# The Effect of Segmental Manipulation of the Cervical Spine on Grip Strength in Patients with Mechanical Cervical Spine Dysfunction

A dissertation in partial compliance with the requirements for a Master`s Degree In Technology in the Department of Chiropractic at the Durban Institute of Technology.

By

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I solemly declare this is my own work in compilation and execution.

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# Dedication

This research is dedicated to my grandmother, Mrs Lutchmee Naidoo. Thank you ma for the lessons of courage, love and determination that you have thought me. I know that you are shining down upon me from the courts of heaven. I love you and miss you dearly.

**Acknowledgements**

Thank you to my supervisor, DR C Myburgh, for all the assistance in helping me to complete this work and helping me realise more of my capabilities.

To my family Vanitha, Stanley, Clement and Sharazaal…thanks for the constant love and support.

To Samantha, the integral and complete part that you have played in my life echoes an eternity…thank you

To Joe Williams… thanks for being such a fatherly figure.

To Mrs Ireland…there is a place where there are more people like you…heaven.

Thanks to all who participated in this research…may God bless.

Last but not least, thank you to my lord Jesus Christ…this belongs to you.

# Abstract

Chiropractic researchers have hypothesized as to how the removal of a cervical dysfunction may affect the nervous system negatively. However, little focus has been placed on possible optimizing effects, such as grip strength. This study attempted to establish that relationship. Therefore, the specific aim of this study was to determine the relative effectiveness of segmental manipulation of the cervical spine on grip strength in patients with mechanical cervical spine dysfunction.

Subjects were recruited mainly from the Durban Institute of Technology via personal interviews. The subjects had to be between the ages of 18 and 35 years old. In order to be included into the study the subjects had to asymptomatic barring a cervical spine dysfunction. All subjects had to undergo a case history, a physical examination and a regional cervical examination .A sample size of 120 patients were used. These patients were randomly divided into four groups of 30 patients depending on the level of fixation that they presented with i.e. group 1 ( C4-C5 fixation), group 2 ( C5-C6 fixation) , group 3 ( C6-C7 fixation) and group 4 ( C7-T1 fixation).
All patients received a spinal manipulation for removal of the fixation.

Objective information was gathered with the aid of a grip dynamometer which was connected to a bridge amplifier. Both these instruments were then connected to a desk top computer with the aid of powerlab instrumentation. Surface EMG leads were also connected to this system. Chart4windows was the software used.

The data was analysed using the paired t- test for intra- group analysis and the analysis of variance for inter- group analysis. The statistical level of significance was set at 5% for both tests.

In this study all four groups showed significant improvement in the isometric contractibility ( grip strength) following a spinal manipulation. Group one showed no improvement in dynamic electrical contractibility ( surface EMG) while all other groups showed an improvement following segmental spinal manipulation. However, from the statistical evidence gathered, no discernable difference could be shown for grip strength and surface EMG between the four groups. It was thus fair to surmise that segmental manipulation of the cervical spine significantly improves grip strength in patients with mechanical cervical spine dysfunction and that this effect is equivalent, no matter what the level of cervical spine involvement.

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# CHAPTER ONE

## 1.1 INTRODUCTION

Functional status and performance enhancement has traditionally been a contentious yet exciting avenue of scientific enquiry ( Gentle 1996). The notion that spinal manipulation could somehow influence or even improve on the function of the nervous system, still remains within the realms of philosophy and is an untested theory within the chiropractic profession ( Wyke 1985).

Technical advances in measurement instrumentation is however, starting to approach a level of sensitivity and specificity which enables researchers to detect small yet significant changes in muscle electrical activity ( Williford 1999).

Practically, one cannot refute the benefits of having a strong grip. Athletes involved in sport that require a firm grip, openly welcome any method of improving this grip ( Williford 1990). Some studies have shown a correlation of segmental manipulation and how this may improve muscle tone but no information exists to clarify the role of segmental manipulation of the cervical spine and how this may influence grip strength in patients suffering with mechanical cervical spine dysfunction ( Rogers 1997). This study will form the basis of information on this subject.

## 1.2 The Statement of the Problem

The study proposed to investigate the relative effectiveness of manipulation of the cervical spine between cervical nerve 5 and thoracic nerve 1, on grip strength, in patients suffering with mechanical cervical spine dysfunction.

### 1.2.1. Objective One

The first objective was to assess whether isometric contractibility is altered before and after spinal manipulation, in terms of objective clinical findings.

### 1.2.2 Objective Two

The second objective was to assess whether dynamic electrical contractibility is altered before and after spinal manipulation, in terms of objective clinical findings.

### 1.2.3 Objective Three

The third objective was to integrate the data with respective objective clinical findings, in order to establish if manipulation between cervical nerve 5 and thoracic nerve 1 level of the spine, alters grip strength.

# CHAPTER TWO

## 2.1 INTRODUCTION

A strong grip strength is essential for most sports and recreation and indeed many trades and crafts ( Gentle, 1996: 10 - 12 ). The human performance laboratory of Auburn University , investigated the need for strong grip strength in a sample of 60 fire fighters, in the maintenance of greater hose control. All participants included in the study were between the ages of 18 and 32 years and were graded as being above average in their fitness tests. Grip strength was measured 3 times using a hand held grip dynamometer prior to hose pressure evaluation. This controlled clinical trail revealed that participants with a strong hose grip showed greater control of hydrostatic pressure through the hose, allowing for more water to pass through at a given time. Consequently, the authors strongly lent their support to any tool that could increase grip strength ( Williford, Collins & Wrigth, 1999 ). These sentiments were echoed by researchers in a controlled pilot study conducted at the Centre For Performance Enhancement, Quebec, who found a thirty percent decrease in grip strength in asymptomatic hockey players between the ages of 21 and 25 during half time. Grip strength was recorded three times using a grip dynamometer before the start of play and then at half time. The centre suggested that one of the elements enhancing goal - scoring ability was the maintenance of a strong grip on the hockey stick and therefore welcomed any measure that could improve it ( Kinney , Collins & Brett, 1995).

The brachial plexus of nerves, which originate from cervical nerve 5 to thoracic nerve 1 segments of the spine, are responsible for the actions of the flexor muscles of the upper limb ( Ringdahl, 1993: 280 - 289 ). Therefore one could reasonably argue that any factor, which impacts on the nervous system in this area, could arguably affect the muscular activity relating to grip strength.

A spinal fixation is an aberrant relationship between adjacent articular structures that may have functional or pathological sequelae ( Haldeman, 1992 : 627 ). Gatterman (1990 : 30 ) states that cervical fixations exist in both symptomatic and asymptomatic patients with a 35 % incidence. Homewood ( 1977 : 142 - 145 ) theoretically described the mechanism by which a fixation may interfere with the nerve supply and result in decreased muscular activity. Although Gatterman ( 1990 : 35 ) agrees with this theory in principle, no published research can be cited to provide proof of its validity. Hence, the impact of functional rather than clinical cervical motion segment abnormality on the flexor muscles of the upper limb remains untested.

This literature review therefore aims to provide an outline of cervical spine dysfunction, its mechanisms, diagnosis and its impact on the nervous system and how this may affect grip strength.

**2.2 Anatomy and innervation of cervical spine facet joints**

The neck is the most mobile part of the spine (Bland 1994: 3). It consists of several joints and is an area that sacrifices stability for mobility and thus is vulnerable to injury (Magee 1992: 34).

The cervical vertebrae are divided into 2 anatomical parts: (i) The craniovertebral or suboccipital joints between skull (CO) and atlas (C1) and between atlas and axis (C2), and (ii) the zygopophyseal joints from the inferior surface of C2 to the superior surface of T1 (Kapandji 1990 ).

The occipitoatlantal joints (CO-C 1) and atlanto-axial joints are atypical joints in that they have no intervertebral discs, no zygopophyseal (facet) joints and show different movement to the rest of the cervical joints. CO-C1 allows for flexion and extension while CI-C2 accounts for 50% of total cervical rotation (Gatterman 1990 ).

The lower cervical vertebra form a"3 joints complex" with the adjacent vertebra. The first joint is between bodies of the vertebra. They are joined by a fibrocartilagenous disc. This intervertebral disc serves to unite as well as to keep the vertebra apart. (Gatterman 1990: 14). The other 2 joints are the posterior (zygopophyseal or facet) joints. These are paired articulations between the inferior articular process of one vertebra and the superior articular process of the vertebra below. They are true diarthrodial joints, have articular cartilage, a loose capsule lined with synovial.membrane, reinforced with ligaments and related muscles ( Gatterman 1990: 14 ).
These joint complexes or motion segments act together as a unit to produce movement. Flexion-extension, side bending and rotation are products of this synergism or coupling (Haldeman 1992: 130).

Co-ordination of neck movements and static posture is maintained and co-ordinated through many joint movements and combinations of muscle actions. This combined functioning is predominantly automatic and unconscious i.e. reflex action (Gatterman 1990: 260).

The deep intersegmental spinal muscles that attach to the articular and spinous processes of the vertebra ensure efficient action of the superficial muscles (main movers) by adjusting small movements of the vertebral column (Gatterman 1990: 16).

The structures in and around the vertebral joints: muscle, tendon, ligaments, periosteum, disc and facet joints, are extensively innervated by nerves that relay sensory information to the central nervous system (Bolton 1997).

There are various mechano and nociceptive receptors in the facet joint, surrounding muscle, ligament and intevertebral disc. These are as follows:

**Muscle spindles**: -probably the most common encapsulated nerve ending in the neck

-found in relatively large numbers compared to muscles in other areas of the body

-tend to be found in the deeper portions of the muscles (Bolton 1997).

**Golgi tendon organ** -found in musculotendinous junction and in fascia dividing muscle into compartments (often in association with muscle spindles).

**Pacinian corpuscles** -found in muscle adjacent to tendons and fibrous connective tissue.

most are found in outer layers of fibrous material of the facet joints (Bolton 1997).

Of particular interest to the manipulative therapist are the intrinsic receptors of the joint. These were classified by Wyke in 1967 and presented in the concise text by Colloca (1997: 23) in the following table:

Table 2.1 Articular receptors

| TYPE | MORPHOLOGY | LOCATION | CHARACTERISTICS |
|---|---|---|---|
| I | Thinly encapsulated globular corpuscles | Fibrous capsules of joints in the superficial layers | Static and dynamic mechanoreceptors, low threshold, slowly adapting |
| II | Thinly encapsulated conical corpuscles | Fibrous capsules of joints in the deeper synovial layers | Dynamic mechanoreceptors, low threshold, rapidly adapting |
| III | Thinly encapsulated fusiform corpuscles | Applied to surfaces of joint ligaments( collateral and intrinsic) | Dynamic mechanoreceptors, very high threshold, slowly adapting |
| IV | | Fibrous capsule of joints | Nociceptive mechanoreceptors, very high threshold,non-adapting |

Of all the receptors listed in table 2.1, type I, II, and III have been associated with segmental manipulation and reflex performance ( Wyke 1985).

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**2.9  Facet Joint Dysfunction**

The term dysfunction implies that at one anatomical level the components of the joint are not functioning normally" (Kirkaldy-Willis 1992: 105).

Dysfunction has been called many names. Subluxation and fixation are commonly used to describe this state of altered functioning. Haldeman (1992: 627) says a subluxation is an aberrant relationship between adjacent articular structures that may have functional or pathological sequelae, causing an alteration in the biomechanics and/or neurophysiological reflections of these articular structures. Fixation according to Haldeman (1992: 623) is a state whereby an articulation has become temporarily immobilised in a position that it may normally occupy during any phase of physiological movement. From this definition it would seem that the joint fixation, or loss of motion, is one part of the subluxation or dysfunctional joint. The other symptoms and signs, adjusted from Kirkaldy-Willis' (1992: 109) model for low back to reflect that of the neck, are: Symptoms: neck pain (often local, sometimes  referred), painful movement. Signs: local tenderness, muscle contracted (spasm),  extension painful, normal neurological exam and, as mentioned above, hypomobility.

## 2.4 Causes of Dysfunction

2.4.1 Direct and indirect trauma

According to Shafer and Faye (1989) dysfunction is often caused by a definite but minor trauma and is often classified as a sprain or strain.

Dishman ( 1988) maintains that pain arising from a synovial joint or intervertebral disc will evoke a splinting reflex from the surrounding muscle. Pain from muscle pathology will also cause local muscle spasm and produce loss of movement in that joint.

2.4.2 Mechanical causes

The locking or fixation of a facet joint is often presumed to be from mechanical derangement like intra-articular jamming, shortening, adhesions and in congruency of the joint surfaces (Mootz 1995: 178-180).

*2.4.2.1 Intra-articular jamming*

May be due to meniscoids, synovial folds or hypertrophic villi becoming entrapped within the joint. This interferes with movement, causes pain, muscle spasm (through aberrant receptor feedback) and inflammation (chemical irritation) (Gatterman 1990: 45,46, Haldeman 1990: 206).

Panzer ( 1995: 419) agrees with meniscoid entrapment but offers formation of intra and extra-capsular adhesions, abnormal capsule tension and osseous mechanical locking as alternative causes.

*2.4.2.2 Shortening and scarring*

Gatterman (1990: 45) mentions ligament shortening (from prolonged muscular hypertonicity) and articular adhesions (fibrosis) as possible mechanisms of keeping a joint fixed. This is more likely to be in long-standing cases.

Bove ( 1997) puts forward the theory that scar tissue between the nerve and nerve bed is the cause of pain and decreased movement. Damage to the delicate intrinsic nerve (nervi nevorum), through stretching, causes adhesions and nerve sensitization.

*2.4.2.3 Congruency*

Greenman (1989: 61) proposes that the hypomobility is due to a lack of congruency between the joint surfaces which leads to incorrect tracking. This is echoed by Gatterman (1990: 46,47) when he suggests that facet tropism or asymmetry of the facet joints decreases the mechanical efficiency of the joint.

2.4.3 Reflex changes

This is of particular interest to this study. Korr (1975) sees the aberrant muscle spindle activity as the cause of intersegmental muscle spasm and resultant joint fixation. His theory states that if the vertebral attachments of the short spinal muscles are brought together by unguarded movement and silence of annulospiral activity. The lack of input to the central nervous system results in turning up of the gamma *(y)* motor neuron "gain" increasing the intensity of the muscle spasm. The vertebral attachments cannot resume their normal position and the spasm is perpetuated.

The stimulation of Golgi tendon organs and-joint mechanoreceptors is hypothesised to be involved in the reduction of spasm and the restoration of joint movement.

As can be seen from the above, the causes of joint dysfunction can be singular or multifactorial. Several of the above mechanisms may occur together in a single case or could predispose one to be affected by another  In retrospect, one can also argue that dysfunction adversely affects nerve endings, causing inhibition of nerve function ( Wyke 1985).

It seems possible from the mechanisms described that apparent clinical symptoms do not have to be present for dysfunction to exist.

**2.5 DIAGNOSING DYSFUNCTION:  MOTION PALPATION**

Motion palpation is still the chiropractors' most essential tool in the diagnosis of dysfunction. Dynamic motion palpation is becoming more widespread throughout the field of chiropractic (Dishmann 1988).

Motion palpation may be defined as palpation of the human spine in the diagnosis of discal, muscular or articular mechanical changes ( Dishmann 1988).

Two main varieties of palpation exist, namely static and dynamic motion palpation. Static palpation involves the patient being motionless while the examiner uses manual contact over soft and osseous tissue to detect tissue tone, temperature, areas of tenderness and the degree of osseous alignment. This type of palpation is not reliable due to the fact that some bony prominence could vary between individuals, creating asymmetries that are not related to abnormal mechanical function. Also, the nature of the body is of a dynamic architecture (Alley 1983). Motion palpation may be used to evaluate musculoskeletal compliance to dynamic demands. It may be broadly divided into 2 categories, namely active and passive motion. Active motion may be produced voluntarily by the patient, or aided by the examiner, whereby all the motion is within the patients normal physiological range. Passive motion is not under the patients voluntary control and exceeds the patients active range of motion. This motion is induced by the examiner. When passive motion is considered to be normal in one direction of a motion plane , but is decreased in the opposite direction, it is considered to be a dynamic indication of joint fixation or subluxation. The joint may therefore not meet the functional demands placed on the motion segment. If this condition is not normalized i.e. by manipulation, it is possible that early decompensatory pathological changes may occur in the involved joint.

Mennel (1990) stated that all pathology of the back results in limitation of movement in that part of the spine in which it is situated.

Manual diagnosis done by a trained manipulative therapist can be as effective but less expensive than radiologically- controlled diagnostic blocks in the diagnosis of cervical zygapophyseal syndromes. A study was done by Jull et al (1988), to show the accuracy of manual diagnosis for cervical zygapophyseal joint pain syndromes.

This study consisted of 20 subjects. In 11 of the subjects, the detection of present or absent symptomatic joints was established by means of radiologically- controlled diagnostic nerve blocks. The subjects were then assessed by the manipulative therapist, who had no knowledge of the medical diagnosis. The other 9 subjects were first assessed by the manipulative therapist and then by means of diagnostic blocks. Results showed that the manipulative therapist correctly identified all the 15 patients that had symptomatic zygapophyseal joints, 9 correctly specified the segment level of the symptomatic joint. In this experiment, both static and dynamic motion palpation techniques were used to identify the level of cervical spine dysfunction. This enhanced the reliability of the palpatory findings ( Haas 1993).

Although not a full proof method, this clinical skill does have the ability to discern functional lesions, which as previously described , can be clinically quiescient.

## 2.6 Removal of dysfunction : Manipulation

Manipulation has two uses, firstly to relieve pain resulting from joint dysfunction and secondly to restore the range of motion to a joint whose function is impaired (Mennel 1990, Panzer 1995: 424).
This is thought to be brought about by mechanical changes within the joint by introducing paraphysiologica] movement (Sandoz 1976) and / or reflexogenic effects from the stimulation of certain pathways (Wyke 1973, Korr 1975). The effects of manipulation may be catogerised as mechanical, reflexogenic ( pain and muscle spasm) and propriceptive.

### 2.6.1 Mechanical effects

Manual adjustments are delivered in such a way as to gap or separate the joint surfaces. Often occurring in this process is the phenomenon known as joint cavitation (Sandoz 1976). This is the "cracking" sound often heard with a joint manipulation and is also known as the "audible release" (Brodeur 1995).

When a joint undergoes manipulation it first passes through the physiological (active and passive) range of movement. It then must cross the elastic barrier to pass into the paraphysiological space. It is at this point that the cavitation sound is heard, a sudden give is felt and the range of motion is slightly increased beyond the usual limits .The manipulation should end here as to go any further would cause tissue damage (Sandoz 1976).

This model provides us with a simple explanation for understanding how crossing into the paraphysiological space, can induce extra range of motion.

Sandoz (1976) does mention the extra force component that separates manipulation from mobilisation but neglects to mention the rate of this force application, or speed of the thrust across the elastic barrier. So from this model just crossing the elastic barrier is seen as the important part of the manipulation and not how quickly or slowly this is done. Which has been more recently shown to be of influence in the success of a manipulation (Hertzog 1995).

Brodeur (1995) in his review of the literature on joint cracking, modifies and expands Sandoz's model. He surnmarises the main points as follows:

1) The volume of the joint remains constant for normal joint loads. 2) If the stress on the capsule exceeds a certain threshold, the capsule snaps back from the synovial fluid, increasing the volume of the joint capsule (which also decreases the pressure) and causing cavitation to take place as the internal joint pressure drops.

3) The sudden increase in volume drops the tension on the capsule, allowing the joint space to rapidly distend (enlarge).

4) The rapid distension is checked by a sudden jerk to a stop as the ligament and periarticular tissue reach their anatomical limits.

5) The time interval between the sudden increase in joint volume from the snap- back cavitation process and the sudden jerk on the periarticular ligament and

tendons is shorter than the time required tor muscle stretch reflexes to protect the joint from sudden separation.

6) Hence, the jerk on the ligaments and the other periarticular structures causes the firing of high threshold mechanoreceptors. .It is hypothesised that this causes reflex relaxation of muscles as well as reflex actions that inhibit pain.

2.6.2 Reflexogenic effects

2.6.2.1 *Pain*

The following sub-section serves to explain the basic principles involved in pain and pain control, as pertinent to manipulation.

Mechanoreceptors, because of their different natures, respond to different kinds of loads. Types I and III are slow reacting and are therefore good at sensing static loads whereas type II receptors are better at sensing dynamic loads at the beginning and end of joint movement. Mechanoreceptor input travels to the spinal cord through the dorsal roots of the spinal nerves (Colloca 1997: 39,42).

These nerve fibres along with others have been categorised as types A and C. A being fast-conducting (5-15 msec) myelinated and subdivided into alpha, gamma and beta, while C fibres are slow (1 msec), small and unmyelinated. Gamma fibres carry the first sharp pain while the C fibres are thought to be responsible for delayed secondary aching pain. Both types arrive at the tract of Lissauer to terminate on neurons in the dorsal horn of the cord grey matter. Interneurons connect the incoming axons to second order neurons which ascend to the , higher centres via various pathways (Colloca 1997: 39).

There is an intimate relationship between the nociceptors and mechanoreceptors (Colloca 1997). The intensity of the nociceptive stimulus is not solely dependant on the intensity of the mechanical or chemical stimulation, it is continuously modulated through both peripheral and central mechanisms that can inhibit or excite the initial stimulus at the interneural connections (Colloca 1997: 42).

In 1965 Melzack and Wall proposed a "Gate Control Mechanism" within the substansia gelatinosa of the dorsal horn. Impulses travelling in the larger myelinated mechanoreceptor fibres takes precedence over the small-diameter nociceptive fibres and act to inhibit the transmission of nociceptive activity.

Thus a decrease in mechanoreceptor input, through fixation/ dysfunction, could lead to an increase in pain. Likewise, an adjustment could stimulate the static and dynamic low threshold mechanoreceptors (more specifically Type I and II receptors) in and around the joint, to cause presynaptic inhibition of the pain stimuli from the nociceptors (type IV receptors) (Colloca 1997: 42).

Although the theory has undergone many alterations to date, the basic principle that pain can be blocked by proprioreceptive input at the vertebral level, is still well accepted (Curl 1994: 292).

2.6.2.2 *Muscle spasm*

The following reflex mechanisms and structures in and around the joint have been linked to muscle spasm and the reduction thereof: the sympathetic nervous system, muscle spindles, Golgi tendon organs, fascilitated motor neuron pools and articular receptors (Gatterman 1990: 44, Bergmann 1995: 110-111).

Nociceptive reflexes from an irritated area can through complex mechanisms affect the sympathetic nervous system which increases the muscular tone of this area. Thus by interrupting or decreasing the nociceptive input to the central nervous system, through the above mechanism (2.6.2.1), the normal muscle tone could be reset (Colloca 1997: 42).

When articular surfaces are separated during an adjustment, the hypertonic intersegmental muscle is suddenly stretched, initiating muscle spindle mediated reflexes that relieve the hypertonicity as discussed in 2.5.3. (Korr 1975).

Golgi tendon organs act as brakes and limit excessive joint movement by initiating reflex. inhibition ofmotor activity in the muscles operating the joint (Gatterman 1990: 44). High velocity thrusts are thought to be able to stimulate Golgi tendon organs around the joint, causing reflex inhibition of motor activity thus breaking into the muscle spasm cycle (Korr 1975, Sandoz 1981).

Stretching of the joint capsule and thus stimulating mechanoreceptors is said to reflexly inhibit fascilitated motor neuron pools that are responsible for the increased muscle tone and spasm that are found with joint dysfunction. In much the same way as it does to the nociceptive stimuli (Cassidy, Kirkaldy-Willis 1992: 288, Colloca 1997: 47).

Thus manipulation, in retrospect, may reflexly enhance the functioning of muscles. One may then surmise that this may concurrently enhance functional performance.

### 2.6.3 Muscle tone and proprioception

This short sub section will attempt to show that cervical spine manipulation has other input into the nervous system and has some effect on the regulatory mechanisms of proprioception and muscle tone.

In a study conducted by Rogers (1997) to determine the effectiveness of manipulation of the cervical spine in reducing neck pain, proprioception was one of the variables measured. Blinded patient's ability to reproduce a neutral head position was tested. One group received manipulation to the cervical spine while the other was subjected to cervical muscle stretches. The manipulation group scored better than the stretch group with a 41% improvement over only 12% improvement of the stretch group (Rogers 1997). The study received criticisms for its small sample size yet this pilot study points to the possibility that manipulation of the cervical spine might positively influence the proprioreceptive functioning of the cervical spine.

In a study conducted by Nansel (1993) to determine the effect of lower and upper cervical adjustments on lumbar muscle tone in 68 asymptomatic subjects. The authors using C2 and C7 bilateral adjustments and tissue compliance meters on either side of the lumbar spinous processes determined that upper cervical adjustments did not produce significant change in compliance whereas lower cervical adjustments induced significant decrease in lumbar muscular tone. They presumed the effect to be from tonic neck reflexes involving intersegmental pathways. This study although not directly linked to cervical dysfunction indicates that manual thrust manipulations to the cervical spine influences the tone of musculature elsewhere in the body. Pointing to the concept that manipulation has input that into the nervous system to affect reflexes that may be pertinent to spinal health. This awakens the possibility that manipulation of the cervical spine may influence grip strength.

## 2.7 The Rationale For Segmental Spinal Manipulation

Several authors have contributed to the study of segmental manipulation and the effects that this may have elsewhere in the body. The nervous system, particularly joint receptors, has been implicated in producing this effect.

Wyke (1985) discussed the central effects of articular mechanoreceptor activity. He claimed that the afferent discharges derived from articular mechanoreceptors, especially from the type-I and type-II receptors embedded in the joint capsules, are of particular importance to manipulative therapists. This is by virtue of the threefold effects that they produce when they enter the neuraxis, in response to joint manipulation. These effects are as follows: reflexogenic effects, perceptual effects and pain inhibitory effects. Most relevant to Wyke's study were his comments on the reflexogenic effects of spinal manipulation. He determined that since the articular mechanoreceptor afferent nerve fibers give off collateral branches that are distributed intersegmentally as well as segmentally throughout the neuraxis, manipulation of an individual joint should not only affect motor unit activity in the muscles operating over the joint being manipulated, but also in more remote muscles (even on the opposite side of the body). It is through this mechanism that manipulation of joints by therapists gives rise to the reflex changes in muscle tone (involving both facilitation and inhibition. of motor unit activity). This has long been empirically familiar to practitioners of manipulative therapy.

The work of Yamashita (1993) suggests that the threshold of the joint receptors are important as a contributor to overall neural response during an adjustment, but that receptors have different thresholds and sense different phenomena. It has been found that a small number of receptors with a low threshold may produce a larger effect than a large number of receptors with a higher threshold (Wyke, 1985).

Herzog ( 1995), stated that thrust-like forces produced during high velocity spinal manipulation may elicit reflex responses in mechanoreceptors embedded in the capsules of articular facet joints and in the treatment area. This increase in sensory input has also been associated with diminished pain perception and reflex activation of skeletal muscles

Herzog also demonstrated a hypo-reflexive response of the target muscles appearing within 5-200 ms of the onset of the treatment thrust in thoracic spine manipulation of two asymptomatic subjects receiving a total of 15 spinal manipulations. Suter (1994) confirmed the above results in a study of 11 asymptomatic subjects receiving a total of 86 spinal manipulations and in addition found reflex responses in the back musculature not directly located in the area of thrust application. The short, burst-like EMG responses following the onset of manipulation were associated with type II mechanoreceptor responses from the capsule of the facet joints. Such reflex responses were not observed for slow applications of the treatment forces or following isolated audible releases occurring during slow treatments (Suter, 1994).

Triano (1992) conducted a study on the biomechanical effects of the spinal adjustment and found that higher velocity spinal manipulations performed on the cervical spine have also been shown to elicit reflex responses in neck musculature possibly by stimulating the joints mechanoreceptors.

Grice (1974) demonstrated decreased muscle hypertonicity following following manipulation. Two reflex systems have been implicated as possible mechanisms whereby muscle hypertonicity is reduced by manipulation. The first, is the stretch reflex which involves the  muscle spindles of the intersegmental muscles (Korr, 1975). The second suggests the arthrokinetic response involving both joint receptors and intersegmental muscles (Wyke 1967). Korr (1975) suggests that if the attachments of short spinal muscles are approximated by unguarded movement and silence annulospiral receptor activity, the lack of input to the CNS then results in a turning up of the Gama motor neuron gain, increasing the intensity of the muscle contraction producing the spasm. It is therefore feasible that a high velocity manipulative thrust performed at the extreme of the

joints motion activates the Golgi-tendon organs, inhibiting muscle activity therefore reducing muscle spasm (Korr 1975). Wyke (1967) refers to this joint regulation of postural muscle tone as the arthrokinetic reflex and it is that the afferent input from the nociceptors type IV receptor is inhibited by static and dynamic mechanoreceptors type I and II -a form of presynaptic inhibition (Wyke 1967).
Lewit (1978) believes that most of these reflex mechanisms are a response to nociceptive stimuli and that pain stimulus gives rise to reflex protective spasm, guarding a painful joint. However, if pain stimulus is not articular e.g.: myofascial pain, we again have a defensive muscle spasm usually involving the segmental back muscles (Lewit 1978: 16). Lewit (1978) suggests that this in turn acts on and interferes with normal mobility of the involved functional spinal unit. Hence the rationale for adjusting the spinal level of main segmental nerve supply. This study has limited itself to adjusting between C4and T1( origin of the brachial plexus of nerves) and recording the effect it may have on grip strength.

One can thus surmise that segmental manipulation does reflexly affect muscle tone but the effect that this may have on functional performance still remains untested.

### 2.7.1 THE EFFECT OF SEGMENTAL MANIPULATION ON GRIP STRENGTH

In a study done by Valente ( 1994 ) on the treatment of carpal tunnel syndrome , it was found that chiropractic manipulations rendered 3 times a week for 4 weeks to the subjects cervical spine , right elbow and wrist facilitated a significant increase in grip strength. The study called for further investigations using double - blind , cross over designs with longer samples.

In a study done by Kaufman ( 1999 ) on the manipulative management of colles' fracture, it was found that specific joint manipulation of the wrist resulted in increased grip strength and active range of motion. In a similar study for lateral epicondylitis, Vincenzino et al ( 1988 ) found that manipulation of the elbow showed significant increase in grip strength.

These studies verify that manipulation does influence grip strength, the only draw-back being, is that all the patients used were symptomatic.

To date, no studies could be found that investigated the effect that manipulation of asymptomatic patients, may have on their grip strength.

Evidence therefore exists indicating that segmental manipulation of the spine does reflexly affect muscles both locally and else-where in the body via the joints mechanoreceptors. However the effect that this may have on the functional status or performance of the muscles has not yet been determined. This study aims to close that gap by determining the effect that segmental manipulation of the cervical spine may have on grip strength in patients with mechanical cervical spine dysfunction.

# CHAPTER 3

## 3.0 MATERIALS AND METHODS

### 3.1 INTRODUCTION

This chapter deals with how the study was conducted. This included the study design, the subjects ( patients ) used, the interventions ( treatment ) they received as well as the data collected from them and the statistical procedures that this data was subjected to.

**Figure 3.1 Flow chart illustrating overview of experimental chronology**
( 10 - 12 weeks for running experiment)

Notify students → Schedule appointment → Explanation of procedure → Signing informed consent form → Case history, physical examination regional examination → Examiner A ( motion palpation screening ) → Examiner B ( motion palpation screening) →Examiner C ( motion palpation screening) → Comparison between examiners →Participant included or excluded → If included → Participant accepted into group A, B, C or D → Soape note → Record grip strength ( 3 readings) → Record suface emg (3 readings) → Manipulate dysfunction → Record grip strength ( 3 readings) → Record surface emg (3 readings).

### 3.2 STUDY DESIGN

This study was designed to be a quasi-experimental pre - post design.

### 3.2.1 Objective of the study

The object of the study was to determine the relative effectiveness of segmental manipulation of the cervical spine on grip strength in patients with mechanical cervical spine dysfunction in terms of isometric contractibility and dynamic electrical contractibility.

### 3.2.2 SAMPLING PROCEDURE

#### 3.2.2.1 *Selection of Subjects*

The subjects consisted of first and second year tertiary education students.

Subjects chosen were asymptomatic barring a cervical spine fixation ( this must be the only dependant variable ). Verbal permission for addressing students at their classes, were acquired from the respective lecturers.

Written permission was also attained from the respective head of departments, in this regard. The patients had to be between the ages of 18 and 35 years old (to reduce the risk of chronic degenerative diseases).

Those initially accepted received a covering letter (Appendix 1) which explained the experiment. A standard case history ( Appendix 2 ), physical examination (Appendix 3 ) and regional cervical examination was then performed. (Appendix 4 ).

Patients who presented with a cervical facet syndrome, neurological deficit, history of fracture or surgery in the cervical region and systemic disorders affecting the cervical region were excluded from the study.

Only asymptomatic patients barring a cervical spine fixation between C4 and T1 ( origin of nerve supply of flexor muscles of forearm ) were included into the study.

3.2.2.2 *Allocation of the Subjects*

Once the patients had signed the informed consent form (Appendix 5 ), they were motion palpated (Appendix 6) and randomly allocated into one of four groups depending on the level of fixation i.e group 1 ( C4 - C5 fixation ), group 2 ( C5 - C6 fixation) group 3 ( C6 - C7 fixation ) and group 4 ( C7 - T1 fixation ).

## 3.3 **The Data**

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

### 3.3.1 <u>The primary data</u>

The patients isometric contractibility ( using a digital grip dynamometer attached to a desktop computer ) was measured. " Chart 4 windows " was the designated soft-ware programme that was used .

The patients dynamic electrical contractibility ( surface electromyography ) was also measured as a linear correlation of the above. This was also digitally monitored using the above mentioned soft - ware and hard - ware.

### 3.3.2 <u>The secondary data</u>

This consisted of the literature review. Current documentation of Spinal Manipulative Therapy ( SMT ) and grip strength were consulted.

## **3.4 Methods of measurement (Objective Measurements )**

### 3.4.1 <u>Grip dynamometer : Isometric Contractibility</u>

Grip strength or isometric contractibility was measured with a grip dynamometer.

The instrument is designed to measure isometric force between the examiner and the limb segment being tested. The advantage of this type of instrument is that numerical values can be assigned for manual muscle test grades of good and normal within the limit of the instrument. Several authors agree on the reliability and validity of this instrument as an indirect measurement of maximal skeletal muscle contraction (Gill, 1985; Oliver, 1986; Kendall, 1993 ). These authors also found that there was no statistically significant difference in grip strength between the dominant and non-dominant hand. Hence for this experiment only dominant hand measurements were taken. The grip dynamometer was connected to a bridge amplifier which in turn was connected to a desk top computer. All readings were recorded by means of a graph which facilitated comparisons of grip strength before and after manipulation.

Grip strength was measured with the patient seated with the elbow in ninety degrees of flexion ( Balogun, 1991 ). All patients then maintained a position of twenty five to thirty five degrees of wrist extension coupled with seven degrees of ulnar deviation in order to record the optimum grip strength ( O` Driscoll, 1985) An average of three readings before and after manipulation, was taken in order to make an accurate measurement of the isometric contractibility ( Ringdahl,1993:132 ).

### 3.4.2 Surface electromyography

Dynamic electrical contractibility or surface electromyography was also measured as a control for grip strength as this has a direct linear correlation with 3.4.1 above (Kendall, 1993 ).Two surface EMG leads (negative and positive) were placed over the flexor compartment of the dominant forearm while another lead ( live) was strapped around the dominant hand. The leads were connected to a powerlab which in turn was connected to the desk top computer. Surface e.m.g readings were concurrently recorded on another graph while the first graph recorded isometric contractibility. ( Supplier : LASEC; 32 Old Mill Road, Cape- Town ).

### 3.5 The location of the data

The primary data was obtained from the grip dynamometer and the surface EMG readings ( see figures 1-3, chapter 4). The data was collected before and after the manipulation of the dysfunction. The secondary data were sourced from current journals, books and the internet.

## 3.6 Interventions

### 3.6.1. Manual Thrust

All four groups received standard, high velocity, low amplitude manual thrust, to the cervical spine. The levels of dysfunction were determined by using motion palpation ( Appendix 5). With all the manual techniques, the joint slack was taken out to the elastic barrier and a high velocity, low amplitude thrust was delivered in the direction of the fixation.

The choice of technique was guided by motion palpation findings ( Shafer and Faye 1989 : 37 ). An audible cavitation was not required to indicate a successful adjustment. ( Suter et al 1994 ).

The techniques employed were diversified rotary and lateral break techniques according to the "Compendium of Chiropractic Technique " ( Szaraz 1990 : 46, 50, 57, 60, 77 ) and are all summarized below.

3.6.1.1. Cervical rotary -Index contact

Indicated for rotary fixations from C1 - C7. The doctor is on the side of the lesion and takes a firm index contact on the articular pillar of the involved vertebra. The indifferent hand cups the patient's ear with hooked fingers against the rim of the occiput to provide rotation and cephalad traction. The segment as well as the head and cervical spine until segment reaches restriction. A quick, short amplitude pectoral thrust is then delivered in a rotary direction. Slight ulnar deviation, during thrust, provides rotary movement.

3.6.1.2. Sitting cervical

Used for rotary fixations from C2 - C6. The patient sits on a chair while the doctor takes his stance on the opposite side of the lesion. Contact is taken with the palmar aspect of the middle finger by reaching over in front of the patient. The contact is made over the posterior aspect of the TVP of the involved vertebra. The contact finger is reinforced with the adjacent fingers while the thenar aspect of the hand supports the patient's chin. The indifferent hand takes a web contact against the rim of the occiput, to provide cephaled traction. The patient drops the head into the contact hand. A single thrust is given under traction in a rotary fashion.

3.6.1.3. Lateral break

Indicated for lateral fixations from C1 - C6. The patient is supine with the head piece level. The doctor is at the head of the patient, slightly toward the side of the lesion. Once the lesion has been identified the neck is deviated away from the lesion to separate the TVPs. An index contact is taken with the wrist straight. The indifferent hand cups the occiput and provides cephalad traction. Joint slack is taken up towards the lesion and a sudden short amplitude, pectoral, thrust is given straight across with no cervical rotation.

### 3.7 Statistical Analysis

The SPSS version 9.0 (SPSS Inc. 444N. Michigan Avenue, Chicago, Illinois, 60611, USA) was used for data analysis.

The sample size per group is large ( N1 = 30, N2 = 30, N3 = 30, N4 = 30 ). Hence, parametric test methods were used for statistical data analyses (Fischere et al 1993). There was one consultation only with objective data being rewarded before and after removal of the fixation.

For intra - group analysis, the paired t- test was used to determine whether any significant differences occurred in grip strength and surface EMG after manipulation of the fixation. All tests were done at the $\alpha$ = 0,05 level of significance.

For inter -group analysis, Analysis of Variance was used to determine whether there was any significant difference between the four groups after the manipulation.

3.7.1 Paired t- test (intra-group)

Ho: There is no difference in grip strength ( before and after manipulation)

Ha: There is an improvement in grip strength after manipulation

$\alpha$ **= 0.05,** one - tailed test

**Decision Rule:**

If $p < \alpha$, reject Ho.

If $p \geq \alpha$, accept Ho

(1) $p = \frac{\text{reported p value}}{2}$ If Ha is of form > and z is positive
If Ha is of form < and z is negative

(2) $p = 1 - (\frac{\text{reported p value}}{2})$ If Ha is of form > and z is negative
If Ha is of form < and z is positive

**( The reported p value is the SPSS print out value of p)**

3.7.2 Anova ( inter- group)

Anova was used to determine whether there was any difference between the four groups.

Ho: There is no difference between the four groups

Ha: At least one group is different from the rest.

$\alpha$ **= 0.05**

**Decision Rule:**

If $p < \alpha$, reject Ho.

If $p \geq \alpha$, accept Ho

Were p is the reported p- value.

# CHAPTER FOUR

## 4.0 THE RESULTS

### 4.1 Introduction

This study consisted of a sample of 120 patients, divided into four groups of 30, depending on the level of the cervical spine fixation i.e. group 1 ( C4/C5 fixation), group 2 (C5/C6 fixation), group 3 ( C6/C7 fixation) and group 4 ( C7/T1 fixation). Four volunteers were rejected as they did not satisfy the age criteria for the study ( 18 - 35 years of age).

This chapter will represent the data and attempt to analyse the data in tabular form in order to accept or reject the hypotheses.

**Key for Abbreviations in Tables**

DF: Degrees of freedom

Sig: Significance

EMG: Electromyography

VS: Versus

## 4.2 DEMOGRAPHIC DATA

### 4.2.1 AGE DISTRIBUTION

Table 4.2.1: Age distribution with sample of 120 patients.

| AGE | GROUP 1 | GROUP 2 | GROUP 3 | GROUP 4 | TOTAL % OF PATIENTS |
|---|---|---|---|---|---|
| 18-21 | 7 | 18 | 14 | 13 | 47.3% |
| 22-25 | 22 | 6 | 14 | 16 | 40.0% |
| 26-29 | 0 | 6 | 2 | 1 | 7.5% |
| 30-35 | 1 | 0 | 0 | 0 | 0.8% |

4.2.2 Gender Distribution

Table 4.2.2: Gender distribution with sample of 120 patients.

| GENDER | GROUP 1 | GROUP 2 | GROUP 3 | GROUP 4 | TOTAL |
|---|---|---|---|---|---|
| MALE | 10 | 14 | 9 | 19 | 52 |
| FEMALE | 20 | 16 | 21 | 11 | 68 |

**4.3 Data Output**

The following three graphs represents an example of a typical data output.

Channel one represents isometric contractibility ( grip strength) while channel three represents the corresponding dynamic electrical contractibility ( surface e.m.g).

The graphs consist of six diagrams in total. The first three diagrams represent the grip strengths with the corresponding e.m.g values below it, before removal of the dysfunction; while the next three diagrams represent the grip strengths and corresponding emg values, after removal of the dysfunction. A solid black line separates the pre and post manipulation results.

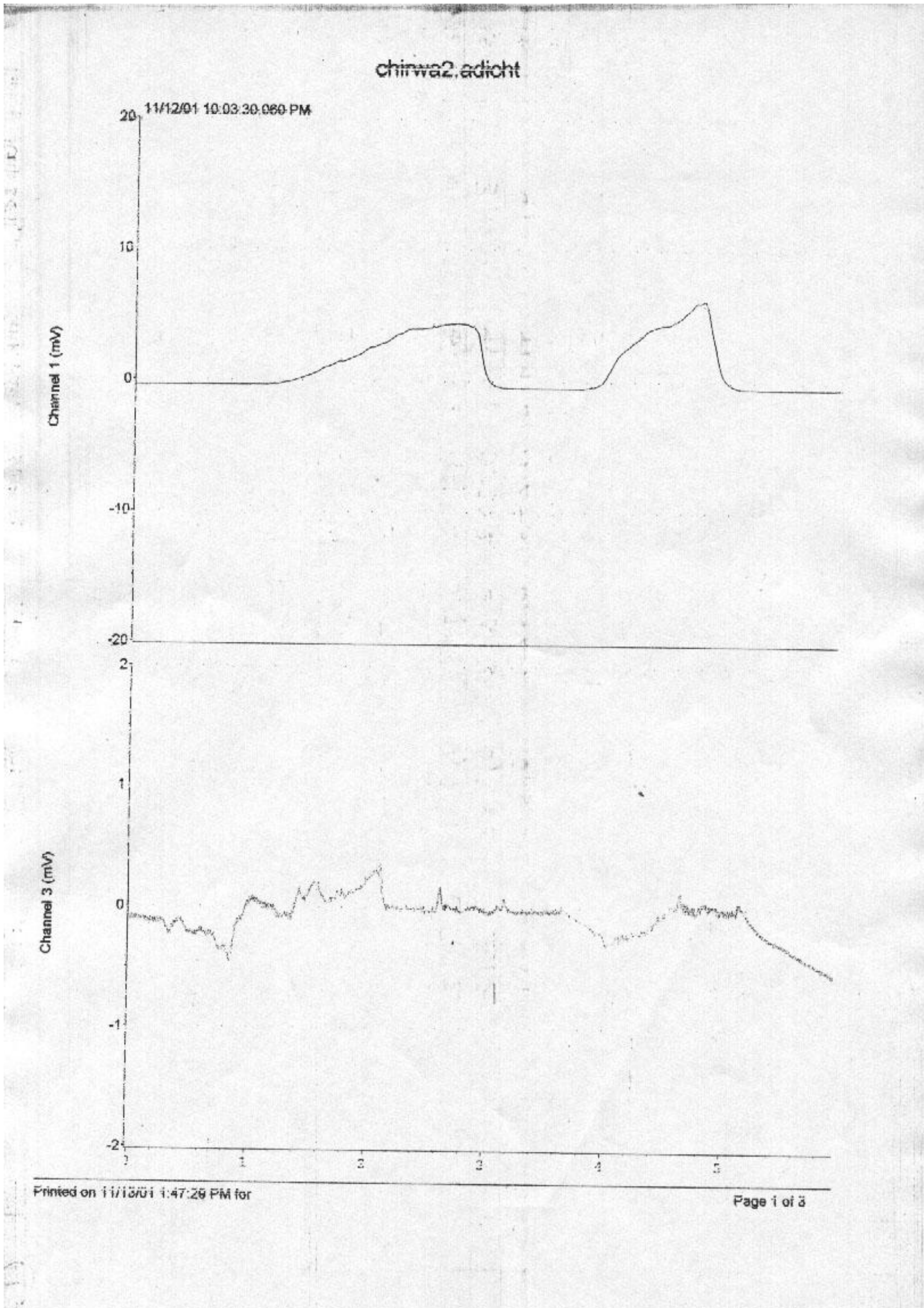


Figure 1 : Two diagrams representing grip strength and emg before manipulation

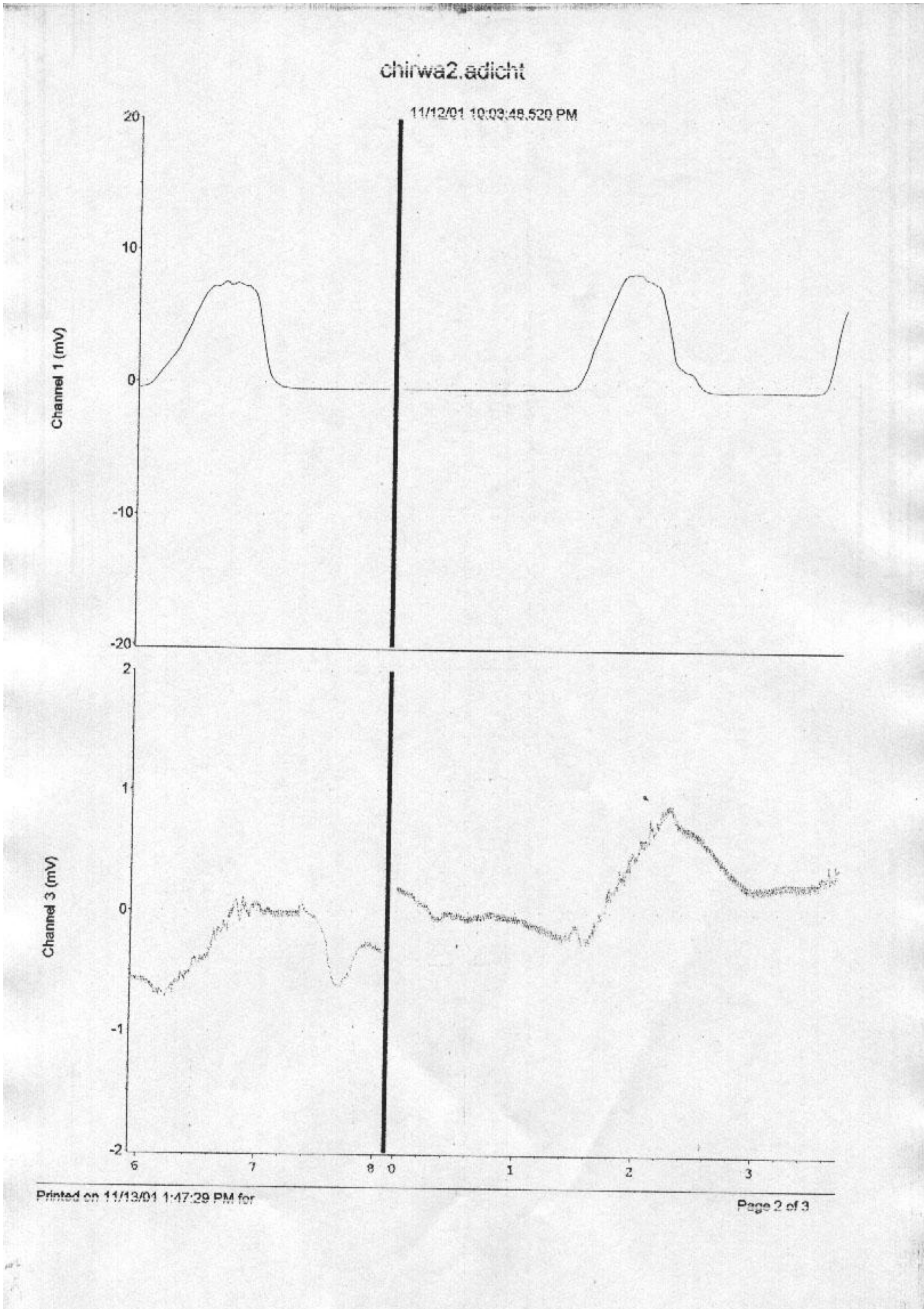


Figure 2: Diagram before the solid line represents grip strength and e.m.g pre-manipulation while diagrams after the solid line represents post manipulation

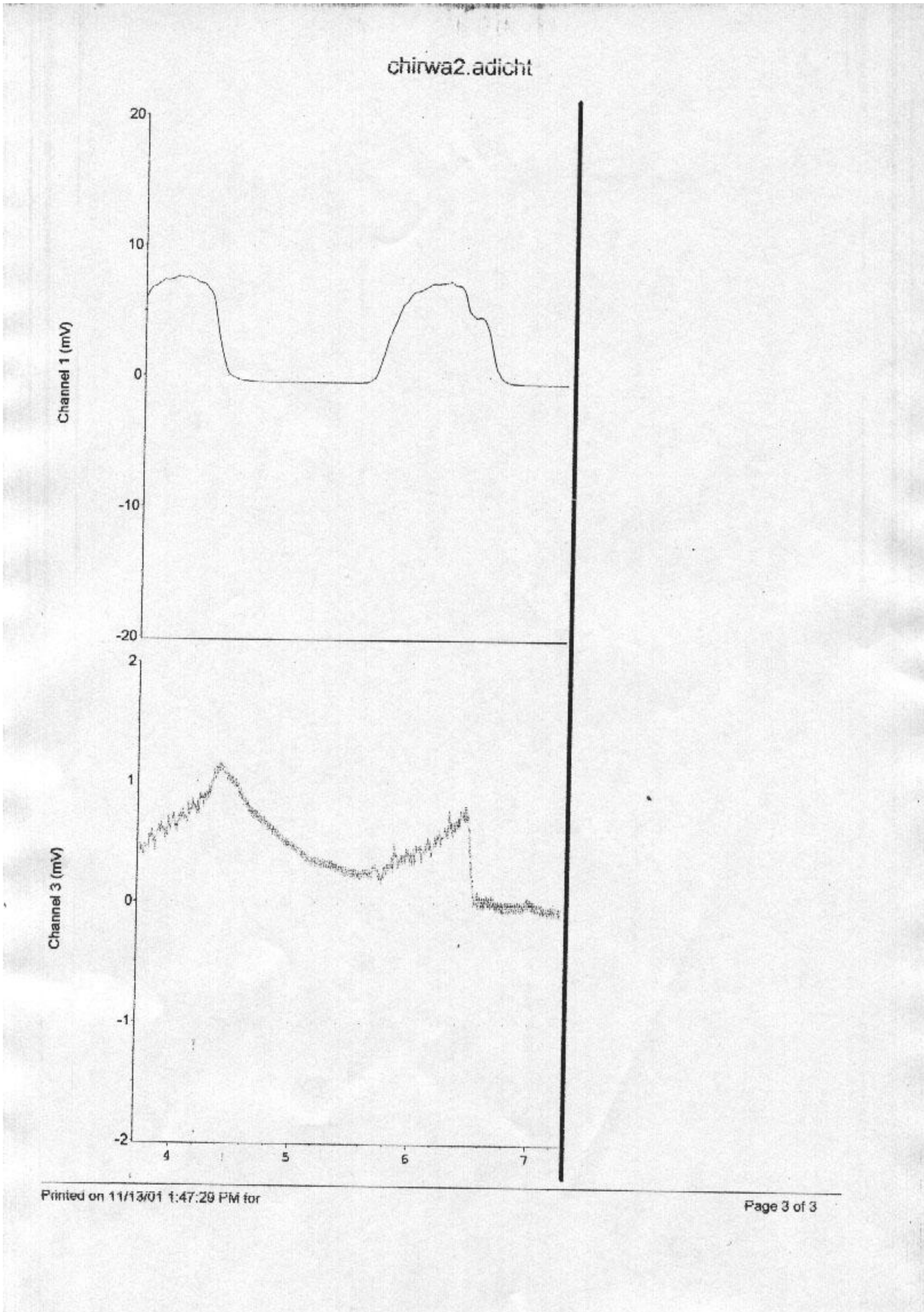

Figure 3: Diagrams representing grip strength and e.m.g post manipulation

## 4.4 RESULTS OF DATA ANALYSIS

### 4.4.1 PAIRED -T TESTS

#### 4.4.1.1 *INTRA-GROUP COMPARISON (GROUP 1)*

Table 4.4.1.1: Comparison of objective measures before and after removal of a C4-C5 fixation

| **OBJECTIVE MEASURE** | **df** | **P - VALUE** |
|---|---|---|
| Grip mean before vs grip mean after | 29 | .000 |
| EMG peak before vs EMG peak after | 29 | .343 |
| EMG mean before vs EMG mean after | 29 | .084 |

The result between grip strength mean before and grip strength mean after is declared **statistically significant** ( $p < .05$) hence rejecting the null hypothesis.

The result of emg peak before and emg peak after is declared **statistically insignificant** ($p \geq .05$) hence accepting the null hypothesis.

The result of emg mean before and emg mean after is declared **statistically insignificant** ( $p \geq .05$) hence accepting the null hypothesis.

4.4.1.2 *INTRA-GROUP COMPARISON (GROUP 2)*

Table 4.4.1.2: Comparison of objective measures before and after removal of a C5-C6 fixation

| **OBJECTIVE MEASURE** | **df** | **P - VALUE** |
|---|---|---|
| Grip mean before vs grip mean after | 29 | .000 ( < .001) |
| EMG peak before vs EMG peak after | 29 | .000 (< .001) |
| EMG mean before vs EMG mean after | 29 | .000 ( < .001) |

The result between grip strength mean before and grip strength mean after is declared **statistically significant** ( $p < .05$) hence rejecting the null hypothesis.

The result of emg peak before and emg peak after is declared **statistically significant** ($p < .05$) hence rejecting the null hypothesis.

The result of emg mean before and emg mean after is declared **statistically significant** ($p < .05$) hence rejecting the null hypothesis

4.4.1.3 *INTRA-GROUP COMPARISON (GROUP 3)*

Table 4.4.1.3: Comparison of objective measures before and after removal of a C6-C7 fixation

| OBJECTIVE MEASURE | df | P - VALUE |
|---|---|---|
| Grip mean before vs grip mean after | 29 | .000 ( < .001) |
| EMG peak before vs EMG peak after | 29 | .000 ( < .001) |
| EMG mean before vs EMG mean after | 29 | .329 |

The result between grip strength mean before and grip strength mean after is declared **statistically significant** ($p < .05$) hence rejecting the null hypothesis.

The result of emg peak before and emg peak after is declared **statistically significant** ($p < .05$) hence rejecting the null hypothesis.

The result of emg mean before and emg mean after is declared **statistically insignificant** ($p \geq .05$) hence accepting the null hypothesis

4.4.1.4 *INTRA-GROUP COMPARISON (GROUP 4)*

Table 4.4.1.4: Comparison of objective measures before and after removal of a C7-T1 fixation

| **OBJECTIVE MEASURE** | **df** | **P - VALUE** |
|---|---|---|
| Grip mean before vs grip mean after | 29 | .000 ( < .001) |
| EMG peak before vs EMG peak after | 29 | .000 ( < .001) |
| EMG mean before vs EMG mean after | 29 | .001 |

The result between grip strength mean before and grip strength mean after is declared **statistically significant** ($p < .05$) hence rejecting the null hypothesis.

The result of emg peak before and emg peak after is declared **statistically significant** ($p < .05$) hence rejecting the null hypothesis.

The result of emg mean before and emg mean after is declared **statistically significant** ($p < .05$) hence rejecting the null hypothesis

4.4.2 INTER-GROUP COMPARISON

Table 4.4.2: Comparison of group 1, group 2, group 3, and group 4 using Anova test to analyse results obtained after manipulation.

| | | **Within groups** | **df** | **Mean square** | **F** | **Sig.** |
|---|---|---|---|---|---|---|
| **Grip after mean** | **Between groups** | .605 | 3 | .202 | .144 | .933 |
| | **Within groups** | 157.235 | 112 | 1.404 | | |
| | **Total** | 157.840 | 119 | | | |
| **Emg peak after** | **Between groups** | .107 | 3 | .342 | 1.073 | .363 |
| | **Within groups** | 3.726 | 112 | 1.543 | | |
| | **Total** | 3.833 | 119 | | | |
| **Emg mean after** | **Between groups** | .235 | 3 | .312 | 1.052 | .373 |
| | **Within groups** | 2.812 | 112 | 1.502 | | |
| | **Total** | 2.892 | 119 | | | |

Since the p-values are all $\geq$ .05, the null hypothesis is accepted for the inter-group comparison, indicating that at the $\alpha = 0.05$ level of significance there was **no difference** between the four groups.

# CHAPTER FIVE

## 5.1 INTRODUCTION

The sample utilized for this study was consisted of 120 subjects. Statistical analysis can therefore be deemed relatively accurate and representative of a normal distribution curve. Of the 152 patients that volunteered for the study, 28 did not fulfill their commitment to the appointment. Of the remaining 124 patients, 4 patients were excluded because they did not comply with the age criteria for the study.

## 5.2 The Demographic Data

The average age of the patients that participated in the study was nineteen years. 47.3% of the patients were between the ages of eighteen and twenty one years , 40% of the patients were between the ages of twenty two and twenty five, 7.5% were between twenty six and twenty nine whilst 0.8% were between the ages of thirty and thirty five years. A younger population of students were purposefully chosen as students at this age are more naïve to the research process thus eliminating any possible bias.

Gender distribution revealed that 52 of the 120 patients were male.

## 5.3 Discussion of the Results

It is important to remember the following

1) All patients in the study received spinal manipulation for removal of the detected fixation
2) Group one received spinal manipulation between the C4 and C5 levels of the spine
3) Group two received spinal manipulation between the C5 and C6 levels of the spine.
4) Group three received spinal manipulation between the C6 and C7 levels of the spine.
5) Group four received spinal manipulation between the C7 and T1 levels of the spine.
6) The objective data was recorded with a grip dynamometer which measured grip strength. The surface electromyography was simultaneously measured as this is a direct linear correlation of the above.

### 5.3.1 <u>The First Objective</u>

The first objective was to assess whether isometric contractibility was altered before and after spinal manipulation, in terms of objective clinical findings.

#### 5.3.1.1 *Intra- Group Analysis*

Results from the analysis of the paired t test for group one showed that there was a statistically significant improvement in isometric contractibility ( grip strength ) after spinal manipulation of the C4-C5 fixation.

Results from the analysis of the paired t test for group two showed that there was a statistically significant improvement in isometric contractibility ( grip strength ) after spinal manipulation of the C5-C6 fixation.

Results from the analysis of the paired t test for group three showed that there was a statistically significant improvement in isometric contractibility ( grip strength ) after spinal manipulation of the C6-C7 fixation.

Results from the analysis of the paired t test for group four showed that there was a statistically significant improvement in isometric contractibility ( grip strength ) after spinal manipulation of the C7-T1 fixation.

5.3.1.2 *Inter- Group Analysis*

Results from the inter- group analysis using analysis of variance showed that there was no statistically significant difference in isometric contractibility ( grip strength ) between the four groups.

5.3.2 <u>The Second Objective</u>

The second objective was to assess whether dynamic electrical contractibility was altered before and after spinal manipulation, in terms of objective clinical findings.

5.3.2.1 *Intra- Group Analysis*

Results from the analysis of the paired t test for group one showed that there was no statistically significant improvement in dynamic electrical contractibility ( surface emg ) after spinal manipulation of the C4-C5 fixation.

Results from the analysis of the paired t test for group two showed that there was a statistically significant improvement in dynamic electrical contractibility ( surface emg ) after spinal manipulation of the C5-C6 fixation.

Results from the analysis of the paired t test for group three showed that there was a statistically significant improvement in dynamic electrical contractibility ( surface emg ) after spinal manipulation of the C6-C7 fixation.

Results from the analysis of the paired t test for group four showed that there was a statistically significant improvement in dynamic electrical contractibility ( surface emg ) after spinal manipulation of the C7-T1 fixation.

5.3.2.2 *Inter- Group Analysis*

Results from the inter- group analysis using analysis of variance showed that there was no statistically significant difference in dynamic electrical contractibility ( surface emg ) between the four groups.

## 5.4 **Problems With The Objective Data**

Although a bridge amplifier was used to filter out any environmental influences e.g. noise which may interfere with the results, this may not have been completely successful. Slight atmospheric changes may have interfered with the sensitivity of the surface emg recordings.

## 5.5 **Comparison of Results**

This is the first study of its kind and is proposed to form the basis of future studies . Therefore since no other related studies were found in journals, cd- roms, text books or the internet, it is thus impossible to make direct comparisons to other research studies.

## 5.6 **Conclusion**

In this study all four groups showed statistically significant improvement in isometric contractibility ( grip strength) following removal of a spinal fixation. The first group showed no improvement in dynamic electrical contractibility ( surface emg) whilst all the other groups showed a statistical improvement following segmental spinal manipulation. The study also showed that there was no difference in isometric and dynamic electrical contractibility between the four groups.

In retrospect of the above results, there seems to be a common mechanism present, following manipulation, which acts to the same degree in improving grip strength. This mechanism, it appears, is independent of the level of dysfunction. This is in keeping with the work done by Wyke (1985) who maintained that the segmental reflex changes occurring in muscles, is brought about by the mechanoreceptors which are evenly distributed segmentally and intersegmentally in the cervical spine.

Suter (1994) also attributed the reflex changes that occurred elsewhere in the body following manipulation, to the mechanoreceptors found in the joint.

Authors thus far have shown in uncontrolled studies that removal of a segmental dysfunction may reflexly influence the tonicity of muscles but no one has shed any light on how segmental manipulation may alter the functional status of muscles…until this research.

# CHAPTER SIX

## 6.1 **Conclusion**

### 6.1.1 The Third Objective

The third objective was to integrate the data with respective objective clinical findings, in order to establish if manipulation between cervical nerve 5 and thoracic nerve 1 level of the spine, alters grip strength

According to the results of this study, segmental spinal manipulation of the cervical spine statistically increases grip strength in patients suffering with mechanical cervical spine dysfunction.

## 6.2 **Recommendations**

This study should be repeated with a larger sample size per group so that even more accurate results can be attained.

A study investigating the duration of this increased grip strength should be conducted.

Questionaires should be designed and incorporated into the study to give it more strength in terms of subjective data.

A more reliable measure of surface emg should be used in order to obtain more accurate results.

It may be of interest to ascertain the effectiveness of a shoulder, elbow or a wrist manipulation on grip strength in patients with mechanical cervical spine dysfunction.

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