group. These results support the findings of Rebechini-Zasadny *et al.* (1981) and Suter and McMorland (2002) as well as trends noticed in Naidoo (2002) and Dixon's (2005) studies, in which fixated joints in the cervical spine produce reflexogenic effects on peripheral limb musculature once manipulated.

5.3.2 Power

Maximum power produced by the subject during the 200m sprint tests was recorded as Watts by the Paddle monitor software, and noted pre and post manipulation. The watts were measured in each stroke using the Paddle monitor software and the maximum watt value produced during the tests was recorded as the maximum watts by the software.

The fixated group again showed an increase in maximum power (Watts) over the 200m sprint, post manipulation and the mean value increased from approximately 202.5 watts in the first sprint test pre manipulation to approximately 212.5 watts after the cervical manipulation was performed on a fixated cervical spine segment. It was also again noted that there was a decrease in maximum power in the non-fixated and placebo groups in the same relationship as seen in the time taken to complete the 200m sprint tests.

This is in line with the readings and mean averages noted in the time taken to complete the 200m sprint event, although all of the readings have been noted to not be statistically significant.

Table 4.4, 4.5, and 4.6 show a difference in the mean maximum in the initial test pre intervention between the groups. In group 1, the mean maximum power pre intervention was approximately 202.5 watts, group 2 approximately 199 watts, and group 3 approximately 187.5 watts. These values show a significant difference in strength between the subjects in group 1 and group 3 and may also have contributed to inconsistent results in and between the groups. This may be due to the point noted earlier regarding the homogeneity of the subjects and the fact that the subjects were varied in terms of the type of kayaking performed and the small sample of sprint specialists in the research. The difference in power between the groups may also have been influenced by a greater number of national representatives being allocated into groups unwittingly and again highlights the limitations of the study and the need to repeat the study with equally rated and dedicated sprint kayakers.

Another limitation in this study which may have resulted in skewed results is the different paddle blades used by the subjects. Although wing blades are standard and conventional blades have not been used in kayaking for at least a decade, it is important to note that there are many variations of the wing paddle blade, and that multiple manufacturers across the world produce a number of their own variations to suit a specific style of kayaking. This may have been influential when the subjects were tested on the kayak ergometer. Particular styles of paddling may not have been suited to kayak ergometry. There have been no studies, to the researchers' knowledge, to support or refute these possible limitations, but they must be noted in light of the results and for further research.

These results and the trends noted in the fixation groups are in line with the studies by Wyke (1985) and Suter *et al.* (2000), in which they note the increase in motor neuron excitability and reflexogenic effects, which may arise due to a low amplitude, high velocity thrust applied to the cervical spine. These trends also coincide with the research by Rebechini-Zasadny *et al*. (1981), Naidoo (2002), and Dixon (2005), in which there is a noted increase in muscle strength at a site distant to that of the manipulation - post manipulation.

Although these results did not reach statistical significance, they were consistent in that the fixated group reacted positively to manipulation and there was a decrease in mean time taken to complete the 200m, in addition to a mean increase in maximum power of the stroke post manipulation. The non-fixated and placebo groups also followed this consistency, although the trends were an increase in mean time and a decrease in maximum power post manipulation, contrary to Dixon's (2005) study in which the trend was toward an increase in the power of the rotator cuff muscles in the asymptomatic non-fixated group. This also contradicts the theories by Vernon and Mrozek (2005) and Leach (2004), in which they describe a normal joint to theoretically have a greater degree of neurological stimulation than a dysfunctional joint, as it is able to be manipulated into the para-physiological range, as described by Sandoz (1976).

The research has, thus not ruled out that manipulation of the cervical spine in asymptomatic kayakers may have a positive influence in speed and maximum power on the kayaking stroke, although caution must be taken to make these assumptions, considering the statistical insignificance of the results.

5.4 In summary

This study has not shown statistically significant results that manipulation of the cervical spine results in an increase in the power of the kayaking stroke. There was, however, a trend toward an increase in speed (measured in time) and power (measured in watts) of the kayaking stroke following manipulation of fixated joints of the cervical spine, in asymptomatic subjects. These trends were noted in the fixated group, which appeared to have a decreased mean time in the 200m sprint test. It was also noted in this same group that there was an increase in mean peak power over the 200m sprint test. The placebo and non-fixated group showed no mean increase in peak power or decrease in mean time. A larger study is needed to provide further evidence to support or refute these results and to confirm or deny the hypothesised benefits of manipulation on peripheral musculature.

CHAPTER 6

CONCLUSION AND RECOMENDATIONS

6.1 Conclusion

The purpose of this study was to investigate whether or not cervical spine manipulation resulted in an increase in power of the kayaking stroke.
The hypothesis and objectives, as set out before the study were as follows:

Objective 1: The first objective was an intra-group analysis (Manipulation of fixated joint vs. non-fixated joint vs. placebo laser) with respect to objective findings (Time taken to travel 200m and peak power recorded).

Objective 2: The second objective was an inter-group analysis (Manipulation of fixated joint vs. non-fixated joint vs. placebo laser) with respect to objective findings (Time taken to travel 200m and peak power recorded).

Hypothesis: It was hypothesised before the study, that manipulation of the cervical spine would result in an increase in the power of the kayaking stroke and that it would be regardless of whether the cervical segment being manipulated was fixated or not.

The fixation group (Group 1) showed a statistically insignificant increase in peak power, as well as a statistically insignificant decrease in time taken to complete the 200m sprint test post manipulation and, thus the hypothesis set out before the research was rejected.

The non-fixation group (Group 2) showed no improvement in peak power or time taken post manipulation, as was the case with the placebo laser group (Group 3), which showed no increase in objective readings.

The research does not support the hypothesis above, however, in that there was a difference in trends noted between the fixated and non-fixated groups, with the non-fixated group producing results in line with those found in the placebo group.

This was, therefore, only partially in compliance with the above hypothesis, which stated that there would be an increase in power of the kayaking stroke following manipulation, regardless of the degree of fixation.

6.2 Recommendations

1. A similar study could be conducted by comparing male and female subjects.
2. This study should be repeated using a larger sample size per group so that more accurate results can be obtained.
3. A similar study should be conducted to determine if there is an increase in power and speed of the kayaking stroke over a greater distance.
4. Surface EMG could be used on peripheral muscles to increase objective data.
5. Research should be conducted to determine the effect of manipulation, in symptomatic patients, on the power of the kayaking stroke.
6. Subjects in this study were of varying levels, therefore, it is suggested that future research in this area should look at testing kayakers of similar levels of skill.

APPENDICES

Appendix A
LETTER OF INFORMATION

DATE:

Dear Participant, welcome to my research project.

Title of Research:
An investigation to identify changes in the power of the kayaking stroke following manipulation of the cervical spine in asymptomatic kayakers.

NAME OF RESEARCH STUDENT

Neil Cuninghame Contact number (0836388934)

NAME OF RESEARCH SUPERVISOR
Dr. Neil Gomes Contact number (031- 572 7000)
[M Chiropractic]

You have been selected to take part in a study to investigate the effect of cervical spine manipulation on the power of the kayaking stroke.
Thirty people will be required to complete this study.
All participants, including you, will be split into three equal groups.
Each of the groups will receive a standard clinical assessment of their cervical spines.
Two groups will receive spinal manipulative therapy and the other group will receive laser therapy of their cervical spine.

Inclusion and Exclusion:

Please try not to alter your normal lifestyle or daily activities in any way, as this could interfere with the results of the study. Those taking part in the study must be between the ages of 20 and 50.

Any kayakers who do not meet the required number of days training per week (3) or the number of hours training per week (4) would be excluded. Kayakers would also be excluded if they have had any surgery or previous trauma to the cervical or upper thoracic region. Kayakers who are found to have contraindications to manipulation, such as arteriosclerosis, vertebrobasilar insufficiency, fractures, severe sprains, osteoarthritis, clotting disorders or osteoporosis. Other contraindications would include any arthritides or severe trauma to the cervical region.
Research process:

At the first consultation you will be screened for suitability as a participant using a case history, physical examination and cervical spine regional examination.

Risks and discomfort:

The testing is relatively harmless; however, some muscle stiffness after testing may be experienced.

Remuneration and costs:

Subjects taking part in the study will not be offered any form of remuneration for taking part in the study. Upon completion of the research process, the normal cost of consultations will be charged for those patients wanting further treatment. All patient information is confidential and the results of the study will be made available in the Durban University of Technology library in the form of a mini-dissertation.

Implications for withdrawal from the research:

You are free to withdraw at any stage.

Benefits of the study:

Your full co-operation will assist the Chiropractic profession in expanding its knowledge on the immediate effects of spinal manipulation. The manipulative treatment that will be given is a common treatment intervention in the treatment of cervical facet syndrome (neck pain).
All treatments are free of charge.

Confidentiality and ethics:

All patient information will be kept confidential and will be stored in the Chiropractic Day Clinic for 5yrs, after which it will be shredded.
Please don't hesitate to ask questions on any aspect of this study. Should you wish, you can contact my research supervisor at the above details or alternatively you could contact the Faculty of Health Sciences Research and Ethics Committee as per Mr. Vikesh Singh (031) 2042701.

Thank you.
Yours sincerely,

…………………………………..	…………………………………
Neil Cuninghame	Dr. Neil Gomes
(Research student)	(Supervisor)

Appendix B

INFORMED CONSENT FORM

(To be completed by patient / subject)

Date :

Title of research project:

An investigation to identify changes in the power of the kayaking stroke following manipulation of the cervical spine in asymptomatic kayakers

Name of supervisor : Dr. Neil Gomes [M Chiropractic]
Tel : (031) 572 7000

Name of research student : Neil Cuninghame
Tel : 0836388934

Please circle the appropriate answer **YES /NO**

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

Please ensure that the researcher completes each section with you.
If you have answered NO to any of the above, please obtain the necessary information before signing.

Please print in block letters:

Patient /Subject Name:____________________Signature: ____________

Parent/ Guardian:____________________Signature:____________

Witness Name:____________________Signature:____________

Appendix C

Case History

DURBAN UNIERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:____ Date: __________

File #: ____________ Age: __________

Sex : __________ Occupation:______________________________

Intern : ______________________________ Signature:______________________

FOR CLINICIANS USE ONLY:
Initial visit
Clinician: Signature :

Case History:

Examination:
Previous:
Current:

X-Ray Studies:
Previous:
Current:

Clinical Path. lab:
Previous:
Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL:
Reason for Conditional:

Signature: Date:

Conditions met in Visit No:	Signed into PTT:	Date:
Case Summary signed off:		Date:

<u>Intern's Case History:</u>

1. **Source of History:**

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

3. **Present Illness:**

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

4. **Other Complaints:**

5. **Past Medical History:**

< General Health Status

< Childhood Illnesses

< Adult Illnesses

< Psychiatric Illnesses

< Accidents/Injuries

< Surgery

< Hospitalisations

6. Current health status and life-style:

< Allergies

< Immunizations

< Screening Tests incl. x-rays

< Environmental Hazards (Home, School, Work)

< Exercise and Leisure

< Sleep Patterns

< Diet

< Current Medication
Analgesics/week:

< Tobacco

< Alcohol

< Social Drugs

7. Immediate Family Medical History:

< Age

< Health

< Cause of Death

< DM

< Heart Disease

< TB

< Stroke

< Kidney Disease

< CA

< Arthritis

< Anaemia

< Headaches

< Thyroid Disease

< Epilepsy

< Mental Illness

< Alcoholism

< Drug Addiction

< Other

8. Psychosocial history:

< Home Situation and daily life

< Important experiences

< Religious Beliefs

9. Review of Systems:

< General

< Skin

< Head

< Eyes

< Ears

< Nose/Sinuses

< Mouth/Throat

< Neck

< Breasts

< Respiratory

< Cardiac

< Gastro-intestinal

< Urinary

< Genital

< Vascular

< Musculoskeletal

< Neurologic

< Haematologic

< Endocrine

< Psychiatric

Appendix D

Physical

Durban University of Technology ***PHYSICAL EXAMINATION: SENIOR***

Patient Name :	**File no :**	**Date :**
Student :	**Signature :**	

VITALS:

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

GENERAL EXAMINATION:

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

SYSTEM SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION
NEUROLOGICAL EXAMINATION
COMMENTS
Clinician: **Signature :**

Appendix E

DURBAN UNIVERSITY OF TECHNOLOGY
REGIONAL EXAMINATION - CERVICAL SPINE

Patient: .... File No: ....

Date: .... Student: ....

Clinician:... Sign: ....

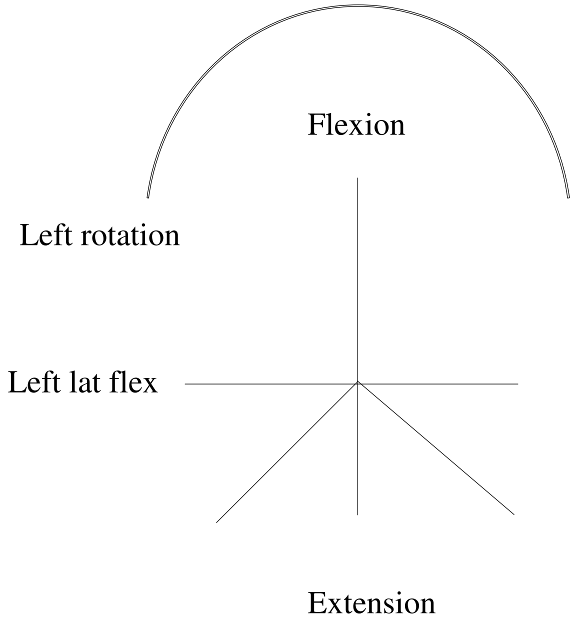
OBSERVATION:

Posture
Swellings
Scars, discolouration
Hair line
Body and soft tissue contours

Shoulder position
Left :
Right :
Shoulder dominance (hand):
Facial expression:

RANGE OF MOTION:

Right rotation
Extension (70º):
L/R Rotation (70º):
L/R Lat flex (45º):
Right lat flex
Flexion (45º):



PALPATION:

Lymph nodes
Thyroid Gland
Trachea

ORTHOPAEDIC EXAMINATION:

Tenderness		Right	Left
Trigger Points:	SCM		
	Scalenii		
	Post Cervicals		
	Trapezius		
	Lev scapular		

	Right	Left		Right	Left

Doorbell sign			Cervical compression		
Kemp's test			Lateral compression		
Cervical distraction			Adson's test		
Halstead's test			Costoclavicular test		
Hyper-abduction test			Eden's test		
Shoulder abduction test			Shoulder compression test		
Dizziness rotation test			Lhermitte's sign		
Brachial plexus test					

NEUROLOGICAL EXAMINATION:

Dermatones	**Left**	**Right**	**Myotomes**	**Left**	**Right**	**Reflexes**	**Left**	**Right**
C2			C1			C5		
C3			C2			C6		
C4			C3			C7		
C5			C4					
C6			C5					
C7			C6					
C8			C7					
T1			C8					
			T1					

Cerebellar tests:	Left	Right
Disdiadochokinesis		

VASCULAR:	**Left**	**Right**		**Left**	**Right**
Blood pressure			Subclavian arts.		
Carotid arts.			Wallenberg's test		

MOTION PALPATION & JOINT PLAY:
Left: Motion Palpation:
Joint Play:
Right: Motion Palpation:
Joint Play:

<u>BASIC EXAM: SHOULDER:</u>

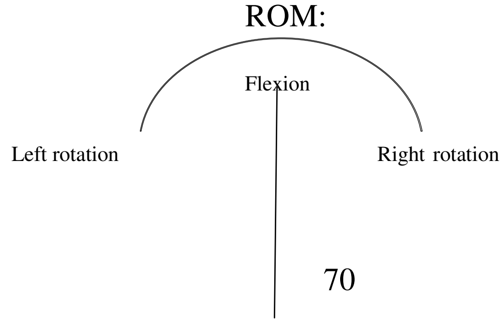
Case History:

ROM: Active:
Passive:

<u>BASIC EXAM: THORACIC SPINE:</u>

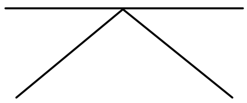
Case History:

ROM:



RIM:

Orthopaedic:
Neuro:
Vascular:



Motion Palpation:	
Orthopaedic:	
Neuro:	
Vascular:	
Observ/Palpation:	
Joint Play:	

Appendix F

SOAPE Note

DURBAN UNIVERSITY OF TECHNOLOGY

Patient Name:		***File #:***	***Page:***
Date: ***Visit:*** ***Intern:*** ***Attending Clinician:***		***Signature:***	
S: *Numerical Pain Rating Scale (Patient)* *Intern Rating* *Least* ***0 1 2 3 4 5 6 7 8 9 10*** *Worst* ***0:*** ***E:*** ***Special attention to:***		***A:*** ***P:*** ***Next appointment:***	
Date: ***Visit:*** ***Intern:*** ***Attending Clinician:***		***Signature:***	
S: *Numerical Pain Rating Scale (Patient)* *Intern Rating* *Least* ***0 1 2 3 4 5 6 7 8 9 10*** *Worst* ***O:*** ***E:*** ***Special attention to:***		***A:*** ***P:*** ***Next appointment:***	
Date: ***Visit:*** ***Intern:*** ***Attending Clinician:***		***Signature***	

Appendix G

DURBAN UNIVERSITY of TECHNOLOGY

Faculty of Health Sciences

ETHICS CLEARANCE CERTIFICATE

Student Name	**Neil Cuninghame**	**Student No**	**20200713**
Ethics Reference Number	**FHSEC** 029/08	**Date of FRC Approval**	25/8/08
Research Title:	An investigation to identify changes in the power of the canoeing stroke following manipulation of the cervical spine in asymptomatic canoeists.		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with Institutional requirements and confirms the following ethical obligations:

1. The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the DUT 186 and agrees to comply with them.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. ***The following section must be completed if the research involves human participants:***

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	X		
❖ Potential psychological and physical risks have been considered and minimised	X		
❖ Provision has been made to avoid undue intrusion with regard to participants and community	X		
❖ Rights of participants will be safe-guarded in relation to: - Measures for the protection of anonymity and the maintenance of Confidentiality.	X		
• - Access to research information and findings.	X		
- Termination of involvement without compromise	X		
- Misleading promises regarding benefits of the research	X		

SIGNATURE OF STUDENT/RESEARCHER — 5/8/08 DATE

SIGNATURE OF SUPERVISOR/S — 5/8/08 DATE

SIGNATURE OF HEAD OF DEPARTMENT — 7/8/8 DATE

SIGNATURE: CHAIRPERSON OF RESEARCH ETHICS COMMITTEE — 25/08/08 DATE

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