A COMPARATIVE STUDY OF THE EFFECTIVENESS OF CHIROPRACTIC MANIPULATIVE AND ACTION POTENTIAL SIMULATION THERAPY ON MYOFASCIAL TRIGGER POINTS WITHIN THE TRAPEZIUS MUSCLE

A dissertation submitted to the Faculty Health Sciences, Technikon Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Technology: Chiropractic

By

Raydon Whitlock
(Student number: 9500139)

Supervisor: Dr V. Cascioli
Co-supervisor: Dr P. Birdsey

Johannesburg, 2001
DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the Degree of Master of Technology at the Technikon Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other Technikon or University.

______________________________

14th day of November 2001
Thank you Mom and Dad.
Without you this would not have been possible
ACKNOWLEDGEMENTS

1. Dr V. Cascioli for being my supervisor, and helping me with all I needed.
2. Dr P. Birdsey for helping with the co-supervision of the dissertation.
3. Prof. A.V. Boyd for his guidance on statistical analysis methods.
4. Mr N. De Villiers for his help in organising the statistical layout and planning of the dissertation.
5. The clinicians at the TWR chiropractic clinic for their guidance in the treatment of the patients.
6. APS Technologies for sponsoring the use of one of their APS therapy devices.
ABSTRACT

Musculoskeletal pain and discomfort are frequently reported amongst the general population of western countries (Norregaard et al., 1998). According to Travell and Simons (1983) myofascial trigger points are extremely common and become a distressing part of nearly everyone’s life at one time or another.

A review of the related literature indicates a necessity for further investigation into the role of electromodalities in relieving myofascial trigger points. Travell and Simons (1983) have stated that research is needed to clarify the role of transcutaneous electrical nerve stimulation in the treatment of myofascial trigger points. Furthermore the role of action potential simulation therapy needs to be investigated as according to the manufacturers of this machine no research has previously been done to establish the role of this machine in the treatment of myofascial trigger points.

In the case of chiropractic manipulative therapy, a large number of theories have been postulated in an attempt to explain the method by which this form of treatment relieves muscular pain and tension. A few of these include Korr’s “Proprioceptors and somatic dysfunction”, Wyke’s “Neurology of joints”, and Lewit’s “The muscular and articular factor in movement restriction” (Gatterman, 1990). However, despite this fact, there is very little literature on the effect of chiropractic manipulative therapy on myofascial trigger points.

The purpose of this study was to determine the effect of these two forms of treatment on myofascial pain dysfunction syndrome within the trapezius muscle, and then to compare and contrast the two types of treatment in order to establish which proved to be of greater benefit in the treatment of this condition.

Fifty patients participated in this study. There were 2 groups of twenty-five patients. Each of which received 7 treatment consultations and one 4-week follow up consultation. Group 1 received spinal manipulative therapy (SMT) based on
motion palpation findings and the presence of trapezius trigger points 1 and 2, and group 2 received Action Potential Simulation Therapy based on the presence of trapezius trigger points 1 and 2. The patient's cervical range of motion, tenderness of trigger points (algometer readings), numerical pain rating scale 101 and the Vernon-Mior neck pain and disability index, were monitored on the pre- 1st treatment consultation, the post- 1st treatment consultation, and the 3rd, 5th, 7th, and 4-week follow up consultations respectively.

The subjective and objective data was analysed using the Friedman repeated measures test (a non-parametric paired hypothesis test) for the intra-group comparisons and the Mann-Whitney Rank Sum test (a non-parametric un-paired hypothesis test) for the inter-group comparisons.

The results of analysis of the subjective and objective data revealed that there was a statistically significant change in the adjustment group for flexion (range of motion), tenderness of all trigger points (except right trapezius trigger point 2, which showed a numerical increase), the numerical pain rating scale 101, and the Vernon-Mior neck pain and disability index. For the APS therapy group there was a statistically significant change in the tenderness of all trigger points, the numerical pain rating scale 101, and the Vernon-Mior neck pain and disability index. There was however no statistically significant change in any range of motion.

Thus it is apparent that both groups responded favourably to treatment. There was very little difference in the improvement that either group showed despite the very different type of treatment that they experienced. Therefore the researcher is of the opinion that a combination of both treatment protocols would provide the most effective method of treating trapezius trigger points.

For future studies it is recommended that the researcher ensure that there are no trigger points present in any other cervical muscles. It is also advisable for a future researcher to include another treatment group that will utilize both Action Potential Simulation therapy and chiropractic manipulative therapy in combination in order to establish the combined benefit of these treatments.
TABLE OF CONTENTS

DEDICATION i
ACKNOWLEDGEMENTS ii
ABSTRACT iii
TABLE OF CONTENTS v
LIST OF FIGURES ix
LIST OF TABLES xi
LIST OF ABBREVIATIONS xi
LIST OF APPENDICES xii
DEFINITION OF TERMS xiii

CHAPTER ONE
INTRODUCTION 1

1. INTRODUCTION 2
1.1 Statement of the problem 3
1.2 Objectives 3
1.3 Benefits of the study 4

CHAPTER TWO
LITERATURE REVIEW 5

2. LITERATURE REVIEW 6
2.1 Myofascial pain dysfunction syndrome 6
2.1.1 Introduction 6
2.1.2 The trapezius muscle 6
2.1.3 Mechanism of myofascial trigger point formation 13
2.1.4 Characteristics of myofascial trigger points 16
2.1.5 Most commonly used methods of treating myofascial trigger points 17

2.2 Action potential simulation therapy 17

2.2.1 Introduction 17

2.2.2 Summary of APS Current Characteristics 18

2.2.3 Current conditions for which the manufacturers advise the use of APS therapy 18

2.2.4 The effects of APS therapy 19

2.2.5 Contra-indications to APS therapy 21

2.3 Chiropractic manipulative therapy 22

2.3.1 Introduction 22

2.3.2 Fixations of spinal facet joints 22

2.3.3 Motion palpation of spinal fixations 23

2.3.4 The chiropractic adjustment 26

CHAPTER THREE MATERIALS AND METHODS 30

MATERIALS AND METHODS 31

3.1 Introduction 31

3.2 The data 31

3.3 Measurements 31

3.3.1 Goniometer 31

3.3.2 Algometer 32

3.3.3 Vernon-Mior Neck Pain and Disability index 32

3.3.4 Numerical Pain Rating Scale 101 33

3.4 Study design and protocol 33

vi
3.4.1 Goal of the study 33
3.4.2 Process of randomisation 33
3.4.3 Treatment protocol 33
3.5 Statistical analysis 36
3.5.1 Treatment of the data 36
3.5.2 Statistical analysis of the data 37
3.5.3 Columna statistics 40

CHAPTER FOUR RESULTS 41

4. RESULTS 42
4.1 Demographic data 42
4.2 Graphical representation of the data 43
4.2.1 Cervical range of motion in flexion 44
4.2.2 Cervical range of motion in extension 45
4.2.3 Cervical range of motion in left rotation 46
4.2.4 Cervical range of motion in right rotation 47
4.2.5 Cervical range of motion in left lateral flexion 48
4.2.6 Cervical range of motion in right lateral flexion 49
4.2.7 Algrometer readings for left trapezius trigger point 1 50
4.2.8 Algrometer readings for left trapezius trigger point 2 51
4.2.9 Algrometer readings for right trapezius trigger point 1 52
LIST OF FIGURES

i) Figure 1 - Location of the trapezius muscle in relation to surrounding anatomical structures 8

ii) Figure 2 - Location of trigger point 1 within the trapezius muscle. Solid area shows the main referred pain zone and stippling indicates the spillover zone 9

iii) Figure 3 - Location of trapezius trigger points 2 and 3 with solid areas representing main referred pain zones and stippled areas the spillover zones. 10

iv) Figure 4 - Location of trapezius trigger points 4 and 5, with solid areas representing the main pain referral zones and the stippled areas the spillover zones. 11

v) Figure 5 - Location of trigger points 6 and 7 within the trapezius muscle, with the solid areas representing the main pain referral zones of trigger point 6 and the stippled areas the spillover zone. The circular area represents the location of trigger point 7 and the stippled area on the right its referral of pilomotor activity. 12

vi) Figure 6 - Phases of the chiropractic adjustment 27

vii) Figure 7 - Cervical range of motion in flexion for both groups 44

viii) Figure 8 - Cervical range of motion in extension for both groups 45

ix) Figure 9 - Cervical range of motion in left rotation for both groups 46

x) Figure 10 - Cervical range of motion in right rotation for both groups 47
xi) Figure 11 - Cervical range of motion in left lateral flexion for both groups

xii) Figure 12 - Cervical range of motion in right lateral flexion for both groups

xiii) Figure 13 - Algometer readings for left trapezius trigger point 1 for both groups measured in kg/cm²

xiv) Figure 14 - Algometer readings for left trapezius trigger point 2 for both groups measured in kg/cm²

xv) Figure 15 - Algometer readings for right trapezius trigger point 1 for both groups measured in kg/cm²

xvi) Figure 16 - Algometer readings for right trapezius trigger point 2 for both groups measured in kg/cm²

xvii) Figure 17 - Values for Numerical pain rating scale 101 for both groups measured on a scale of 0 – 10

xviii) Figure 18 - Values for Vernon-Mior Neck Pain and Disability index measured in percentage
LIST OF TABLES

i) Table 1 - Demographic data

Page

43

LIST OF ABBREVIATIONS

APS therapy – Action Potential Simulation therapy

C1 – C7 vertebrae – the cervical vertebrae

EMG – Electromyelograph

H₀ – Null hypothesis

Hₐ – Alternative hypothesis

T₁ – T₁₂ vertebrae – The thoracic vertebrae
LIST OF APPENDICES

APPENDIX A - Section of the chiropractic report detailing the use of Vernon-Mior Neck Pain and Disability index and Numerical Pain rating scale 101.

APPENDIX B - Instruction manual for the cervical range of motion instrument.

APPENDIX C - Data sheet for collecting the values on range of motion during treatment.

APPENDIX D - Instruction manual for the algometer.

APPENDIX E - Data sheet for collecting the algometer readings during treatment.

APPENDIX F - Case history form.

APPENDIX G - Cervical spine regional examination form.

APPENDIX H - Information and consent form.

APPENDIX I - Statistical data

APPENDIX J - Numerical pain rating scale 101

APPENDIX K - Vernon-Mior Neck pain and Disability index
# DEFINITION OF TERMS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustment</td>
<td>A high velocity thrust of controlled amplitude, the aim of which is to restore mobility to individual articulations, with the use of either long or short lever techniques applied to specific contacts.</td>
</tr>
<tr>
<td>Algometer</td>
<td>A device used to measure the amount of pressure required to induce tenderness locally within a structure.</td>
</tr>
<tr>
<td>Chiropractic practice</td>
<td>A discipline of the scientific healing arts concerned with the pathogenesis, diagnosis, therapeutics and prophylaxis of functional disturbances, pathomechanical states, pain syndromes, and neurophysiological effects related to the statics and dynamics of the locomotor system, especially of the spine and pelvis</td>
</tr>
<tr>
<td>Electromodalties</td>
<td>Devices used to apply a form of electrical stimulation to the body with the purpose of causing healing in the tissues to which it is applied</td>
</tr>
<tr>
<td>End feel</td>
<td>Discrete short range movements of a joint independent of the action of voluntary muscles, determined by a springing of each joint at the limit of its passive range of motion.</td>
</tr>
<tr>
<td>Fixation</td>
<td>Any physical, functional or psychic mechanism that produces a loss of segmental mobility within a joint's normal physiologic range of motion.</td>
</tr>
<tr>
<td>Goniometer</td>
<td>A device used to measure segmental range of motion</td>
</tr>
<tr>
<td>Hyper</td>
<td>An excessive state</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hypo</td>
<td>A deficient state</td>
</tr>
<tr>
<td>Manipulation</td>
<td>The therapeutic application of manual force. In the case of spinal manipulation this includes all procedures whereby the hands are used to mobilise, adjust, manipulate, apply traction, massage, stimulate, or otherwise influence the spine and paraspinal tissues with the aim of influencing the patients health.</td>
</tr>
<tr>
<td>Motoneurons</td>
<td>Those nerves responsible for leading to movement within a muscle</td>
</tr>
<tr>
<td>Palpation</td>
<td>1) The act of feeling with the hands</td>
</tr>
<tr>
<td></td>
<td>2) The application of variable manual pressure through the surface of the body in order to determine the shape, size, consistency, position, inherent mobility and health of the tissues beneath.</td>
</tr>
<tr>
<td>Motion palpation</td>
<td>Palpatory diagnosis of passive and active segmental range of motion.</td>
</tr>
<tr>
<td>Nociceptor</td>
<td>Nerves responsible for carrying pain impulses to the central nervous system</td>
</tr>
<tr>
<td>Transcutaneous</td>
<td>Meaning through/ via the skin</td>
</tr>
<tr>
<td>Translation</td>
<td>Motion of a rigid body, in which a straight line in the body always remains parallel to itself.</td>
</tr>
</tbody>
</table>
Chapter one

Introduction
1. INTRODUCTION

Local and regional musculoskeletal pain and discomfort are frequently reported in the general population of western countries (Norregaard et al., 1998). Travell and Simons (1983) stated that myofascial trigger points are extremely common and become a distressing part of nearly everyone's life at one time or another.

The severity of the symptoms generated by these myofascial trigger points varies from a painless limitation of range of motion to a debilitating and agonising pain (Travell and Simons, 1983). In the case of debilitating pain and unrecognised myofascial headaches, shoulder and low back pain that have been left to become chronic, the cost of industrial lost time and compensation applications is astronomical. Despite this and the fact that the musculoskeletal system is the largest single organ of the human body, muscles receive little attention in modern medical school teaching and medical textbooks (Travell and Simons, 1983). Thus the importance of establishing ever new and improved means of treating conditions affecting this system and its components becomes obvious.

Electrical Stimulation therapy is a well-known non-invasive means of controlling pain without using narcotics as stated by Kahn (1994). According to Travell and Simons (1983) research is needed to clarify the role of transcutaneous electrical nerve stimulation in the treatment of myofascial pain syndromes. A review of the related literature indicates that there is a necessity to investigate the role of electromodalities in the treatment of myofascial pain dysfunction syndromes. According to the Manufacturers of Action Potential Simulation therapy no research has been carried out to establish the role of this machine in treating patients suffering from this condition.

Previous research by Van Papendorp et al., (2000) indicates that the use of APS therapy results in a rise in the levels of β-endorphin and leucine encephalin, both of which are part of the bodies natural pain suppression system, furthermore Berger (1999) stated that local blood flow increases at the site of APS therapy application,
and it is the combination of these two factors which results in a reduction in the patients pain.

It has often been found that trigger points that have been present for a long period of time require numerous treatments before the referred pain, local tenderness, twitch response and restricted ROM disappear. There has also been a certain degree of post treatment pain and local tenderness found after treatment of myofascial trigger points. Cold temperature has, in the past, been used to counteract this tenderness as was shown by Travell and Simons (1983). However it is postulated by the researcher that APS is a better means of aiding a patient in a quicker recovery and preventing unwanted side effects associated with treatment.

Manipulative therapy has been used for many centuries as a treatment tool; its origins date back to the ancient Chinese, Japanese, Polynesian, Indian, Egyptian and Tibetan societies. Although the precise nature of biomechanical dysfunction of spinal joints has not been demonstrated scientifically, many acceptable theories based on the demonstrated principles of biomechanics have been postulated. These theories which are based on studies by Korr (Proprioceptors and somatic dysfunction) and Wyke (Neurology of joints) will be covered in depth in the literature review (Gatterman, 1990).

1.1 Statement of the problem

The purpose of this study was to compare the effectiveness of chiropractic manipulative therapy and Action Potential Simulation therapy in treating myofascial pain dysfunction syndrome of the trapezius muscle.

1.2 Objectives

i) The first objective was to determine the effectiveness of Action Potential Simulation therapy in the treatment of myofascial trigger points within the trapezius muscle.

ii) The second objective was to determine the effectiveness of chiropractic manipulative therapy in the treatment of myofascial trigger points within the trapezius muscle.
iii) The third objective was to compare the effectiveness of these two forms of treatment and establish which is of greater benefit in the treatment of myofascial trigger points within the trapezius muscle.

1.3 Benefits of the study

If, as a result of this study, it was found that either chiropractic manipulative therapy or Action Potential Simulation therapy were of benefit in the treatment of myofascial pain dysfunction syndrome, it would enable health care professionals to utilise additional means of treatment in this condition.

This study will pave the way for further research into this field of treatment. It will help to highlight additional areas that will need further research with regards to myofascial trigger points, Action Potential Simulation therapy and chiropractic manipulative therapy, thereby improving our understanding of these factors and our competency as chiropractors.
Chapter two

Literature review
2. LITERATURE REVIEW

2.1 Myofascial pain dysfunction syndrome

2.1.1 Introduction

Fricton et al., (1985) defined myofascial pain as a disorder in which pain is referred from myofascial structures which may be located either locally or distant from the site of the pain. Myofascial trigger points are a common cause of musculoskeletal and occasionally visceral pain in people of all ages and both sexes. According to Travell and Simons (1983) they become a distressing part of everybody’s life at one time or another, despite this fact, muscles receive little attention in modern medical school teaching and medical textbooks.

A myofascial trigger point is a hyperirritable band of skeletal muscle or its associated fascia. It is tender to compression and can evoke a characteristic referred pain pattern or autonomic phenomenon. Trigger points may be classified as either active or latent. Active trigger points cause pain and possible autonomic phenomena without the presence of an outside stimulus as stated by Esenyel et al., (2000). This is not the case with a latent trigger point; however, compression of latent trigger points may result in the above effect. Both active and latent trigger points are associated with a restriction of movement and weakness of the affected muscle (Chang-Yu et al., 2000).

2.1.2 The trapezius muscle

Muscle attachments

According to Moore (1992) the medial attachments of this muscle are:

i) The medial third of the superior nuchal line.

ii) The external occipital protuberance.

iii) Ligamentum nuchae.

iv) The spinous processes of C7 – T12 vertebrae.

v) The lumbar and sacral spinous processes.
The lateral attachments of this muscle according to Moore (1992) are:

i) The lateral third of the clavicle.

ii) The acromion process.

iii) The spine of the scapula.

Action and innervation of Trapezius muscle

The innervation of this muscle according to Moore (1992) is:

i) The spinal root of cranial nerve XI.


The various actions of this muscle are:

i) The superior fibres elevate the scapula.

ii) The middle fibres retract the scapula.

iii) The inferior fibres depress the scapula.

(Moore 1992)

iv) When acting unilaterally it is responsible for rotating the head to the opposite side.

v) Acting bilaterally the entire muscle is responsible for extending the cervical and thoracic spine.

vi) The upper trapezius muscle fibres, when acting unilaterally are responsible for laterally flexing the head and neck towards the same side.

(Travell and Simons, 1983)
Figure 1. Location of the trapezius muscle in relation to surrounding anatomical structures (Netter, 1994).
Location and referred pain pattern of trigger points within the trapezius muscle

i) Trigger point 1 ~ According to Travell and Simons (1983) this trigger point is located in the upper anterior fibres of the trapezius muscle just above the clavicle and at the junction of the middle and lateral thirds of the clavicle. It refers pain over the postero-lateral aspect of the neck into the suboccipital region. Pain is referred slightly over the occiput, over the temple and to the eye. Pain may also be referred to the angle of the jaw.

![Diagram of the neck and head highlighting a trigger point on the trapezius muscle.](image)

**Figure 2.** Location of trigger point 1 within the trapezius muscle. Solid area shows the main referred pain zone and stippling indicates the spillover zone (Travell and Simons, 1983).
ii) Trigger point 2 - This trigger point is located in the upper posterior fibres of the trapezius muscle. It occurs in the fibres posterior to the location of trigger point 1. It refers pain locally over the upper trapezius fibres and into the subocciput as was shown by Fricton et al., (1985).

iii) Trigger point 3 – Travell and Simons (1983) showed that this trigger point is located in the lower trapezius fibres along the medial border of the scapula at approximately the level of T7 vertebra. It refers pain locally over the trigger point and up over the paraspinal and rhomboid regions to the upper trapezius fibres and over the acromion.

**Figure 3.** Location of trapezius trigger points 2 and 3 with solid areas representing main referred pain zones and stippled areas the spillover zones (Travell and Simons, 1983).
iv) Trigger point 4 – According to Travell and Simons (1983) this trigger point is located slightly lateral to the medial border and just below the spine of the scapula. Its referred pain pattern extends infero-medially from the medial border below the level of the spine of the scapula. The pain extends towards the spinous processes of the thoracic vertebrae. The pain has a burning type of character.

v) Trigger point 5 – This trigger point is located just medial to the medial border just above the level of the spine of the scapula. Its referred pain pattern extends supero-medially towards the C7 spinous process. The pain has a burning type of character as is shown by Travell and Simons (1983).

Figure 4. Location of trapezius trigger points 4 and 5, with solid areas representing the main pain referral zones and the stippled areas the spillover zones (Travell and Simons, 1983).
vi) Trigger point 6 – Travell and Simons (1983) showed that this trigger point is located in the middle trapezius fibres slightly medial to the acromion process. It refers pain locally over the acromion.

vii) Trigger point 7 – According to Travell and Simons (1983) the position of this trigger point can vary slightly in location from one person to the next, but its general location is in the middle trapezius fibres above the medial aspect of the spine of the scapula. This trigger point refers pilomotor activity or "gooseflesh" to the lateral arm and forearm.

Figure 5. Location of trigger points 6 and 7 within the trapezius muscle, with the solid areas representing the main pain referral zones of trigger point 6. The circular area represents the location of trigger point 7 and the stippled area on the right its referral of pilomotor activity (Travell and Simons, 1983).
2.1.3 Mechanism of myofascial trigger point formation

According to Chang-Yu et al., (2000) the primary factors involved in causing myofascial trigger points are as follows:

i) Mechanical stresses (most relevant to this study)
ii) Nutritional inadequacies
iii) Metabolic and endocrine abnormalities
iv) Psychological factors
v) Chronic infection

Mechanical Stresses

The first of these is structural inadequacies, and as stated by Travell and Simons (1983), the reason for this is that the mechanical stress creates a strain on the musculature that the muscles attempt to correct. This in turn results in correction of the axial alignment of the body (functional scoliosis) in order to keep the head and shoulders balanced over the feet. In order to maintain this change in the axial alignment, the muscles have to undergo a change in their tone thereby predisposing them to the development of the myofascial trigger points.

The second and possibly most relevant to this study are postural stresses (this study consisted primarily of students and those people who have a desk job). Fricton et al., (1985) stated that the initiating factors in these incidences are overload of the involved muscles (as a result of maintaining a specific posture for prolonged periods of time), once again resulting in a change in muscle tone and ultimately leading to fatigue. They furthermore show that when a specific posture or position is held for a length of time or a repetitive movement occurs that only incorporates specific ranges of motion, then we get the development of articular fixations and muscle spasm. In this case the myofascial trigger points represent the muscle spasm. Norregaard et al., (1998) also stated that the physiological method by which this appears to occur is that there is a reduced blood flow to the involved muscle. This alteration in microcirculation is in turn due to increased intramuscular pressure, as a result of changes in sympathetic function, as may occur in response to stress.
The third factor considered here is the formation of trigger points as a result of constriction of a muscle once again leading to reduced blood flow. These situations occur most commonly as a result of tight clothing and handbag straps according to Travell and Simons (1983).

Nutritional inadequacies

Travell and Simons (1983) listed a lack of the following nutritional substances as playing a role in the formation of myofascial trigger points:

i) Vitamins B1, B6, B12, C  
ii) Folic acid  
iii) Calcium  
v) Iron  
vi) Potassium

They further state that lasting relief of myofascial trigger points is often obtained by the use of these substances.

Metabolic and endocrine inadequacies

Travell and Simons (1983) have shown that any compromise of the supply to, and metabolism of energy within muscle will aggravate and perpetuate the formation of myofascial trigger points.

Psychological factors

According to Chang-Yu et al., (2000) stress is a major cause of trigger point formation, the following psychological factors are considered to be associated with stress:

i) Depression – According to Travell and Simons (1983) depressed patients may perceive their pain as being far greater than it is. Norregaard et al., (1998) showed that during acute stress reactions numerous central nervous system and neuroendocrine alterations occur.
i) **Hopelessness** – Patients who believe that their pain is due to untreatable conditions often live in dread of aggravating their condition, therefore they limit movement which in any way causes pain. This includes all those movements that would stretch muscles and help them to recover. Thus the excessive restriction of movement and activity exacerbates and perpetuates the trigger points (Travell and Simons, 1983).

iii) **Anxiety and tension** – In many individuals, high levels of anxiety are expressed in the form of increases in muscle tension (Travell and Simons, 1983). Acute stress leads to sustained contraction, which overloads the muscles and perpetuates the trigger points (Norregaard *et al.*, 1998).

This is reinforced by Weiten (1992), who stated that when organisms are exposed to stress for prolonged periods of time they may go through 3 stages of response, the first being an alarm reaction whereby the organism is constantly on the lookout for the stress inducing factor, the second is a stage of resistance during which physiological arousal or awareness continues to be at a higher level than normal, but physiological changes occur in order for the organism to cope (this includes increased muscle tension), and the 3rd being a stage of exhaustion during which the body’s resources may be depleted and physiological arousal and resistance are at a minimum. Thus when the muscles are in a constant or prolonged state of tension and exhaustion they are in turn predisposed to the development of trigger points (Fricton *et al.*, 1985).

Norregaard *et al.*, (1998) also showed that there is an increase in the electromyelograph (EMG) activity of muscles in people who are under large amounts of stress; this then leads to a subsequent development of trigger points within the muscles in question.

**Chronic infection**

Travell and Simons (1983) stated that a number of disease conditions are capable of perpetuating myofascial trigger point syndromes. These include viral diseases (especially herpes simplex), any chronic focus of bacterial infection and infestations of certain parasites. The mechanism by which these disease processes perpetuate the trigger points is unknown.
2.1.4 Characteristics of myofascial trigger points

Ko et al., (2000) stated that the primary identifying features of myofascial trigger points are the presence of a taut band, local twitch response and referred pain, with the most important feature of the trigger point being the presence of a taut band.

During an examination of myofascial trigger points the following are common findings:

According to Chang-Yu et al., (2000) movement of the affected muscle is limited and stretching of the affected muscle increases the pain. At approximately the length at which the pain begins, electromyelograph (EMG) activity (indicating protective spasm) also begins to occur. This further increases the tension on the muscle fibres and greatly increases the painfulness of further stretch. The stretch Range of Motion (ROM) is reduced. This is because the increased tension on the muscle will not allow it to extend to its full length. Muscle in the immediate vicinity of a trigger point feels tense to palpation. Pain is increased when the affected muscle is strongly contracted against resistance, this effect is most marked when the muscle is contracted in a shortened position. The strength of the muscle contraction is weakened; this is due to the already shortened state of some of the fibres within the muscle. These factors disappear following effective treatment of the trigger point as stated by Travell and Simons (1983).

Esenyel et al., (2000) showed that trigger points are capable of referring pain to a specific zone local or remote to the location of the trigger point. Various autonomic disturbances may also be associated with trigger points (Gerwin et al., 1997). Moderate sustained pressure over an active trigger point causes or intensifies the referred pain in the zone of that trigger point. Referred pain has the same patterns of referral in different people for the same trigger point (Fritton et al., 1985).

Trigger points are found in a palpable band as sharply circumscribed areas of exquisite tenderness. Snapping palpation of a local trigger point frequently elicits a local muscle twitch response (Gerwin et al., 1997). Digital pressure on an active
trigger point usually elicits a “jump” sign i.e. the patient’s pain is out of proportion to the amount of pressure being exerted and they try to escape it according to Travell and Simons (1983).

2.1.5 Most commonly used methods of treating myofascial trigger points

1. The chiropractic adjustment (Schafer and Faye, 1990)
2. Stretch and spray
3. Dry needling
4. Ischaemic compression (Travell and Simons, 1983)
5. Massage
6. Ultrasound
7. Drug therapy
8. Transcutaneous Electrical Nerve Stimulation (TENS) (Esenyel et al., 2000)

2.2 Action potential simulation therapy

2.2.1 Introduction

Health care professionals use Electrophysical agents to treat many pain conditions. Muscle and nerve stimulating currents produce electrical pulse trains that cause excitation of peripheral nerves and subsequently muscle tissue. These electrical pulses enter the muscles by means of surface electrodes and hence all of these stimulators may be referred to as transcutaneous electrical neuromuscular stimulators (Kitchen et al., 1996).

In 1992 A. Labbe introduced a new form of this type of treatment called Action Potential Simulation therapy and reported that this electrophysical stimulator mimicked the naturally occurring action potentials of a neuron, thereby helping to improve the transmission of impulses along neurons with abnormal action potential generation (Berger, 1999).
2.2.2 Summary of APS Current Characteristics

i) Impulse – combination of direct and alternating current.
ii) Waveform – monophasic square pulse with an exponential decay.
iii) Pulse duration – 800 microseconds to 6.6 milliseconds.
iv) Frequency – 150 Hz
v) Pulse width – variable with automatic adjustment
vi) Change in skin potential per impulse – 0.70 mV.
vii) Effect – Depolarisation without an unpleasant sensation.
viii) Amplitude – Variable, with a 4mA peak into a 500 ohm load

(Berger, 1999)

2.2.3 Current conditions for which the manufacturers advise the use of APS therapy

i) Osteoarthritis
ii) Rheumatoid Arthritis
iii) Gout and ankylosing spondylitis
iv) Fracture pain as in trauma or osteoporosis
v) Nerve root compression in any dermatome
vi) Phantom limb pain
vii) Post-herpetic and trigeminal neuralgias
viii) Sinusitis
ix) Fibrositis
x) Headaches including migraine
xi) Sports injuries
xii) Epicondylitis (golfers or tennis elbow)
xiii) Bursitis
xiv) Bunions
xv) Post wisdom teeth extraction pain
xvi) Spinal disease (observed but not proven improvement of strength in multiple sclerosis)
xvii) Improvement of paraesthesia in diabetic neuropathy
xviii) Oedema  

  xix) Bruises  

  xx) Burns  

  xxi) Varicose ulcers and bedsores  

  xxii) Circulatory disorders  

  xxiii) Bells palsy and facial paralysis  

(Berger, 1999)

2.2.4 The effects of APS therapy

  Pain Relief

  This is attributed in part to an increase in \( \beta \)-endorphins and leucine enkephalin.  

  According to van Papendorp et al., (2000) the plasma concentration of \( \beta \)-endorphin increased 400% after 5 treatments using the APS therapy device on patients with some form of chronic pain such as chronic lower back pain, osteoarthritic pain, etc.

  The function of \( \beta \)-endorphin is to act as an endogenous analgesic (Sim et al., 1977). This occurs when lymphocytes penetrate inflamed tissues from the circulatory system and secrete \( \beta \)-endorphin (Jessop, 1998). This in turn activates peripheral opioid receptors resulting in an inhibition of pain (Machelska et al., 1998).

  According to Guyton and Hall (1996) leucine enkephalin is a pain-relieving hormone found naturally in the body, which reduces pain and inflammation.  

  Guyton and Hall (1996) further stated that enkephalins are a part of the pain suppression system in the brain and spinal cord. It is believed that the enkephalins cause presynaptic and postsynaptic inhibition of the type C and A delta pain fibres where they synapse in the dorsal horns. This is probably achieved by blocking calcium channels in the membranes of the nerve terminals. Furthermore blockage of these channels appears to last for prolonged periods because after activating the analgesia system it appears to have an effect that lasts for many minutes and even hours.
It is thus postulated that one of the means by which the release of these substances, and thus the subsequent reduction in pain, could result in resolution of the trigger points is by breaking the pain cycle and thus allowing protective spasm and subsequently myofascial trigger points to resolve.

Improved circulation, reduction in inflammation, increased mobility

According to Berger (1999) circulation improves (shown using thermography) as a result of using the APS therapy device. This results in an improved rate at which antibodies, enzymes, neurotransmitters, and hormones are conveyed to the treated area. Combined with a more rapid removal of metabolic waste products this results in a reduction of pain and inflammation. In turn a reduction of the inflammatory process causes a reduction in swelling and thus a decrease in tension on the tissues (De Wet and Oosthuizen, 1999). This subsequently allows for an increase in the amount of movement permitted within an area of the body.

It has also been shown that it is possible for muscle to contract as a result of an electrical stimulation. This contraction has a similar effect to voluntary contraction, that is, according to Forstre and Palastanga (1985) there is an increase in metabolism with a consequent increase in the demands for nutrients. There is concurrently increased waste and metabolite formation which causes capillary dilation and an increase in the blood flow to the muscle which in turn helps to remove waste products and inflammatory substances and thus helps to reduce swelling and increase ROM. The removal of waste products also removes those substances that result in the stimulation of nociceptor pain fibres and thereby helps to relieve pain and thus result in interruption of the pain cycle and subsequently relieve the protective spasm and thus the trigger points. Furthermore movement of the affected musculature allows for stretching and relaxing of the affected muscle, this movement helps to relieve tension within the muscle and thereby resolve trigger points.

A muscle must be long enough to permit normal mobility of the joints and be short enough to contribute to joint stability as stated by Kendali, McCready and Provance (1993). Mennel (1992) showed that if relief is delayed, morbid changes occur in the
muscle such as circulatory problems in both the vascular and lymphatic systems. The pumping of muscle is essential to the efficiency of these systems.

A fasciculation appears as a twitching or local contraction of fibres within the muscle. According to Travell and Simons (1983) one of the methods by which we establish if a trigger point is indeed being treated is the presence of a local twitch response to the application of dry needling, pressure, or other forms of treatment. Berger (1999) stated that fasciculations are often observed along a muscle to which the APS therapy device is applied. Thus it is postulated by the researcher that the fasciculations, or local muscle twitches which occur as a result of using the APS therapy device are similar to those experienced by applying dry needling directly to the trigger point.

2.2.5 Contra-indications to APS therapy

i) Pacemakers
ii) Over the pregnant abdomen
iii) Epileptic sufferers

Use caution with:

i) Anticoagulant medication
ii) Allergies to medications

(Berger, 1999)
2.3 Chiropractic manipulative therapy

2.3.1 Introduction

Historically western physicians and surgeons have used spinal manipulation to treat musculoskeletal disorders and occasionally visceral disorders throughout the world, however in the past 2 centuries orthodox medical practitioners have abandoned spinal manipulation, thus before the birth of chiropractic this form of treatment was practiced by uneducated traditional bonesetters (Haldeman, 1992).

Today chiropractic and spinal manipulation are widely used means of treating neuromusculoskeletal disorders. Chiropractic is seen as that branch of the healing arts that specialises in the correction of biomechanical disorders of the spinal column, by means of spinal diagnosis and therapy at a sophisticated and refined level (Gatterman, 1990).

2.3.2 Fixations of spinal facet joints

The most important concept in understanding chiropractic is that of the spinal fixation. This term is used when referring to any joint that has a reduced range of motion, but in particular a spinal facet joint, therefore an accurate definition of this term is: “Any physical, functional or psychic mechanism that produces a loss of segmental mobility within its normal physiologic range of motion” (Schafer and Faye, 1990).

From this definition it is easy to see that there are a number of different factors which may lead to a loss of movement within a vertebral motion segment, thus we can say that there are various types of spinal fixations.

Types of spinal fixations

i) Muscular fixations – These are the most numerous type of fixations. The most commonly involved muscles in this type of fixation are rotators, multifidi, interspinales, intertransversani, obliquus capitis, levatores costarum, spinalis groups and different portions of the quadratus
lumborum. Very characteristic of these muscles fixations is that they restrict mobility from the start when challenged and the end feel exhibits a little bit of 'give', they immediately become non-tender and relaxed after correct treatment and the segment which they were restricting becomes mobile, they are usually secondary to another fixation.

ii) Ligamentous fixations – An early physiologic change that is observed in all types of fixations is the shortening of the involved ligaments to accommodate the reduced range of motion, i.e. they shorten in order to remove any slack.

iii) Articular fixations – These appear to be as a result of intra-articular joint 'gluing' as a result of intra-articular and peri-articular soft tissue degeneration.

iv) Bony restrictions – Bony growths on the periphery of a joint may produce a sudden arrest in an otherwise normal and free motion.

(Schafer and Faye, 1990)

The method by which trigger points develop in response to these joint fixations is that the muscles that move a dysfunctional joint become hypertonic in response to the pain from irritation (Schafer and Faye, 1990).

2.3.3 Motion palpation of spinal fixations

Motion palpation is used to determine the:

i) Normal active range of motion

ii) Hypermobile or aberrant motion

iii) Capsular end feel

Motion palpation is used to determine which joints are in a state of dysfunction and which direction the loss of motion is in. The spinal level of involvement and the direction in which the joint fails to move determine the type of chiropractic adjustment and its line of drive. The line of drive usually being in the direction of resistance (Haldeman, 1992).
Motion palpation techniques

Cervical region - Motion palpation of the cervical spine is divided into 2 regions; the first region (upper cervical region) is designed to test movement between the atlas and occiput and the atlas and axis. The second region examines the movement of joints of the mid and lower cervical spine (Haldeman, 1992).

In all areas of palpation the examiner is seated behind the patient.

i) Upper cervical rotation between the atlas and the occiput – Using his palpating hand the examiner places the tip of his middle finger on the transverse process of the atlas and his index finger on the anterior aspect of the mastoid process, and rotates the patient's head from posterior to anterior on the side of palpation. If the mastoid process displaces the tip of the middle finger from the transverse process of the atlas then normal motion is occurring in this direction, if not then a fixation is present in this direction of movement. Then when rotating the patient's head from anterior to posterior the mandible will displace the examiner's middle finger from the transverse process in normal motion in this direction, if it doesn't then a fixation is present in this direction.

ii) Anterior glide palpation between the occiput and atlas – Using his palpating hand the examiner places the index finger slightly anterior to the tip of the transverse process. The examiner’s non-palpating hand is placed with the palm of the hand on the occiput and the fingers on top of the head. The non-palpating hand pushes the cranium forward parallel to the floor. The palpating hand feels for an increase in the distance between the anterior aspect of the transverse process of the atlas and the mandible. If this increase occurs then the movement is normal in this direction, if not then a fixation exists in this direction.

iii) Lateral flexion of the cervical spine – When palpating for lateral flexion of the occiput on the atlas the index finger of the palpating hand is placed on the transverse process of the atlas, and the non-palpating hand is placed on the contra-lateral side on top of the head. The patient's head is then
laterally flexed and the examiner looks for a springy end feel of lateral flexion, if this is present then the motion in this segment is normal, if not then a fixation exists in this direction. For the mid and lower cervical spine the doctor repeats the process listed above except that the index finger of the contact hand is placed on the articular pillar of the vertebra in question.

iv) Rotation of the mid and lower cervical spine – The index finger of the palpating hand is placed on the articular pillar of the vertebra in question, the head is then rotated posterior to anterior on the side involved and the examiner applies a small amount of pressure with the contact hand to determine a springy end-feel, if present then the motion is normal, if not then a fixation is present in this direction.

v) Extension of the mid and lower cervical spine – The same palpating technique is used in extension as for other movements in the mid and lower cervical spine, the only difference is that the examiner moves the patients head and neck into extension.

vi) Flexion of the mid and lower cervical spine – The middle finger of the contact hand is placed over the anterior aspect of the transverse process of the respective vertebra. The head and neck are then moved into flexion and at the apex of this movement the examiner gently pulls back with the contact hand and looks for a springy end-feel to the movement. If this is present then the movement in this direction is normal, if not then a fixation exists at the involved level in this direction.

(Haldeman, 1992)

Thoracic region - In all cases the examiner is seated behind the patient.

i) Thoracic flexion and extension palpation - The non-palpating arm of the examiner is draped over the patients shoulder. The thumb of the palpating hand is placed between the spinous processes of the vertebrae. For flexion the patient is brought into a flexed position and the examiner feels for separation of the spinous processes of the involved vertebrae. If this is present then the movement is normal, if not then a fixation is present in
this direction. For extension the patient is brought into an extended position and the examiner feels for approximation of the spinous processes. If present then there is normal movement in this direction, if not then there is a fixation in this direction.

ii) Thoracic rotation palpation – The same palpating position is used here, except that the thumb of the contact hand is placed on the side of the spinous process. The examiner then rotates the patient from posterior to anterior on the opposite side and the examiner feels for a springy end-feel, if this is present then the movement in this direction is normal, if not then a fixation is present in this direction.

(Haldeman, 1992)

2.3.4 The chiropractic adjustment

This is defined as a passive, manual manoeuvre during which a joint is suddenly moved beyond its normal physiological range of motion, without exceeding the boundaries of anatomical integrity. The primary characteristic of the adjustment is a high velocity and low amplitude impulse delivered at the end of the normal passive range of motion. This is usually accompanied by a cavitation or cracking noise (Sandoz, 1976). Once a joint has been adjusted it readapts to its full range of motion (Schafer and Faye, 1990).
Phases of the adjustment

Both Sandoz (1976) and Schafer and Faye (1983) state that during the chiropractic adjustment we distinguish 3 zones of movement, the first of these is the physiologic zone, which is divided into the zones of active and passive movement. At the end of the passive movement zone we find the elastic barrier of resistance, which separates the physiologic zone from the paraphysiologic zone. This elastic barrier of resistance can be overcome without causing damage to the joint. This is the barrier that the chiropractic adjustment overcomes. At the end of the paraphysiologic zone of movement we find the barrier called the limit of anatomical integrity, this barrier separates the paraphysiologic zone from the pathological zone. If we overcome this barrier it results in damage to the soft tissue structures of the joint.

Figure 6. Phases of the chiropractic adjustment (Sandoz, 1976).
Three phenomena are observed at the point where the elastic barrier of resistance is overcome:

i) The articular surfaces of the joint separate.
ii) A cavitation or cracking noise occurs as a result of the liberation of synovial gasses.
iii) A radiolucent cavity appears in the joint space.

Following the occurrence of these 3 factors we observe an increase in the physiological range of motion of the joint in all directions. This is because the paraphysiological space is now temporarily incorporated into the physiological space. This period is referred to as the refractory period and lasts approximately 15 – 20 minutes. It is important to remember that the first barrier of resistance encountered during this time is the anatomical limit of integrity; therefore a second adjustment to the joint may result in damage to the soft tissues (Sandoz, 1976).

Possible mechanisms by which the chiropractic adjustment affects trigger points within the trapezius muscle

In the case of the chiropractic adjustment we utilise two primary theories based on studies by Korr and Wyke to explain the mechanism by which chiropractic helps to relieve myofascial trigger points.

Wyke (1967) who determined that mechanoreceptors located in spinal joints are major contributors to postural and kinesthetic sensation explains this model. He stated that muscles are capable of reacting individually to nociceptor and mechanoreceptor stimuli arising in individual vertebral motion segments. The most important factor in the theory is that afferent input from nociceptors is inhibited by static and dynamic mechanoreceptors. This means that stimulation of these mechanoreceptors by stretching the apophyseal joint capsule during chiropractic manipulative therapy reduces nociceptive input at the anterolateral spinothalamic tract thereby reducing pain. This reduction in pain subsequently interrupts the pain – spasm – pain cycle and thereby reduces localised muscle spasm and thus the triggerpoints (Gatterman, 1990).
Korr (1975) attributes intersegmental muscle spasm and fixation of joints to aberrant muscle spindle activity. He concludes that muscle contraction may be increased or decreased by the muscle spindle, thus if the vertebral attachments of the short spinal muscles are approximated by an unguarded movement and result in the annulospiral receptor activity being silenced, this lack of input to the central nervous system results in an increase in γ-motoneuron activity, this increases the intensity of muscle contraction and thereby results in muscle spasm. This muscle spasm in turn results in the vertebral muscle attachments not being able to return to their original position. Korr (1975) theorises that the Golgi tendon organs provide the mechanism by which manipulation relieves the muscle spasm producing joint fixation, by acting as brakes and initiating a reflex inhibition of motor activity in muscles acting over the joint. Thus it is feasible that a high velocity thrust performed at the extreme of a restricted joints motion will activate the golgi tendon organ and inhibit muscle activity, thereby reducing muscle spasm.

According to Haldeman (1992), the nervous system also plays an important role in the amount of tension within a muscle. This is because the muscle spindle reflex, which determines the sarcomere length, is controlled by the nervous system. With this being the case and the fact that the sensory segmental nerve supply to the trapezius muscle originates from cervical nerves C3 and C4 it is postulated that the effect of the chiropractic adjustment is due, at least in part, to its direct effect on these nerve roots during manipulation of the respective cervical vertebral segments.
Chapter three

Materials and Methods
3. MATERIALS AND METHODS

3.1 Introduction

The purpose of this chapter is to systematically explain the type of data collected, the way in which it was measured and collected, the treatment protocols followed and the statistical analysis of data, in order for them to be replicated if so desired.

3.2. The data

i) The patient’s perception of the amount of pain and disability (Vernon-Mior Neck pain and disability Index), (Magee, 1997), (Appendix K).

ii) The patient’s perception of their level of pain (Numerical Pain Rating Scale 101), (Magee, 1997), (Appendix J).

iii) The patient’s cervical spine range of motion (Cervical Range of Motion instrument), (Appendix B and C).

iv) The patient’s perception of the tenderness of the trigger point (Aligometer readings), (Travell and Simons, 1983:12), (Appendix D and E).

3.3 Measurements

3.3.1 Goniometer

The Cervical Range of Motion instrument is used to measure the patient’s range of motion in degrees. It measures 3 degrees of movement, that being in the sagittal plane (flexion and extension), coronal plane (right and left lateral flexion) and in the transverse plane (right and left rotation). The values thus obtained were recorded onto a table in order to be compared and statistically evaluated easily.
3.3.2 Algometer

The algometer is a pressure device that measures the pressure applied to the trapezius trigger points in kg/cm squared. These values were recorded onto a table for easy comparison and statistical evaluation.

3.3.3 Vernon-Mior Neck pain and disability index

This questionnaire establishes the degree of the patient's pain and disability in their daily activities. It is also possible to view the restoration of previously ceased daily activities, thus helping to indicate the effectiveness of the treatment.

There are ten sections to the questionnaire and each section has a value of 0 (statement 1) to 5 (statement 6). Thus the total for the questionnaire is 50. A percentage for the questionnaire is then calculated.

Example:

\[ \frac{17 \text{ (total scored)} \times 100}{50 \text{ (maximum total)}} = 34\% \]

If one of the sections is left out then the questionnaire is automatically calculated as a percentage of 45.

Example:

\[ \frac{17 \text{ (total scored)} \times 100}{45 \text{ (maximum total)}} = 37.78\% \]

The overall rating for the questionnaire is as follows:

0 – 20% = minimal disability
20 – 40% = moderate disability
40 – 60% = severe disability
60 – 80% = crippled
80 – 100% = bed bound or exaggerating
(Magee 1997) (Appendix K)

3.3.4 Numerical Pain Rating Scale 101

This questionnaire requires that the patient rate their pain on a scale of 0 – 10 to establish a baseline level of pain that the patient has experienced since their previous consultation (Appendix I).

3.4. Study design and protocol

3.4.1 Goal of the study

Since the goal of the research study was to compare Action Potential Simulation Therapy and the Chiropractic Adjustment in the treatment of trapezius trigger points, all treatment and statistical analysis was geared towards measuring the effectiveness of the treatment protocols received. Therefore a pretest-postest randomised – groups design was used in this study.

3.4.2 Process of randomisation

As the patients entered the study, they were placed into groups alternating between group 1 and group 2 so that by the end of the study there were 2 equal groups of 25 patients. Group 1 received Chiropractic manipulative therapy, and group 2 received Action Potential Simulation Therapy.

3.4.3 Treatment protocol

Sample selection and criteria

Fifty patients were recruited by the use of poster advertisements and word of mouth as well as verbal advertising in classes of students and patients presenting to the technikon health clinic complaining of posterior cervical spine pain. These patients
were then screened prior to consideration for the study in order to ensure that they were suffering from trapezius trigger points. Patients from the ages of 18 - 45 were considered for the study.

The patients then completed a Vernon-Mior Neck Pain and Disability index and a Numerical Pain Rating Scale 101. A complete patient history (Appendix F), and full cervical spine examination (Appendix G) were then carried out to determine the patient's eligibility for the study, and to confirm the presence of the trigger points. Tenderness of the trapezius trigger points was then assessed using an algometer and the patient's cervical spine range of motion was also assessed using the Cervical Range of Motion instrument (goniometer). The patient must have had trigger points in the region of trapezius trigger points 1 or 2 on either the right or left hand side.

If after these examinations the patients fulfilled the requirements, they were accepted into the study.

Treatment of the patients

Subsequent to acceptance into the study the patients were assigned to one of either of the treatment groups according to the order in which they applied to take part in the study.

Group 1

The adjustment group was then motion palpated in order to establish what fixations they had in either the cervical or thoracic regions of their spines (refer to pages 24, 25 and 26 of the literature review). They then received chiropractic manipulative therapy in these respective regions, the reason for this being that the trapezius muscle attaches to the occiput and the spinous processes of C7 to T12 vertebrae (Moore, 1992), and according to Schaefer and Faye (1990) the trigger points or muscular spasms associated with specific joints and vertebral levels can be completely corrected using the chiropractic adjustment. A number of specific adjustments were used in these treatments depending on the type and location of the fixations found.
These techniques included:

1. Superior condyle
2. Sitting rotary cervical
3. Lateral atlas index
4. Cervical break
5. Phalangeo-metacarpal
6. Anterior thoracic
7. Malar posterior transverse
8. Thumb movement – bench TM
9. Crossed bilateral transverse pisiform

(Kirk, Lawrence, & Valvo, 1991)

The readings for the algometer, goniometer and the 2 questionnaires were taken again immediately after the first treatment.
These measurements were again taken immediately after the third, fifth, seventh and 1 month follow up consultations.

Group 2

This group received Action Potential Simulation therapy for the treatment of their trigger points. Prior to the treatment the electrodes were marked according to which were to be used as positive and negative electrodes.

The patient was requested to lie prone and the posterior aspect of the thorax was exposed. The electrodes were then placed with the negative poles at the angle of the neck overlying the location of trapezius trigger point 2 and the positive poles were placed over the lower trapezius fibres at the level T10 vertebra approximately 3cm from the spinous processes. The machine was put on a continuous current mode for the period of 8 minutes to allow the tissues to warm up. The intensity of the current was then increased to patient tolerance (between 0.70mA and 1.0mA) as recommended by Berger (1999).
Once the initial 8-minute period was completed the device was switched off and the positive electrodes were removed and replaced on the skin overlying the location of trapezius trigger point 1. The intensity of the current was then increased to patient tolerance (between 0.70mA and 1.0mA). The current was switched from a continuous to a pulsed mode and the patient was treated for another 8-minute period as shown by Berger (1999).

On subsequent visits the same procedure was followed excepting that the intensity was increased to greater than 1.0mA, again stopping at the level of patient tolerance.

All patients were given 7 treatments over a period of 4 weeks, with a follow-up consultation 4 weeks later. After treatments 1, 3, 5, 7 and at the 4-week follow-up the patient was required to complete a Numerical Pain Rating Scale 101 and the Vernon-Mior Neck Pain and Disability index. They were also measured using the Goniometer and the Algometer after the treatments and the 4-week follow up consultation. The follow-up consultation was used to determine the lasting effectiveness of the treatments.

3.5 Statistical analysis

3.5.1 Treatment of the data

Treatment of the objective data

In order to solve the objective component of the study the data was treated as follows:

i) The Goniometer was used to calculate the cervical range of motion in degrees. This was used in the measurement of the cervical flexion, lateral flexion, and rotation from the neutral position of the neck. These values were recorded independently for the control and the experimental group.

ii) The Algometer was used to measure the tenderness of trigger points 1 and 2 of the trapezius muscle in kg/cm² for the control and experimental groups respectively.
iii) This data was statistically analysed to establish whether any significant changes occurred in the cervical range of motion or tenderness of the trigger points.

Treatment of the subjective data

In order to solve the subjective component of the study the data was treated as follows:

i) The Vernon-Mior Neck Pain and Disability index was screened to ensure that the patient had correctly completed it. The scores were added and accurately converted to a percentage. The scores were then recorded independently for group 1 and group 2. Comparisons were drawn up to establish differences between any of the consecutively measured treatments within the groups.

ii) The Numerical Pain Rating Scale 101 was screened to ensure that the patient had correctly completed it. The scores were recorded independently for the control and experimental groups. Comparisons were drawn up to establish differences between any of the consecutively measured treatments within the groups.

iii) This data was statistically analysed to establish if there was any significant change in the patients perception of their pain or disability.

3.5.2 Statistical analysis of the data

The data collected was analysed using 2 non-parametric tests. The size of the 2 groups is large enough to have a true reflection of the general population between the ages of 18 and 45 (parameters for inclusion in the study).

Non-parametric paired hypothesis tests

The objective data - The cervical range of motion and algometer readings were statistically analysed using Friedman Repeated Measures tests on each treatment
group. Group 1 is considered to be the adjustment group and group 2 is considered to be the APS therapy group. Comparisons were made between the measurements taken:

i) Prior to the first treatment (BT) and post first treatment (PT).
ii) Prior to the first treatment (BT) and post seventh treatment (7T).
iii) Prior to the first treatment (BT) and at the 4 week follow-up (8T).
iv) Post first treatment (PT) and post seventh treatment (7T).
v) Post first treatment (PT) and at the 4 week follow-up (8T).

<table>
<thead>
<tr>
<th>l.e.</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BT → PT</td>
<td>BT → PT</td>
</tr>
<tr>
<td></td>
<td>BT → 7T</td>
<td>BT → 7T</td>
</tr>
<tr>
<td></td>
<td>BT → 8T</td>
<td>BT → 8T</td>
</tr>
<tr>
<td></td>
<td>PT → 7T</td>
<td>PT → 7T</td>
</tr>
<tr>
<td></td>
<td>PT → 8T</td>
<td>PT → 8T</td>
</tr>
</tbody>
</table>

The subjective data - The subjective readings for each questionnaire were statistically analysed using Friedman Repeated Measures tests on each treatment group. Group 1 is considered to be the adjustment group and group 2 is considered to be the APS therapy group. Comparisons were made between the measurements taken:

i) Prior to the first treatment (BT) and post first treatment (PT).
ii) Prior to the first treatment (BT) and post seventh treatment (7T).
iii) Prior to the first treatment (BT) and at the 4 week follow-up (8T).
iv) Post first treatment (PT) and post seventh treatment (7T).
v) Post first treatment (PT) and at the 4 week follow-up (8T).

<table>
<thead>
<tr>
<th>l.e.</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BT → PT</td>
<td>BT → PT</td>
</tr>
<tr>
<td></td>
<td>BT → 7T</td>
<td>BT → 7T</td>
</tr>
<tr>
<td></td>
<td>BT → 8T</td>
<td>BT → 8T</td>
</tr>
<tr>
<td></td>
<td>PT → 7T</td>
<td>PT → 7T</td>
</tr>
<tr>
<td></td>
<td>PT → 8T</td>
<td>PT → 8T</td>
</tr>
</tbody>
</table>
Non-parametric un-paired hypothesis tests

The objective data - All the cervical range of motions and algometer readings for the 2 groups were compared using the Mann-Whitney Rank Sum test. Comparisons were made at the following stages in the treatments:

- i) Prior to the first treatment (BT).
- ii) At the 4 week follow-up (8T).

<table>
<thead>
<tr>
<th>L.e.</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT</td>
<td>→ BT</td>
<td></td>
</tr>
<tr>
<td>8T</td>
<td>→ 8T</td>
<td></td>
</tr>
</tbody>
</table>

The subjective data - The Numerical Pain Rating Scale readings for both groups were compared using the Mann-Whitney Rank Sum tests at the following stages in the treatments of the patients:

- i) Prior to the first treatment (BT).
- ii) Immediately after the 1st treatment.
- iii) At the 4 week follow-up (8T).

<table>
<thead>
<tr>
<th>L.e.</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT</td>
<td>→ BT</td>
<td></td>
</tr>
<tr>
<td>PT</td>
<td>→ PT</td>
<td></td>
</tr>
<tr>
<td>8T</td>
<td>→ 8T</td>
<td></td>
</tr>
</tbody>
</table>
The Vernon-Mior Neck Pain and Disability Index readings (in percentages) for both groups were compared using the Mann-Whitney Rank Sum tests at the following stages in the treatments of the patients:

i) Prior to the first treatment (BT).

ii) At the third consultation.

iii) At the 4 week follow-up (8T).

I.e. Group 1 Group 2

<table>
<thead>
<tr>
<th>BT</th>
<th>→</th>
<th>BT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3T</td>
<td>→</td>
<td>3T</td>
</tr>
<tr>
<td>8T</td>
<td>→</td>
<td>8T</td>
</tr>
</tbody>
</table>

3.5.3 Column statistics

These were calculated for both the objective and subjective data.

Statistical analysis was performed using the software program "Jandel scientific-SigmaStat and SigmaPlot version 2.02"
Chapter four

Results
4. RESULTS

4.1 Demographic data

Table 1. Demographic data

<table>
<thead>
<tr>
<th>Data</th>
<th>C.M.T</th>
<th>APS therapy</th>
<th>Combined total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age distribution</td>
<td>19 – 27 years</td>
<td>18 – 30 years</td>
<td>18 – 30 years</td>
</tr>
<tr>
<td>Mean age</td>
<td>21.76 years</td>
<td>22.76 years</td>
<td>22.26 years</td>
</tr>
<tr>
<td>Gender distribution</td>
<td>11 Male</td>
<td>14 Male</td>
<td>25 Male</td>
</tr>
<tr>
<td></td>
<td>14 Female</td>
<td>11 Female</td>
<td>25 Female</td>
</tr>
<tr>
<td>Race distribution</td>
<td>20 White</td>
<td>18 White</td>
<td>38 White</td>
</tr>
<tr>
<td></td>
<td>3 Black</td>
<td>6 Black</td>
<td>9 Black</td>
</tr>
<tr>
<td></td>
<td>2 Indian</td>
<td>1 Indian</td>
<td>3 Indian</td>
</tr>
</tbody>
</table>

The above table indicates the age distribution, mean age, gender distribution and race distribution of the chiropractic manipulative therapy and APS therapy groups respectively, as well as giving a summary of these factors for a combination of both groups.
4.2 Graphical representation of the data

The graphs should be interpreted using the following parameters:

- On graphs 1 – 6 the red bars represent group 1, receiving chiropractic manipulative therapy.
- On graphs 7 – 12 the green bars represent group 1, receiving chiropractic manipulative therapy.
- On graphs 1 – 6 the green bars represent group 2, receiving Action Potential Simulation therapy.
- On graphs 7 – 12 the blue bars represent group 2, receiving Action Potential Simulation therapy.
- The black lines extending from the top of each bar are error bars, which represent the standard error of the mean, i.e. the corrected form of the standard deviation for the sample size. The bigger the sample size, the smaller the standard error.
- The first bar in the sequence represents the reading, which was taken before the treatments began.
- The last bar in the sequence (labelled treatment 8) represents the 4-week follow up consultation.
4.2.1 Cervical range of motion in flexion (Fig. 7)

When the 2 groups were compared prior to the first treatment it was found that there was no statistically significant difference between them (P-value = 0.141). When looking at the 2 groups independently we see that there is no statistically significant increase in this range of motion of the APS therapy group over the course of the treatment (P-value = 0.893). However in the adjustment group there is a statistically significant increase (P-value = 0.0308). We also see a statistically significant increase in the range of motion when comparing the measurements prior to the 1st treatment with those of the 7th treatment in the adjustment group (P-value < 0.05). Of further interest is the statistically significant increase in the range of motion of the adjustment group between the measurements prior to the 1st treatment and those taken immediately after the 1st treatment (P-value < 0.05). No statistically significant changes were observed in either group between the 7th treatments and the 4-week follow up consultations.
4.2.2 Cervical range of motion in extension (Fig. 8)

When the 2 groups were compared prior to the first treatment it was found that there was no statistically significant difference between them (P-value = 0.3000). When looking at the 2 groups independently we see that there is no statistically significant increase in the range of motion of either group over the course of the treatment (Adjustment group P-value = 0.629, APS therapy group P-value = 0.786), we do however observe a numerical increase in both groups for these measurements. No statistically significant difference was observed between the 2 groups when comparing their range of motion at the 4-week follow up consultation (P-value = 0.6237). The adjustment group did however display a slightly greater numerical increase by this stage.
4.2.3 Cervical range of motion in left rotation (Fig. 9)

When the 2 groups were compared prior to the first visit it was found that there was no statistically significant difference between them (P-value = 0.200). Examination of the 2 groups independently of one another revealed that there was no statistically significant increase in the range of motion over the course of the treatment (Adjustment group P-value = 0.225, APS therapy group P-value = 0.233), there was however a numerical increase in these values for both groups. In the APS therapy group there was a slight numerical decrease in the range of motion from the 7th treatment to the 4-week follow up consultation, but this was not statistically significant. There was no statistically significant difference between the 2 groups range of motion at the 4-week follow up consultation (P-value = 0.6949).
4.2.4 Cervical range of motion in right rotation (Fig. 10)

When the 2 groups were compared prior to the 1st treatment a statistically significant difference was noted between the input groups (P-value = 0.0228). Examination of the 2 groups independently of one another revealed that there was a statistically significant increase over the course of the treatment of the adjustment group (P-value = 0.0238), this was however not seen in the APS therapy group (P-value = 0.395) despite a numerical increase in the range of motion. Statistically significant increases (P-value < 0.05) were also noted in the adjustment group when comparing measurements taken prior to the 1st treatment and those taken at the 5th treatment and at the 4-week follow up. No statistically significant difference was noted between the 2 groups at the 4-week follow up consultation (P-value = 0.7636).
4.2.5 Cervical range of motion in left lateral flexion (Fig. 11)

When the 2 groups were compared prior to the 1st consultation no statistically significant difference was noted in their range of motion (P-value = 0.5123). When looking at the 2 groups independently of one another, a numerical increase in the range of motion was observed, however no statistically significant changes were noted over the course of the treatment in either group (Adjustment P-value = 0.106, APS therapy P-value = 0.763). A numerical increase was also noted in the range of motion between the 7th treatment and one month follow up consultation of the adjustment group, whereas a numerical decrease was noted in the APS therapy group for these values, however these measurements are not statistically significant. No statistically significant change was noted between the 2 groups at the 4-week follow up consultations.
Figure 12. Cervical range of motion in right lateral flexion for both groups

4.2.6 Cervical range of motion in right lateral flexion (Fig. 12)

A comparison between the input groups revealed no statistically significant difference in the range of motion (P-value = 0.4654). Examination of the 2 groups independently of one another revealed that there was a numerical increase in the range of motion, but no statistically significant difference over the course of the treatment for either group (Adjustment group P-value = 0.107, APS therapy group P-value = 0.900). Both groups displayed a numerical decrease in the range of motion between the 7th treatments and 4-week follow up consultation, but no statistically significant difference was noted. No statistically significant difference was noted between the 2 groups at the 4-week follow up consultation despite the adjustment group displaying a numerically greater improvement by this stage.
4.2.7 Algometer readings for left trapezius trigger point 1 (Fig. 13)

A comparison between the input groups revealed no statistically significant difference in algometer readings (P-value = 0.7619). When examining both groups independently a statistically significant increase in pressure was noted over the course of the treatment in both the adjustment and APS therapy groups respectively, indicating that the trigger points were less tender (Adjustment group P-value = 0.00576, APS therapy group P-value = 0.000107). A slight numerical difference was noted between the adjustment and APS therapy groups at the 4-week follow up consultation with the APS therapy group having a numerically higher value, but this is not statistically significant. When looking at the measurements between the 7th treatment and 4-week follow up consultation a numerical increase in the pressure tolerance was noted in the APS therapy group, and a numerical decrease for the same values in the adjustment group. These values are not statistically significant however.
4.2.8 Algometer readings for left trapezius trigger point 2 (Fig. 14)

A comparison between the input groups revealed no statistically significant difference in algometer readings (P-value = 0.884). When examining both groups independently a statistically significant increase in pressure tolerance was noted over the course of the treatment in both the adjustment and APS therapy groups respectively indicating a reduction in trigger point tenderness (Adjustment group P-value = 0.000791, APS therapy group P-value = 0.0000340). Of interest is the rather large increase in the pressure tolerance between the measurements taken prior to the 1st consultation and those taken immediately after the first consultation in the adjustment group (P-value < 0.05). No statistically significant difference was noted between the 2 groups at the 4-week follow up consultation.
4.2.9 Algometer readings for right trapezius trigger point 1 (Fig. 15)

A comparison between the input groups revealed no statistically significant difference in algometer readings (P-value = 0.669). When examining both groups independently a statistically significant increase in pressure tolerance was noted over the course of the treatment in both the adjustment and APS therapy groups respectively indicating a reduction in the tenderness of the trigger points (Adjustment group P-value = 0.00271, APS therapy group P-value = 0.000414). There was no statistically significant difference noted between the 2 groups measurements taken at the 4-week follow up consultation (P-value = 0.8854).
4.2.10 Algometer readings for right trapezius trigger point 2 (Fig. 16)

A comparison between the input groups of the APS therapy group and the adjustment group revealed no significant difference in algometer readings (P-value = 0.907). When examining both groups independently a statistically significant increase in pressure tolerance was noted over the course of the treatment in the APS therapy group indicating a reduction in trigger point tenderness (P-value = 0.0000731). No statistically significant change was noted in the adjustment increase for these measurements (P-value = 0.0550). There was no statistically significant difference between the 2 groups at the 4-week follow up consultation.
4.2.11 Numerical pain rating scale 101 (Fig. 17)

No statistically significant differences in pain were noted between the 2 input groups to begin with (P-value = 0.415). When examining both groups independently a statistically significant decrease in pain was noted over the course of the treatment in both the adjustment and APS therapy groups respectively (Adjustment group P-value = 0.00000395, APS therapy group P-value = 0.000000331). Of particular interest is the drop in pain experienced by the adjustment group in those measurements taken prior to the 1st consultation and those taken immediately after it (P-value < 0.05). There is no statistically significant difference in the measurements taken at the 4-week follow up consultation between the 2 groups.
4.2.12 Vernon-Mior neck pain and disability index (Fig. 18)

No statistically significant differences in pain and disability were noted between the 2 input groups to begin with (P-value = 0.741). When examining both groups independently a statistically significant decrease in pain and disability was noted over the course of the treatment in both the adjustment and APS therapy groups respectively (Adjustment group P-value = 0.0000140, APS therapy group P-value = 0.0000000882). Of particular interest is the drop in pain and disability between the post 1st treatment measurements and the measurements taken at the 3rd consultation of the APS therapy group (P-value < 0.05). There is no statistically significant difference between the 2 groups at the 4-week follow up consultation.
Chapter five

Discussion
5. DISCUSSION

5.1 Introduction

This chapter includes a discussion of the results obtained in the evaluation of the data in the previous chapter. It includes that information dealing with the cervical range of motion, the algometer readings and the pain and disability questionnaires. Two main sections of discussion will be covered:

i) Objective results

ii) Subjective results

The following two hypotheses will be referred to:

i) The treatment group receiving chiropractic manipulative therapy (adjustment) will show positive results in terms of objective and subjective measurements.

ii) The treatment group receiving Action Potential Simulation therapy will show positive results in terms of objective and subjective measurements.

5.2 The objective results

5.2.1 Range of motion

Despite the fact that a numerical improvement occurred in both groups in most of the ranges of motion, only a few of these were statistically significant (Fig. 7 and 10). The adjustment group experienced statistically significant improvement in flexion and right rotation, with a numerical improvement in all other ranges of motion. This improvement in flexion reached a peak after the 5th treatment, after which there was a slight decrease (not statistically significant), which levelled off from the 7th treatment to the 4-week follow up consultation (Fig. 7). The significant improvement in right rotation in the adjustment group was maintained through to the follow up consultation, there was however a statistically significant difference in the input groups of the adjustment and the APS therapy groups for right rotation. This difference cannot be accounted for, but it does explain why there is an improvement (P- value = 0.0238) in the adjustment group and not the APS therapy group (P- value
= 0.395) when both groups ended up, after their 4-week follow up consultations, with very similar ranges of motion (Fig. 10).

A study by Atkinson (1999), in which patients were treated to establish the relative effectiveness of combined spinal manipulative therapy and action potential therapy versus combined spinal manipulative therapy and placebo action potential therapy on mechanical lower back pain, revealed that there was a significant improvement in both groups with regards to range of motion. However the experimental group (in which action potential therapy was switched on) displayed greater improvement than those in the control group. Despite the fact that this study included all forms of mechanical lower back pain and was not limited to myofascial trigger point involvement it indicates that there could be a significant benefit to the combined use of chiropractic manipulative therapy and APS therapy as opposed to treating patients in a mutually exclusive situation.

5.2.2 Algometer readings

Statistically significant changes were observed in both groups in trapezius trigger points 1 and 2 on the left and 1 on the right. A statistically significant change was observed in trapezius trigger point 2 on the right in the APS therapy group. The adjustment group showed a very strong numerical change (P-value = 0.0550) but this was not statistically significant. The significant improvements for both groups were maintained right through until the follow up consultations. The adjustment group displayed slight numerical increases in trigger point tenderness between the 7th treatment and the follow up consultation, whereas the APS therapy group maintained the lack of tenderness throughout.

A study by Pooke (1999), at Technikon Natal involving 30 patients, revealed that when adjusting the vertebral level of segmental nerve supply of muscles with myofascial trigger points improvements were noted in the patients subjective perception of the pain as well as pain tolerance (algometer reading), a relative lack of improvement was noted in the patients range of motion. It is noted that in the present study the motor supply of the trapezius muscle originates from the Cranial Nerve XI and thus its vertebral level of segmental nerve supply cannot be adjusted directly,
however the sensory fibres supplying this muscle originate from C3 and C4, furthermore the spinal component of Cranial Nerve XI derives its fibres from the ventral roots of the first five cervical segments (Gatterman, 1990). Thus it is postulated by the researcher that in the current study the chiropractic adjustment could have had an effect on these nerve fibres resulting in a reflex inhibition of pain, or that the changes occurred as a result of mechanical changes to the joints over which the muscle acts.

In a study by Van Papendorp et al., (2000) 285 patients with varying manifestations of pain were evaluated using the visual analogue pain scale (VAPS) and the mobility index (MI) for a relief of pain over a five-day period of using the APS therapy device. The mean VAPS and MI improved significantly in the patient group as a whole. Their explanation for this reduction in pain is based on the theory that A-beta fibres (low threshold mechanoreceptors from the skin) give off collateral branches as they pass upward in the spinal cord, these in turn impinge upon nociceptor cells of the A-delta and C-pain fibres, thus reducing the excitability of these nociceptor cells. They thus suggested that electrical impulses that stimulate these A-beta fibres are effective in reducing pain perception.

5.3 Subjective results

5.3.1 Numerical Pain rating Scale 101

Both groups displayed statistically significant improvements in pain reduction over the course of the treatment (Adjustment group P- value = 0.00000395, APS therapy group P- value = 0.000000331). The adjustment group showed a very large, rapid decrease in the pain immediately after the first treatment. This then levelled off until the 5th treatment and then began to improve again at the 7th treatment and 4 week follow up consultation. Both groups continued to improve up until the 4-week follow up consultation.

In a study by Verhoef et al., (1997), involving 369 patients with neck and/or back pain who presented to 13 separate chiropractic practices, it was found that
chiropractic manipulative therapy was effective in resolving pain and functional impairments. These improvements were more noticeable in those patients presenting with severe pain, and those who were suffering with acute pain conditions.

It is postulated that the rapid resolution of the pain that myofascial trigger points cause is as a result of the inhibitory effect that the chiropractic adjustment has on the nociceptor pain fibres through stimulation of the mechanoreceptors in the joint capsule of the facet joints (as was explained in the literature review on pg.28 under the heading Possible mechanisms by which the chiropractic adjustment affects trigger points within the trapezius muscle).

In a study by Van Papendorp et al., (1999) involving 24 patients the effect of APS therapy on the plasma levels of \( \beta \)-endorphin, leucine encephalin and substance \( P \) was investigated. The study revealed that the use of APS therapy resulted in the plasma levels of \( \beta \)-endorphin and leucine encephalin rising significantly, but that there was no clear results for the changes in the levels of substance \( P \). Due to the fact that \( \beta \)-endorphin and leucine encephalin are a part of the body's natural pain mediating system, this is believed to be at least partly responsible for the reduction in pain experienced by patients as a result of the use of the APS therapy device.

5.3.2 Vernon-Mior Neck Pain and Disability Index

Both groups displayed statistically significant improvements in the patient's perception of their pain and disability. The APS therapy group continued to show improvements up until the 4-week follow up consultation, whereas the adjustment group levelled off from the 7th treatment to the 4-week follow up consultation. The APS therapy group showed a very sudden and marked decrease in these values after the 3rd treatment. The difference between the APS therapy and adjustment groups at this stage is statistically significant, however by the end of the treatment period and at the 4-week follow up consultation there is no significant difference between the groups.
According to Berger (1999) APS therapy leads to a release of melatonin. This substance is responsible for relief from anxiety, and has been reported to improve sleep and decrease the effects of seasonal affective disorders. It was discussed earlier in the literature review how patients that are anxious and under stress often perceive pain as being worse than it really is, thus it is postulated by the researcher that the relaxing effect that melatonin has is partly responsible for the patient being less aware of their discomfort.
Chapter six

Conclusions and Recommendations
6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Both chiropractic manipulative therapy and Action Potential Simulation therapy are effective methods of treating myofascial trigger points. Chiropractic manipulative therapy proved to be effective in improving the cervical range of motion in flexion, whereas Action Potential Simulation therapy did not show any significant change in this regard. Both forms of treatment proved to be very effective in relieving the tenderness of trigger points (as was determined by the algometer readings), as well as leading to marked improvements in cervical spine pain and disability (Numerical pain rating scale 101 and the Vernon-Mior neck pain and disability index).

It was also shown that chiropractic manipulative therapy is the treatment of choice when trying to improve the patients' pain as rapidly as possible. This very rapid reduction in pain occurred immediately after the 1st treatment, but the reduction levelled off and a much slower decrease was seen thereafter. Action Potential Simulation therapy showed a very dramatic reduction in the patients perception of their pain and disability after the 3rd treatment, and continued to decrease right up until the 4-week follow up consultation. The adjustment group in this instance showed a steadier rate of decline in pain and disability, until there was no statistically significant difference between the groups at the 4-week follow up consultation.

Based on the results of this study both Action Potential Simulation therapy and chiropractic manipulative therapy were excellent treatments for myofascial trigger points.
6.2 Recommendations

When placing the patients into their respective groups it is recommended that the examiner ensure that all variables are equal between the 2 groups prior to treatment to make the results more valid. Future studies should check that no trigger points are present in any other cervical muscles that may have an effect on cervical range of motion and the patients’ perception of their pain.

It is also advisable that future studies include another treatment group that will utilize Action Potential Simulation therapy and chiropractic manipulative therapy in combination in order to establish if the combined effect of these treatments will further benefit the patients. It is possible that this would allow for the greater initial improvement shown by the adjustment group in pain perception, as well as the more rapid recovery shown by the Action Potential Simulation group in pain and disability.

It would also be advisable to establish the efficacy of treating a patient group for 4 treatments with only chiropractic manipulative therapy followed by another 4 treatments of only Action Potential Simulation therapy.
REFERENCES


APPENDICES
APPENDIX A

Section of the chiropractic report detailing the use of Vernon-Mior Neck Pain and Disability index and Numerical pain Rating Scale 101
Visual Analog Scales and Numerical Rating Scales

Instructions on Use and Scoring

A. Visual Analog Scale (VAS)

1. This package does not include a Visual Analog Scale (VAS) ready for use with patients. This is because a Numerical Rating Scale (NRS) is equally valid, easier to use with patients, and preferred - an NRS ready for use with patients is found at the bottom of each of the questionnaires enclosed with this package.

The NRS, as you will see, asks the patient to measure pain severity by selecting 1 of 11 boxes. The VAS is potentially more sensitive, but requires oral directions to and supervision of the patient.

2. The VAS is simply a 100 mm line with two pain descriptors. Thus:

No Pain ———— | Excruciating Pain

The patient records his/her pain level by making one perpendicular line. You then measure the pain level from the left end of the 100 mm line to the perpendicular line. The second time the patient completes a VAS you make the same measurement, then compare the scores. Because the line is 100 mm long, the difference between the two scores is a percentage difference.

Experience suggests that, even with the clearest written instructions to the patient, there needs to be oral reinforcement and supervision. Otherwise some patients will use a circle or cross rather than a perpendicular line, making the pain rating imprecise and strictly invalid.

B. Numerical Rating Scale (NRS)

1. This is simply a refined VAS, giving the patient more defined pain categories to check.

PLEASE NOTE: The Oswestry, Roland-Morris and Neck Pain Disability Questionnaires included in this package have a NRS at the foot of the page. The NRS is, however, a quite separate measurement of outcome from the questionnaires. Both measures appear on one page for convenience only. If you wish to use them separately, simply delete the NRS when photocopying the questionnaires.
Back and Neck Pain Disability Questionnaires

Instructions on Use and Scoring

A. When and How to Use

1. When to Use. The point of these questionnaires is to measure a change in condition or health status. Thus have the patient complete the questionnaire:

   a) Before treatment has begun. It can be part of the routine initial documentation.

   b) Periodically during management when you think a measurable change in health status should have occurred.

      i) For acute pain complaints (three weeks duration or less) the questionnaire should be completed at one week intervals.

      ii) For most other pain complaints completion of the questionnaire at two week intervals is appropriate.

   c) At the point at which the patient is released from your care.

2. Choice of Questionnaire:

   a) For patients with neck pain use the Neck Pain Disability Questionnaire.

   b) For patients with low-back pain you have a choice - use either the Oswestry or the Roland-Morris. Obviously one patient should be given the same questionnaire throughout. You may will decide to use one questionnaire with all your back pain patients - this would be valid and least confusing for your staff. However the Roland is more sensitive in documenting change with acute and sub-acute pain (less than six weeks) - in other words you are likely to show a bigger percentage improvement under chiropractic care with these patients using the Roland-Morris. In contrast, the Oswestry is more sensitive in measuring results with chronic pain patients.

3. Instructions to Patient: Instructions appear at the top of each questionnaire.
4. Responsibilities of person administering the Questionnaire: Your duties are to see that:

a) The patient completes the questionnaire at appropriate times before and during a course of treatment.

b) With the Oswestry and the Neck Pain Disability Questionnaires, that each section of the questionnaire has been completed. If a section is incomplete have the patient complete the questionnaire before his/her departure from the office. The questionnaire is invalid if completed at any other time.

c) The questionnaire is scored and filed in a timely fashion.

d) PLEASE NOTE: The patient must not be told his/her score after completion of the questionnaire, or shown previously completed questionnaires and/or scores.

B. How to Score, Interpret and Report

1. Oswestry

a) In each section scores of 0 (statement 1) to 5 (statement 6) are possible. Thus, if all sections are completed a score of 50 (100%) is possible.

Example: \[ \frac{16 \text{ (total scored)}}{50 \text{ (total possible)}} \times 100 = 32\% \]

b) If one section is missed score as follows:

Example: \[ \frac{16 \text{ (total scored)}}{45 \text{ (total possible)}} \times 100 = 35.5\% \]

c) With respect to interpretation of total scores, these overall ratings may be given (they come from the British trial of chiropractic published in the British Medical Journal in June 1990 - Meade TW, Dyer S et al (1990) 'Low Back Pain of Mechanical Origin: Randomised Comparison of Chiropractic and Hospital Outpatient Treatment,' BR Med J 300:1431-37.):

Overall rating

<table>
<thead>
<tr>
<th>% Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20%</td>
<td>Minimal disability</td>
</tr>
<tr>
<td>20-40%</td>
<td>Moderate disability</td>
</tr>
<tr>
<td>40-60%</td>
<td>Severe disability</td>
</tr>
<tr>
<td>60-80%</td>
<td>Crippled</td>
</tr>
<tr>
<td>80-100%</td>
<td>Bedbound or exaggerating</td>
</tr>
</tbody>
</table>
d) With respect to reporting questionnaire results to the patient, do not explain the scoring method as this may influence response on subsequent questionnaires. It is valid to give the total percent disability scored, but focus on the point difference and what this means.

For example, take a patient who has answered the questionnaire on intake and after two weeks. There may be a reduction in percentage difference of 6%, say, and you can report this. Then by comparing the two questionnaires completed, you can report specific areas of reduced disability.

e) Background information on Oswestry. The original Oswestry Low-Back Pain Disability Questionnaire was developed during the 1970s at a hospital spine unit in Oswestry, Shropshire, England. It has been revised a number of times during testing for scientific validity. The version used in the British trial of chiropractic included a section asking questions on ‘sex life’. This section was problematical since many patients left it unanswered or simply checked the first section saying that sex life was normal.

The current and revised form of the Oswestry now recommended and included with this package, which replaces the section on sex life with one on changing degree of pain and has a number of other improvements, has been developed and validated by chiropractors. It was initially prepared and tested by Alan Breen DC PhD, Director of Research, Anglo European College of Chiropractic, England, and is the form of the Oswestry that was used and validated by John Hsieh, Reed Phillips et al (JMP'T (1992) 15(1):4-9, paper enclosed with this package).

2. Roland-Morris

a) This questionnaire has 24 items of behaviour that may be affected by back pain. Simply add or sum to yield a score on a range from 0 to 24. A patient is meant to put a mark next to each statement or leave it blank (i.e. in effect a yes or no answer). If a word such as "sometimes" is written, this answer can be scored and added into the total as 0.5.

On successive use during management the Roland-Morris yields a percentage reduction of disability (or improvement in function), and it is this measurement of change in health status that is the real point of use of questionnaires and measurement of outcomes generally. As already explained it is more sensitive in measuring change for patients with acute pain.

Assume for example a patient who has a pre-treatment score of 14, two weeks later a score of 7, and four weeks later a score of 2. The overall improvement in function is 86% calculated as follows:
12 (points of improvement during management)  
14 (pre-treatment points)  
\[ \frac{100}{1} = 86\% \]

b) With respect to reporting to patients, you can report variation in point score, percentage improvement in function, and then give details of improved function by comparing the completed questionnaires.

3. Neck Pain Disability

Has been adapted by chiropractic researchers from the Oswestry - score, interpret and report in exactly the same way as above.

C. Time and User Friendliness

1. A major benefit of use of questionnaires is that they are not only scientifically valid but also inexpensive and involve next to no time at all for the doctor. Questionnaires can be administered and scored by staff. Scoring takes only one minute, and staff time can be minimized if questionnaires are scored and filed immediately after they have been completed.

On this basis the only time required of the doctor is in reporting of results to the patient. Once a doctor is familiar with the forms this can be done from the file in the presence of the patient without any advance preparation.

PLEASE NOTE AGAIN: The patient should not personally review the questionnaires and become familiar with the scoring method and answers previously given.
APPENBIX B

Instruction manual for the cervical range of motion instrument
CROM Procedure Manual

Procedure for Measuring Neck Motion with the CROM

CROM (Cervical Range of Motion Instrument) is a product of:

PERFORMANCE ATTAINMENT ASSOCIATES
3550 LaBore Road, Suite 8
St. Paul, MN 55110-5126
612-484-0004 or 800-835-2766
Figures

1. CROM with rotation arm and magnetic yoke .................................. 2
2. CROM with forward head arm and vertebra locator ......................... 2
3. Suboccipital resting posture ....................................................... 3
4. Suboccipital flexion ................................................................... 3
5. Suboccipital extension ................................................................. 3
6. Cervical flexion ......................................................................... 4
7. Cervical extension ...................................................................... 4
8. Left lateral flexion ...................................................................... 5
9. Right lateral flexion ................................................................. 5
10. Magnetic yoke pointing north ...................................................... 6
11. Left rotation ............................................................................ 6
12. Right rotation .......................................................................... 6
13. CROM with forward head arm and vertebra locator ...................... 7
14. Right rounded shoulder ............................................................. 8

Introduction

Pain and loss of motion in the cervical region are common problems that increase with age. Over 40 million adult Americans suffer from some form of osteoarthritis or degenerative joint disease, and 50 to 85 percent of these people will experience debilitating back or neck pain of a temporary or chronic nature.

Accurate measurement of cervical motion during the course of a therapeutic regime can provide objective data on the benefits of the selected treatment. However, currently available measurement devices are time consuming, cumbersome, poorly standardized and poorly accepted by practitioners. In response to this lack of a acceptable means of measurement, existing devices were evaluated and the following design criteria established:

- quickly read
- standardized landmarks and positioning
- standardized protocol
- reproducibility
- simple design
- reasonable cost

Based on these criteria, the CROM instrument, accessories and protocol were developed. The CROM accurately and quickly measures the range of sagittal, coronal and horizontal movements that can be performed by the head and neck.

To perform and document accurate cervical measurements you will need the following items:

- CROM instrument, including the rotation arm and the forward head arm
- magnetic yoke
- vertebra locator
- tape measure
- recording sheets
- procedure manual
The CROM Instrument is aligned on the nose bridge and ears and is fastened to the head by a velcro strap (see figure 1).

Three dial angle meters are used to take most of the measurements. The sagittal plane meter and the lateral flexion meter are gravity meters. The rotation meter is magnetic and responds quickly to the shoulder-mounted magnetic yoke, accurately measuring cervical rotation. Because the rotation meter is controlled by the magnetic yoke, shoulder substitution is eliminated.

Two frequently observed problems seen in patients with cervical dysfunction are forward head (cranio-thoracic postures) and rounded shoulders (scapular protraction). Forward head is the anterior glide of the cervical spine and head with cervical hyperextension. The CROM Instrument, with the forward head arm and the vertebral locator, accurately measures forward head (see figure 2).

Rounded shoulder is the anterior movement of the scapula (shoulder and upper extremity) on the thorax. Rounded shoulder measurements are taken with the tape measure.

**Suboccipital Flexion and Extension**

Instruct the subject to position the CROM Instrument as if putting on a pair of glasses. Fasten the velcro strap in line with the bows. You will not need the magnetic yoke, rotation arm, forward head arm or vertebral locator for these measurements. Instruct the subject to stand facing away from an outside corner of a wall or edge of a open door frame. The subject’s sacrum, thoracic spine and occiput must be in contact with the corner of the wall or door edge (see figure 3). Instruct the subject to maintain constant pressure to prevent substitution movements. Since the sagittal plane meter normally reads zero when the ear bows are parallel to the horizontal plane, this reading (zero or otherwise) indicates the subject’s resting suboccipital posture; record it on the recording sheet.

Instruct the subject to flex the suboccipital area as much as possible while maintaining equal pressure at the skull, thorax and sacrum (see figure 4). Record this measurement.

Instruct the subject to extend the suboccipital area as much as possible without allowing the skull, thorax and sacrum to leave the contact surface (see figure 5). Record this measurement.

*A sample recording sheet is provided in the back of this manual. Tablets of the recording sheet may be ordered from your dealer as PAA Form 101.*
Cervical Flexion and Extension

Instruct the subject to sit erect in a straight-back chair with the sacrum against the back of the chair, the thoracic spine away from the back of the chair, arms hanging at sides and feet flat on the floor. Next, instruct the subject to position the CROM instrument as if putting on a pair of glasses. Fasten the velcro straps snugly in line with the bows. You will not need the magnetic yoke, rotation arm, forward head arm or vertebra locator for these measurements.

To assure full flexion in this multi-joint area, first instruct the subject to "nod your head to make a double chin" (suboccipital flexion). Then encourage the subject to flex further until full cervical flexion is obtained (see figure 6). To take the reading on the sagittal plane meter, read through the meter's beveled edge; from this angle the pointer will be magnified to the dial edge. Record this measurement in the appropriate space on the recording sheet.

To measure cervical extension, first instruct the subject to "nod your head back" (suboccipital extension). Then have the subject extend further until full extension is achieved (see figure 7). Record this measurement also.

Lateral Flexion

Instruct the subject to sit erect in a straight-back chair with the sacrum against the back of the chair, the thoracic spine away from the back of the chair, arms hanging at sides and feet flat on the floor. Note: to eliminate rotation during lateral flexion the subject should focus on a point on a wall straight ahead. The sagittal plane meter will read zero if the subject is looking straight ahead. The lateral flexion meter will also read zero if the head is not laterally flexed. If the lateral flexion meter does not read zero, record the reading as lateral flexion at rest. You will not need the magnetic yoke, rotation arm, forward head arm nor vertebra locator for these measurements.

Instruct the subject to flex the head laterally to the left, keeping the shoulders level and without rotating the head (see figure 8). Monitor for shoulder elevation by lightly placing your hand on the right shoulder, and correct manually any head motion outside the coronal plane. Note and record the measurement from the lateral flexion meter.

Now instruct the subject to flex the head laterally to the right, again keeping the shoulders level without rotating the head (see figure 9). As before, monitor for left shoulder elevation and correct head motion.

Figure 6: Cervical flexion

Figure 7: Cervical extension

Figure 8: Left lateral flexion

Figure 9: Right lateral flexion
Rotation

You will need to use the CROM instrument plus the magnetic yoke and rotation arm for these measurements. To obtain an accurate rotation measurement, first determine which direction is north.

Next, place the magnetic yoke on the subject's shoulders with the arrow pointing north (see figure 10). Instruct the subject to sit erect in a straight-back chair with the sacrum against the back of the chair, the thoracic spine away from the back of the chair, arms hanging at sides and feet flat on the floor. The lateral flexion and sagittal plane meters must read zero for the rotation meter to be level; if necessary, assist the subject into the correct position.

As the subject faces straight ahead, grasp the rotation meter between your thumb and index finger and turn the meter until one of the pointers is at zero.

Instruct the subject to focus on a horizontal line on the wall so the head is not tipped during rotation. Have the subject turn the head as far to the left as possible (see figure 11), and to ensure that no shoulder rotation occurs, tightly stabilize the right shoulder with your hand. (Note: if the head and shoulders are rotated together the pointer will not move because the magnetic yoke positioned on the shoulders eliminates shoulder substitution.) Record this measurement in the appropriate place on the recording sheet.

While you lightly stabilize the left shoulder, instruct the subject to turn the head as far as possible to the right (see figure 12). Record this measurement also.

*You can find magnetic (map) north by noting the direction of the red needle on the rotation meter when it is at least four feet from the magnetic yoke.

Forward Head

Instruct the subject to sit erect in a straight-back chair with the sacrum against the back of the chair, the thoracic spine away from the back of the chair, arms hanging at side and feet flat on the floor. You will need to use the CROM instrument plus the forward head arm and the vertebra locator for this measurement, but not the magnetic yoke nor the rotation arm.

Attach the forward head arm on the CROM in place of the rotation arm (see figure 13). Stand to the subject's left side so you can read the sagittal plane meter. To assure that the forward head arm is horizontal, assist the subject to position the head with the sagittal plane meter reading zero.

While the subject maintains this position, locate the seventh cervical vertebra and place the foot (bottom tip) of the vertebra locator on the spinous process. Position the locator so the bubble is centered within the vertical lines on the vial. The forward head arm is calibrated in centimeters for the horizontal distance from the nose bridge to the locator contact point with the seventh vertebra.

Now, instruct the subject to slide the head as far back as possible, while keeping the chin level. Note the measurement at the junction of the forward head arm and the vertebra locator and record it as retraction.

Next, instruct the subject to relax and record this measurement as the resting posture.

Then, instruct the subject to protract or procline the head forward as much as possible, while keeping the chin level. Record this measurement as protraction.
Rounded Shoulder
(scapular protraction)

Instruct the subject to sit erect in a straight-back chair with the sacrum against the back of the chair, the thoracic spine away from the back of the chair, arms hanging at side and feet flat on the floor. You will need only the tape measure to take this measurement.

To measure scapular protraction, first locate the following landmarks:

- the posterolateral borders of the acromion
- the vertebral spinous process at the intersection of a line connecting the inferior angle of the scapulae.

If the scapulae are at noticeably different heights locate spinous processes for each side at the vertebral intersection of a horizontal line from the inferior angle of the scapula to the spine.

After you have located the landmarks, use the tape measure to measure the distance from the spinous process to the right acromion (see figure 14). Record this measurement and then repeat the measurement on the left side.

Next, while the subject assumes a corrected posture, take each measurement again, indicating the maximal potential for improvement.

Figure 14: Right rounded shoulder

CROM Recording Sheet

Name: ___________________________ Date of Initial Evaluation: ___________________________
Facility: __________________________ Examiner: __________________________

DATES

MEASUREMENTS
Suboccipital: Resting Posture  Flexion  Extension

Cervical:  Flexion  Extension

Lateral Flexion: Resting Posture  Left  Right

Rotation:  Left  Right

Forward Head: Retraction  Flexion  Extension

Round Shoulder: Left  Right
APPENDIX C

Data sheet for collecting the values on range of motion during treatment
Goniometer Readings

Rotation
Left------------------ Right------------------

Lateral flexion
Left------------------ Right------------------

Flexion------------------

Extension------------------

Rotation
Left------------------ Right------------------

Lateral flexion
Left------------------ Right------------------

Flexion------------------

Extension------------------
APPENDIX D

Instructions on use of algometer

(Taken from: Trávell and Simons, 1983, 2: 11, 12)
Postisometric Relaxation

The process of postisometric relaxation is to contract the tense muscle isometrically against resistance and then to encourage it to lengthen during a period of complete voluntary relaxation. Gravity is an effective force to "encourage" release of the muscle tension.

Postisometric relaxation begins by having the patient perform an isometric contraction of the tense muscle at its initial tolerated length, while the clinician stabilizes that part of the body to prevent muscle shortening. Contraction should be slight (10–25% of maximum voluntary contraction). After holding this contraction for 3–10 sec., the patient is instructed to "let go" and to relax the body completely. During this relaxation phase, the clinician gently takes up any slack that develops in the muscle, noting the increase in range of motion. Care is taken to maintain the stretched length of the muscle and not to return it to the neutral position during subsequent cycles of isometric contraction and relaxation.  

Respiration

The effectiveness of postisometric relaxation is augmented by combining it with phased respiration. Since inhalation encourages contraction of most muscles and exhalation encourages their relaxation, the contraction-relaxation cycle is coordinated with these phases of respiration. The patient slowly inhales during the isometric contraction phase and then slowly exhales during the relaxation phase. These breaths should be deep. Patients who have difficulty using such a slow respiratory pattern are helped by pausing, breathing naturally several times, and relaxing between each cycle.

For the torso, inhalation facilitates moving toward the neutral erect position. Leaning forward is naturally associated with exhalation and relaxation. From the forward-flexed position, standing or sitting up straight is associated with inhalation. Similarly, when one is in a retroflexed (bent-back) position, inhalation again facilitates straightening up toward the erect position; exhalation facilitates further backward extension.

Chapter 2 / General Issues 11

The jaw elevator muscles have a respiratory reflex response opposite to that of most muscles. The elevators are reflexly relaxed during the inhalation associated with a yawn. Since yawning requires activation of jaw depressors, this may be an example of overriding reciprocal inhibition. For these jaw elevators, the isometric contraction phase is coordinated with exhalation, and the relaxation (stretch) phase is coordinated with inhalation (the patient is instructed to yawn or imagine yawning).

Eye Movements

In general, eye movements facilitate the movement of the head and trunk in the direction of the patient’s gaze and inhibit movement in the opposite direction. This holds true for lifting the head and torso as well as for stooping and rotation. Eye movement (gaze) does not facilitate side bending, however. Looking up does facilitate straightening up from the side-bent position. These eye movements should not be exaggerated, because a maximum-effort movement may have an inhibitory effect.  

4. NEW MEASUREMENT TECHNIQUES

This section will consider new developments in algometry, tissue compliance measurement, thermography, and magnetic resonance spectroscopy as they relate to an understanding of myofascial TrPs.

Algometry, tissue compliance measurement, and thermography are valuable for substantiating clinical observations and as research tools. By themselves they cannot be used for diagnosing myofascial TrPs.

Algometry

There are two types of algometers, a mechanical spring-operated force gauge and an electrical strain gauge.

Spring-operated Algometers

Pressure algometry is not new, but devices specifically designed to measure pressure threshold, pressure tolerance, and tissue compliance in relation to myofascial TrPs are new.  

UNIVERSITY OF JOHANNESBURG

4. NEW MEASUREMENT TECHNIQUES

This section will consider new developments in algometry, tissue compliance measurement, thermography, and magnetic resonance spectroscopy as they relate to an understanding of myofascial TrPs.

Algometry, tissue compliance measurement, and thermography are valuable for substantiating clinical observations and as research tools. By themselves they cannot be used for diagnosing myofascial TrPs.

Algometry

There are two types of algometers, a mechanical spring-operated force gauge and an electrical strain gauge.

Spring-operated Algometers

Pressure algometry is not new, but devices specifically designed to measure pressure threshold, pressure tolerance, and tissue compliance in relation to myofascial TrPs are new.

4. NEW MEASUREMENT TECHNIQUES

This section will consider new developments in algometry, tissue compliance measurement, thermography, and magnetic resonance spectroscopy as they relate to an understanding of myofascial TrPs.

Algometry, tissue compliance measurement, and thermography are valuable for substantiating clinical observations and as research tools. By themselves they cannot be used for diagnosing myofascial TrPs.

Algometry

There are two types of algometers, a mechanical spring-operated force gauge and an electrical strain gauge.

Spring-operated Algometers

Pressure algometry is not new, but devices specifically designed to measure pressure threshold, pressure tolerance, and tissue compliance in relation to myofascial TrPs are new.
The pressure threshold is that pressure which is first perceived as painful by the subject as increasing pressure is applied. Fischer\textsuperscript{24,29} described a spring-operated pressure threshold meter that records forces up to 11 kg. This force gauge has a 1-cm\textsuperscript{2} circular rubber tip. The scale reads the pressure applied to the TrP directly in kg/cm\textsuperscript{2}. This device is usually sensitive enough at the low end of the scale to identify differences in sensitivity between active TrPs, yet remains on scale when measuring the higher pressure threshold of normal muscles.\textsuperscript{20,23,29}

The companion pressure tolerance meter\textsuperscript{29} measures the maximum pressure a subject can tolerate over muscles and bones, up to 17 kg. Normally, pressure tolerance is greater over muscle than over bone. Reversal of this relative sensitivity suggests the presence of a generalized myopathy.\textsuperscript{22} The reason for having two similar instruments is that the threshold meter often goes off scale if one attempts to use it to measure tolerance, and the tolerance meter is too insensitive to resolve accurately the differences in the sensitivity of active TrPs.

Trunks and associates\textsuperscript{37} developed a spring-operated algometer that was adapted from the Preston pinch gauge. The hemispheric tip of the instrument has an area of contact of 2 cm\textsuperscript{2}. The unit was designed to simulate the pressure applied by the thumb when examining a patient for the tender points of fibromyalgia.

\textbf{Strain Gauge Algometers}

The user can rapidly rescale the sensitivity of an electronic strain gauge algometer to perform both pressure threshold measurements and pressure tolerance measurements. Strain gauge algometers also permit direct recording and computer input.

Ohrbach and Gale\textsuperscript{71} designed a strain gauge pressure tolerance meter for testing tender spots in masticatory muscles. It had a tip area of only 0.5 cm\textsuperscript{2}. Jensen and associates\textsuperscript{44} developed a strain gauge pressure algometer for measurement of sensitivity in the temporal region to study patients with headache. Schiffman and co-workers\textsuperscript{28} developed a strain gauge pressure algometer especially designed to transmit the feeling that one has when palpating a taut band. Its bluntly pointed plastic tip simulates the shape of a fingertip. Inter-rater reliability of their pressure algometer for 14 muscles of the head and neck was consistently higher than the reliability of palpation.

\textbf{Applications}

Using the Fischer pressure threshold meter,\textsuperscript{20,23} a comparison of normal values with those obtained at corresponding TrP sites showed that a difference between right and left sides in excess of 2 kg/cm\textsuperscript{2} represents abnormal sensitivity. Moreover, any pressure threshold at a muscle site in excess of 3 kg/cm\textsuperscript{2} was considered abnormal.\textsuperscript{20,23} The muscles of females were more sensitive to pressure than were those of males in two studies using different instruments.\textsuperscript{23,24}

List and associates\textsuperscript{49} found the Fischer algometer reliable and valid for measuring sensitivity (tenderness) in the masseter muscle. A well-controlled study by Reeves and co-workers\textsuperscript{27} demonstrated that the same meter provided a reliable measure of myofascial TrP sensitivity in five masticatory and neck muscles. They also found significantly increased sensitivity at the TrP compared with that of the muscle 2 cm away from the clinically determined spot of maximum tenderness. Jæger and Reeves\textsuperscript{41} demonstrated that myofascial TrP sensitivity decreases in response to passive stretch. Fischer\textsuperscript{28} gave examples of the change in sensitivity observed following different therapies.

Applying the Jensen instrument to the study of migraine patients, investigators\textsuperscript{43} concluded that myofascial TrPs appear to be a significant factor in migraine headache, contributing particularly to interval headaches between migraine attacks.

Thomas and Aidinis\textsuperscript{90} objectively and quantitatively measured the threshold for grimacing and movement responses by pressure algometry in a patient with musculoskeletal pain syndrome during light Pentothal anesthesia.

A pressure threshold meter provides an objective measure of the effectiveness of treatment.\textsuperscript{80,81,29} The meter itself does not identify the cause of the tenderness being measured.
APPENDIX E

Data sheet for collecting the algometer readings during treatment
**Algometer Readings**

**Vist:**

<table>
<thead>
<tr>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. TP1-----</td>
<td>1. TP1-----</td>
</tr>
<tr>
<td>2. TP2-----</td>
<td>2. TP2-----</td>
</tr>
</tbody>
</table>

**Vist:**

<table>
<thead>
<tr>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. TP1-----</td>
<td>1. TP1-----</td>
</tr>
<tr>
<td>2. TP2-----</td>
<td>2. TP2-----</td>
</tr>
</tbody>
</table>

**Vist:**

<table>
<thead>
<tr>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. TP1-----</td>
<td>1. TP1-----</td>
</tr>
<tr>
<td>2. TP2-----</td>
<td>2. TP2-----</td>
</tr>
</tbody>
</table>

**Vist:**

<table>
<thead>
<tr>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. TP1-----</td>
<td>1. TP1-----</td>
</tr>
<tr>
<td>2. TP2-----</td>
<td>2. TP2-----</td>
</tr>
</tbody>
</table>
APPENDIX F

Case history form
TECHNIKON WITWATERSRAND
CHIROPRACTIC DAY CLINIC

CASE HISTORY

Date: __________________

Patient __________________________  File No: __________________

Age: _______  Sex: _______  Occupation: __________________________

Intern: __________________________  Signature: __________________

FOR CLINICIAN'S USE ONLY

Initial visit clinician: __________________  Signature: __________________

Case History: __________________________

____________________________________

____________________________________

____________________________________

Examination:
  Previous:  TWR  Current:  TWR
  Other
  Other

X-ray Studies:
  Previous:  TWR  Current:  TWR
  Other
  Other

Clinical path. lab:
  Previous:  TWR  Current:  TWR
  Other
  Other

Case status:
  PTT:  Conditional:  Signed off:  Final sign out:

Recommendations:
Intern's case history

1. Source of history:

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

3. Present illness:
   Location
   Onset
   Duration
   Frequency
   Pain (character)
   Progression
   Aggravating factors
   Relieving factors
   Associated Sx's & Sg's
   Previous occurrences
   Past treatment and outcome

4. Other complaints:
5. Past history:

   General health status

   Childhood illnesses

   Adult illnesses

   Psychiatric illnesses

   Accidents/injuries

   Surgery

   Hospitalisation

6. Current health status and lifestyle

   Allergies

   Immunizations

   Screening tests

   Environmental hazards

   Safety measures

   Exercise and leisure

   Sleep patterns

   Diet
Current medication

Tobacco

Alcohol

Social drugs

7. Family history:
   Immediate family:

   Cause of death
   DM
   Heart disease
   TB
   HBP
   Stroke
   Kidney disease
   CA
   Arthritis
   Anaemia
   Headaches
   Thyroid disease
   Epilepsy
   Mental illness
   Alcoholism
   Drug addiction
   Other

8. Psychosocial history:

   Home situation

   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 G

Cervical spine regional examination form
TECHNIKON WITWATERSRAND
CHIROPRACTIC DAY CLINIC

REGIONAL EXAMINATION
CERVICAL SPINE

Date: _____________
File No: ___________
Signature: __________

Patient: ____________________
Clinician: _________________
Intern: _____________________

Signature: ___________

OBSERVATION

- Posture
- Size
- Swellings
- Scars
- Discolouration
- Hairline
- Bony and soft tissue contours
- Shoulder level:
- Muscle spasm
- Facial expression

RANGE OF MOTION

Flexion = 45° - 90°
Extension = 55° - 70°
L/R Rotation = 70° - 90°
L/R Lateral flexion = 20° - 45°
Flexion

L. Rot          R. Rot.

L. lat flex     R. lat flex

Ext.

/ = pain-free limitation; // = painful limitation

PALPATION

- Lymph nodes.
- Trachea.
- Thyroid gland.
- Pulses / thrills
- Tenderness
- Muscle Tone
- Active MF Trigger Points: - SCM.
  - Trapezius.
  - Scaleni.
  - Levator Scapulae.
  - Posterior Cervical musculature.
ORTHOPAEDIC EXAMINATION

1. Doorbell Sign
2. Max. Cervical Compression
3. Spurling's manoeuvre
4. Lateral Compression (Jackson's test)
5. Kemp's Test
6. Cervical Distraction
7. Shoulder abduction Test
8. Shoulder depression Test
9. Dizziness rotation Test
10. Lhermitte's Sign
11. O'Donoghue Maneuère
12. Brachial Plexus Tension
13. Carpal tunnel syndrome:
   • Tinel's sign
   • Phalen's Test
14. TOS:
   • Halstead's test
   • Adson's test
   • Eden's (traction) test
   • Hyperabduction (Wright's) test - Pec minor
   • Costoclavicular test

Remarks: ________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
**VASCULAR**

**LEFT**                  **RIGHT**

**BLOOD PRESSURE.**

**CAROTIDS.**

**SUBCLAVIAN ARTERIES.**

**WALLENBERG'S TEST.**

**COMMENTS:**

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

**MOTION PALPATION**

<table>
<thead>
<tr>
<th>Jt. play</th>
<th>Left</th>
<th>Right</th>
<th>Jt. play</th>
</tr>
</thead>
<tbody>
<tr>
<td>P/A</td>
<td>Lat</td>
<td>Fle</td>
<td>Ext</td>
</tr>
<tr>
<td>C1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DERMATOMES</td>
<td>Left</td>
<td>Right</td>
<td>MYOTOMES</td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
<td>-----------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td>Neck Flexion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lat. Neck Flexion</td>
</tr>
<tr>
<td>C4</td>
<td></td>
<td></td>
<td>Shoulder Elevation</td>
</tr>
<tr>
<td>C5</td>
<td></td>
<td></td>
<td>Shoulder Abduction</td>
</tr>
<tr>
<td>C6</td>
<td></td>
<td></td>
<td>Elbow Flexion</td>
</tr>
<tr>
<td>C7</td>
<td></td>
<td></td>
<td>Elbow Extension</td>
</tr>
<tr>
<td>C8</td>
<td></td>
<td></td>
<td>Elbow Flexion at 90°</td>
</tr>
<tr>
<td>T1</td>
<td></td>
<td></td>
<td>Forearm Pronation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Forearm Supination</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wrist Extension</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wrist Flexion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Finger Flexion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Finger Abduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Finger Adduction</td>
</tr>
</tbody>
</table>
APPENDIX H

Information and consent form
SUBJECT INFORMATION AND CONSENT FORM

You are suffering from trigger points within the trapezius muscle which may result in neck pain and stiffness and possibly headaches. We are conducting research investigating an additional method of treatment for trigger points. We are asking you to participate in this research to help determine the role of this method of treatment.

If you participate you will be required to undergo a case history and a regional examination of your neck. You will be asked to fill in certain questionnaires from time to time. The amount of movement in your neck as well as the pressure which elicits tenderness will be evaluated on occasion. You will be assigned randomly to one of two groups. You will receive 7 treatment sessions and a follow up consultation 4 weeks later.

All patients who participate in this research will contribute to chiropractic knowledge, resulting in the selection of better methods of treatment of trigger points in the future.

Participation in this research is voluntary and you are free to refuse to participate or to withdraw your consent and discontinue participation at any time.

I have fully explained the procedures identifying those that are investigational, and have explained their purpose. I have asked whether or not any questions have arisen regarding the procedures and have answered the questions to the best of my ability.

Date:--------------------- Researcher:---------------------

I have been fully informed as to the procedures to be followed, including those which are investigational and have been given a description of the attendant discomforts, risks and benefits to be expected and the appropriate alternative procedures.

In signing this consent form I agree to this method of treatment and I understand that I am free to withdraw my consent and discontinue my participation in this study at any time. I understand also that if I have any questions at any time, they will be answered.

Date--------------------- Patient:---------------------
APPENDIX I

Statistical data
<table>
<thead>
<tr>
<th>Flexion</th>
<th>Adjustment</th>
<th>APS therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>61.8</td>
<td>65.6</td>
</tr>
<tr>
<td>std dev</td>
<td>66.8</td>
<td>67.76</td>
</tr>
<tr>
<td>std error</td>
<td>66.8</td>
<td>70.24</td>
</tr>
<tr>
<td>95% conf</td>
<td>66.4</td>
<td>70.24</td>
</tr>
<tr>
<td>size</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>total</td>
<td>1545</td>
<td>1640</td>
</tr>
<tr>
<td>min</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td>max</td>
<td>92</td>
<td>60</td>
</tr>
<tr>
<td>min pos</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td>max pos</td>
<td>0</td>
<td>48</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>other</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>skewness</td>
<td>0.645739</td>
<td>-0.10382</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extension</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>75.36</td>
</tr>
<tr>
<td>std dev</td>
<td>93.7862</td>
</tr>
<tr>
<td>std error</td>
<td>25.29</td>
</tr>
<tr>
<td>95% conf</td>
<td>5.767816</td>
</tr>
<tr>
<td>99% conf</td>
<td>7.618627</td>
</tr>
<tr>
<td>size</td>
<td>42</td>
</tr>
<tr>
<td>total</td>
<td>1984</td>
</tr>
<tr>
<td>min</td>
<td>42</td>
</tr>
<tr>
<td>max</td>
<td>98</td>
</tr>
<tr>
<td>min pos</td>
<td>0</td>
</tr>
<tr>
<td>max pos</td>
<td>0</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
</tr>
<tr>
<td>other</td>
<td>0</td>
</tr>
<tr>
<td>skewness</td>
<td>-0.73759</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Left rotation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>63.88</td>
</tr>
<tr>
<td>std dev</td>
<td>67.32</td>
</tr>
<tr>
<td>std error</td>
<td>2.504</td>
</tr>
<tr>
<td>95% conf</td>
<td>5.168811</td>
</tr>
<tr>
<td>99% conf</td>
<td>7.006517</td>
</tr>
<tr>
<td>size</td>
<td>26</td>
</tr>
<tr>
<td>total</td>
<td>1597</td>
</tr>
<tr>
<td>min</td>
<td>42</td>
</tr>
<tr>
<td>max</td>
<td>106</td>
</tr>
<tr>
<td>min pos</td>
<td>0</td>
</tr>
<tr>
<td>max pos</td>
<td>0</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
</tr>
<tr>
<td>other</td>
<td>0</td>
</tr>
<tr>
<td>skewness</td>
<td>0.113843</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Right rotation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>60</td>
</tr>
<tr>
<td>std dev</td>
<td>11.21011</td>
</tr>
<tr>
<td>std error</td>
<td>2.240233</td>
</tr>
<tr>
<td>95% conf</td>
<td>4.6274</td>
</tr>
<tr>
<td>99% conf</td>
<td>6.271279</td>
</tr>
<tr>
<td>size</td>
<td>25</td>
</tr>
<tr>
<td>total</td>
<td>1500</td>
</tr>
<tr>
<td>min</td>
<td>32</td>
</tr>
<tr>
<td>max</td>
<td>80</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
</tr>
<tr>
<td>other</td>
<td>0</td>
</tr>
<tr>
<td>skewness</td>
<td>0.23184</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>APS therapy</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>66.4</td>
</tr>
<tr>
<td>std dev</td>
<td>68.28</td>
</tr>
<tr>
<td>std error</td>
<td>68.36</td>
</tr>
<tr>
<td>95% conf</td>
<td>67.72</td>
</tr>
<tr>
<td>99% conf</td>
<td>4.839423</td>
</tr>
<tr>
<td>size</td>
<td>25</td>
</tr>
<tr>
<td>total</td>
<td>1500</td>
</tr>
<tr>
<td>min</td>
<td>32</td>
</tr>
<tr>
<td>max</td>
<td>80</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
</tr>
<tr>
<td>other</td>
<td>0</td>
</tr>
<tr>
<td>skewness</td>
<td>-0.23184</td>
</tr>
</tbody>
</table>
### Left lateral flexion

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>std dev</th>
<th>std err</th>
<th>95% conf</th>
<th>skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>size</td>
<td>50.92</td>
<td>53.88</td>
<td>54.36</td>
<td>53.64</td>
<td>54.2</td>
</tr>
<tr>
<td>total</td>
<td>1273</td>
<td>1347</td>
<td>1304</td>
<td>1390</td>
<td>1364</td>
</tr>
<tr>
<td>min</td>
<td>34</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>max</td>
<td>72</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>pos</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>err</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>skewness</td>
<td>-0.01229</td>
<td>-0.01879</td>
<td>-0.01229</td>
<td>-0.01879</td>
<td>-0.01229</td>
</tr>
</tbody>
</table>

### Right lateral flexion

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>std dev</th>
<th>std err</th>
<th>95% conf</th>
<th>skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>size</td>
<td>50.92</td>
<td>53.88</td>
<td>54.36</td>
<td>53.64</td>
<td>54.2</td>
</tr>
<tr>
<td>total</td>
<td>1273</td>
<td>1347</td>
<td>1304</td>
<td>1390</td>
<td>1364</td>
</tr>
<tr>
<td>min</td>
<td>34</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>max</td>
<td>72</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>pos</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>err</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>skewness</td>
<td>0.01229</td>
<td>0.01879</td>
<td>0.01229</td>
<td>0.01879</td>
<td>0.01229</td>
</tr>
</tbody>
</table>

### LTP1

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>std dev</th>
<th>std err</th>
<th>95% conf</th>
<th>skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>size</td>
<td>2.808</td>
<td>3.332</td>
<td>3.424</td>
<td>3.692</td>
<td>4.148</td>
</tr>
<tr>
<td>total</td>
<td>104915</td>
<td>1.347713</td>
<td>1.482194</td>
<td>1.674705</td>
<td>1.873482</td>
</tr>
<tr>
<td>min</td>
<td>1.5</td>
<td>1.6</td>
<td>1.6</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>max</td>
<td>5.8</td>
<td>8.1</td>
<td>8.1</td>
<td>8.1</td>
<td>6.7</td>
</tr>
<tr>
<td>pos</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>err</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>skewness</td>
<td>0.74538</td>
<td>0.206671</td>
<td>1.340015</td>
<td>2.255834</td>
<td>1.68562</td>
</tr>
</tbody>
</table>

### LTP2

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>std dev</th>
<th>std err</th>
<th>95% conf</th>
<th>skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>size</td>
<td>2.8</td>
<td>3.726</td>
<td>3.336</td>
<td>3.684</td>
<td>4.036</td>
</tr>
<tr>
<td>total</td>
<td>0.903235</td>
<td>1.100379</td>
<td>1.156808</td>
<td>1.20564</td>
<td>1.256137</td>
</tr>
<tr>
<td>min</td>
<td>1.7</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>max</td>
<td>5.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>6.8</td>
</tr>
<tr>
<td>pos</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>err</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>skewness</td>
<td>1.830108</td>
<td>1.449707</td>
<td>1.681346</td>
<td>1.930679</td>
<td>2.186819</td>
</tr>
</tbody>
</table>

### RTP1

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>std dev</th>
<th>std err</th>
<th>95% conf</th>
<th>skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>total</td>
<td>0.863034</td>
<td>0.959049</td>
<td>0.683248</td>
<td>1.032466</td>
<td>1.04306</td>
</tr>
</tbody>
</table>

---

**Note:** The values in the tables represent measurements or calculations possibly related to biomechanical or architectural data. The specific context is not provided, but typical applications might include structural engineering, biomechanics, or medical research.
### RTP2

<table>
<thead>
<tr>
<th>mean</th>
<th>3.096</th>
<th>3.604</th>
<th>3.612</th>
<th>3.904</th>
<th>4.252</th>
<th>4.086</th>
</tr>
</thead>
<tbody>
<tr>
<td>std dev</td>
<td>1.81098</td>
<td>1.48562</td>
<td>1.48042</td>
<td>1.646835</td>
<td>1.745738</td>
<td>1.381322</td>
</tr>
<tr>
<td>std err</td>
<td>0.238184</td>
<td>0.297124</td>
<td>0.280084</td>
<td>0.323367</td>
<td>0.349149</td>
<td>0.276364</td>
</tr>
<tr>
<td>95% conf</td>
<td>0.487469</td>
<td>0.613246</td>
<td>0.580464</td>
<td>0.673754</td>
<td>0.720619</td>
<td>0.570729</td>
</tr>
<tr>
<td>99% conf</td>
<td>0.660641</td>
<td>0.831101</td>
<td>0.80022</td>
<td>0.92129</td>
<td>0.97619</td>
<td>0.773034</td>
</tr>
<tr>
<td>total</td>
<td>77.74</td>
<td>90.01</td>
<td>90.3</td>
<td>97.6</td>
<td>106.3</td>
<td>102.2</td>
</tr>
<tr>
<td>min</td>
<td>1.5</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>max</td>
<td>6.7</td>
<td>8.1</td>
<td>8.1</td>
<td>9.5</td>
<td>9.5</td>
<td>8.6</td>
</tr>
<tr>
<td>min pos</td>
<td>1.5</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>2.5</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>other</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.799267</td>
<td>0.762792</td>
<td>1.35432</td>
<td>1.538334</td>
<td>1.367393</td>
<td>1.50474</td>
</tr>
</tbody>
</table>

### Vermont-Mior

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>std dev</td>
<td>10.45342</td>
<td>3.912114</td>
<td>8.172563</td>
<td>10.30204</td>
<td>7.79419</td>
<td>6.857891</td>
</tr>
<tr>
<td>std err</td>
<td>2.090664</td>
<td>1.782423</td>
<td>1.634513</td>
<td>2.060408</td>
<td>1.55236</td>
<td>1.371578</td>
</tr>
<tr>
<td>95% conf</td>
<td>4.315046</td>
<td>3.678913</td>
<td>3.373353</td>
<td>4.252557</td>
<td>3.20918</td>
<td>3.038065</td>
</tr>
<tr>
<td>99% conf</td>
<td>5.847961</td>
<td>4.987087</td>
<td>4.571987</td>
<td>5.73273</td>
<td>4.502328</td>
<td>3.968313</td>
</tr>
<tr>
<td>total</td>
<td>428.8</td>
<td>366.57</td>
<td>290.99</td>
<td>233.22</td>
<td>166.6</td>
<td>173.25</td>
</tr>
<tr>
<td>min</td>
<td>2.22</td>
<td>2.22</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>max</td>
<td>44.44</td>
<td>37.77</td>
<td>31.11</td>
<td>35.55</td>
<td>26.66</td>
<td>22.22</td>
</tr>
<tr>
<td>min pos</td>
<td>2.22</td>
<td>2.22</td>
<td>2.22</td>
<td>2.22</td>
<td>2.22</td>
<td>2.22</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>other</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.998067</td>
<td>0.877399</td>
<td>0.857048</td>
<td>1.183474</td>
<td>1.357</td>
<td>0.908265</td>
</tr>
</tbody>
</table>

### Pain 101

<table>
<thead>
<tr>
<th>mean</th>
<th>4.36</th>
<th>2.6</th>
<th>2.56</th>
<th>2.4</th>
<th>2.16</th>
</tr>
</thead>
<tbody>
<tr>
<td>std dev</td>
<td>1.855259</td>
<td>1.683251</td>
<td>1.961594</td>
<td>1.936492</td>
<td>1.607275</td>
</tr>
<tr>
<td>std err</td>
<td>0.33105</td>
<td>0.338665</td>
<td>0.383319</td>
<td>0.387298</td>
<td>0.321455</td>
</tr>
<tr>
<td>95% conf</td>
<td>0.683366</td>
<td>0.694826</td>
<td>0.791147</td>
<td>0.79538</td>
<td>0.693648</td>
</tr>
<tr>
<td>99% conf</td>
<td>0.928022</td>
<td>0.941662</td>
<td>1.072001</td>
<td>1.083332</td>
<td>0.891569</td>
</tr>
<tr>
<td>size</td>
<td>25.25</td>
<td>25.25</td>
<td>25.25</td>
<td>25.25</td>
<td>25.25</td>
</tr>
<tr>
<td>total</td>
<td>109.65</td>
<td>65</td>
<td>64</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>max</td>
<td>9.6</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>min pos</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>other</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.207776</td>
<td>0.692706</td>
<td>0.43189</td>
<td>0.780756</td>
<td>0.983227</td>
</tr>
</tbody>
</table>

- 4.108
- 1.87434
APPENDIX J

Numerical pain Rating scale 101
NUMERICAL PAIN RATING SCALE 101.

Patient name: __________________ File number: _______ Date: __________

Rate the severity of your pain by checking one box on the following scale:

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Excruciati</th>
</tr>
</thead>
</table>

No pain
APPENDIX K

Vernon-Mior Neck Pain and Disability index
TWR

APPENDIX B  NECK PAIN AND DISABILITY INDEX (VERNON-MIÖR)

Patient name:___________________  File number:___________________  Date:___________________

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

SECTION 1 - PAIN INTENSITY
☐ I have no pain at the moment.
☐ The pain is very mild at the moment.
☐ The pain is moderate at the moment.
☐ The pain is fairly severe at the moment.
☐ The pain is very severe at the moment.
☐ The pain is the worst imaginable at the moment.

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

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

SECTION 4 - READING
☐ I can read as much as I want to with no pain in my neck.
☐ I can read as much as I want to with slight pain in my neck.
☐ I can read as much as I want to with moderate pain in my neck.
☐ I cannot read as much as I want because of moderate pain in my neck.
☐ I cannot read at all because of severe pain in my neck.

SECTION 5 - HEADACHES
☐ I have no headaches at all.
☐ I have slight headaches which occur infrequently.
☐ I have moderate headaches which occur infrequently.
☐ I have severe headaches which occur frequently.
☐ I have headaches almost all the time.

SECTION 6 - CONCENTRATION
☐ I can concentrate fully when I want to with no difficulty.
☐ I can concentrate fully when I want to with slight difficulty.
☐ I have a fair degree of difficulty in concentrating when I want to.
☐ I have a lot of difficulty in concentrating when I want to.
☐ I have a great deal of difficulty in concentrating when I want to.
☐ I cannot concentrate at all.

SECTION 7 - WORK
☐ I can do as much work as I want to.
☐ I can only do my usual work, but no more.
☐ I can do most of my usual work, but no more.
☐ I cannot do my usual work.
☐ I can hardly do any work at all.
☐ I cannot do any work at all.

SECTION 8 - DRIVING
☐ I can drive my car without any neck pain.
☐ I can drive my car as long as I want with slight pain in my neck.
☐ I can drive my car as long as I want with moderate pain in my neck.
☐ I cannot drive my car as long as I want because of moderate pain in my neck.
☐ I can hardly drive at all because of severe pain in my neck.
☐ I cannot drive my car at all.

SECTION 9 - SLEEPING
☐ I have no trouble sleeping.
☐ My sleep is slightly disturbed (less than 1 hr sleepless).
☐ My sleep is mildly disturbed (1-2 hrs sleepless).
☐ My sleep is moderately disturbed (2-3 hrs sleepless).
☐ My sleep is greatly disturbed (3-5 hrs sleepless).
☐ My sleep is completely disturbed (5-7 hrs sleepsless).

SECTION 10 - RECREATION
☐ I am able to engage in all my recreation activities with no neck pain at all.
☐ I am able to engage in all my recreation activities, with some pain in my neck.
☐ I am able to engage in most, but not all of my usual recreation activities because of pain in my neck.
☐ I am able to engage in a few of my usual recreation activities because of pain in my neck.
☐ I can hardly do any recreation activities because of pain in my neck.
☐ I cannot do any recreation activities at all.