A COMPARATIVE STUDY OF THREE DIFFERENT TYPES OF MANUAL THERAPY TECHNIQUES IN THE MANAGEMENT OF CHRONIC MECHANICAL NECK PAIN.

By

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

I, Maria Louisa Elizabeth Roodt, do declare that this dissertation is a representation of my own work in both conception and execution.

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DEDICATION

- Firstly - To my Lord and Saviour for the strength, wisdom and courage throughout this dissertation. To God be all the glory!

  "Trust in the Lord with all your heart and lean not on your own understanding; in all your ways acknowledge Him and He will make your paths straight"

  ~ Proverbs 3 v 5-6 ~

- To my Mom - for your undying love and support through the long years of hard work. For allowing me to take the "scenic" route through the course and still standing behind me, to catch me if I fall and to give me a gentle nudge forward when I needed it. I am the woman I am today because of the way you led by example. Ek is lief vir ma!!!

- Oom Adain and Tannie Wimie – Thank you so very much for giving me the opportunity to fulfil this dream. Your love and support will never be forgotten and will live on forever.

ACKNOWLEDGEMENTS

- To my two supervisors, Dr Laura Wilson and Dr Nikki de Busser - for your continual support, guidance, encouragement and loads of patience throughout this whole research process.

"Every story has an end but in life, every end is just a new beginning."

~ Unknown ~

- To Dr Brain Nook and Dr Charmaine Korporaal - for introducing me into the world of chiropractic. Seeing your passion for the profession is truly inspiring and I studied chiropractic because of you. Thank you.
- To Sue Bezuidenhout – Words can never be express my immense gratitude for your love, support, friendship and being my personal guinea pig to practice on and for being brave enough to let me try new treatment techniques.
- To my two nieces, Megan and Sarah – For being my sunshine and chasing the darkest cloud away with only a smile and for reminding me of what really matters in life.
- To Pat, Linda and Kershnee - Thank you for many laughs (some even had tears), friendship, heart-stopping moments, cup cakes, muffins and plenty cups of coffee.
- To all the lecturers and clinicians at the Chiropractic Department and Day Clinic – Thank you for the academic and life lessons you have taught me throughout the years. Your words of wisdom will be remembered for years to come.
- To the fantastic four: Angela, Carine, Jana and Mandy – each one of you will always have a special place in my heart and our memories will last a lifetime.
- To the class of 2008 – It's been an awesome journey! Thanks for the ride!

"Every great dream begins with a dreamer. Always remember, you have within you the strength, the patience and the passion to reach for the stars to change the world"

~HarrietTubman~

- To Tonya Esterhuizen – Thank you for all your help and guidance with the statistical analysis.
- Last but not least – To all the patients who participated in this study. Without each one of you, this would not have been possible. I thank you from the bottom of my heart.

ABSTRACT

BACKGROUND

The prevalence of neck pain in musculoskeletal practice is second only to that of low back pain (Vernon *et al*., 2007). There is a growing interest in neck pain research due to the escalating disability burden and compensation costs associated with neck pain (Côte *et al*., 2003). Manual therapies are commonly used in the treatment of neck pain (Côte *et al*., 2003). After an extensive literature review by Haldeman *et al*. (2008) they found that manual therapy techniques have some benefit but no one technique was clearly superior to the next. Therefore, the purpose of this study is to compare three commonly used manual therapy techniques in the treatment of chronic mechanical neck pain.

OBJECTIVES

The purpose of this study was to compare three different manual therapy techniques (SMT, MET and PNF) which are commonly used in the treatment of chronic MNP in terms of range of motion, pain and disability.

METHOD

Forty-five patients with chronic mechanical neck pain were obtained through non-probability convenience sampling and assigned into one of three treatment groups (15 per group) using a computer generated randomized table. The three different treatment groups were: Spinal Manipulative Therapy (SMT), Muscle Energy Technique (MET) and Proprioceptive Neuromuscular Facilitation (PNF). Each group received six treatments over a period of three weeks with a follow-up consultation. Measurements were taken at the first, third and sixth treatment and at the follow-up consultation.

SPSS version 15.0 was used to analyse the data. A p value of <0.05 was considered as statistically significant. An intra-group analysis was done using repeated measures ANOVA testing to assess the time effect for each outcome separately. For inter-group analyses the time x group interaction effect was assessed using repeated measures ANOVA testing, and profile plots were used to assess the trend and direction of the effects.

RESULTS

Intra-group analysis of the results revealed that all three groups improved significantly between the first and the final consultation, for all measures. Inter-group analysis of the data did not show any difference between the three groups by the end of the final consultation. However, extension range of motion appeared to improve slightly faster in the PNF group

but it was not significant when compared to the other two groups. Therefore, there was no statistical significance between the three groups.

CONCLUSION

It was concluded that all three treatment groups responded equally to the treatment, thus, suggesting that MET or PNF techniques can be used if SMT is contra-indicated.

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Definition of terms

JOINT DYSFUNCTION

Joint dysfunction is an area where joint mechanics shows an area disturbance of function without structural change. Subtle joint dysfunction affecting quality and range of motion. It is diagnosed through motion palpation, specific signs and symptoms, and radiography (Peterson and Bergman, 2002).

MANIPULATION

Manipulation is characterized by a dynamic thrust of high velocity, low amplitude and specific direction over specific contact points as located through motion palpation (Peterson and Bergman 2002).

MANUAL THERAPY

Manual therapy is a broad term but defined by the use of hands in a curative and healing manner (Lederman, 2005). According to Gatterman (1990), manual therapy techniques are used to manipulation, traction, mobilization, massage, stimulated of influence the spine and paraspinal structures.

MECHANICAL NECK PAIN

Any event or condition (e.g. incorrect posture, ageing, acute injury, congenital or developmental defects) which leads to altered joint mechanics, muscle structure or function resulting in mechanical neck pain (Peterson and Bergman, 2002).

MOBILIZATION

"It is the passive movement performed in such a manner (particularly in relation to speed of the movements) that it is, at all times, within the ability, of the patient to prevent the movement if he chooses to" (Maitland, 2003:9).

MOTION PALPATION

Palpatory diagnosis of passive and active segmental joint range of motion (Gatterman, 1990).

MUSCLE ENERGY TECNIQUE (MET)

According to Greenman (1996:93), MET incorporates the voluntary contraction of a muscle by a patient in precisely controlled direction with different levels of intensities against an equal and opposite counter-force applied by the therapist.

NON-SPECIFIC (SIMPLE) NECK PAIN

Neck pain where the signs and symptoms have a postural or mechanical basis (Binder 2007). This is a new term. For the purpose of this research study the term mechanical neck pain has been used but can be used interchangeably.

CHAPTER ONE
INTRODUCTION

1.1THE PROBLEM AND ITS SETTING

Roughly two thirds of the general population have “non-specific (simple) neck pain” at some time in their lives, with the highest prevalence in middle age (Binder, 2007). Presenting symptoms have a mechanical or postural basis rather than being due to radiculopathy or gross trauma.

The aetiology of neck pain is multifactorial and poorly understood (Binder, 2007 and Peterson and Bergman, 2002). The common factors include poor posture, depression, anxiety, aging, acute injury and occupational or sporting activities. This leads to altered joint mechanics, muscle structure or function and can result in mechanical neck pain. Gatterman (1998) and Peterson and Bergman (2002) state that the most common cause of mechanical neck pain (MNP) is zygophyseal joint locking and muscle strain.

The opportunity to develop new approaches to treat mechanical spinal pain have arisen as there is question over the efficacy of common conventional therapies (Skargen *et al*., 1997 and Giles and Muller, 1999). A wide variety of treatment protocols for mechanical neck pain (MNP) are available, however, the most effective management remains an area of debate. This is because the value of most current protocols for this condition remain unverified (McMorland and Suter, 2000). In a review of current literature Haldeman *et al*. (2008) supported the use of neck manipulations, mobilizations, education, acupuncture analgesics, massage, low-level laser and exercise therapy in the treatment of “non-specific” (simple) neck pain. They concluded that none of these active treatments were superior to any other in the short or long term and that no one treatment has been studied in enough detail to assess its efficacy or effectiveness adequately. Therefore there is a need to further investigate and compare treatment protocols.

Spinal conditions are most often treated by manipulations (Skargen *et al.,* 1997). However, muscle energy technique (a form of mobilization) is often used when manipulation is contra-indicated (Liebenson, 1996 and Greenman, 1996). In the current literature both these treatment protocols have been shown to be equally effective in MNP (Koes *et al*., 1992, Scott-Dawkins 1996, Hurwitz *et al.,* 2002 and Vernon *et al.,* 2007) but two studies (Cassidy *et al*., 1992a and Martinez-Segura *et al*., 2006) showed SMT to be superior to MET.

The use of proprioceptive neuromuscular facilitation (PNF) more specifically the contract-relax, antagonist-contract (CRAC) technique in neck pain has not been widely studied but is positioned to be the most effective stretching technique for increasing range of motion, especially in the short term (Sharman *et al.,* 2006), and when compared to ballistic or static stretching (Shrier and Gossal, 2000 and MacDougall, 1999). A decrease in muscle stiffness is said to increase joint range of motion (Shrier and Gossal, 2000). For this reason PNF is comparable to SMT and MET but the effects of PNF in terms of treating disability is not well known.

1.2 AIM AND OBJECTIVES OF THE STUDY

The purpose of this study is to compare three different manual therapy techniques (SMT, MET and PNF) which are commonly used in the treatment of chronic MNP according to subjective and objective clinical outcomes.

The specific objectives of the study included the following:

1.2.1 To determine the effectiveness of SMT, MET and PNF in terms of subjective measurements.

1.2.2 To determine the effectiveness of SMT, MET and PNF in terms of objective measurements.

1.2.3 To compare SMT, MET and PNF in terms of subjective and objective measurements.

1.3 THE HYPOTHESES

The following alternate hypotheses were set to address the specific objectives identified in 1.2.1 and 1.2.2:

The first hypothesis

All three treatment techniques will be effective in terms of subjective clinical findings.

The second hypothesis

All three treatment techniques will be effective in terms of objective clinical findings.

The following null hypothesis was set to address the specific objective identified in 1.2.3:

The third hypothesis

All three manual treatment techniques will be equally effective, when compared to each other.

1.4 POTENTIAL BENEFITS OF THIS STUDY

This study will add to the growing body of knowledge regarding the benefit of manual therapy used in the treatment of chronic mechanical neck pain. The expected outcomes of this study was to show if these three manual therapy techniques yield comparable outcomes and if one technique is superior to the next which should be the alternate choice of therapy when manipulation is contra-indicated.

CHAPTER TWO

REVIEW OF THE RELATED LITERATURE

2.1 INCIDENCES AND PREVALENCES OF NECK PAIN

The prevalence of neck pain in musculoskeletal practice is second only to that of low back pain (Vernon *et al*., 2007). In a cross-sectional survey on neck pain within the general Norwegian population, Bovim *et al*. (1994) found that 34.4% of the 9918 responders had experienced neck pain within the last year and 13.8% reported neck pain lasting more than six months. In a Canadian epidemiological neck pain study (*n* = 1133) Côte *et al*. (2003) found that the six month prevalence of neck pain was 54.2%. Guez *et al.* (2002) did a population-based study on the prevalence of neck pain in northern Sweden (*n* = 6000) and found that 43% of the population reported neck pain (48% woman and 38% men) and 18% of the population (19% woman and 13% men) had chronic neck pain (lasting longer than six months). Thirteen percent of these cases were of a non-traumatic origin and only 5% were traumatic.

In South Africa, Ndlovu (2006) did a survey (*n* = 1000) of the indigenous African population within the greater Durban area and found that individuals between the ages of 21 – 30 years of age had a 50% incidence of neck pain and individuals between the ages of 31 – 60 years of age had a 46.7% - 54.5% incidence of neck pain. Similar results were found by Drews (1994) who did a cross-sectional survey (*n* = 324) of patients presenting to the Durban University of Technology (formerly known as Natal Technikon) chiropractic teaching clinic and compared those results to patients presenting at private chiropractic clinics in the greater Durban area between February 1994 to the end of April 1994. The results concluded that 57.4% of patients who attended the private chiropractic clinics and 54.4% of the teaching clinic patients complained of neck pain.

Drews (1994) further concluded that of the 54.4% (*n* = 162) of neck pain sufferers from the teaching clinic, 16.7% had neck pain only, 21.6% had neck pain with associated headaches and 16.1% had neck pain with arm pain. This was confirmed by Venketsamy (2007) who did a retrospective study (1995 – 2005) within the DUT chiropractic teaching clinic files and found the overall prevalence of cervical spine complaints to be 17.92% (*n* = 1342).

Due to the high incidence and prevalence of neck pain, both locally and internationally it is important to further evaluate treatment techniques in the form of clinical trials to improve the prognosis of chronic mechanical neck pain.

2.2 INTRODUCTION TO MECHANICAL NECK PAIN

There has been a slow but constant increase in the amount of attention paid to neck pain due to its escalating costs and burden on society (Côte *et al*., 2003). In the Netherlands, Borghouts *et al.* (1990) researched several national administrative data bases and found that the total cost of neck pain in 1996 was estimated to be US $686 million and the disability from neck pain accounted for 50% (US $ 341 million) of the total costs.

2.2.1 Definition, aetiology, risk factors and diagnosis of mechanical neck pain

The term mechanical neck pain (MNP) can be explained as the physical forces acting upon the cervical spine. Pain can be caused by abnormal stress and strain on the vertebral column and surrounding structures through poor posture, lifting and sitting habits (Mechanical Pain, 2009). Gatterman (1998) and Bergman *et al.* (1993) state that the most common cause of mechanical neck pain is zygophyseal joint locking and muscle strain.

According to Haldeman (2008), the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Associated Disorders suggested the following classification system for neck pain:

- Grade I: Neck pain with no or minor interference with daily activities
- Grade II: Neck pain with major interference on activities of daily living
- Grade III: Neck pain with neurological signs and symptoms
- Grade IV: Neck pain due to structural pathology

According to Binder (2007), most patients present with “non-specific (simple) neck pain” where the signs and symptoms have a postural or mechanical basis. Therefore, for the purpose of this study mechanical neck pain will be classified as either Grade I or Grade II according to the above classification system.

The aetiology of mechanical neck pain is poorly understood and mostly multifactorial, including poor posture, depression, anxiety, neck strain and occupational or sporting activities (Binder, 2007). Peterson and Bergman (2002) state that any event or condition (e.g. incorrect posture, ageing, acute injury, congenital or developmental defects) which leads to altered joint mechanics or muscle structure or function, can result in mechanical neck pain.

Risk factors for mechanical neck pain include work that is physically demanding or of a repetitive static nature, those of lower socioeconomic standing, individuals with a history of previous neck trauma and those with co-morbid pathologies. It has also been shown that the incidence of neck pain increases with age and is more common among woman (Côte *et al.,* 2003).

The diagnosis of mechanical neck pain can be made according to the following criteria (Grieve 1988):

a) Local chronic cervical pain with or without arm pain
b) Juxtaposition of hypo- and hypermobile segments of the cervical spine due to spondylitic changes
c) Assymetrical neck pain that gets worse as the day progresses and is aggravated by driving, reading etc.
d) Unilateral occipital pain and neck pain
e) Restricted and painful movements, especially rotation and lateral flexion to the painful side
f) Prominent Levator Scapulae and upper and middle Trapezius muscle

2.3 BASIC NORMAL ANATOMY AND BIOMECHANICS OF THE CERVICAL SPINE

The cervical spine consists of seven vertebrae, which are divided into typical (C3-C6) and atypical (C1, C2 and C7) vertebrae (Gatterman, 1990). The vertebral artery passes through the oval transverse foramina of C1 to C6 (Moore and Dalley, 1999).The vertebral body of typical cervical vertebrae is small and longer from side to side than anteroposteriorly. The superior surface is concave (which forms the uncinate joints laterally) and convex inferiorly. The uncinate joints are also known as the joints of Luschka. Some consider these joints to be degenerative spaces in the discs that are filled with extracellular fluid, while others classify them as synovial type joints (Moore and Dalley, 1999) because they have articular cartilage, a joint space, a synovial membrane, subchondral bone and a joint capsule. These joints form a barrier to posterolateral disc protrusion, thereby protecting the spinal cord (Moore, 1999). However, if they hypertrophy narrowing of the intervertebral canal may occur which can lead to nerve root entrapment (Porterfield and DeRosa, 1995).

On the posterior aspect of the vertebrae, the two pedicles and two laminae form the neural arch (Panjabi and White, 1990) which forms the boundaries of the triangular vertebral foramen (Haldeman, 1992). The spinous process, as well as the two transverse processes, arise from the laminae (Panjabi and White, 1990).The joints on the superior and inferior surfaces of the transverse processes are known as zygopophyseal or facet joints. The facet joints are orientated approximately 45° to the horizontal and 90° to the sagital plane (Haldeman, 1992). The superior facet of the facet joint is directed superoposteriorly and the inferior facet is directed in an inferoposterior direction (Moore and Dalley, 1999). The joint capsules are richly innervated by the sinuvertebral or recurrent meningeal nerve and nociceptive fibers (Haldeman, 1992). Therefore, injury to this capsule will result in pain.

Each of the atypical vertebrae is unique in their own way. The atlas is the first cervical vertebrae; it has no body or spinous process but instead two lateral masses connected by anterior and posterior arches. The superior articular facets are concave to receive the occipital condyles of the skull. The C2 vertebrae, known as the axis, has a odontoid peg which projects superiorly from the body. The last cervical vertebrae (C7), also known as vertebra prominens due to its long spinous process, which is not bifid like the rest of the cervical spine. The transverse processes of C7 are large but the transverse foramina are too small for the vertebral artery to pass through (Moore and Dalley, 1999).

There are intervertebral discs in between all cervical vertebrae except C1 and C2. These discs make up one fourth of the length of the cervical spine. They are thicker anteriorly, thereby contributing to the cervical lordosis (Moore and Dalley, 1999).

<u>2.3.1 Relevant neuroanatomy</u>

The central and peripheral nervous systems work as a unit to collect, transmit and process information from many different neurophysiological systems in order to coordinate movement (Hopkins and Ingersoll, 2000).

In the peripheral nervous system, dorsal and ventral rootlets emerge from the spinal cord and combine to form dorsal and ventral spinal nerve roots. These nerve roots fuse within the intervertebral foramen to form spinal nerves. The spinal nerves e.g. C1 to C7 pass above the same-numbered vertebrae with the C8 spinal nerve passing under the C7 vertebrae. On exiting of the spinal canal, spinal nerves divide into dorsal and ventral rami (except C1 which has no dorsal ramus). The dorsal rami supply the paraspinal muscles and skin. The ventral rami are grouped together forming the cervical plexus (C1–C4) and the brachial plexus (C5-C8 and T1) (Rubin and Safdieh, 2007).

Mechanoreceptors are sensory nerve terminals that respond to physical or mechanical stimuli. They transduce sensations (pain, temperature, pressure and touch) to the central nervous system. Within the joint capsule, mechanoreceptors can also act as proprioceptors therefore, their function is to initiate a protective reflex mechanism to stabilize and protect the joint as well as provide position sense (Hopkins and Ingersoll, 2000). Muscle spindles are sensory nerve endings located within skeletal muscle that act as mechanoreceptors (Dorland's Illustrated Medical Dictionary, 2000). When the muscle stimulated through stretching, the muscle causes a reflex contraction also known as the stretch reflex, this brings the tension within the muscle back to normal (Solomon *et al*., 1990).

The three treatment techniques chosen for this study are hypothesized to stimulate these different receptors in their own unique mechanism of action. This will be discussed under the heading of "Physiological effects" in each treatment technique.

2.4 POSTERIOR CERVICAL AND TRAPEZIUS MUSCLE

2.4.1 Posterior Cervical muscles

The Posterior Cervical muscles consist of three muscles:

a) Semispinalis Capitis
b) Longissimus Capitus
c) Semispinalis cervicis

Table 2.1: Anatomy, Innervation and Action

Muscle	Anatomy	Innervation	Action
Semispinalis Capitis	Origin: articular processes of C4 to C6 Insertion: occiput between the superior and inferior nuchal line	Branches of the posterior primary division of the first four to five cervical spinal nerves	Extension of the head when leaning forward
Longissimus Capitis	Origin: articular processes of C3 to C7 and transverse processes of T1 to T5 Insertion: posterior margin of mastiod process of temporal bone	Branches of the posterior primary division of the cervical spinal nerves	Neck extension, secondary action in lateral flexion and rotation on the same side
Semispinalis Cervicis	Origin: transverse processes of T1 to T6 Insertion: spinous processes of C2 to C5	Spinal nerves of C3 to C6	Neck extension and rotation to opposite side

(Travell *et al.,* 1999 and Dorland's Illustrated Medical Dictionary, 2000)

The Posterior Cervical muscles combined with the Splenius Capitis and Splenius Cervicis muscles in order to perform their primary function of neck extension. These muscles also work individually causing neck rotation. The Rotators and Multifidi muscles are found deep to the Posterior Cervical muscles but there are no descriptive functions for these muscles in the cervical spine. However, generally these muscles cause extension when acting bilaterally and rotation of the vertebrae to the opposite side when functioning unilaterally. The Multifidi is said to contribute to lateral flexion of the spine. These deep muscles are said to “control positional adjustments” of the vertebrae rather than movement of the spine (Travell *et al.,* 1999)

2.4.2 The Trapezius muscle

The Trapezius muscle is a diamond shape muscle extending from the occiput to T12 vertebrae and the acromion bilaterally. The Trapezius is divided into three areas according to the direction in which the muscle fibers are orientated. Each of these three parts has a different function. The function of the middle and lower parts of the Trapezius muscle mainly are extension of the thoracic spine, scapular and shoulder movement. Only the upper fibers play a more significant role in neck movement, therefore, for the purpose of this study only the upper fibers will be discussed.

Table 2.2: Anatomy, Innervation and Action

Muscle	**Anatomy**	**Innervation**	**Action**
Upper Trapezius fibers	Origin: medial 1/3 of the superior nucal line and ligamentum nuchea Insertion: lateral 1/3 of the posterior border of clavicle	Spinal portion of cranial nerve XI and cervical plexus (C2-4)	Unilateral: extend and laterally flexes head and neck to same side, and extreme rotation Bilateral: extend head and neck against resistance

(Travell *et al.,*1999).

Synergistically the Sternocleidomastoid muscle acts together with the upper trapezius for neck motions (Travell *et al.,* 1999).

2.5 MANUAL THERAPY

The term manual therapy arises from Latin root *manualis* (by hand) and Greek root *therapeuein* (to treat) (Dorland’s Illustrated Medical Dictionary, 2000). Manual techniques are the therapeutic tools therapist uses to assist the body in the repair and adaptation processes (Lederman, 2005). In a consensus study done by Gatterman and Hansen (1994) in the United States, they found chiropractors defined manual therapy as "procedures by which the hands directly contact the body to treat the articulations and/or soft tissues." The four main categories of manual therapy are: manipulation, mobilization, massage and neuromuscular therapies (Gross *et al.,* 1996). In this study the manual therapy techniques of SMT, MET and PNF stretching were utilized.

Joint dysfunction is defined by Gatterman (1990:49) as the mechanics of the joints showing an area of disturbance of function without structural change. Peterson and Bergman (2002) regard mechanical joint dysfunction as a significant cause of spinal pain syndromes. The manipulable lesion is defined by the term, 'joint dysfunction', within the chiropractic profession (Peterson and Bergman 2002). Through an increase in scientific evidence and continuing professional debate, the term joint dysfunction is seen as a clinical syndrome identified by signs and symptoms rather than a condition defined by one or two characteristics (Peterson and Bergman 2002).

The muscular system is the largest organ of the body, however, in general it receives little attention as a source of major pain and dysfunction (Travell *et al.,*1999). Cervical muscles are often the cause of dysfunction because of the daily wear and tear form poor posture and incorrect lifting and sitting habits (Travell *et al.,*1999). Muscular dysfunction can lead to disturbances in sensory, autonomic and motor functions, including the main signs and symptoms of pain (local and referred), hypertonia, weakness and loss of co-ordination and proprioceptive disturbances. Hypertonic muscles are under increased tension at resting length, hence, the restricted range of motion, pain and limited strength and/or endurance often occur (Travell *et al.,*1999).

The main aim of manual therapy is to decrease pain and increase mobility in areas that are restricted, whether it be joints, connective tissue or skeletal muscles (Korr, 1978). Joint movement and isometric muscle contraction stimulates joint and muscle proprioceptors (Fryer, 2000). This is theorized to produce pain relieve according to the Gate-control theory of Melzack and Wall (1965) where mechanoreceptor afferents carried through large diameter axons to inhibit nociceptive afferents at the dorsal horn of the spinal cord therefore causing inhibition of pain.

2.6 SPINAL MANIPULATION

2.6.1 Introduction and definition

The term 'manipulation' can be used ambiguously in manual therapy to mean passive movement of any kind (Maitland, 2003). For the purpose of this study manipulation will be defined as articular manipulation characterized by a dynamic thrust of high velocity, low amplitude and specific direction over specific contact points located through motion palpation (Peterson and Bergman, 2002).

The application of manipulative therapy is based on the evaluation and integrity of the neuromuscular skeletal system and the presence or absence of joint dysfunction (Peterson and Bergman 2002). Bergman modified the acronym PARTS from Bourdillon and Day (1992) to identify five diagnostic criteria for the identification of joint dysfunction. These five signs and symptoms are indicative of joint dysfunction:

P – Pain and tenderness produced by palpation of the bony and soft tissue elements

A – Localized or at multiple levels, noted through observation, static palpation or x-rays

R – Range of motion which included active, passive and accessory movement felt through motion palpation or x-rays

T – Tone, texture and temperature abnormalities, soft tissue changes observed through palpation or instrumentation

S – Special tests, e.g. Kemps test

2.6.2 Physiological effects of manipulation

The therapeutic effect of manipulation, as explained by Curl (1994), works through two mechanisms. Firstly, the mechanical effect which causes mechanoreceptor stimulation, muscle spindle stretching and the breaking down of joint adhesions which results in an increase in active as well as passive joint motion. Secondly, manipulation causes stimulation of the autonomic nervous system resulting in reflex inhibition of pain and muscle hypertonicity.

The effectiveness of the manipulation is hypothesised to work according to several different theories (Peterson and Bergman, 2002):

a) Mechanical

The high velocity low amplitude manipulation causes rapid separation of two joint surfaces (cavatation) resulting in stretching of the periarticular tissues, thereby releasing intra- and extra-articular adhesions. The cavitation also stimulates joint nociceptors and mechanoreceptors which in turn stimulate the golgi tendon organs, resulting in somatic afferent receptor activity. The combination of these events rather than the cavatation is what makes manipulation effective in breaking the pain cycle, resulting in a decrease in pain and muscle spasm and an increase in joint mobility and soft tissue inflexibility (Peterson and Bergman, 2002). Manipulation maintains tissue extensibility by stimulating the repair of the articular soft tissue and cartilage as well as by preventing excessive fibrosis formation, atrophy and degeneration.

b) Analgesic

It has been hypothesised that the force of manipulation activates both the deep and superficial mechanoreceptors, proprioceptors and nociceptors, resulting in strong afferent impulses to the spinal cord, inhibiting central pain transmission. Korr (1986) theorized that manipulation also releases endogenous opioids (enkephalis and endorphins) which decreased pain sensation. The placebo effect should also be considered as a consultation with a skilled and concerned practitioner may have an analgesic effect.

c) Neurobiologic

Manipulation has the ability to affect both local and distant somatic and visceral tissues by restoring normal joint mechanics resulting in cessation of altered neurogenic reflexes associated with joint dysfunction (Peterson and Bergman, 2002)

d) Circulatory

There are two theories surrounding the effects of manipulation on circulation. Firstly, that segmental vasoconstriction can occur due to the joint dysfunction altering the sympathetic tone of that segment, thereby manipulation would remove the irritation and improve the circulation. Secondly, the efficacy of the circulatory system depends on the integrity of the musculoskeletal system as the venous and lymph systems are dependent on body movement and muscular pumping actions. Leach (1994) attributes the greatest clinical effect of manipulative therapy not only to the pure mechanical effect but also to the increased circulation within the joint.

2.6.3 Contra-indications to manipulation

Gatterman (1990) lists the contra-indications to manipulation as:

Vascular

- Vertebral atery insufficiency
- Aterioscleros is of major blood vessels
- Aneurysm

Tumors

- Lung, thyroid, prostrate and breast (known to metastesis to the spine)
- Primary bone tumors

Bone infections

- Tuberculosis
- Osteomyelitis

Traumatic injuries

- Fractures, joint instability or hypermomility, severe sprain or strains
- Unstable spondylolisthesis

Arthritis

- Rheumatoid arthritis (transverse ligaments rupture, increased inflammation
- Ankylosis spondylitis (increased inflammation)
- Psoriatic arthritis (transverse ligament rupture)
- Ossteoarthritis (increased instability and neurologcal compromise)
- Ubcoarthritis (vertebral compromise)

Physiological considerations

- Malingering
- Hysteria
- Hypochondriasis
- Pain interelance

Metabolic disorders

- Clotting disorders
- Osteoporosis
- Osteomalacia

Neurological disorders

- Disc protrisions
- Disc lesions
- Space-occupying lesions

Dabbs and Lauretti (1995) estimated that the risk of a cerebrovascular accident is 1-3 per million manipulations and Hurwitz *et al.* (1996) calculated the risk of serious adverse effects (e.g. disc herniations, death etc.) to be 5-10 per 10 million manipulations.

2.6.4 The effectiveness of manipulation

Schafer and Faye (1990) hypothesise that SMT restores movement to a fixated joint through the application of a high velocity low amplitude thrust. The sudden stretch of the muscle spindels relaxes the paravertebral musculature and an impulse is sent into the central nervous system (CNS). This has a normalizing effect on the CNS reflexes that maintain abnormal muscle tone. Clinically there will be an increase in range of motion and a decrease in muscle spasm (Lewit, 1991).

In a pilot study (n = 50) by Cassidy *et al*. (1992b), assessing the immediate effect of cervical spine manipulation in the treatment of MNP, showed that post-treatment all planes of range of motion increased and that pain scores also decreased post-treatment. A study (n = 36) by Pikula (1999) on the effect of manipulation in acute unilateral neck pain, revealed that following a single manipulation ipsilateral to the neck pain, increased ROM and decreased pain intensity (according to the Visual Analog Scale). Van Schalkwyk and Parkin-Smith (2000) had similar results in terms of increased range of motion and decreased pain in their study (n = 30) on the efficacy of two different types of manipulation (cervical rotary and lateral break) in the treatment of mechanical neck pain. Both types of manipulation were equally effective. Whittingham and Nilsson (2001) conducted a double-blind randomized controlled trial (n = 105) to study the effect of spinal manipulation on cervical ROM. The authors concluded that after receiving spinal manipulation, active range of motion in the cervical spine increased significantly ($p < 0.0006$).

Vernon *et al*. (1990) in a pilot study (n = 9), showed cervical spinal manipulation to immediately increase pain pressure threshold levels, while a review of the literature by Hurwitz *et al.* (1996), revealed that patients with sub-acute and chronic neck pain showed an improvement in the visual analogue scale when SMT was compared to muscle relaxants or “usual medical care”. Giles and Muller (1999) conducted a prospective, independently assessed pre-intervention and post-intervention pilot study comparing spinal manipulation, acupuncture and nonsteroidal anti-inflammatory drugs in the treatment of chronic spinal pain syndromes (neck and back). The results concluded that the manipulation group (n = 36) (after a treatment period of 4 weeks) was the only group that showed a statistically significant improvement (p = < 0.001). More specifically, patients who received neck manipulations had a 25 % improvement on the neck disability index scores and pain reduction, according to the visual analogue scale, was 33% for the neck. These studies advocated the use of SMT in the treatment of chronic MNP. In a retrospective, outcome-based analysis of patients with MNP, McMorland and Suter (2000) found that, patients under chiropractic management had a statistical significant reduction in their pain-related disability after treatment.

These studies advocated the use of SMT in the treatment of chronic MNP however there is a need for future research studies as most of these studies were pilot studies with small sample sizes with no placebo group.

2.6.5 Conclusion

Manipulation forms the foundation of the chiropractic profession (Peterson and Bergman, 2002). High velocity, low amplitude manipulations are applied to dysfunctional joints. These dysfunctional joints are identified through a diagnostic criteria outlined by Peterson and Bergman (2002). Studies have shown manipulation to be effective in decreasing pain and increasing range of motion (Cassidy *et al*., 1992(b), Giles and Muller, 1999, Van Schalkwyk and Parkin-Smith, 2000 and Whittingham and Nilsson, 2001) in patients with cervical spine pain. However, due to several contra-indications to high velocity low amplitude manipulation it is important to assess the patient thoroughly in order to evaluate if the patient will benefit from this form of treatment.

2.7 MUSCLE ENERGY TECHNIQUE

2.7.1 Introduction and definition

Muscle Energy Technique (MET) is a type of manual therapy which was founded by Dr Fred L. Mitchell, Sr., an osteopathic physician. According to Greenman (1996:93), MET "involves the voluntary contraction of the patients' muscle in a precisely controlled direction, at varying levels of intensity, against a distinctly executed counter-force applied by the operator". MET can be further classified into: reciprocal inhibition, post-isometric relaxation and joint mobilization (Chaitow, 1998). For this study the joint mobilization technique of MET was utilised.

MET is used clinically to restore joint mobility (Chaitow, 1998). According to Edwards (1993), this is done by the researcher placing the joint in a specific position and asking the patient to contract against the unyielding force imposed by the researcher. This isometric contraction allows the muscle to pull on its bony attachment of the segment that is not being stabilized by the operator's counterforce, thereby causing movement in relation to its articulating counterpart. An advantage of this treatment technique is that the patient controls the movement; therefore, it can be terminated if pain is experienced.

There are two main types of muscle contraction in MET: isometric and concentric isotonic. After each isometric contraction, the agonist can be stretched to a new resting length and at the same time the antagonist develops an increase in tone. This equalizes to muscle balance and tone between the hypertonic/relaxed and agonistic/antagonistic muscles (Greenman, 1996).

Post-isometric relaxation (PIR) techniques overlaps with MET as both of these techniques work on the basis of the subsequent relaxation experience by a muscle, or groups of muscles, after a brief period of isometric contraction (Chaitow, 1998). The concentric isotonic contraction that is used in MET is what makes it different from PIR technique. Concentric isotonic contractions are made against a progressively increasing counter-force (resistance), resulting in increased strength and tone of the muscle. This will cause inhibition of the antagonistic muscle activity as it is performed throughout the range of motion of the muscle. These concentric isotonic contractions of the muscle are also used to mobilize joint dysfunctions (Greenman, 1996).

2.7.2 Physiological effects of muscle energy technique

Greenman (1996) stated that MET can be used to:

a) Lengthen a shortened contracted or spastic muscle
b) To strengthen a physiologically weakened muscle or group of muscles
c) To reduce localized edema
d) To relieve passive congestion
e) Mobilize an articulation with restricted mobility

According to Kisner and Colby (2002), joint mobilisation is thought to:

a) Help maintain or improve extensibility and tensile strength of articular tissues
b) Reduce the effects of mechanical limitations
c) Elongate hypomobile ligamentous, capsular and connective tissues
d) Stimulation of mechanoreceptors causing inhibition of transmission of nociceptive stimuli, thereby decreasing pain

2.7.3 Contra-indications to muscle energy technique

Some patients may experience minimal side-effects of muscle soreness due to the patients' muscle effort and the metabolic processes of muscle contraction resulting in carbon dioxide, lactic acid and other metabolic waste products. This muscle soreness is frequently experienced in the first 12 to 36 hours post treatment (Chaitow, 1998). MET is generally safe according to DiGiovanna (1991). It is often used when manipulation is contra-indicated (Liebenson, 1996 and Greenman, 1996). However, if pathology (e.g. osteoporosis, arthritis) is suspected one needs to establish that diagnosis in order to modify the application of MET correctly in terms of the amount of effort or number of repetitions used (Chaitow, 1998). MET is a safe procedure as the patient controls the dosage.

2.7.4 The effectiveness of muscle energy technique

In a study done by Schwerla *et al*. (2008) osteopathic intervention, including MET comparing mobilization to placebo ultrasound in the treatment of chronic mechanical neck pain (n = 41), found that the group receiving mobilization had decreased pain and improved quality of life scores when compared to the placebo group, however, only subjective measurements were taken.

Boodhoo (2002) treated chronic mechanical neck pain sufferers (n = 60) using MET and de-tuned laser therapy in the treatment group and de-tuned laser alone in the placebo group. The results showed that there was a statistically significant improvement in the MET group in terms of range of motion and pain reduction after six treatments. In two different studies on asymptomatic subjects, Schenk *et al*. (1994) found after six treatments over a period of four weeks, all six planes of motion increased; however, the only statistical significant ($p < 0.05$) increase was seen in left and right rotation (n = 18). The second study by Burns and Wells (2006) also showed that the group receiving MET had a significant overall increase in cervical ROM.

According to Hoving *et al*. (2002), mobilization when compared to exercise therapy and continued general practitioner care resulted in statistically significant improvements in pain intensity and favourable results in terms of disability scores. The authors did not classify the type of neck pain as either sub-acute or chronic while the minimum criterion for entrance into the study was neck pain of 2 weeks duration. The above findings support the use of MET in the treatment of chronic MNP.

2.7.5 Conclusion

Muscle energy technique is a manual therapy technique of osteopathic origin (Chaitow, 1998). It can be used as a joint mobilization technique through placing a joint in a specific position and controlled muscle contraction (Greenman, 1996). MET is often considered as the safer option to manipulation (Liebenson, 1996 and Greenman, 1996) because of its few contra-indications and minimal side effects of muscle soreness (Chaitow, 1998). The effects of MET is said to improve tissue extensibility, strengthen muscle groups, stimulation of mechanoreceptors and mobilize restricted joints. These effects can be seen in studies done by Schenk *et al*. (1994), Boodhoo (2002), Burns and Wells (2006) and Schwerla *et al*. (2008), who have noted a increase in range of motion and a decrease in pain after the application of MET.

2.8 PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION

2.8.1 Introduction and definition

Proprioceptive neuromuscular facilitation (PNF) is a specialized stretching technique which was developed in the late 1940's by a neurophysiologist, Dr. Herman Kabat, MD, PhD together with two physiotherapists, Margaret Knott and Dorothy Voss (McAtee, 1993). In his work with polio patients he noted that "one motion, one joint, one muscle at a time" treatment was not sufficient, he then applied the principles of neurophysiology and realised that motion occurs in spiral-diagonal patterns and not isolated movements. He explained it by using the example of combing one's hair, that the shoulder joint undergoes abduction, external rotation and extension. He then used these patterns to stimulate the nervous system the "normal" way rather than "one muscle" at a time (McAtee, 1993).

Contract-relax, antagonist-contract (CRAC) technique is a modified form of PNF which involves isometric contraction prior to the stretch to achieve greater range of motion gains and has been advocated as the most effective stretching technique (McAtee, 1993, McCarthy *et al*., 1997 and Sharman *et al*., 2006). Sufficient resistance must be applied by the researcher in order for the patient to use maximal effort. However, the muscular response must not be compromised by the maximal effort (Pitt-Brook, 2004). The CRAC technique consists of three different phases:

Phase 1

Agonist is placed in a stretched position

↓

Patient contracts agonist against unyielding force of researcher resulting in an isometric contraction

↓

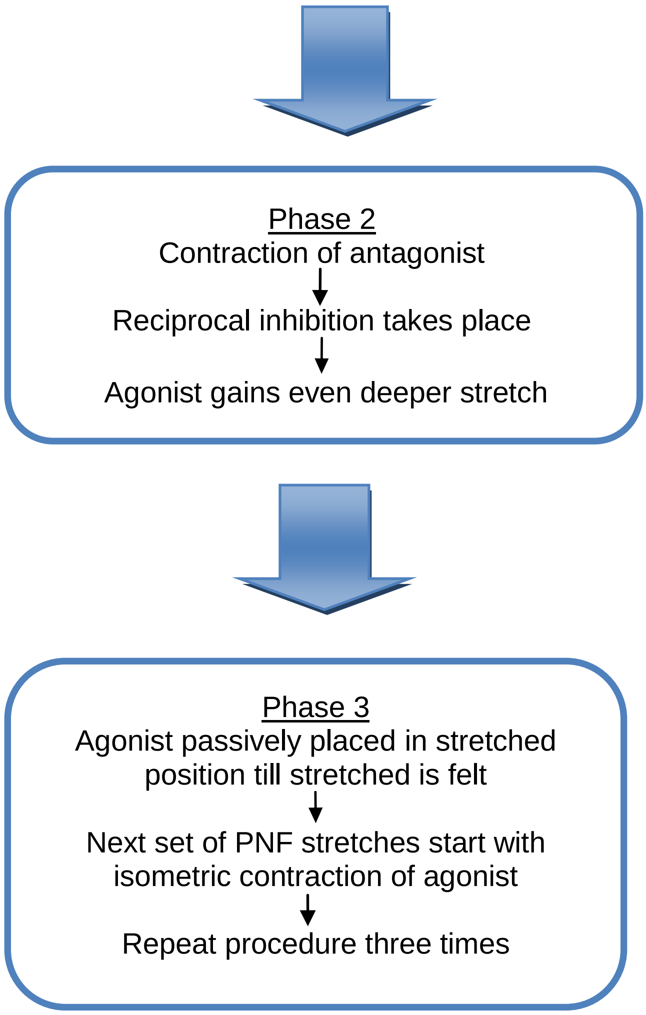
Held for eight seconds

↓

Muscle fatigues

↓

Brief refractory period allowing muscle to relax and stretch



(Adapted from Adler *et al*., 1993 and Nook, 1995)

2.8.2 Physiological effects of proprioceptive neuromuscular facilitation

Prentice (1983) and Guyton and Hall (1997) explain the effectiveness of PNF through the following two mechanisms:

a) Reciprocal inhibition is the mechanism of action by which PNF increases muscle length and relaxation

b) Autogenic inhibition occurs if the stretch is continued over a prolonged period; the inhibitory signals from the Golgi tendon will override excitatory impulses causing relaxation of the muscle.

According to Libenson (2006), PNF stretching treats muscles primarily by relaxing overactive muscles and stretching shortened muscles. Arnheim and Prentice (1993) attribute the effectiveness of PNF to increase muscle activity through muscle spindle actions and increasing contraction by applying resistance to the muscle. The four major neurophysiological principles are summarized below (Arnheim and Prentice, 1993):

a) Muscle and joint activity – through muscle spindle and golgi tendon activity
b) Irradiation – occurs when a maximal contraction of a muscle is achieved by applying resistance, thereby causing excitation of primary muscle which then overflows to its synergistic muscles which become involved to help overcome the resistance
c) Sherrington's law of successive induction – flexion enhances extension and extension enhances flexion
d) Sherrington's law of reciprocal inhibition – a voluntary contraction of a muscle will cause reflex relaxation of its antagonistic muscle

<u>2.8.3 Contra-indications to proprioceptive neuromuscular facilitation</u>

PNF is relatively safe (McAtee, 1993). Moerau and Nook (1992) list the following contra-indications:

a) Initiation or increase of pain
b) Lack of stability in any of the articulations
c) Acute soft tissue injury

Additional contra-indications according to Voss *et al*. (1985) include:

a) Trauma
b) Infection
c) Vascular compromise
d) Anti-coagulant therapy
e) Severe diabetes mellitus
f) Sensory deficit

<u>2.8.4 The effectiveness of proprioceptive neuromuscular facilitation</u>

In a study done on female chronic lower back pain sufferers (*n* = 86), comparing static versus dynamic PNF programs, the results showed a significant improvement in lumbar mobility, static and dynamic muscle endurance and the Oswestry Lower Back Index in both groups (Kofotolis and Kellis, 2006). MacDougall (1999) found a greater increase in flexibility (clinically but not statistically) when she compared PNF stretching to ballistic or static stretching for the treatment of active myofascial trigger points of shoulder girdle and neck muscles (*n* = 30). However, a small sample size were used.

Wilson (2002) did a study (*n* = 60) comparing a combination of PNF stretching of posterior cervical muscles and cervical manipulation to cervical manipulation alone in the treatment of mechanical neck pain, both groups responded similarly however the group receiving manipulation and PNF stretching showed clinically significant (not statistically) greater improvements in terms of increased pain threshold levels and a increased active range of motion when compared to the group receiving manipulation alone. No placebo group was used in this study therefore the effect of the PNF stretching cannot be isolated.

2.8.5 Conclusion

The CRAC technique is a specialized form of PNF stretching that utilized the contraction of the agonist and antagonist to achieve gains in range of motion (Pitt-Brook, 2004). It has been advocated as the most effective stretching technique (McAtee, 1993, McCarthy *et al*., 1997 and Sharman *et al*., 2006) through neurophysiological principles. There is a paucity literature regarding the use of PNF in the treatment of chronic MNP; however, unpublished literature (MacDougall, 1999 and Wilson, 2002) shows a clinically significant trend of improvement in terms of pain and ROM. It is considered a safe manual therapy technique with no side effects. The main symptoms of mechanical neck pain are decreased range of motion and pain which justifies the inclusion of this group into this study.

2.9 COMPARATIVE STUDIES

2.9.1 Spinal manipulative therapy versus muscle energy technique

In studies done by Cassidy *et al*. (1992a) (n = 100) and Martinez-Segura *et al*. (2006) (n = 70) comparing the short-term effect of SMT to MET showed that manipulation was superior to MET in decreasing pain and increasing ROM. Koes *et al*. (1992) compared manual therapy (SMT and MET) to other forms of treatment for neck pain, and found that manual therapy produced better results but they did not specify whether SMT or MET was used. However, Scott-Dawkins (1996) compared mobilization (MET) and manipulation in the treatment of chronic neck pain (n = 60) and found that there was no statistical difference between the two groups.

Hamilton *et al*. (2007) did a study (n = 90) on the effects of SMT and MET in suboccipital tenderness. Data analysis revealed significantly greater pain pressure threshold in both SMT and MET groups ($p < 0.01$) but not in the control group ($p = 0.35$) five minutes post treatment. However, thirty minutes post treatment only the MET group showed a significant change ($p < 0.03$) compared to the SMT ($p = 0.29$) and control group ($p = 0.21$). however, all these patients were asymptomatic.

In a systematic review of randomized clinical trials on adults with chronic MNP, Vernon *et al.* (2007) found that there is moderate to high-quality evidence suggesting that subjects with chronic MNP show a clinically important improvement from a course of mobilization or manipulation at 6 to 104 weeks post treatment. In a randomized clinical trial, Hurwitz *et* *al.* (2002) found that both cervical manipulation and passive mobilization yielded similar improvements regarding pain severity and disability in the treatment of neck pain in a six month follow up. Both these studies indicate a long term improvement but neither study indicate if one technique is superior to the next.

2.9.2 Proprioceptive neuromuscular facilitation versus spinal manipulative therapy and/or muscle energy technique

To this researcher's knowledge after an extensive search there was no published literature regarding the use of PNF compared to either SMT or MET in the treatment of MNP available. However PNF has been advocated as the best stretching technique therefore this study aims to determine its effectiveness in eth treatment of MNP.

2.9.3 Conclusion

After reviewing more than a 1000 studies the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Associated Disorders (2008) concluded that there was sufficient evidence to support the use of neck manipulations, mobilizations, education, acupuncture analgesics, massage, low-level laser and exercise therapy in the treatment of neck pain which was classified into Grade 1 (little or no interference with daily living) and Grade 2 (limits activities of daily living). They concluded that none of these active treatments were superior to any other in the short or long term. Task Force member Dr. Carroll stated that "There is typically no single cause and no single effective treatment for Grade 1 and 2 neck pain" (Haldeman *et al*., 2008). This conclusion was also drawn by Aker *et al*. (1996) after doing a systematic overview and meta-analysis on conservative management of mechanical neck pain. They stated that no one treatment has been studied in enough detail to assess its efficacy or effectiveness adequately.

The aim of manual therapy in the treatment of MNP is to increase ROM and decrease pain. In view of the current literature, both SMT and MET are effective in the treatment of chronic MNP but it is ambiguous to which treatment is superior. The CRAC technique of PNF stretching is advocated to be the most effective stretching technique to increase ROM, but has not been studied with regards to pain in the cervical spine nor has it been compared to SMT or MET. Proprioceptive stretching is often used as part of a treatment protocol and not in isolation.

Therefore, this study aimed at comparing three commonly used manual therapy techniques for the treatment of chronic MNP in isolation to establish if one technique is superior to the next and to establish if the benefit of PNF stretching is comparable to that of pain relief as seen in SMT and MET.

CHAPTER THREE
MATERIAL AND METHODS

3.1 DESIGN

This was a prospective, randomized, comparative clinical trial conducted at the Durban University of Technology (DUT) Chiropractic Teaching Day Clinic. Ethical clearance was obtained from the Faculty of Health Sciences Research Committee and an ethics clearance certificate was issued (FHSEC 028/08) in accordance with the Declaration of Helsinki (Amended 2000).

3.2 PATIENT RECRUITMENT

Patients were recruited for this study through pamphlets and adverts (Appendix A), that were distributed in and around the Steve Biko campus of DUT and at Queensmead Softball club. Screening clinics were held inside the DUT library, where potential research participants were canvassed and informed about the research. If they were interested and met the criteria of the initial screen an initial consultation was scheduled at the DUT Chiropractic Teaching Day Clinic.

3.3 SAMPLING

Non-probability convenience sampling was used to obtain 45 participants with chronic mechanical neck pain. These participants were then randomly assigned into one of three treatment groups (15 per group) using a computer generated random allocation randomized table. This sample size is in keeping with other studies done at DUT (MacDougall, 1999 and Van Schalkwyk and Parkin-Smith, 2000).

3.4 PATIENT CONSULTATION

Where necessary, telephonic or face-to-face interviews were conducted with prospective patients in order to ascertain whether they were eligible to participate in the study. A series of questions were asked in accordance with the inclusion and exclusion criteria to ascertain their eligibility. These questions included:

a) How old are you?
b) How long have you had neck pain?
c) Do you have any sharp shooting pain in your arm or neck?

d) Have you had any major trauma or surgery to your neck?
e) Have you received any treatment for your neck pain in the last three months?

If they were eligible, an appointment was then scheduled at the DUT chiropractic teaching clinic, where the patient was given a letter of information (Appendix B) containing an informed consent section to fill in and sign prior to the beginning of the consultation. During the consult a full case history (Appendix C), senior physical (Appendix D) and a cervical orthopaedic examination (Appendix E) were conducted to assess the patient. Only those patients fitting the inclusion and exclusion criteria were accepted into the study.

3.5 INCLUSION AND EXCLUSION CRITERIA

The following criteria were used to include/exclude subjects in the research:

3.5.1 Inclusion criteria

a) Participants/patients had to be between the ages of 18 and 45 years as this would exclude those patients who are more likely to have osteoarthritis which is most commonly seen in the fifth and sixth decade of life (Yochum and Rowe, 2005).
b) Neck pain of a minimum duration of six weeks. This classified the neck pain as chronic (Grieve 1988, Fourie 1997 and David *et al*., 1998).
c) Signed informed consent form.
d) Numerical pain rating scale-101 scores between 40 – 80 (Jensen *et al*. 1986) to ensure group homogeneity (Mouton, 1996).
e) The diagnosis of mechanical neck pain was made using the following criteria (Grieve, 1988):
    - Local chronic cervical pain with or without arm pain
    - Juxtaposition of hypo- and hypermobile segments of the cervical spine due to spondylitic changes
    - Assymetrical neck pain that gets worse as the day progress and is aggravated by driving, reading etc
    - Unilateral occipital and neck pain
    - Restricted and painful movements, especially rotation and lateral flexion to the painful side.

f) Special orthopaedic tests: A positive test will indicate pain at the level of dysfunction (Gatterman, 1998). Two of the following three tests had to be present.

- Kemp's test: Performed with the patient in the seated position with the researcher behind them. The cervical spine was placed into a combination of rotation, lateral flexion and extension. Pain was felt at the level of dysfunction.
- Cervical compression test: performed by applying manual downward pressure on top of the patient's head.
- Lateral compression test: Performed with cervical spine in lateral flexion of the head toward the painful side and applying downward pressure.

All three of these tests cause stress on the facet joint and narrowing of the intervertebal foramen. Pain radiating down the arm indicates a radiculopathy and local pain suggests a facet joint dysfunction (Magee, 2006).

<u>3.5.2 Exclusion criteria</u>

a) Neck pain that was not of mechanical origin (Doherty *et al*., 2002) e.g.:

- Inflammatory – infections, rheumatoid arthritis, spondylitis, polymyalgia rheumatica, juvenile idiopathic arthritis.
- Metabolic – osteoporosis, Paget's disease, osteomalacia.
- Neoplasia – metastases, myeloma, reticulosis, intrathecal tumors.
- Other – fibromyalgia.
- Refered pain – pharynx, aortic aneurysm, Pancoast tumour, diaphragm, angina pectoris, teeth, cervical lymph nodes.
- Neurological – nerve root entrapment and disc herniations in the cervical spine.

a) Patients with recent major trauma or fracture of the cervical spine.

b) Patients whose primary complaint is that of headaches or facial pain associated with neck pain.

c) Any patient requiring further analysis e.g. x-rays.

d) Any patient who had received manual therapy of the cervical region in the last three months.

e) Any patient taking anti-inflammatory or muscle relaxant medication would need to have a three day "wash out" period before participating in the study (Seth, 1999).

3.6 RESEARCH METHODOLOGY/PROCEDURE

Once the participant was diagnosed with chronic mechanical neck pain, they were then given the opportunity to ask any further questions and were informed that they may withdraw from the study should they wish to do so. The participant was then randomly allocated via a randomization chart into one of three groups; group A: Spinal Manipulative Therapy (SMT), group B: Muscle Energy Technique (MET) or group C: Proprioceptive Neuromuscular Facilitation (PNF).

3.6.1 Treatment Group A – Spinal Manipulative Therapy

Fixations were located through motion palpation (Peterson and Bergman, 2002) of the cervical spine and manipulated using the diversified technique, as described by Shafer and Faye (1990) and Peterson and Bergman (2002). Fixations were manipulated in the direction of the restriction (decreased motion). To standardize treatment protocol, patients were treated in the supine position using an index contact. See Figure 3.1 for an example.

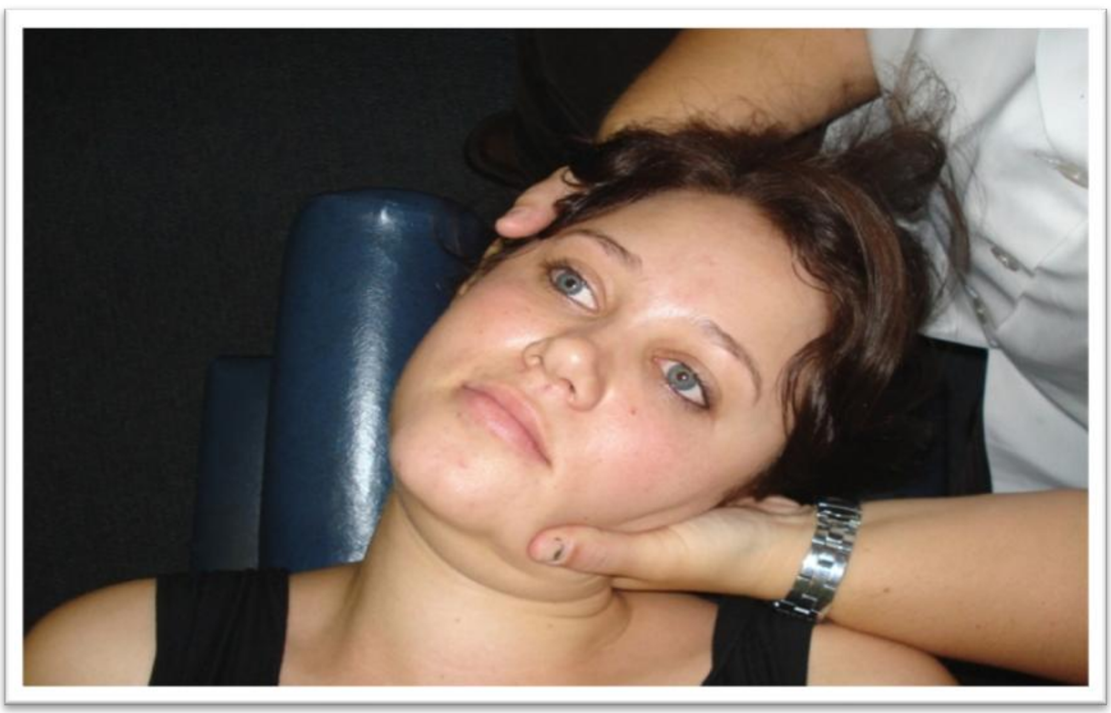


Figure 3.1: Left lateral flexion manipulation (supine)

3.6.2 Treatment Group B – Muscle Energy Technique

Joint fixations/dysfunctions were found using motion palpation (Peterson and Bergman, 2002). MET was then applied to these fixations according to the method outlined by Greenman (1996).

An example of MET applied to a typical cervical vertebra (e.g. C5-C6) with a motion restriction extension, right lateral flexion and right rotation as seen in Figure 3.2:

a) Patient supine with researcher sitting at head
b) The researcher's right index and middle fingertips are placed on the right articular pillar of C6 to stabilize the segment so that C5 can move upon it.
c) The researcher's left hand controls the left side of patient's head and neck.
d) The researcher's right fingers move the C6 segment anteriorly, introducing the movement of extension into the upper cervical spine.
e) The researcher's left hand introduces either rotation or lateral flexion of patient's head and neck till reaching right rotation or right lateral flexion motion barrier.
f) The patient exerts a sub maximal isometric contraction against researcher's resisting left hand into forward flexion, left rotation or left lateral flexion.
g) After three to five seconds of contraction, patient is asked to totally relax and researcher moves the joint to its new restrictive barrier
h) Steps a to g were repeated three to five times and the researcher re-tests the joint for the restrictive motion barrier each time.

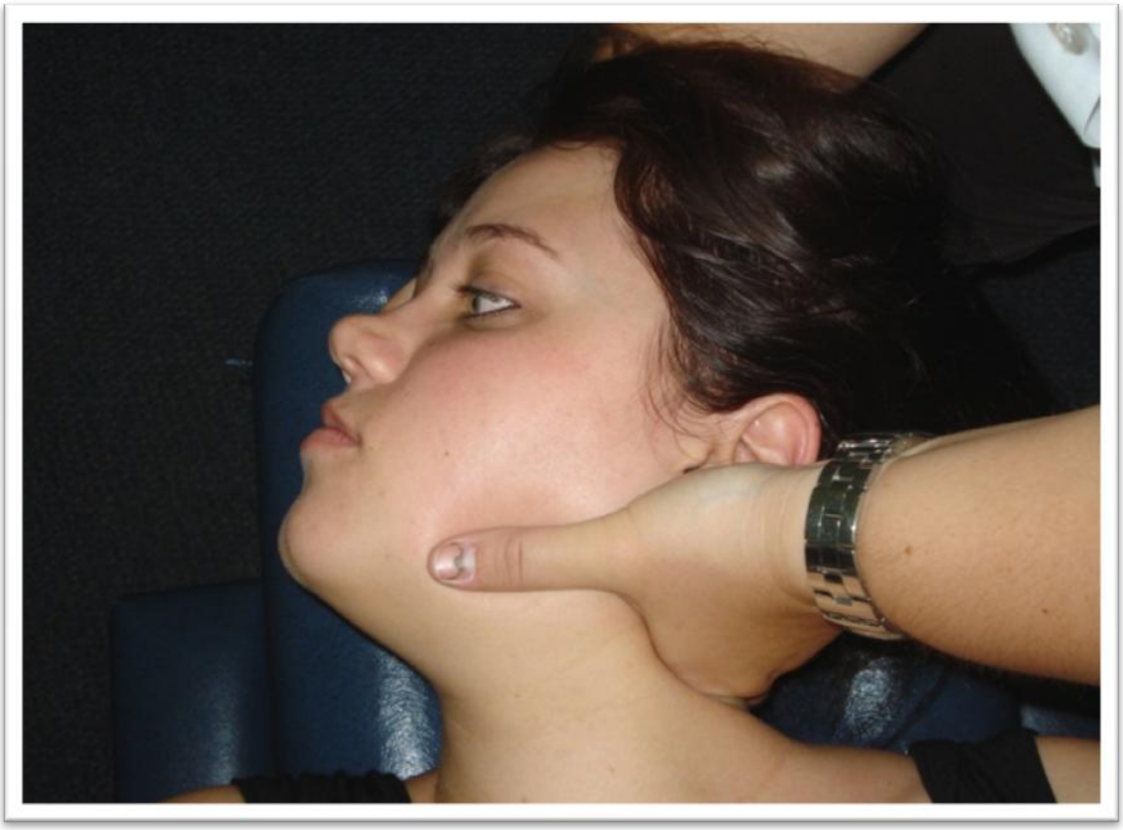


Figure 3.2: MET in right rotation of C5-C6 (supine)

3.6.3 Treatment Group C – Proprioceptive Neuromuscular Facilitation

The contract-relax antagonist-contract (CRAC) technique of PNF was used in this study. It was to be performed on the Posterior Cervical and Trapezius muscles according to the technique as described by Adler *et al*. (1993) and Nook (1995):

a) Stretch Position

i) Posterior Cervical muscles – Patient sits in chair and flexes neck forward as far as what is comfortable. Researcher cups the back of the patients head with elbows in front of the patient's shoulder. Figure 3.3 illustrates this stretch position.

ii) Upper Trapezius muscle – Patient is seated and laterally flexes head as far as what is comfortable. Researcher crosses her arms, places one hand on shoulder and other hand above the ear on the side being stretched, seen in Figure 3.4.

Figure 3.3: PNF stretching of Posterior Cervicals muscles

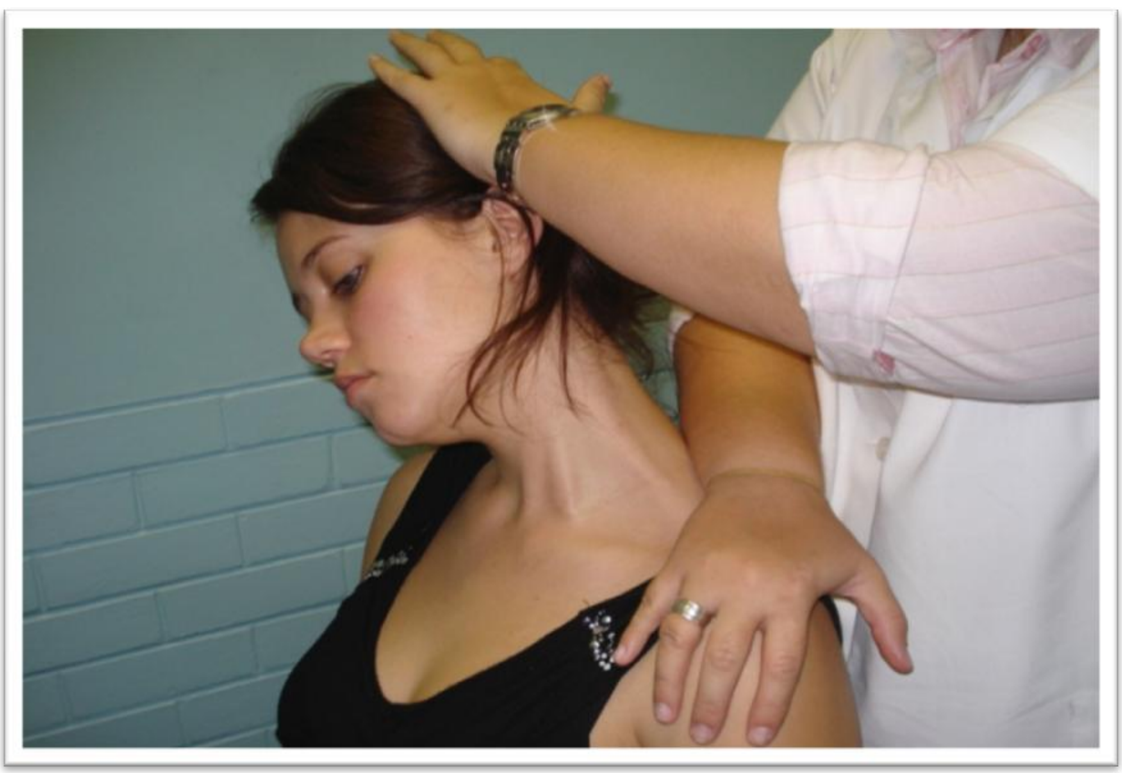


Figure 3.4: PNF stretching of the upper Trapezius muscle

b) <u>Contract Phase</u>

Patient pushes back against the researcher's hand as to extend the neck to contract the Posterior Cervicals OR push against the hand cupping the ear as to bring the head back to the neutral position in the case of the Trapezius muscle. These contractions should be held for eight seconds.

c) <u>Relaxation Phase</u>

Patient relaxes all muscles briefly and returns to a neutral spinal position.

d) <u>Antagonist Contraction Phase</u>

Patient returns head and neck actively to the stretched position: forward flexion for Posterior Cervicals and lateral flexion in the case of Trapezius.

e) <u>Stretch Phase</u>

Researcher then position themselves as in step a, until a stretch is felt by the patient in the relevant muscle.

All PNF stretches started with the patient pushing (eight seconds) into the researcher's hands in the specific direction. This procedure was followed three times in forward flexion and three times in right and left lateral flexion.

3.7 MEASUREMENTS

3.7.1 Objective measurements

To obtain objective measurements, the Cervical Range of Motion (CROM) Goniometer and Pressure Algometer were used. These two instruments are discussed below:

3.7.1.1 Cervical Range of Motion (CROM) Goniometer

The Performance Attained Associates Model CROM (3600 Labore Road, Suite 6, St. Paul, MN 55110-41144) is an instrument used to measure active cervical ROM: extension, flexion, right and left rotation. According to Youdas *et al*. (1991), the CROM showed a high degree of reliability when it was compared to two other types of goniometers. They reported that good inter- and intra- examiner reliability occurred and that the measurement procedure did not seem to affect the patient's condition. A study done by Tousignant *et al*. (2002), found the CROM to have good validity in terms of measuring flexion, extension and lateral flexion in patients with neck pain.

Procedure as described by Rheault *et al*. (1992):

a) CROM instrument was placed on the nose bridge and ears of the patient and fastened at the back of the patient's head with valcro straps
b) The patient's chair was then positioned in such a way that the magnetic field was zeroed on the dial meter for the rotational measurement
c) The correct patient posture was to sit erect with lower back against backrest, mid-back away from the chair, arms hanging freely at the side and feet together on the floor
d) Calibrated dials to zero before measuring active cervical flexion, extension, right and left rotation, and right and left lateral flexion
e) Each motion was measured twice and an average reading was recorded
f) Cervical range of motion was performed in the same order for each patient i.e.: flexion, extension, left lateral flexion, right lateral flexion, left rotation, and right rotation.
g) The readings were recorded on Appendix G.

<u>3.7.1.2 Pressure Algometer</u>

The algometer used in this clinical trial was the Algometer Commander of JTech Medical Industries. According to Livingston *et al.* (1998:19), algometers "are designed to quantify and document levels of tenderness via pressure threshold measurement and pain sensitivity via pain tolerance measurement". In a study done by Fischer (1987), he demonstrated excellent reliability and reproducibility with pressure threshold measurement. Therefore, according to Livingston algometry may be used for objective medico-legal documentation of pain intensity (Livingston *et al*., 1998).

The procedure for taking these measurements was followed as outlined by Livingston *et al.* (1998):

a) Patient was positioned in a relaxed seated position and the area being tested was exposed

b) The procedure was explained to patient and the patient was asked to say "yes" at the onset of pain.
c) Before starting the screen was cleared to ensure a reading of zero.
d) The area of joint dysfunction was located through palpation and was documented for further testing purposes.
e) The applicator tip was placed on the articular pillar to be tested
f) Force was applied perpendicular to the skin's surface at a gradually increasing rate until patient acknowledged the onset of pain. At that moment a reading was taken and recorded on Appendix H.

3.7.2 Subjective measurements

To quantify subjective outcomes, the patients were asked to complete the Canadian Memorial Chiropractic Clinic (CMCC) Neck Disability Index form (Appendix I) and the Numerical Pain Rating Scale (NRS-101) form (Appendix J). These two measurement tools are described below:

3.7.2.1 CMCC Neck Disability Index (NDI)

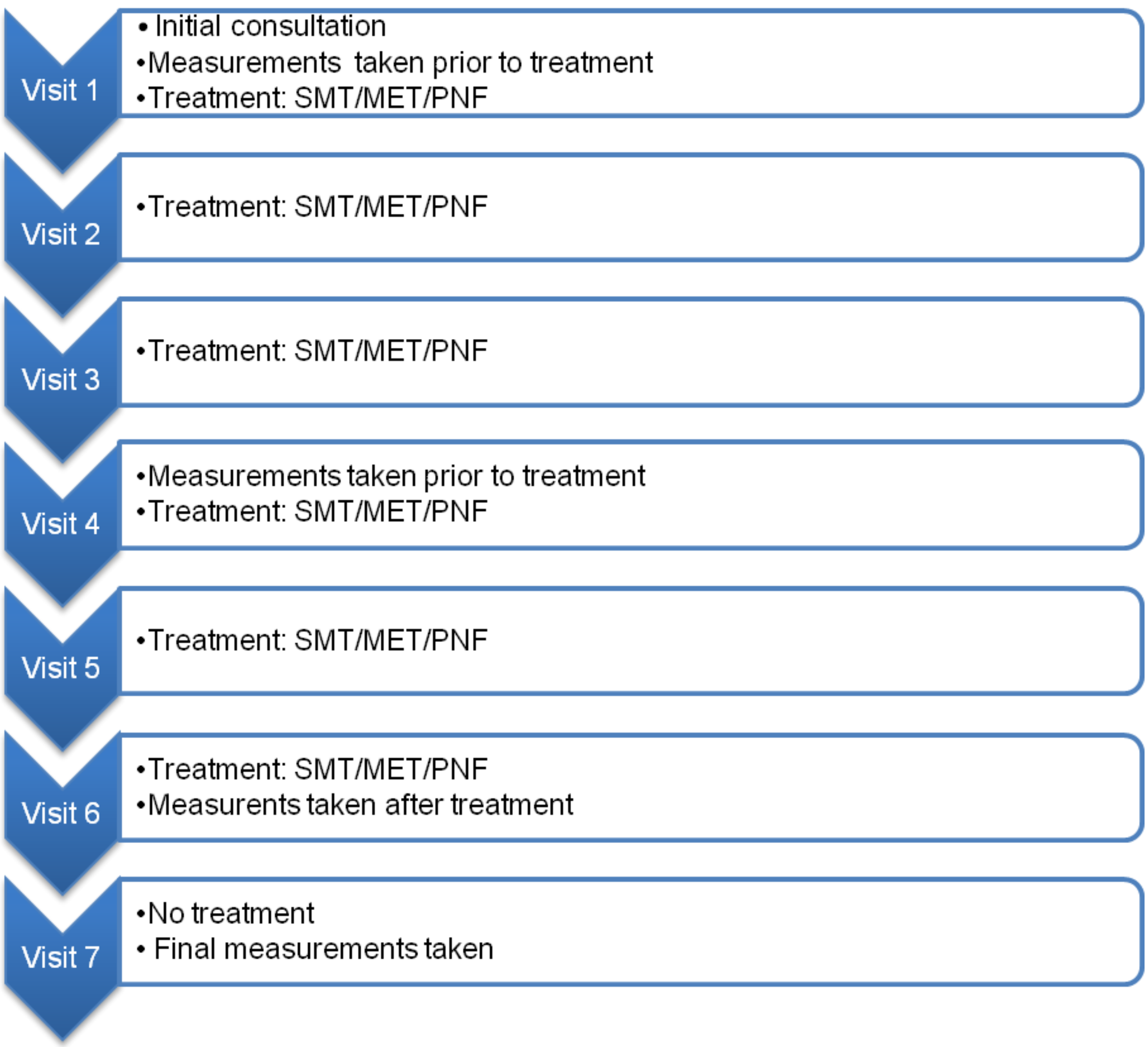
This index was designed by Vernon and Mior (1991) from the Canadian Memorial Chiropractic College (CMCC) to fill the need for a measurement tool to measure the affects of neck pain on activities of daily living (Liebenson, 1996). A study done by Vernon and Moir (1991) together with Cleland *et al.* (2008) showed that the NDI has a high degree of validity, test-retest reliability and internal consistency. It consists of a questionnaire containing ten sections, each consisting of six options. On completion, scores of each section are added together and multiplied by two in order to get a percentage. This percentage indicates the patient's disability measured at different times during the course of treatment.

3.7.2.1 Numerical Pain Rating Scale (NRS-101)

This is a scale in which the patient is asked to rate their perceived level of pain intensity on a numerical scale from 0 to 100, with 0 being no pain and 100 excruciating pain. The patient is asked to give two values a) when pain is at its worst and b) when pain is at its least. The average of these two figures indicated the average pain intensity experienced by the patient. The scale's practicality and validity was shown by Jensen *et al*. (1986) by comparing it to six other methods of assessing clinical pain intensity. Cleland *et al.* (2008) states that the NRS exhibits fair to moderate test-retest reliabitily in patients with MNP. According to Mannion *et al.* (2007), the NRS is the preferable tool in the assessment of pain intensity when compared to traditional types of visual analogue scales. This is in keeping with Jensen *et al*. (1986), who stated that the NRS-101 is “superior” and simple to administer in either a verbal or written form and the scale does not appear to be associated with age.

3.8 SUMMARY OF RESEACH PROTOCOL

This study took place at the DUT Chiropractic Day Clinic. The clinical trial lasted four weeks. In keeping with treatment guidelines (Haldeman *et al*., 1993) patients were treated twice weekly for a period of three weeks with a follow-up consultation scheduled for the fourth week for data collection. Measurements were taken at the following intervals:



3.9 STATISTICAL METHODOLOGY

SPSS version 15.0 (SPP Inc., Chicago, Illinois, USA) was used to analyse the data. A *p* value of <0.05 was considered as statistically significant. One-way analysis of variance (ANOVA) testing was used to compare mean age between the three treatment groups. Pearson's chi square test was used to compare percentages of demographics between the three treatment groups. Intra-group analyses, repeated measures ANOVA testing was used to assess the time effect for each outcome separately. In inter-group analyses the time x group interaction effect was assessed using repeated measures ANOVA testing, and profile plots were used to assess the trend and direction of the effects. Bar graphs were constructed to visualize the level of fixation per group per visit (Esterhuizen, 2009).

CHAPTER FOUR

THE RESULTS

4.1 INTRODUCTION

This chapter discusses the results obtained from the statistical analysis of the data collected throughout the study regarding demographics and objectives one to three, with an additional descriptive analysis of most commonly occurring fixation levels.

4.2 DEMOGRAPHICS

4.2.1 Age

Forty-five participants were enrolled into the study and randomized into three equal groups of 15 each. The mean age of the participants overall was 25.8 years (SD ± 6.3 years) with a range from 18 to 42 years. There was no statistical significant difference in mean age between the three groups ($p = 0.348$). Table 4.1 shows the summary statistics for age by group.

Table 4.1: Summary statistics for age by group ($n = 45$)

Group	Mean	*n*	Std. Deviation
SMT	27.60	15	7.179
MET	24.27	15	4.480
PNF	25.47	15	6.844

$F = 1.083$, $p = 0.348$

4.2.2 Sex

Table 4.2 shows that more females participated in the study, but the ratio of male to female remained fairly similar across the groups ($p = 0.711$).

Table 4.2: Cross-tabulation of sex by group ($n = 45$)

			Group			Total
			SMT	MET	PNF	
Sex	Female	Count	10	12	11	33
		% within group	66.7%	80%	73.3%	73.3%
	Male	Count	5	3	4	12
		% within group	33.3%	20%	26.7%	26.7%

Pearson's chi square = 0.682, $p = 0.711$

4.2.3 Race

There was a similar distribution of race groups in each of the treatment groups (Table 4.3), thus the difference was not statistically significant and the groups were comparable (p = 0.344).

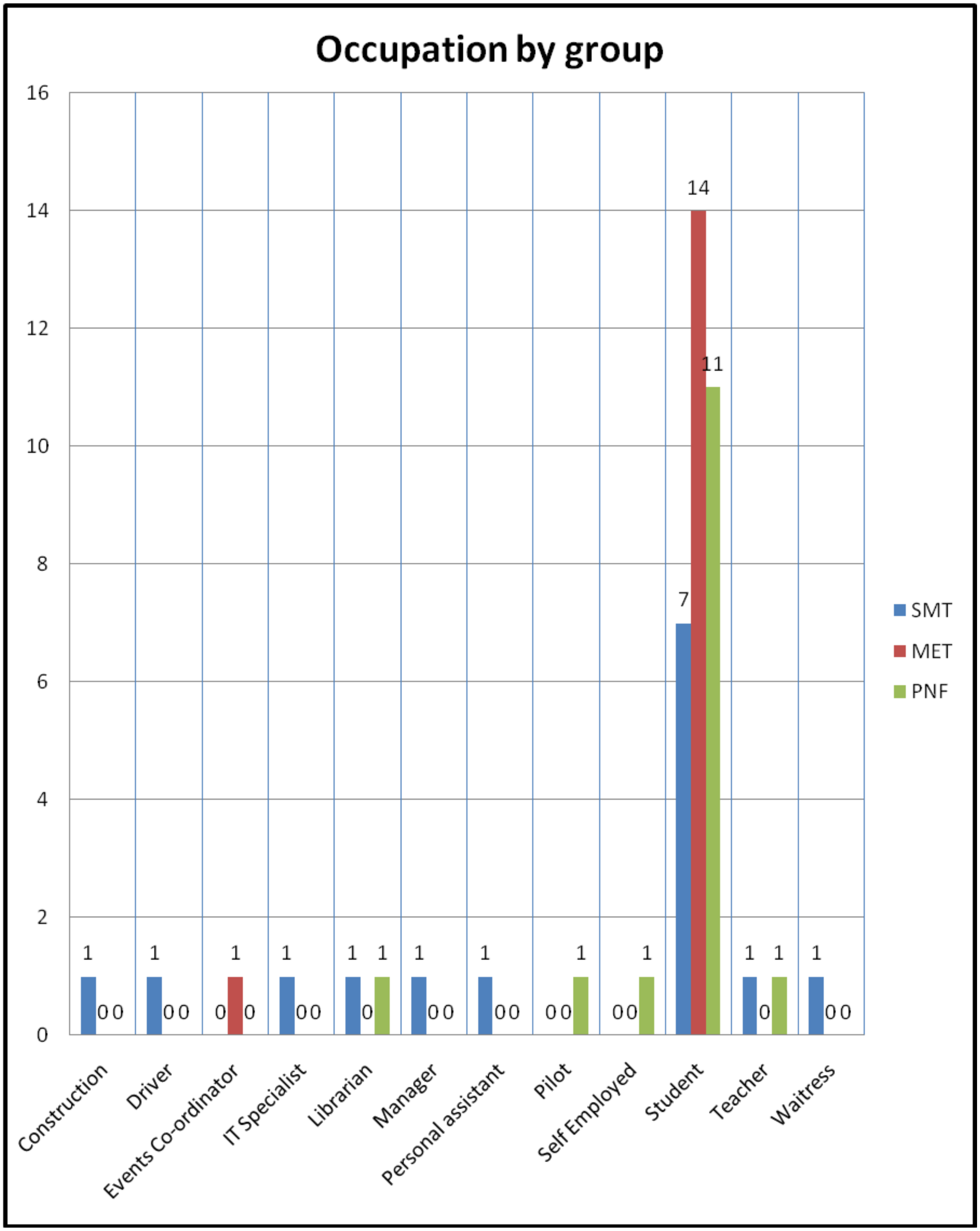
Table 4.3: Cross-tabulation of race by group (n = 45)

			Group			Total
			SMT	MET	PNF	
Race	White	Count	7	5	7	19
		% within group	46.7%	33.3%	46.7%	42.2%
	Indian	Count	2	1	4	7
		% within group	13.3%	6.7%	26.7%	15.6%
	Coloured	Count	1	0	0	1
		% within group	6.7%	0%	0%	2.2%
	Black	Count	5	9	4	18
		% within group	33.3%	60%	26.7%	40%

Pearson's chi square = 6.754, p = 0.344

4.2.4 Occupation

It was not possible to perform statistical comparison between the groups since there were many different occupations, many of them occurring just once, thus resulting in many cells with zero values and invalidation of any statistical comparison. However, for descriptive purposes Figure 4.1 shows the occupations of the participants of the groups, with 'student' being the most common.



<u>Figure 4.1: Occupation by group (*n* = 45)</u>

4.3 OBJECTIVE ONE: TO DETERMINE THE EFFECTIVENESS OF EACH TREATMENT IN TERMS OF OBJECTIVE MEASUREMENTS

This analysis involved intra-group testing of the outcomes of the cervical range of motion (CROM) goniometer (flexion, extension, left lateral flexion, right lateral flexion, left rotation, and right rotation) and the algometer (left and right).

4.3.1 Group A - SMT

4.3.1.1 CROM Goniometer

4.3.1.1.1 Flexion:

Flexion increased significantly over time in the SMT group ($p = 0.035$; Wilk's lambda = 0.502). This is shown in Figure 4.2.

4.3.1.1.2 Extension:

Figure 4.3 shows that there was a non-significant increase in extension over time in the SMT group ($p = 0.430$; Wilk's lambda = 0.801).

4.3.1.1.3 Left lateral flexion:

Figure 4.4 shows that there was a highly statistically significant increase in left lateral flexion over time in the SMT group ($p < 0.001$; Wilk's lambda = 0.215).

4.3.1.1.4 Right lateral flexion:

Figure 4.5 shows that there was a statistically significant increase in right lateral flexion over time in the SMT group ($p = 0.001$; Wilk's lambda = 0.266).

4.3.1.1.5 Left rotation:

There was a highly significant increase in left rotation over time ($p < 0.001$; Wilk's lambda = 0.181) in the SMT group. This is shown in Figure 4.6.

4.3.1.1.6 Right rotation:

There was a highly significant increase in right rotation over time ($p< 0.001$; Wilk's lambda = 0.195 in the SMT group. Figure 4.7 shows that this increase was almost linear.

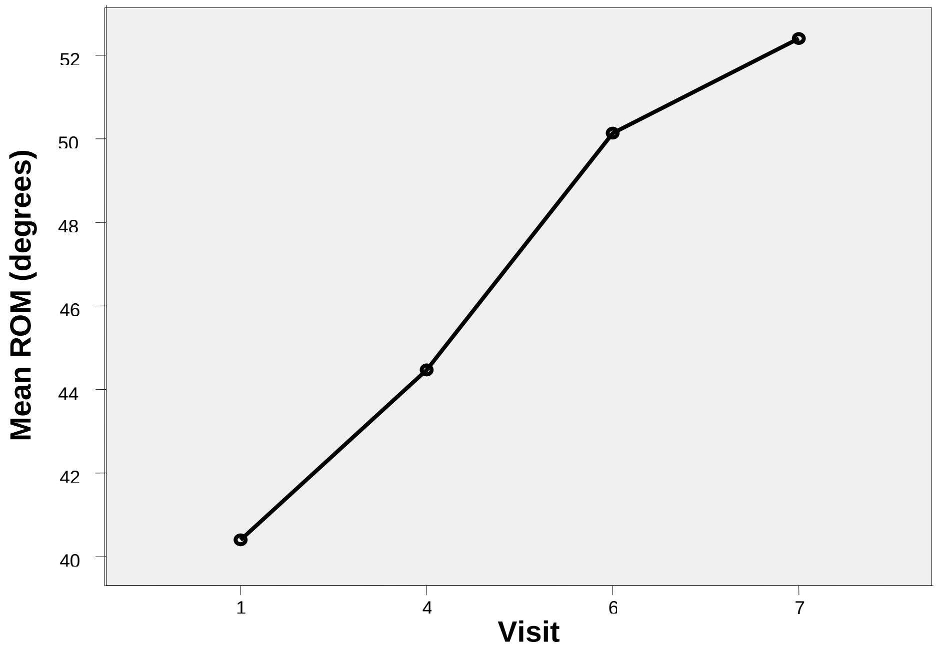


Figure 4.2: Mean degree of flexion by visit in the SMT group

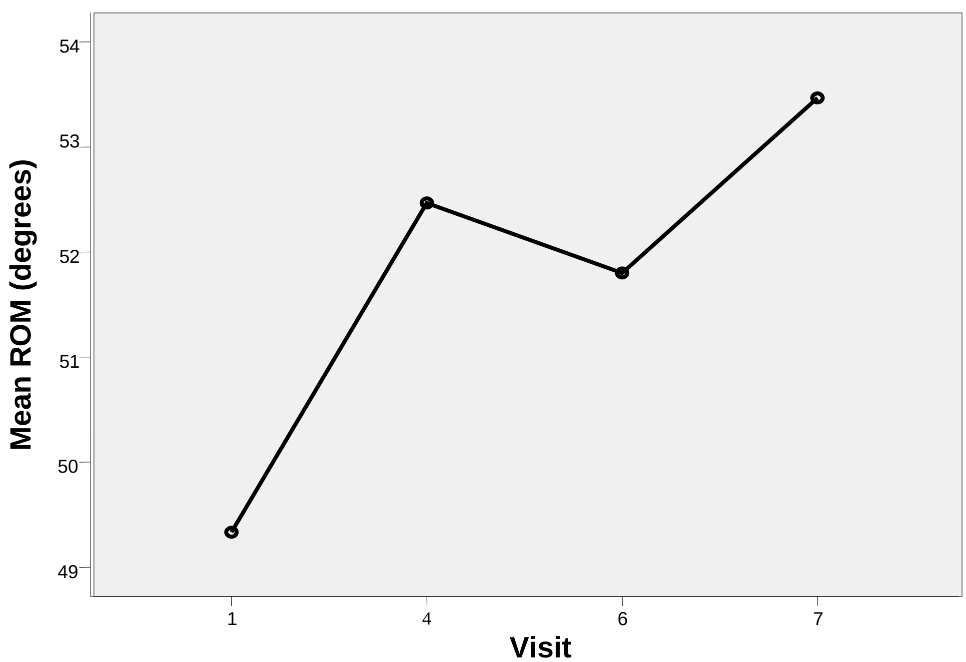


Figure 4.3: Mean degree of extension by visit in the SMT group

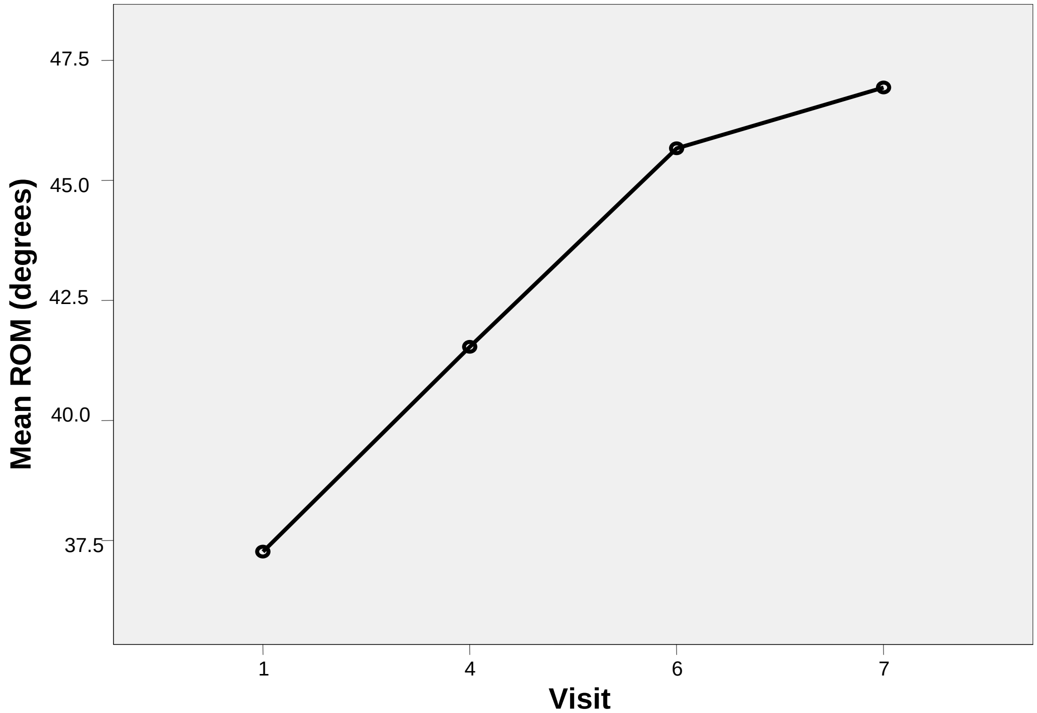


Figure 4.4: Mean degree of left lateral flexion by visit in the SMT group

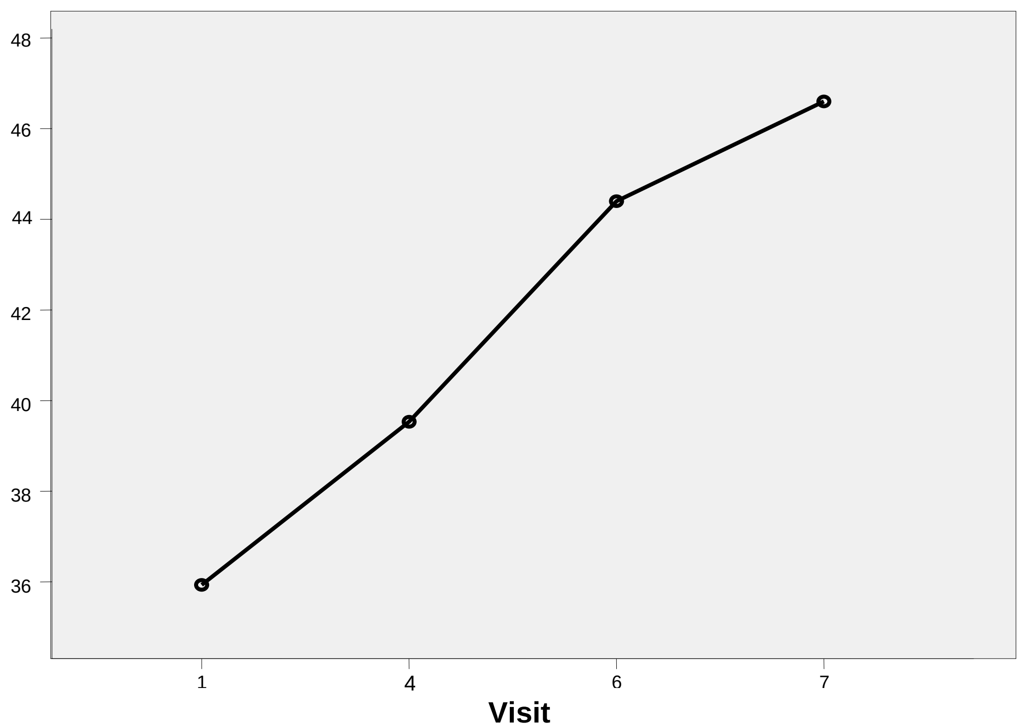


Figure 4.5: Mean degree of right lateral flexion by visit in the SMT group

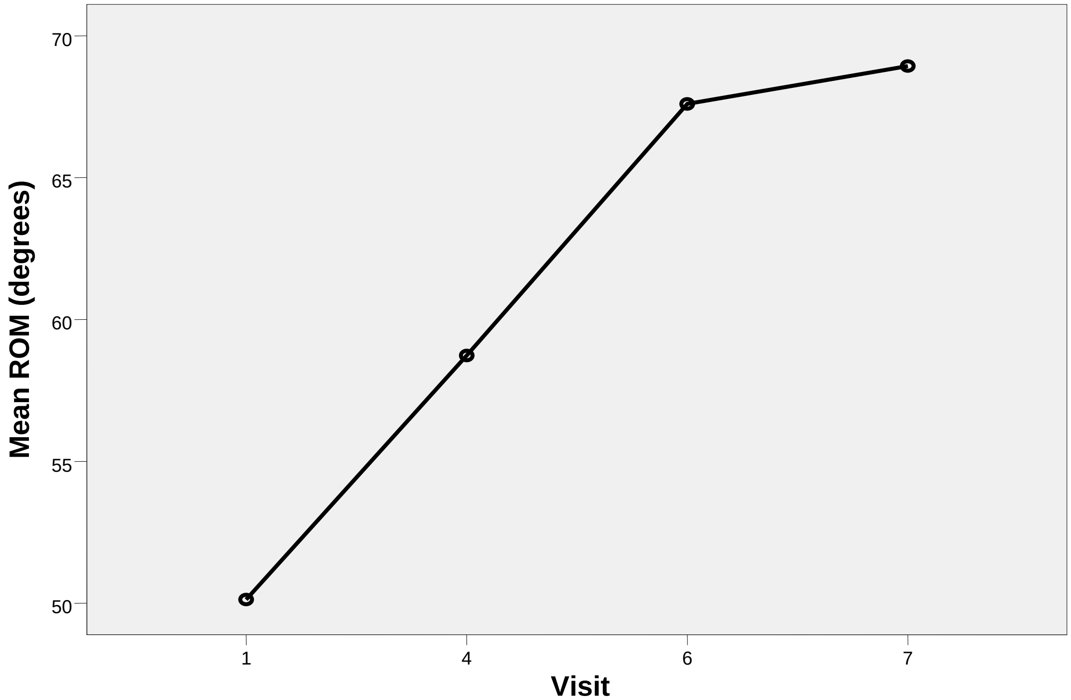


Figure 4.6: Mean degree of left rotation by visit in the SMT group

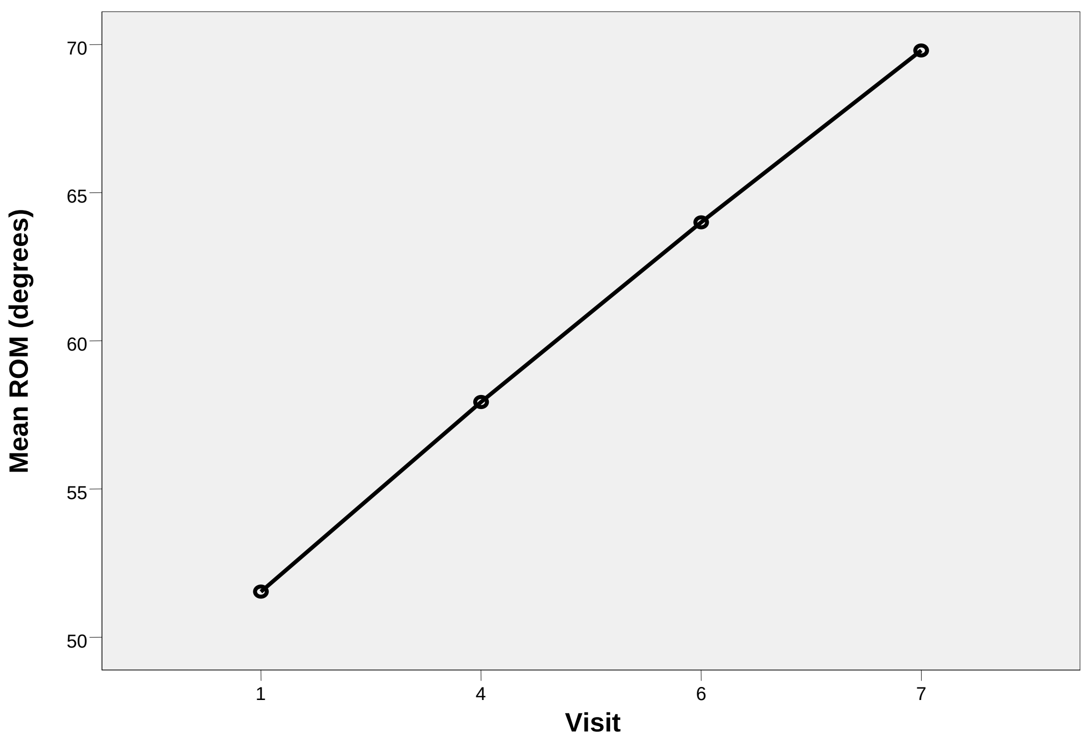


Figure 4.7: Mean degree of right rotation by visit in the SMT group

4.3.1.2 Algometer

4.3.1.2.1 Left algometer:

Figure 4.8 shows that there was a highly statistically significant increase over time for the left algometer reading in the SMT group ($p < 0.001$; Wilk's lambda = 0.208).

4.3.1.2.2 Right algometer:

Similarly, the algometer reading on the right also showed a statistically significant increase over time seen in Figure 4.9 ($p = 0.009$; Wilk's lambda = 0.394).

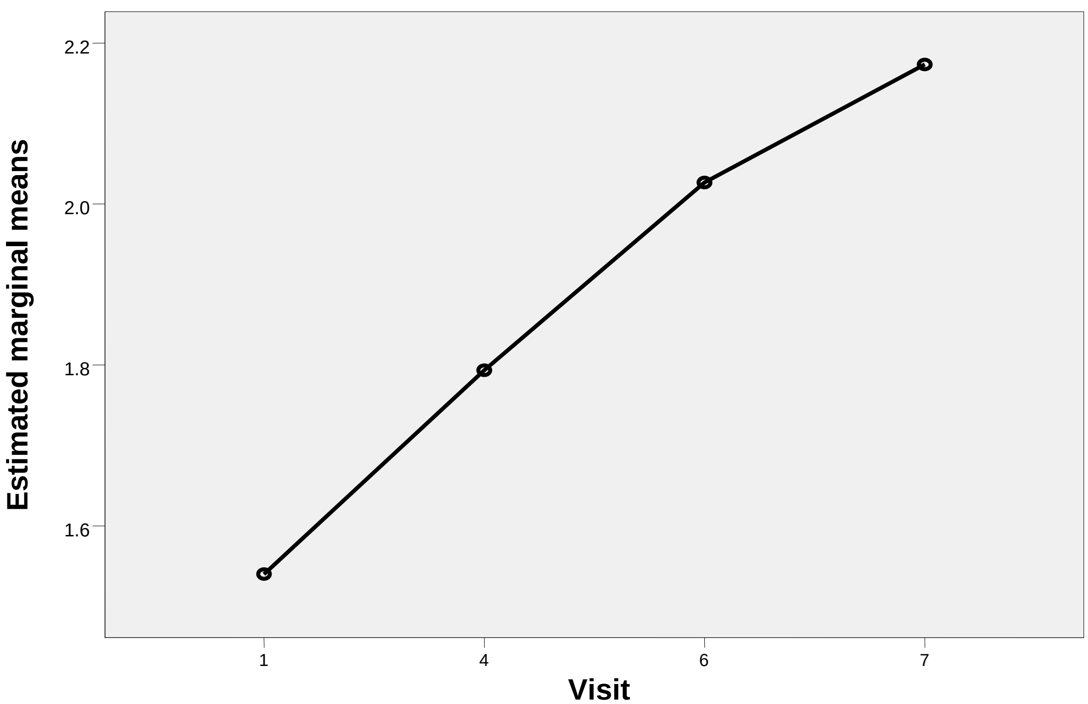


Figure 4.8: Mean algometer readings on the left by visit in the SMT group

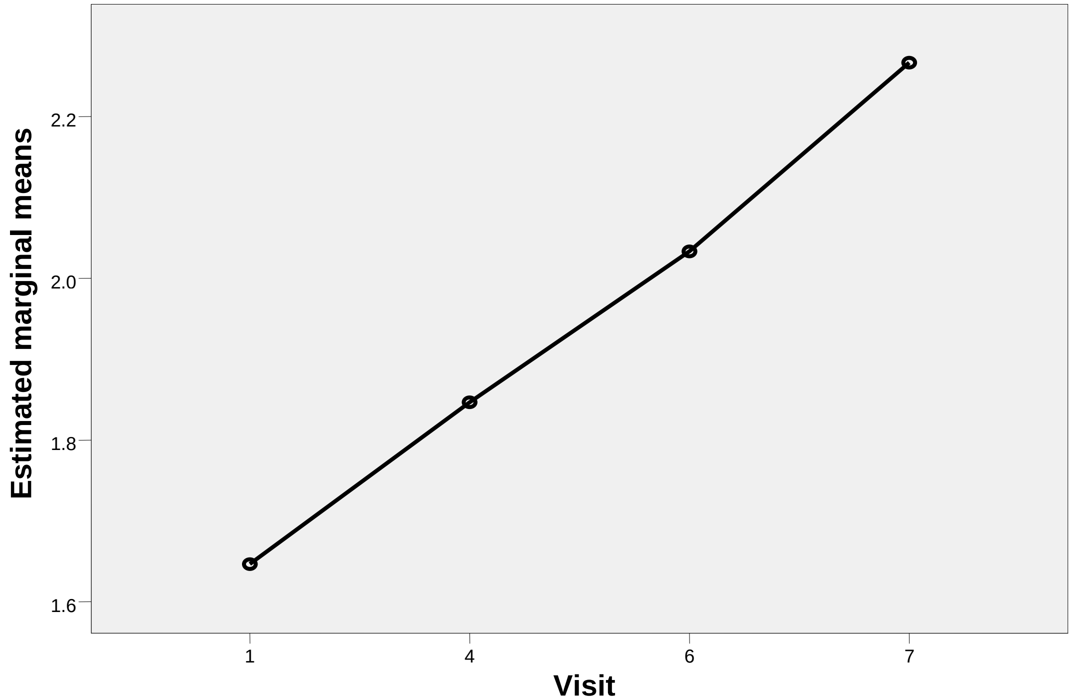


Figure 4.9: Mean algometer reading on the right by visit in the SMT group

Therefore, the SMT group showed significant improvement in almost all objective outcomes (CROM goniometer and algometer) over time, except for extension ROM.

4.3.2 Group B - MET

4.3.2.1 CROM Goniometer

4.3.2.1.1 Flexion:

Figure 4.10 shows there was a highly significant increase in flexion over time in the MET group ($p < 0.001$; Wilk's lambda = 0.163).

4.3.2.1.2 Extension:

Figure 4.11 shows that there was a significant increase in extension over time in the MET group ($p = 0.020$; Wilk's lambda = 0.454).

4.3.2.1.3 Left lateral flexion:

Figure 4.12 shows that there was a highly statistically significant increase in left lateral flexion over time in the MET group ($p = 0.001$; Wilk's lambda = 0.2565).

4.3.2.1.4 Right lateral flexion:

Figure 4.13 shows that there was a statistically significant increase in right lateral flexion over time in the MET group (p = 0.001; Wilk's lambda = 0.341).

4.3.2.1.5 Left rotation:

There was a highly significant increase in left rotation over time (p = 0.002; Wilk's lambda = 0.303) in the MET group. This is shown in Figure 4.14. The increase over time appears linear.

4.3.2.1.6 Right rotation:

There was a highly significant increase in right rotation over time (p < 0.001; Wilk's lambda = 0.238) in the MET group. Figure 4.15 shows that this increase was almost linear.

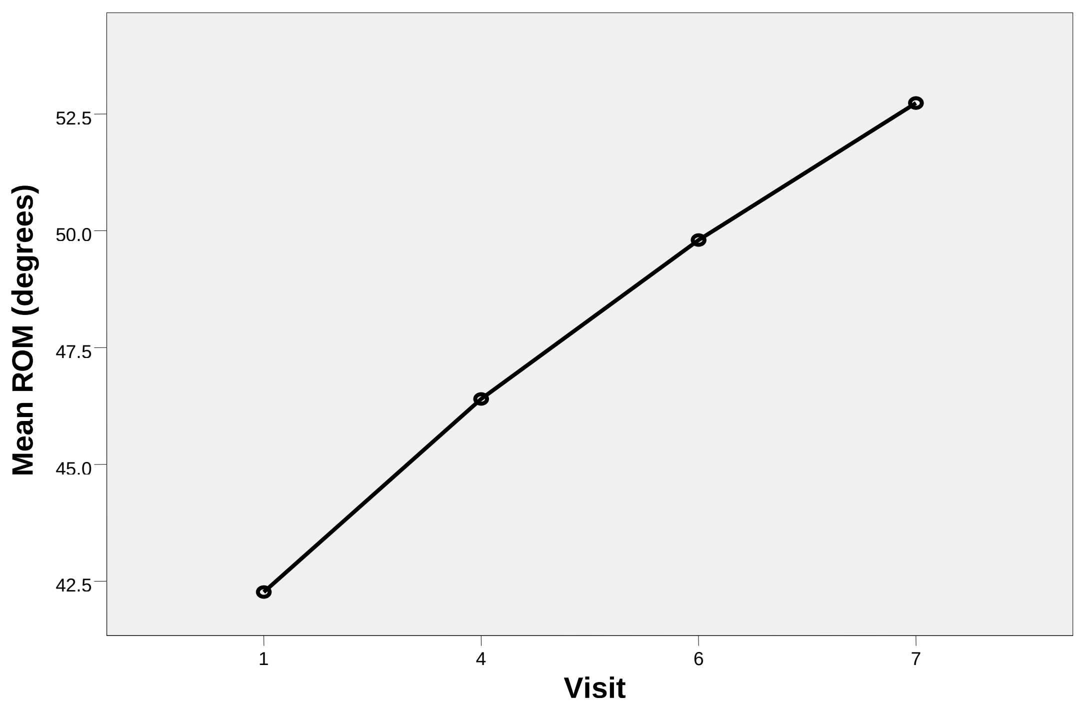


Figure 4.10: Mean degree of flexion by visit in the MET group

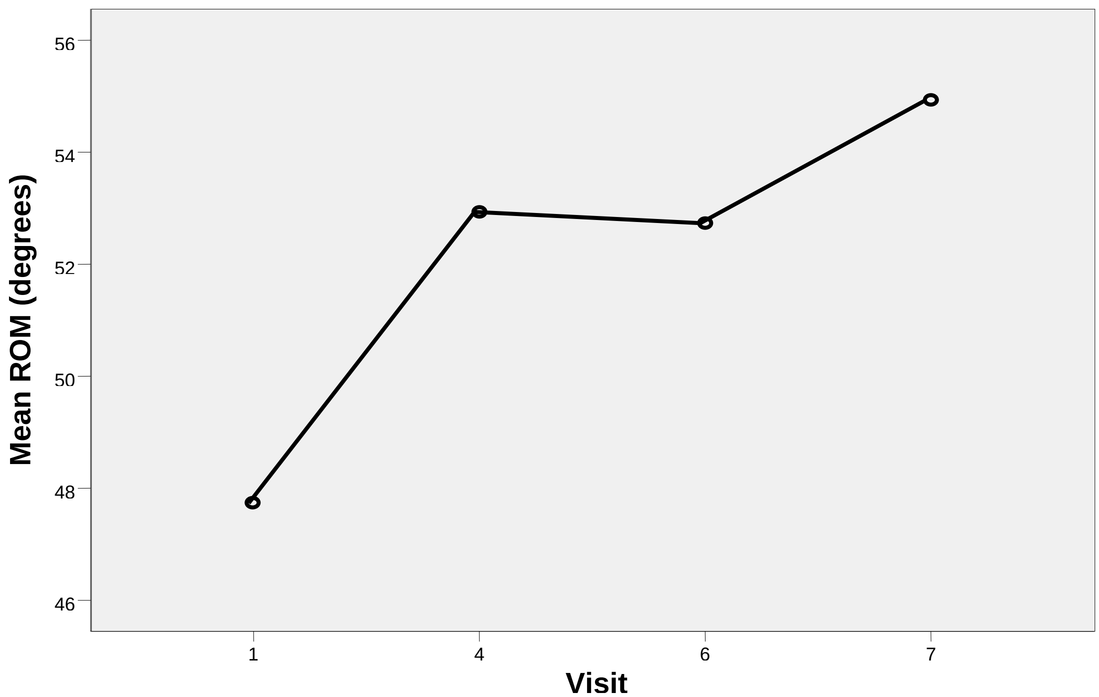


Figure 4.11: Mean degree of extension by visit in the MET group

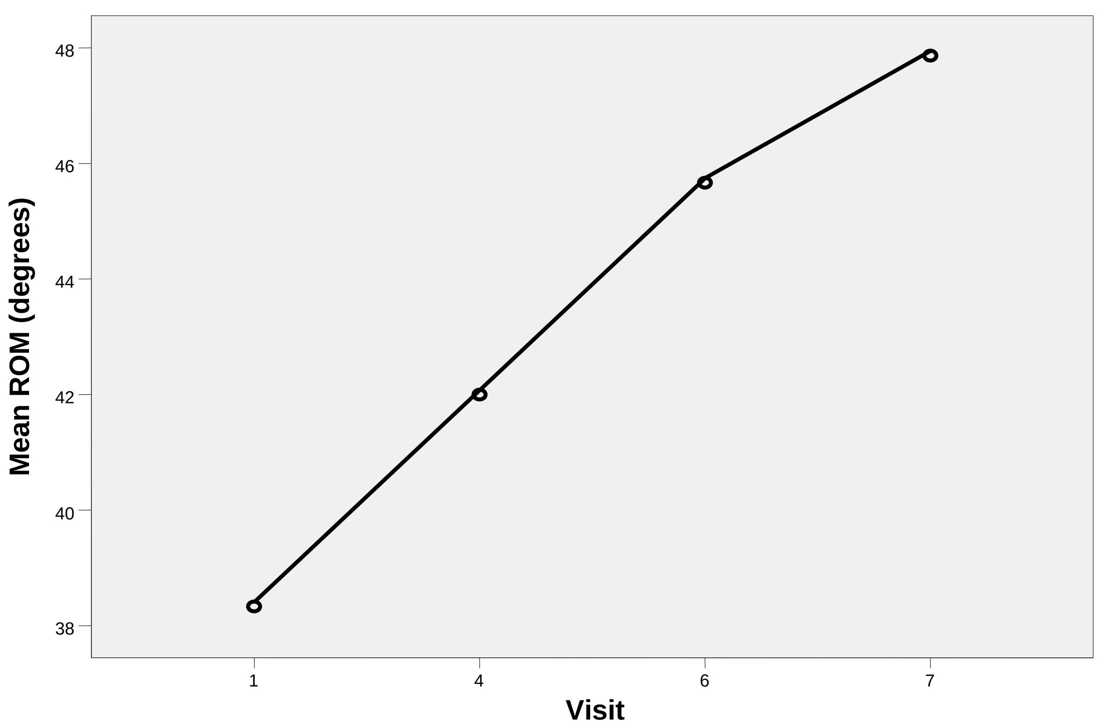


Figure 4.12: Mean degree of left lateral flexion by visit in the MET group

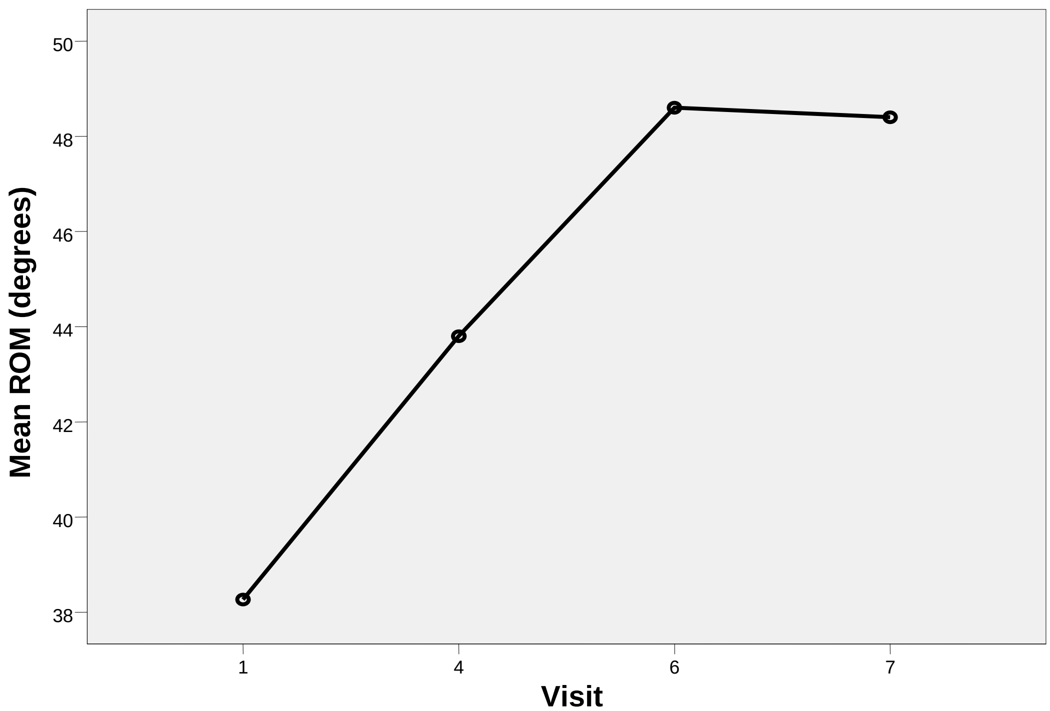


Figure 4.13: Mean degree of right lateral flexion by visit in the MET group

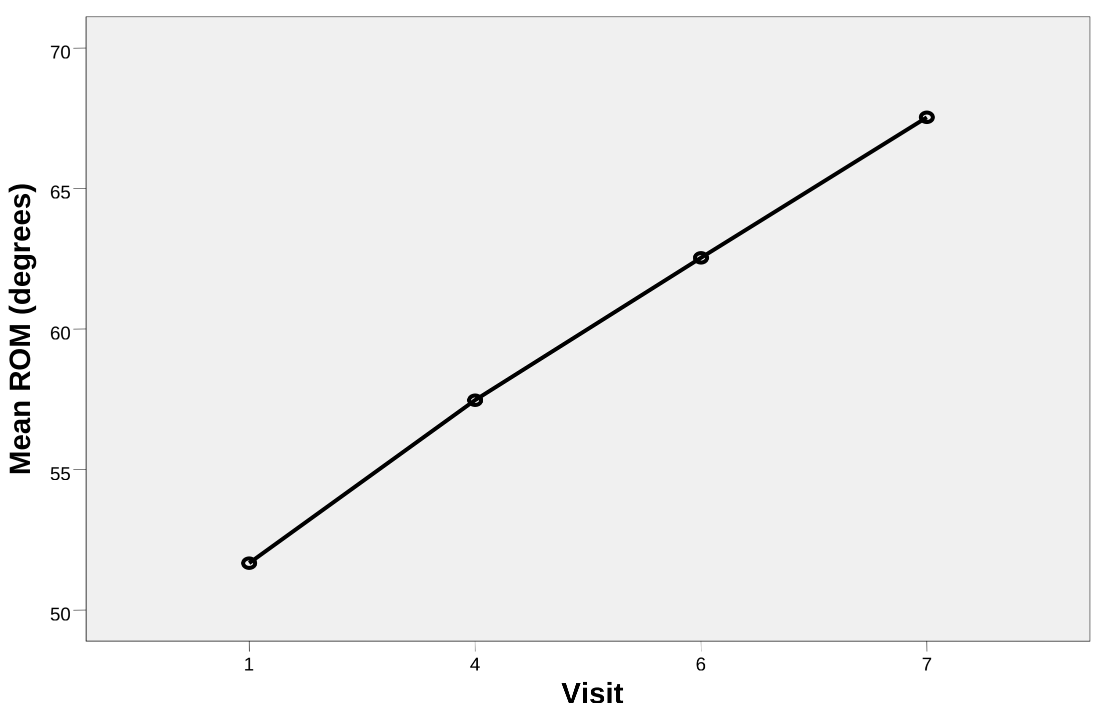


Figure 4.14: Mean degree of left rotation by visit per MET group

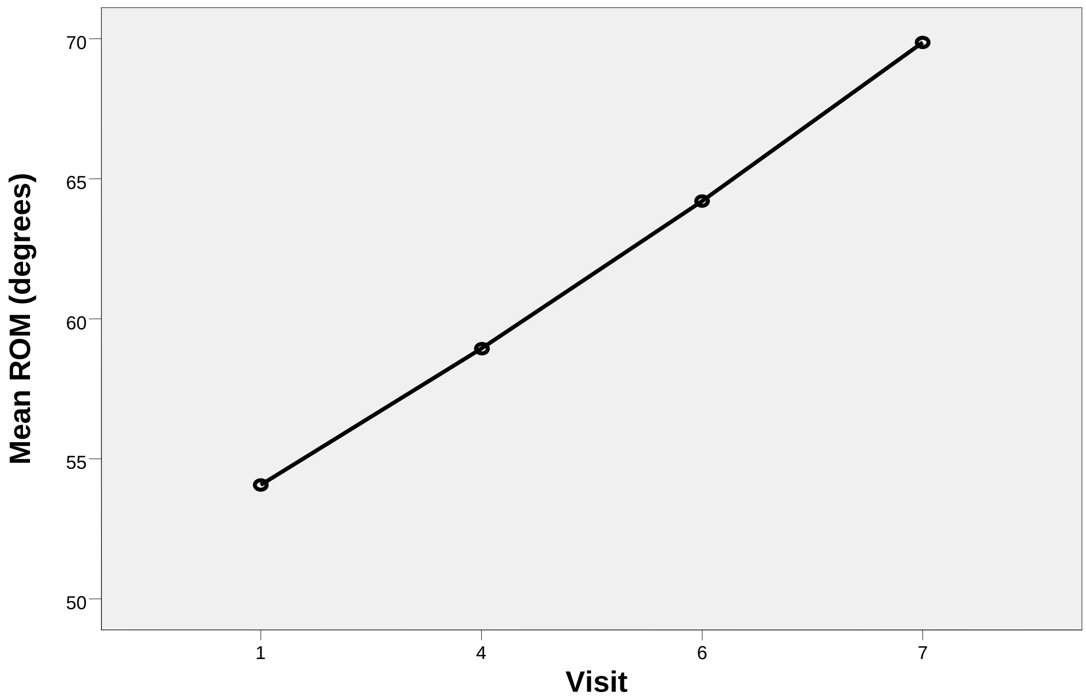


Figure 4.15: Mean degree of right rotation by visit in the MET group

4.3.2.2 Algometer

4.3.2.2.1 Left algometer:

Figure 4.16 shows that there was a statistically significant increase over time for the left algometer reading in the MET group (*p* = 0.012; Wilk's lambda = 0.413).

4.3.2.2.2 Right algometer:

The algometer reading on the right, however, showed a non-statistically significant increase over time seen in Figure 4.17 (*p* = 0.068; Wilk's lambda = 0.564).

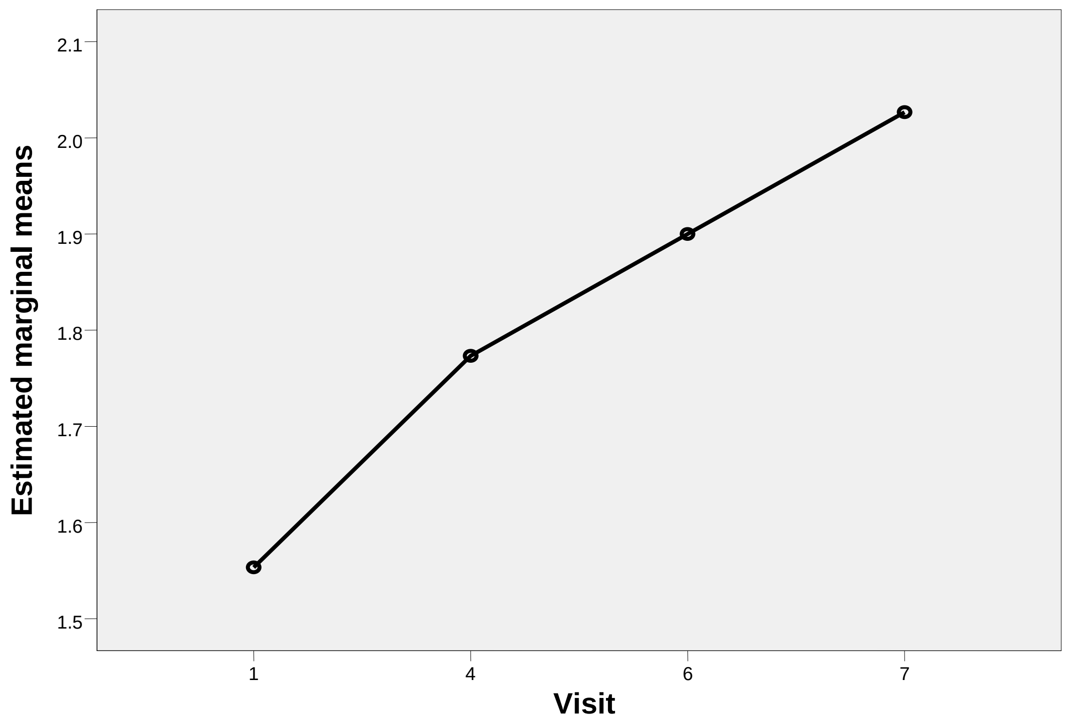


Figure 4.16: Mean algometer reading on the left by visit in the MET group

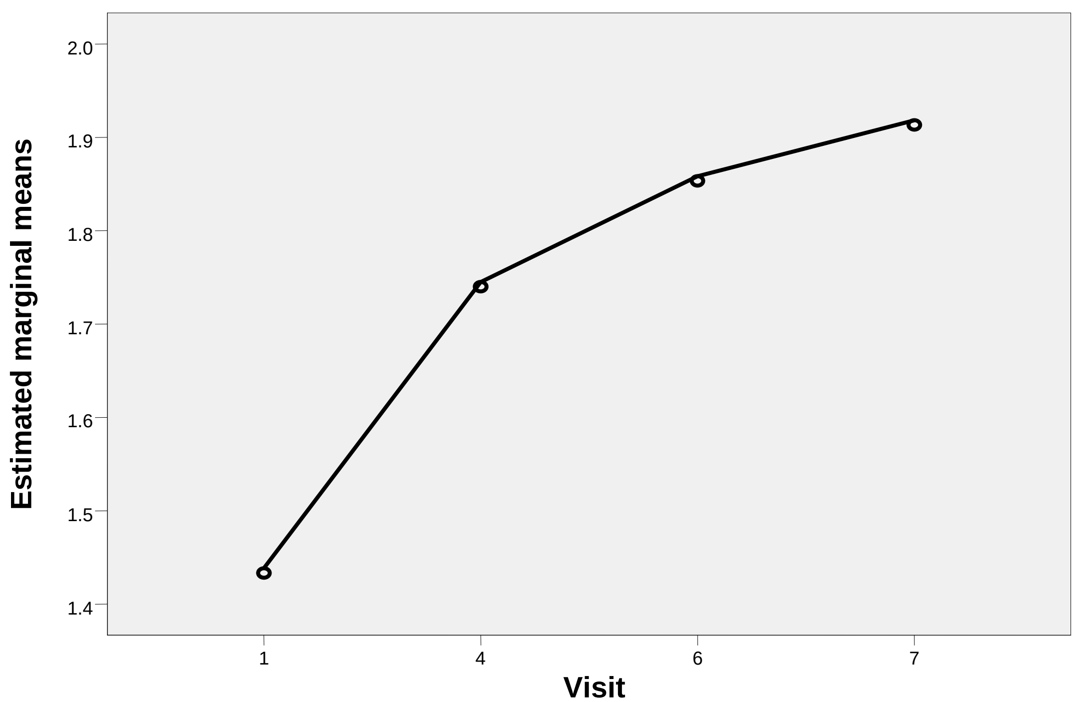


Figure 4.17: Mean algometer reading on the right by visit in the MET group

Therefore, the MET group showed significant improvement in almost all objective outcomes over time.

4.3.3 Group C - PNF

4.3.3.1 CROM Goniometer

4.3.3.1.1 Flexion:

Figure 4.18 shows that flexion increased significantly over time in the PNF group (p = 0.024; Wilk's lambda = 0.468).

4.3.3.1.2 Extension:

Figure 4.19 shows that there was a highly statistically significant increase in extension over time in the PNF group ($p < 0.001$; Wilk's lambda = 0.221).

4.3.3.1.3 Left lateral flexion:

Figure 4.20 shows that there was a highly statistically significant increase in left lateral flexion over time in the PNF group ($p < 0.001$; Wilk's lambda = 0.082).

4.3.3.1.4 Right lateral flexion:

Figure 4.21 shows that there was a highly statistically significant increase in right lateral flexion over time in the PNF group ($p < 0.001$; Wilk's lambda = 0.094).

4.3.3.1.5 Left rotation:

There was a highly significant increase in left rotation over time ($p < 0.001$; Wilk's lambda = 0.087) in the PNF group. Figure 4.22 shows that this increase was almost linear.

4.3.3.1.6 Right rotation:

Figure 4.23 shows there was a highly significant increase in right rotation over time ($p <$ 0.001; Wilk's lambda = 0.074).

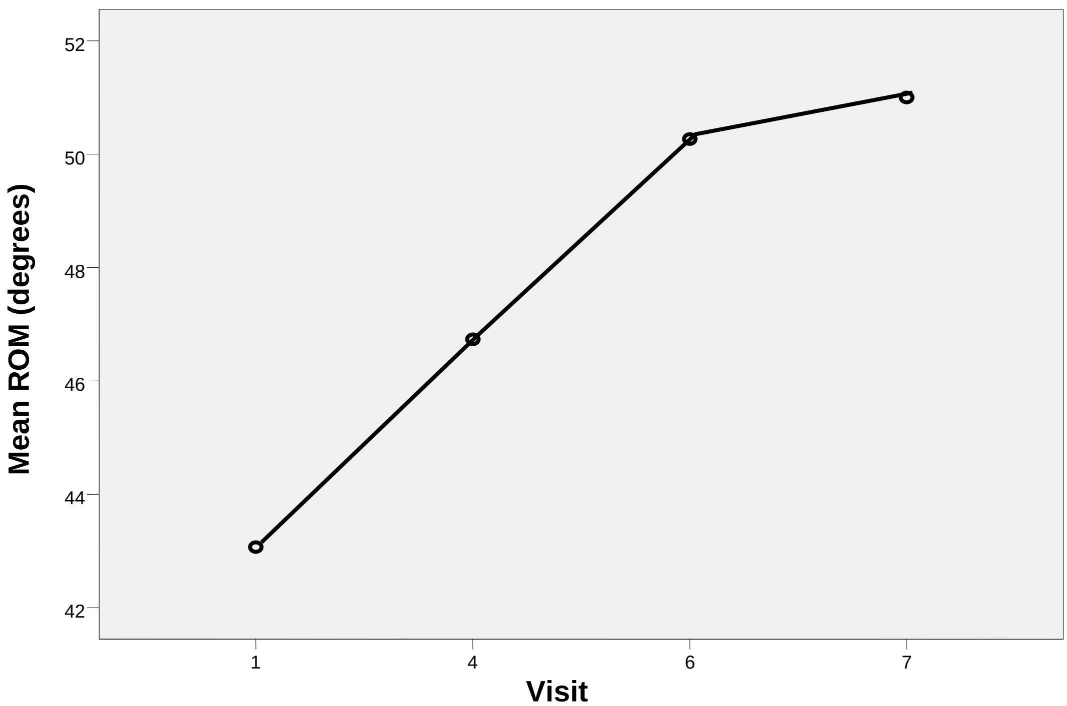


Figure 4.18: Mean degree of flexion by visit in the PNF group

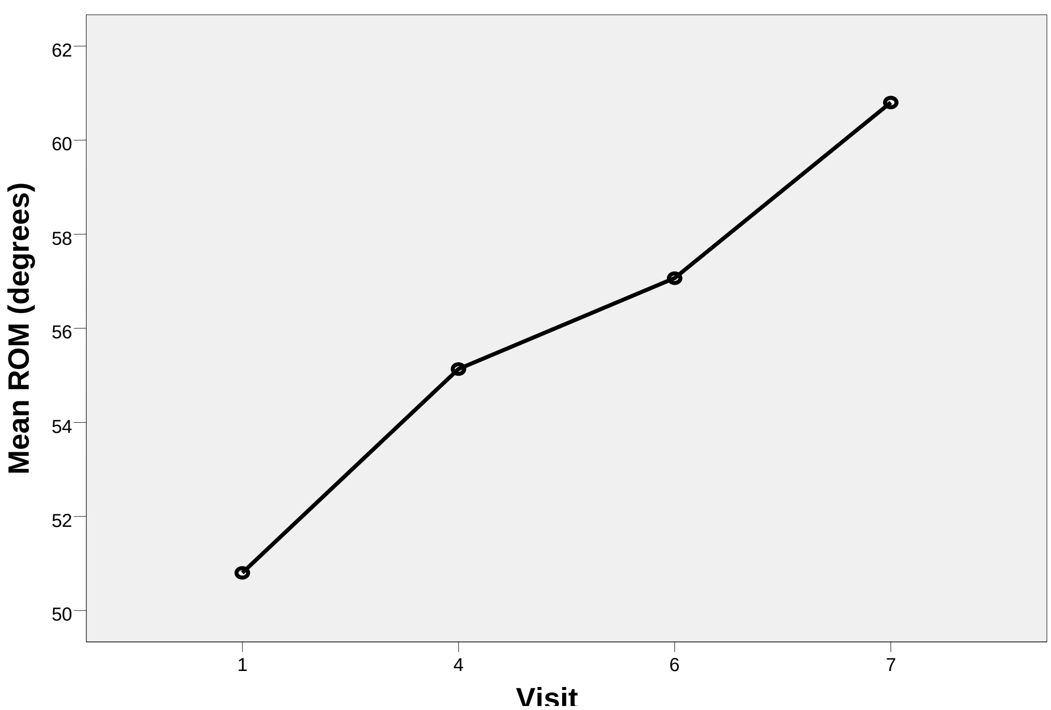


Figure 4.19: Mean degree of extension by visit in the PNF group

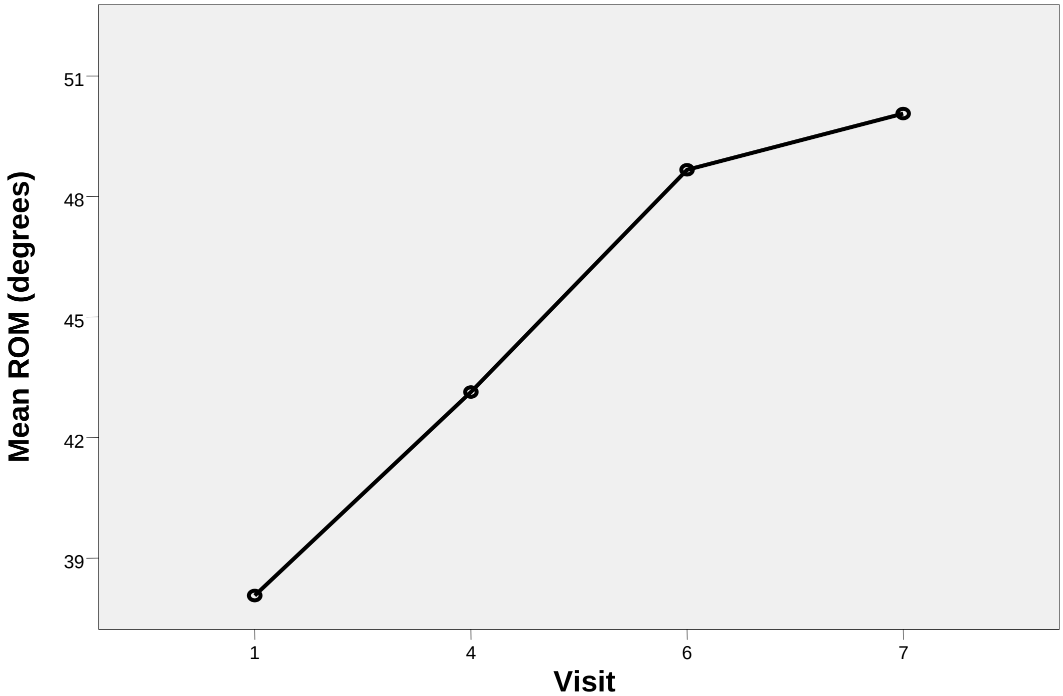


Figure 4.20: Mean degree of left lateral flexion by visit in the PNF group

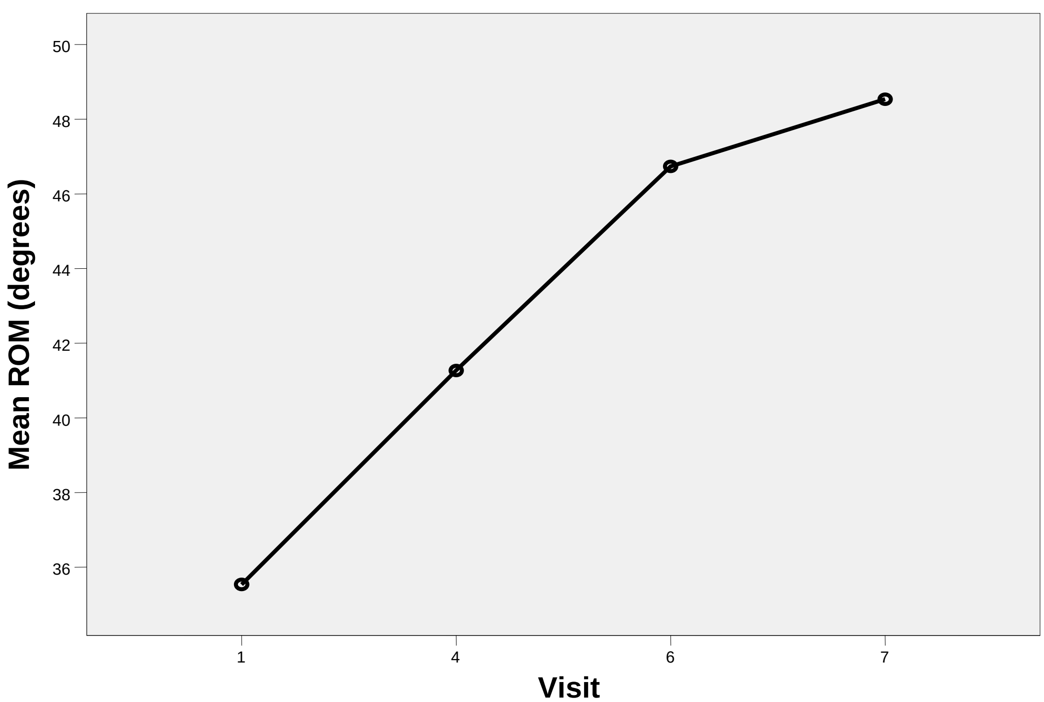


Figure 4.21: Mean degree of right lateral flexion by visit in the PNF group

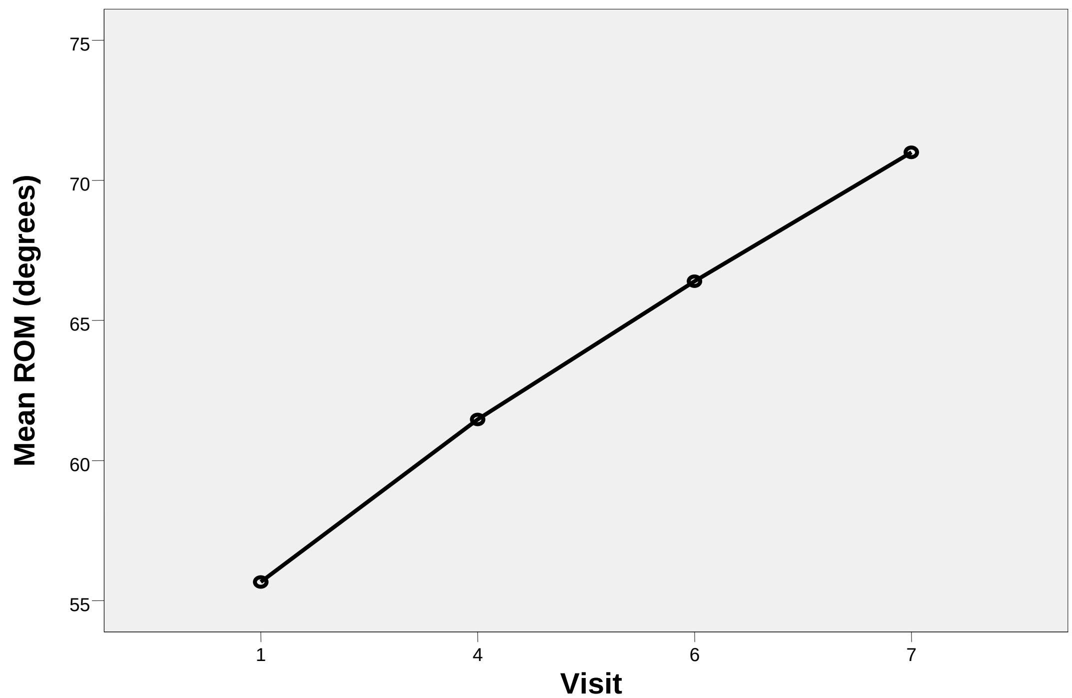


Figure 4.22: Mean degree of left rotation by visit in the PNF group

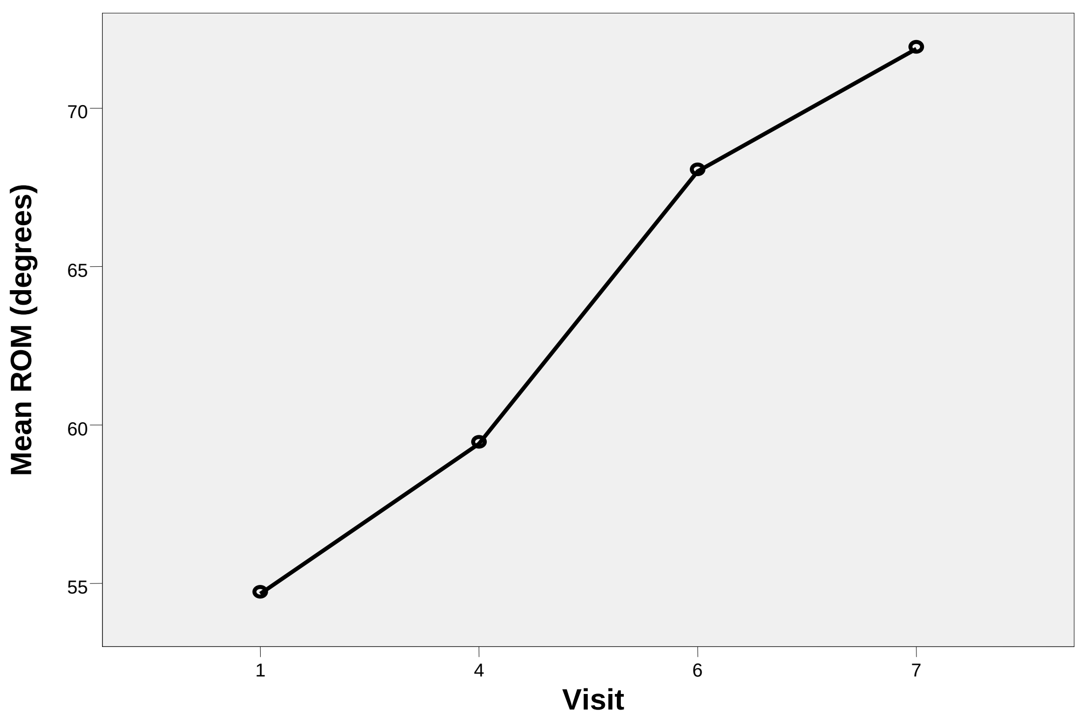


Figure 4.23: Mean degree of right rotation by visit in the PNF group

4.3.3.2 Algometer

4.3.3.2.1 Left algometer:

Figure 4.24 shows that there was a highly statistically significant increase over time for left algometer in the PNF group ($p < 0.001$; Wilk's lambda = 0.135).

4.3.3.2.2 Right algometer:

Similarly, right algometer also showed a statistically significant increase over time seen in Figure 4.25 ($p < 0.001$; Wilk's lambda = 0.121).

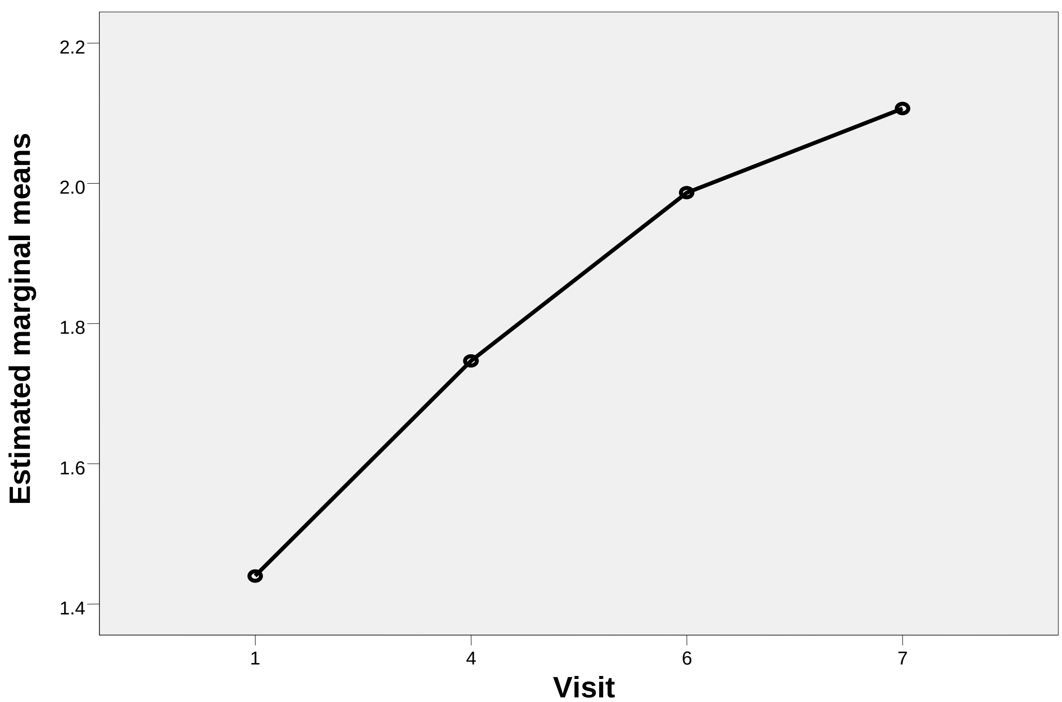


Figure 4.24: Mean algometer reading on the left by visit in the PNF group

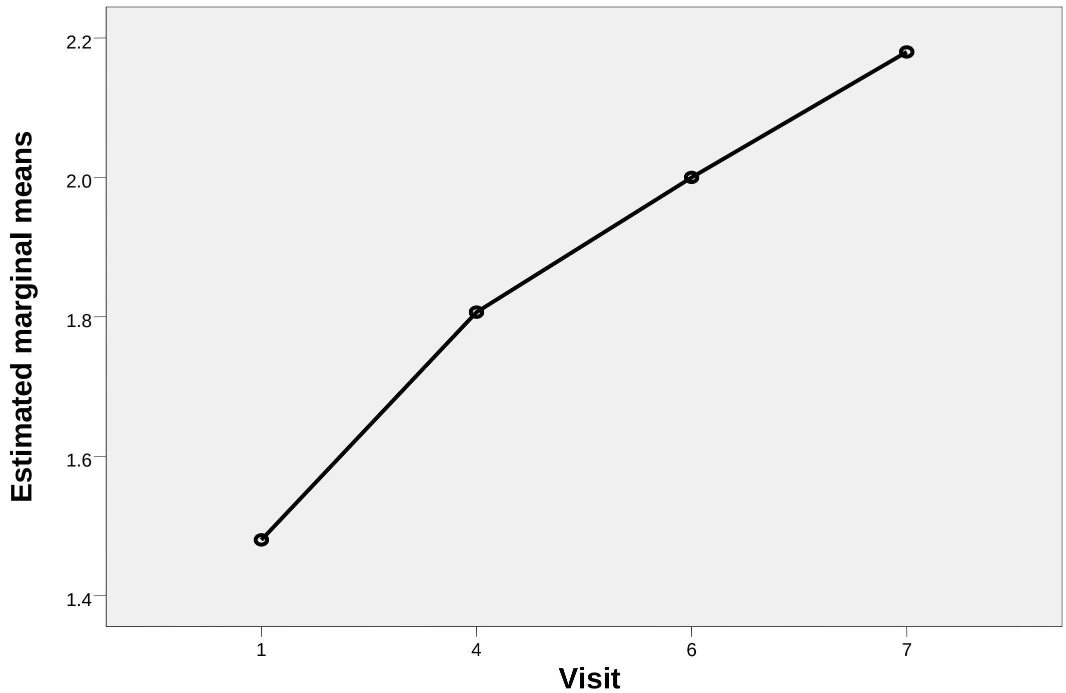


Figure 4.25: Mean algometer reading on the right by visit in the PNF group

Therefore, the PNF group showed significant improvement in all objective outcomes over time.

4.3.4 A summary of the mean values of the three groups per visit

Table 4.4 illustrates the change in mean values of both the ROM and algometer readings (point tenderness) over the treatment period. Initial values are fairly consistent across each group as seen under visit one; as are the values at visit seven, except the degree of extension in the PNF group more markedly than the SMT or MET group. However, this is not statistically significant.

Table 4.4: Mean goniometer and algometer values per visit

	VISIT 1								VISIT 4							
	FLEXION	EXTENSION	LEFT LAT FLEXION	RIGHT LAT FLEXION	LEFT ROTATION	RIGHT ROTATION	LEFT ALGOMETER	RIGHT ALGGOMETER	FLEXION	EXTENSION	LEFT LAT FLEXION	RIGHT LAT FLEXION	LEFT ROTATION	RIGHT ROTAION	LEFT ALGOMETER	RIGHT ALGOMETER
SMT	**40°**	**49°**	**37°**	**36°**	**50°**	**52°**	**1.5**	**1.6**	**44°**	**52°**	**42°**	**40°**	**59°**	**58**	**1.8**	**1.8**
MET	**42°**	**48°**	**38°**	**38°**	**52°**	**54°**	**1.6**	**1.4**	**46°**	**53°**	**42°**	**44°**	**57°**	**59°**	**1.8**	**1.7**
PNF	**43°**	**51°**	**38°**	**36°**	**56°**	**55°**	**1.4**	**1.5**	**47°**	**55°**	**43°**	**41°**	**61°**	**59°**	**1.7**	**1.8**

	VISIT 6								VISIT 7							
	FLEXION	EXTENSION	LEFT LAT FLEXION	RIGHT LAT FLEXION	LEFT ROTATION	RIGHT ROTATION	LEFT ALGOMETER	RIGHT ALGOMETER	FLEXION	EXTENSION	LEFT LAT FLEXION	RIGHT LAT FLEXION	LEFT ROTATION	RIGHT ROTATION	LEFT ALGOMETER	RIGHT ALGOMETER
SMT	**50°**	**52°**	**46°**	**44°**	**68°**	**64°**	**2**	**2**	**52°**	**53°**	**47°**	**47°**	**69°**	**70°**	**2.2**	**2.3**
MET	**50°**	**53°**	**46°**	**49°**	**63°**	**64°**	**1.9**	**1.9**	**53°**	**55°**	**48°**	**48°**	**68°**	**70°**	**2**	**1.9**
PNF	**50°**	**57°**	**49°**	**47°**	**66°**	**68°**	**2**	**2**	**51°**	**61°**	**50°**	**49°**	**71°**	**72°**	**2.1**	**2.2**

4.4 OBJECTIVE TWO: TO DETERMINE THE EFFECTIVENESS OF EACH TREATMENT IN TERMS OF SUBJECTIVE MEASUREMENTS

This analysis involved intra-group testing of the pain and disability outcomes of NDI and NRS-101.

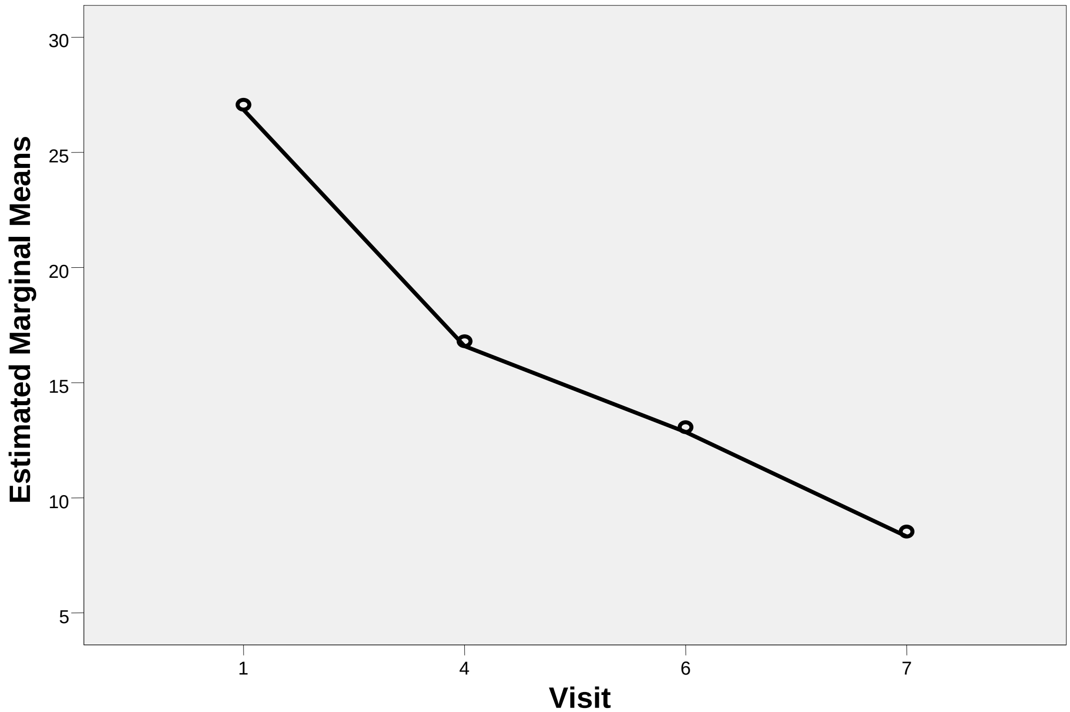
4.4.1 Group A - SMT

4.4.1.1 NDI:

The NDI score showed a statistically significant decrease over time (p = 0.002; Wilk's lambda = 0.299) in the SMT group (Figure 4.26).

4.4.1.2 NRS-101:

Similarly the mean NRS-101 score showed a highly statistically significant decrease over time (*p* = 0.001; Wilk's lambda = 0.263) in the SMT group (Figure 4.27).



<u>Figure 4.26: Mean NDI score by time in the SMT group</u>

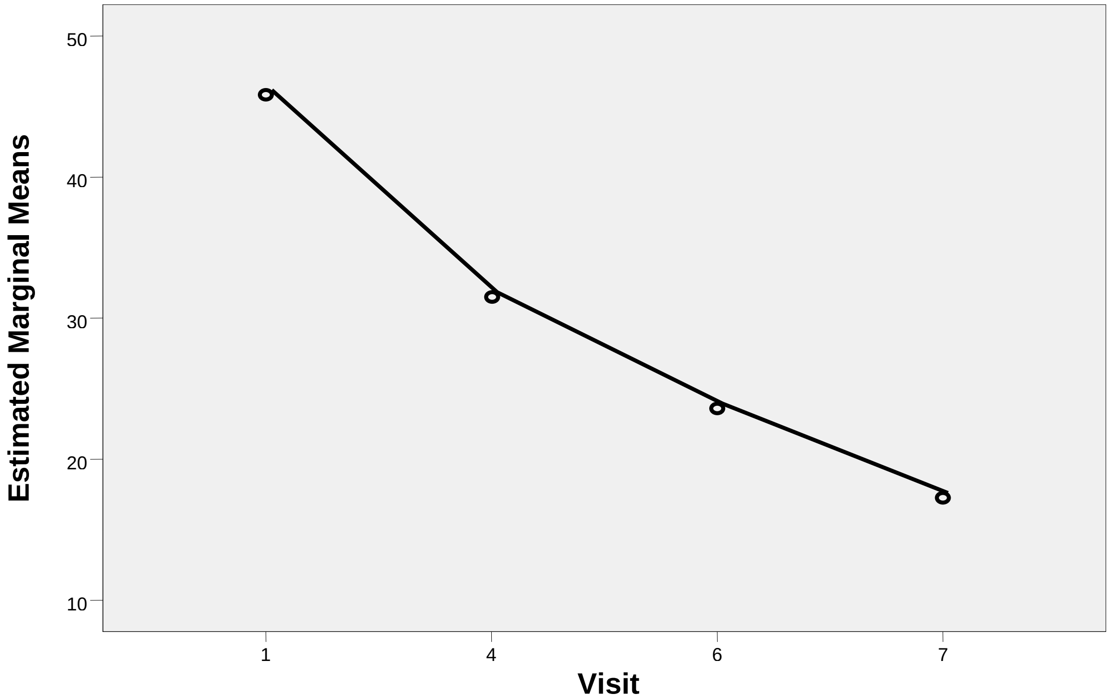


Figure 4.27: Mean NRS-101 score by visit in the SMT group

Therefore, the SMT group showed significant improvement of both subjective outcome measures over time.

4.4.2 Group B - MET

4.4.2.1 NDI:

The NDI score showed a statistically significant decrease over time (p = 0.001; Wilk's lambda = 0.246) in the MET group (Figure 4.28).

4.4.2.2 NRS-101:

Similarly, the mean NRS-101 score showed a statistically significant decrease over time (p = 0.008; Wilk's lambda = 0.388) in the MET group (Figure 4.29).

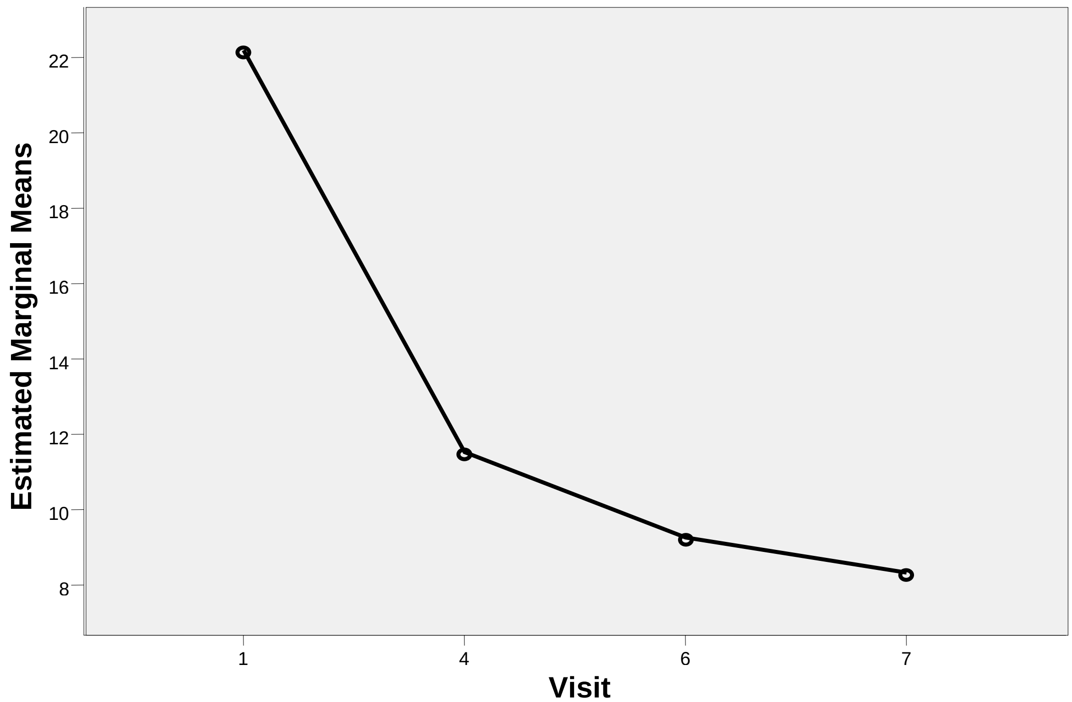


Figure 4.28: Mean NDI score by visit in the MET group

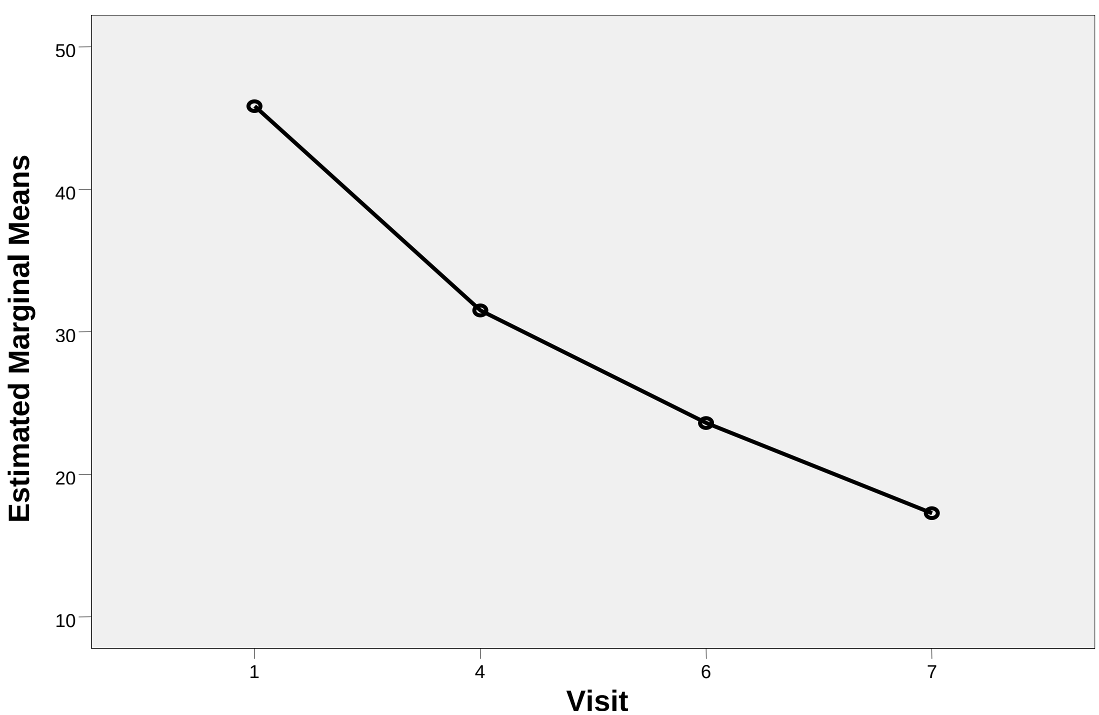


Figure 4.29: Mean NRS score by visit in the MET group

Therefore, the MET group showed significant improvement of both subjective outcome measures over time.

4.4.3 Group C - PNF

4.4.3.1 NDI:

The NDI score showed a highly statistically significant decrease over time ($p < 0.001$; Wilk’s lambda = 0.139) in the PNF group (Figure 4.30).

4.4.3.2 NRS-101:

Similarly, the mean NRS-101 score showed a highly statistically significant decrease over time ($p < 0.001$; Wilk’s lambda = 0.119) in the PNF group (Figure 4.31).

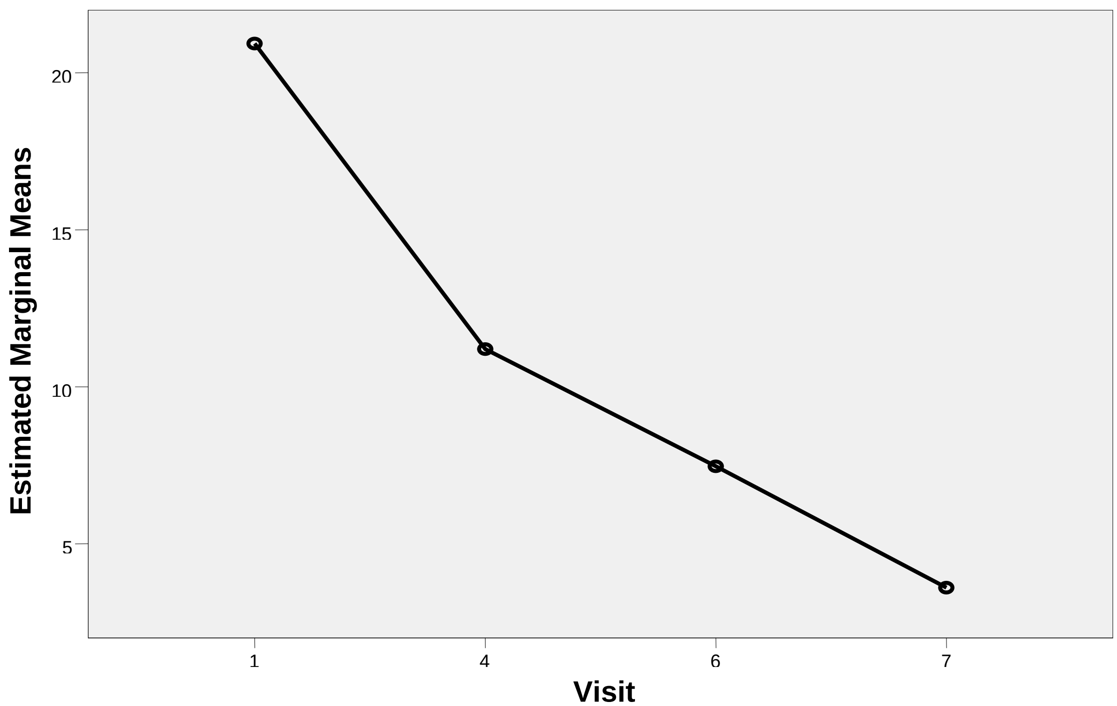


Figure 4.30: Mean NDI score by visit in the PNF group

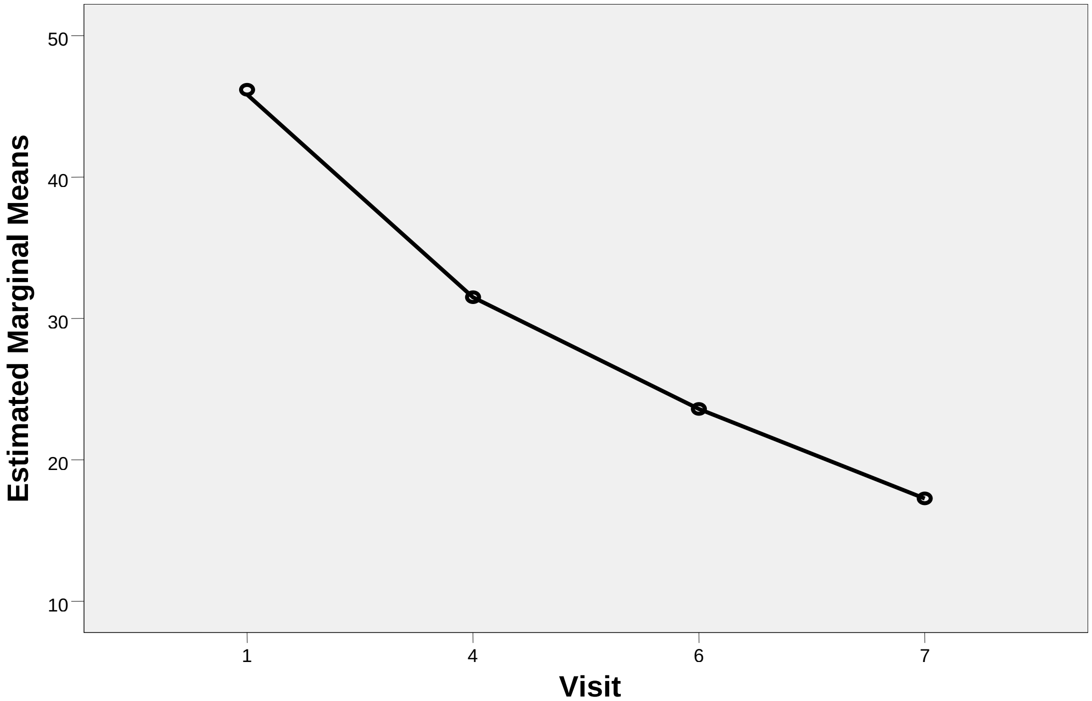


Figure 4.31: Mean NRS-101 score by visit in the PNF group

Therefore, the PNF group showed highly significant improvement in terms of both subjective measures over time.

4.4.4 A summary of the mean scores of the three groups per visit

Table 4.5 illustrates the mean scores in terms of disability and pain and shows that the disability score of SMT group initially was slightly higher than either the MET of PNF group. However, it was not statistically significant. At visit seven, the PNF group had the lowest score, but at visit one the mean score was the lowest compared to the other groups. The change was not significant. In contrast the pain scores were consistent across the groups and all groups improved uniformly.

Table 4.5: Mean NDI and NRS-101 scores per visit

	VISIT 1		VISIT 4		VISIT 6		VISIT 7	
	NDI	NRS-101	NDI	NRS-101	NDI	NRS-101	NDI	NRS-101
SMT	27	47	17	39	13	30	9	18
MET	22	47	11	37	9	31	8	17
PNF	21	46	11	32	7	24	4	17

4.5 OBJECTIVE THREE: TO COMPARE THE THREE TREATMENTS IN TERMS OF THE OBJECTIVE AND SUBJECTIVE MEASURES.

The analyses involved inter-group comparisons of the treatment effect which was measured by the time x group interaction effect in the repeated measures ANOVA model. A non-significant interaction effect signified that the three forms of treatment were equally effective.

4.5.1 Objective measurements

4.5.1.1 CROM Goniometer

4.5.1.1.1 Flexion:

There was no difference in treatment effect for flexion between the three groups (p = 0.877). Figure 4.32 shows that the profiles over time of the three groups were relatively similar and the rate of change was not different.

Table 4.6: Treatment effect within and between groups for flexion

Effect	**Statistic**	***p* value**
Time	Wilk's lambda = 0.481	< 0.001
Time*group	Wilk's lambda = 0.943	0.877
Group	F = 0.029	0.971

4.5.1.1.2 Extension:

There was no difference in treatment effect for extension between the three groups (p = 0.708). Figure 4.33 shows that the profiles over time of the three groups showed similar trends, but the PNF group appeared to increase at a slightly faster rate over time than the other two groups. However, this difference was marginal and not statistically significant.

Table 4.7: Treatment effect within and between groups for extension

Effect	**Statistic**	***p* value**
Time	Wilk's lambda = 0.538	< 0.001
Time*group	Wilk's lambda = 0.912	0.708
Group	F = 0.867	0.427

4.5.1.1.3 Left lateral flexion:

Left lateral flexion also showed no significant difference in treatment effect between the groups (p = 0.793). Thus, the effect was similar in all three intervention groups. Figure 4.34 suggests that the PNF group may have increased at a slightly faster rate than the other groups.

Table 4.8: Treatment effect within and between groups for left lateral flexion

Effect	Statistic	*p* value
Time	Wilk's lambda = 0.191	< 0 .001
Time*group	Wilk's lambda = 0.927	0.793
Group	F = 0.426	0.656

4.5.1.1.4 Right lateral flexion

Right lateral flexion also showed no significant difference in treatment effect between the groups (p = 0.656). Thus, the effect was similar in all three intervention groups (Figure 4.35).

Table 4.9: Treatment effect within and between groups for right lateral flexion

Effect	Statistic	*p* value
Time	Wilk's lambda = 0.266	< 0.001
Time*group	Wilk's lambda = 0.904	0.656
Group	F = 1.034	0.364

4.5.1.1.5 Left rotation

There was no significant difference in treatment effect for left rotation (p = 0.140), as seen in Figure 4.36.

Table 4.10: Treatment effect within and between groups for left rotation

Effect	Statistic	*p* value
Time	Wilk's lambda = 0.273	< 0.001
Time*group	Wilk's lambda = 0.790	0.140
Group	F = 0.988	0.381

4.5.1.1.6 Right rotation

There was no significant difference in treatment effect for right rotation (p = 0.836), as seen in Figure 4.37.

Table 4.11: Treatment effect within and between groups for right rotation

Effect	Statistic	*p* value
Time	Wilk's lambda = 0.184	< 0.001
Time*group	Wilk's lambda = 0.935	0.836
Group	F = 0.812	0.451

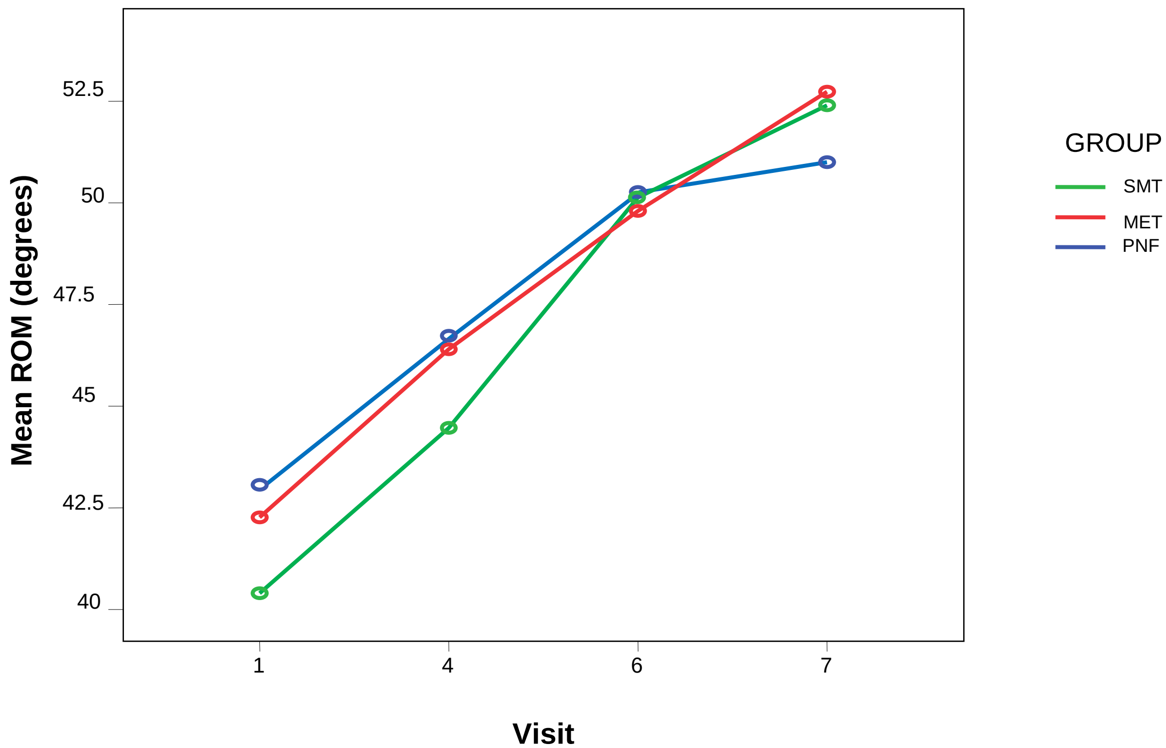


Figure 4.32: Mean degree of flexion by group per visit

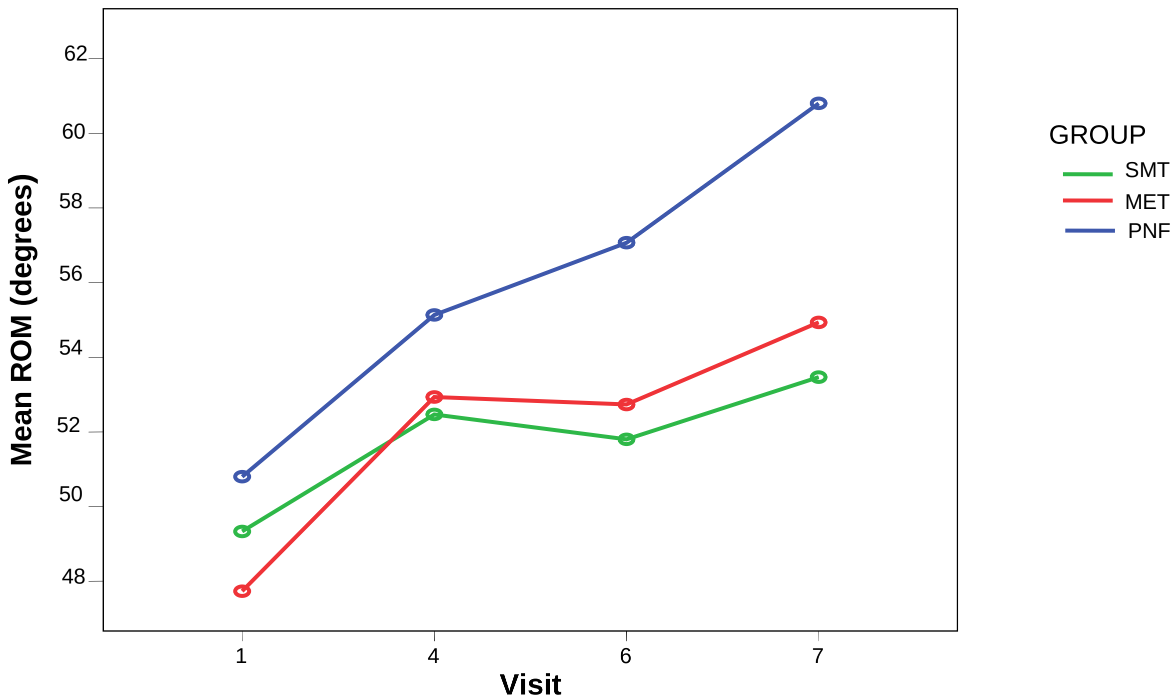


Figure 4.33: Mean degree of extension by group per visit

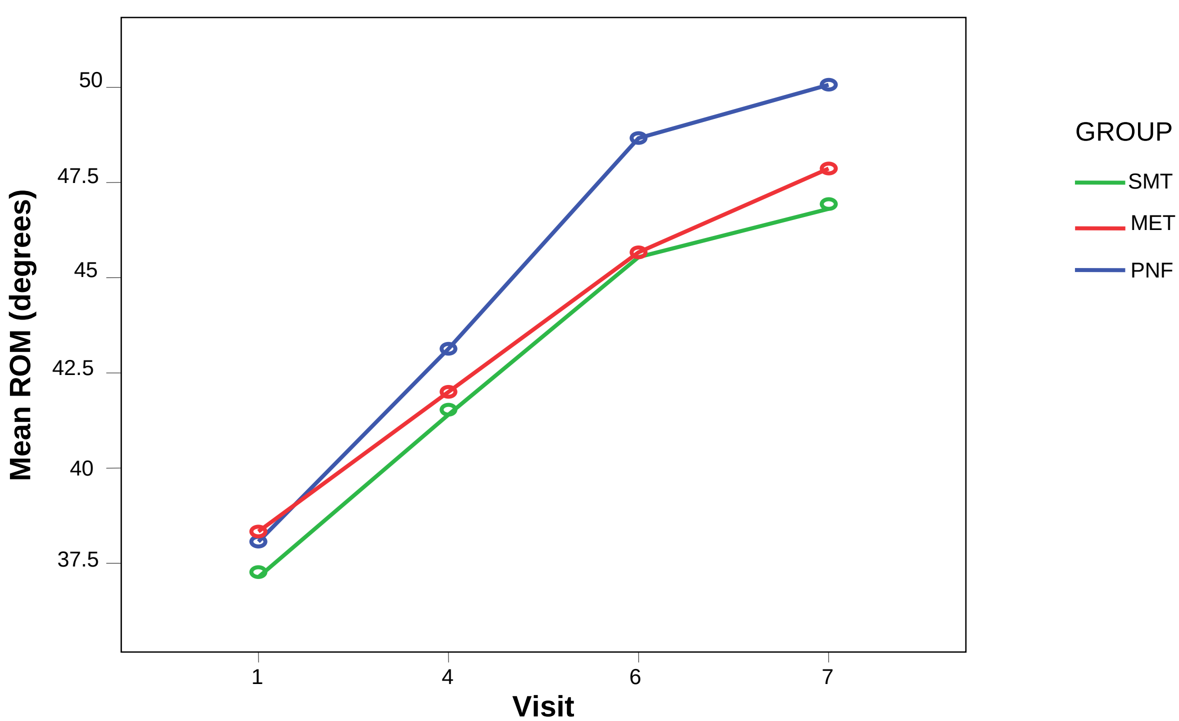


Figure 4.34: Mean degree of left lateral flexion by group per visit

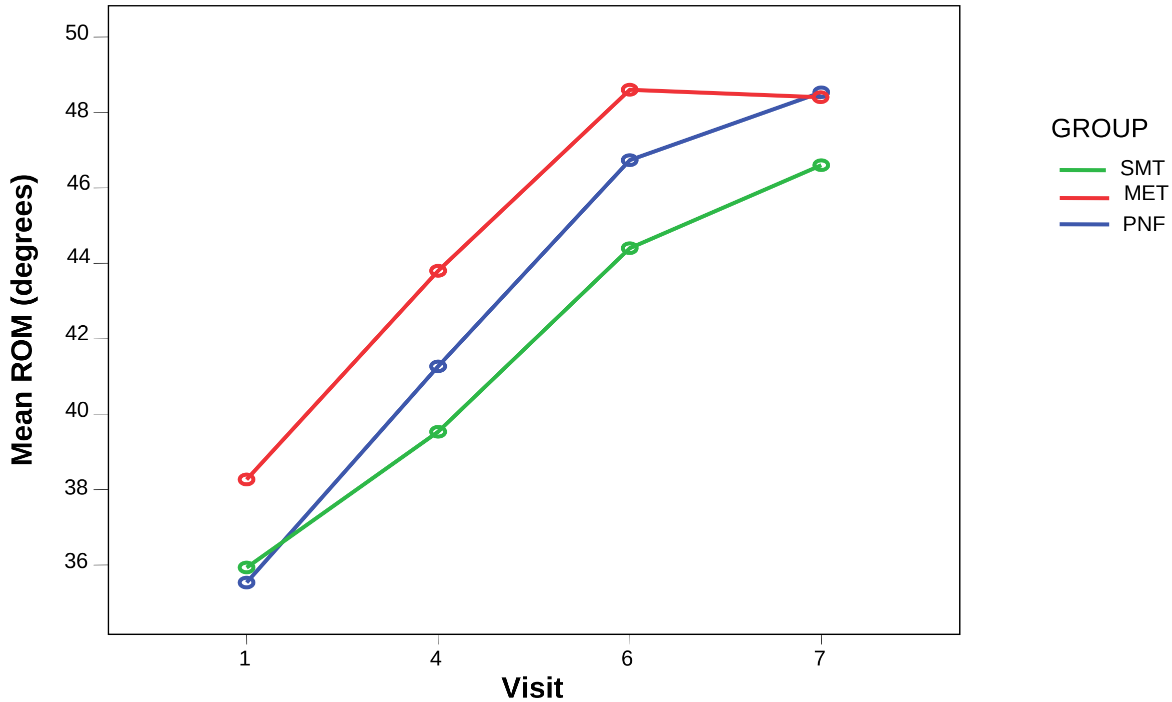


Figure 4.35: Mean degree of right lateral flexion by group per visit

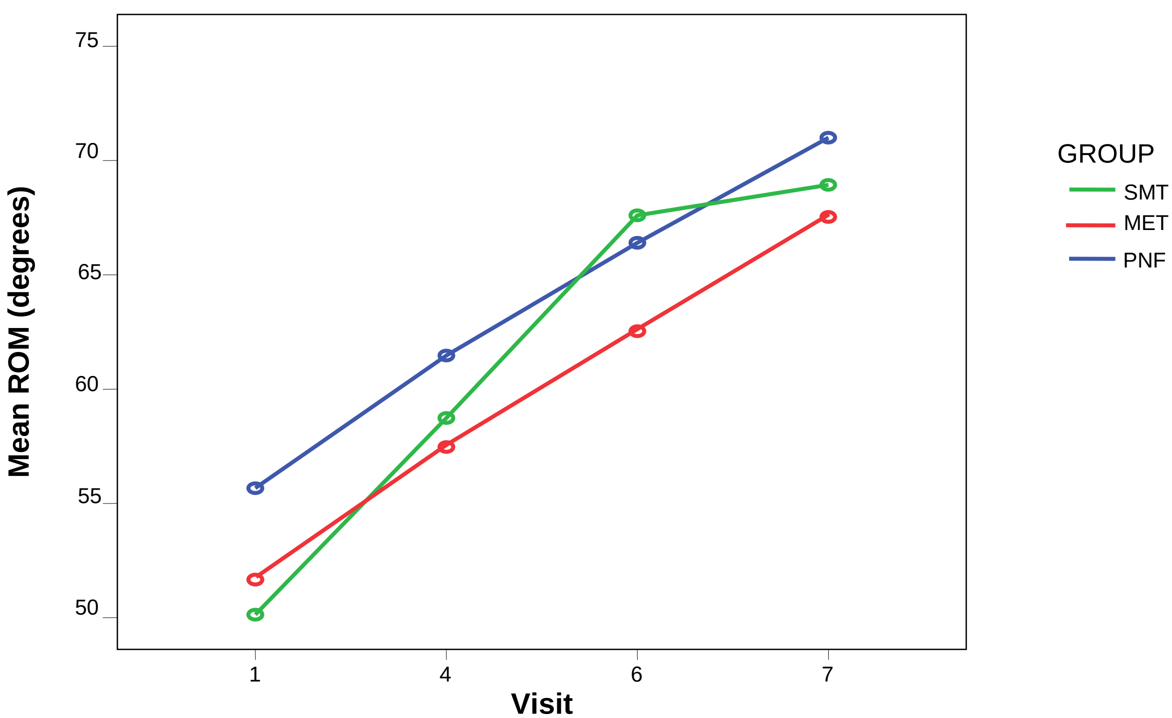


Figure 4.36: Mean degree of left rotation by group per visit

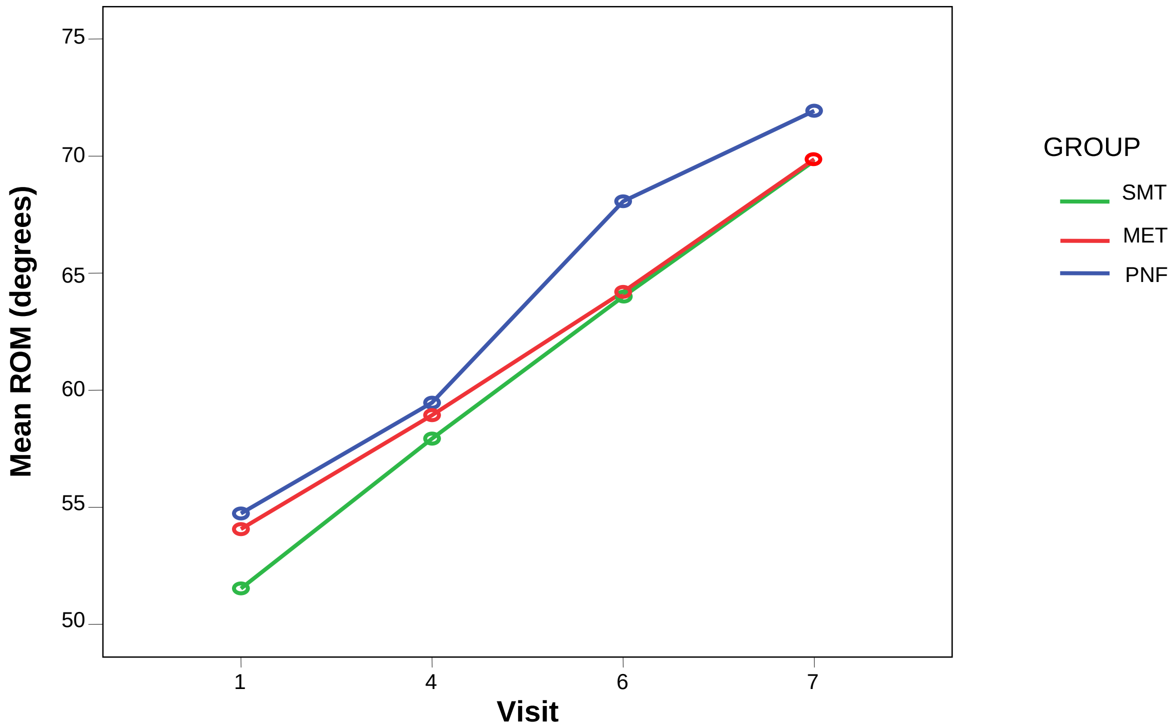


Figure 4.37: Mean degree of right rotation by group per visit

4.5.1.2 Algometer

4.5.1.2.1 Left algometer

For left algometer readings (Figure 4.38), there was no evidence of a difference in treatment effect between the three groups (p = 0.806).

Table 4.12: Treatment effect within and between groups for left algometer

Effect	Statistic	*p* value
Time	Wilk's lambda = 0.412	< 0.001
Time*group	Wilk's lambda = 0.929	0.806
Group	F = 0.129	0.879

4.5.1.2.2 Right algometer

There was no treatment effect difference either with right algometer (p = 0.494), although the MET group performed the poorest for this outcome, as seen in Figure 4.39.

Table 4.13: Treatment effect within and between groups for right algometer

Effect	Statistic	*p* value
Time	Wilk's lambda = 0.393	< 0.001
Time*group	Wilk's lambda = 0.877	0.494
Group	F = 1.166	0.322

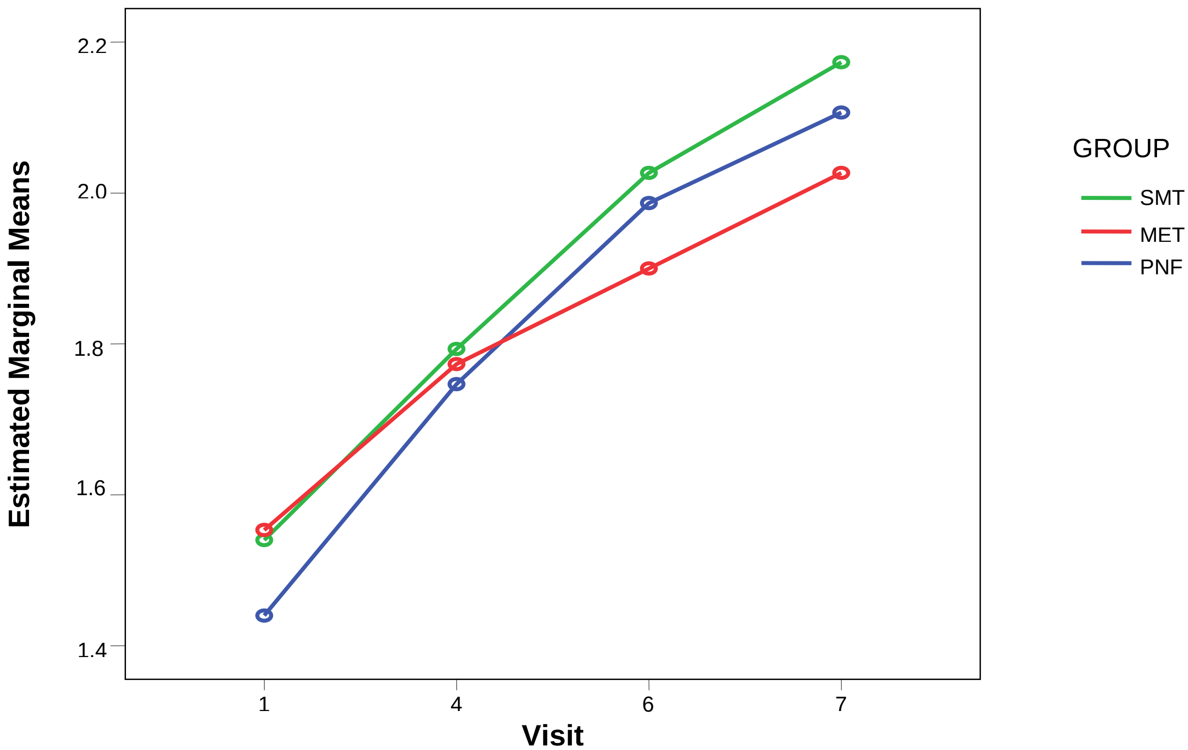


Figure 4.38: Mean left algometer reading by group per visit

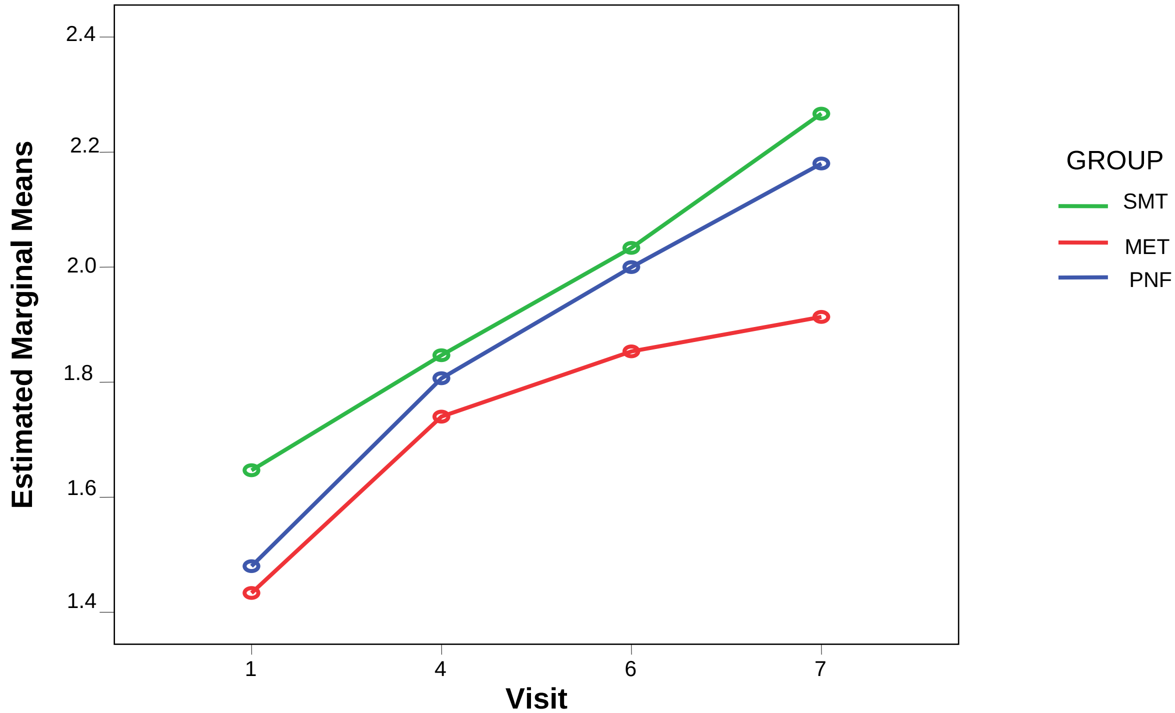


Figure 4.39: Mean right algometer reading by group per visit

Therefore, there was no difference between the effectiveness of the three forms of treatments for any of the objective outcomes.

4.5.2 Subjective measurements

4.5.2.1 NDI

For the NDI score there was no evidence of a difference between the three treatments as shown in Figure 4.40 ($p = 0.519$).

Table 4.14: Treatment effects within and between the groups for NDI

Effect	Statistic	*p* value
Time	Wilk's lambda = 0.255	< 0.001
Time*group	Wilk's lambda = 0.881	0.519
Group	F = 2.114	0.133

4.5.2.2 NRS-101

The treatment effect on NRS was not significantly different between the groups seen in Figure 4.41 ($p = 0.709$).

Table 4.15: Treatment effects within and between the groups for NRS

Effect	Statistic	*p* value
Time	Wilk's lambda = 0.269	< 0.001
Time*group	Wilk's lambda = 0.912	0.709
Group	F = 1.336	0.274

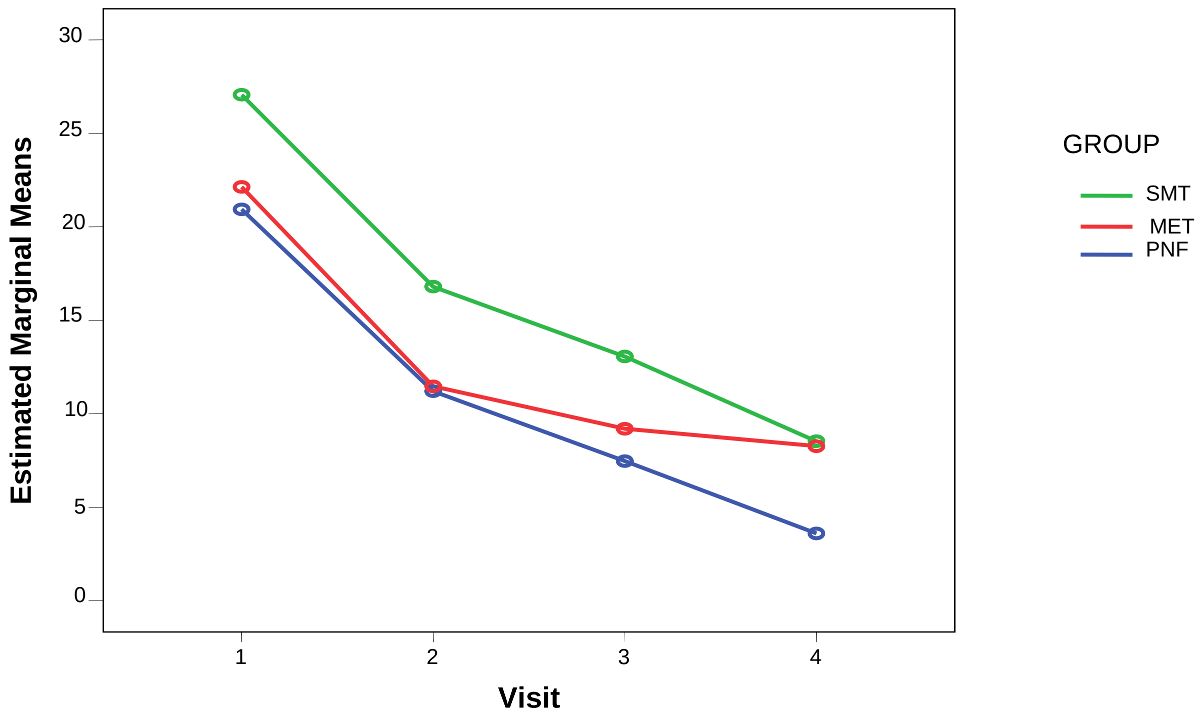


Figure 4.40: Mean NDI score by group per visit

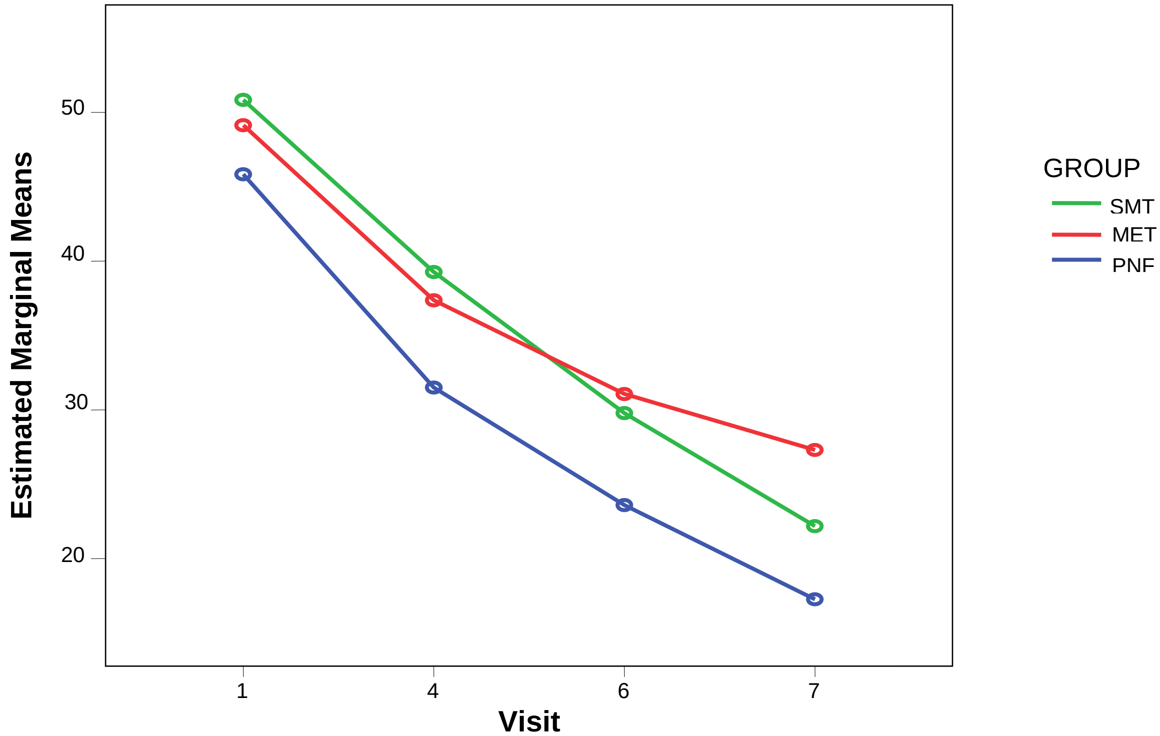


Figure 4.41: Mean NRS score by group per visit

Therefore, there was no difference between the effectiveness of the three forms of treatment for either of the subjective outcomes.

4.6 A DESCRIPTIVE ANALYSIS OF THE MOST COMMONLY OCCURRING FIXATIONS

A descriptive analysis of the most commonly occurring fixations on the left and right side was done. Figures 4.42 – 4.44 show the level at which fixations occurred by group per visit on the left and right side. In total (Figure 4.45), on the left side at visit 1 and 2, C5 fixations were most common; at visit 3, C2 fixations were most common; at visit 4 C2 and C4 were equally as common; and at visit 5, 6 and 7 C2 was again the most common fixation. On the right side (Figure 4.45) at visit 1, C2 was most common; at visit 2, C3 predominated; at visit 3 and 4, C2 was again most common; at visit 5 it was C4; at visit 6 it was C2 and at visit 7 it was C4 that was most common.

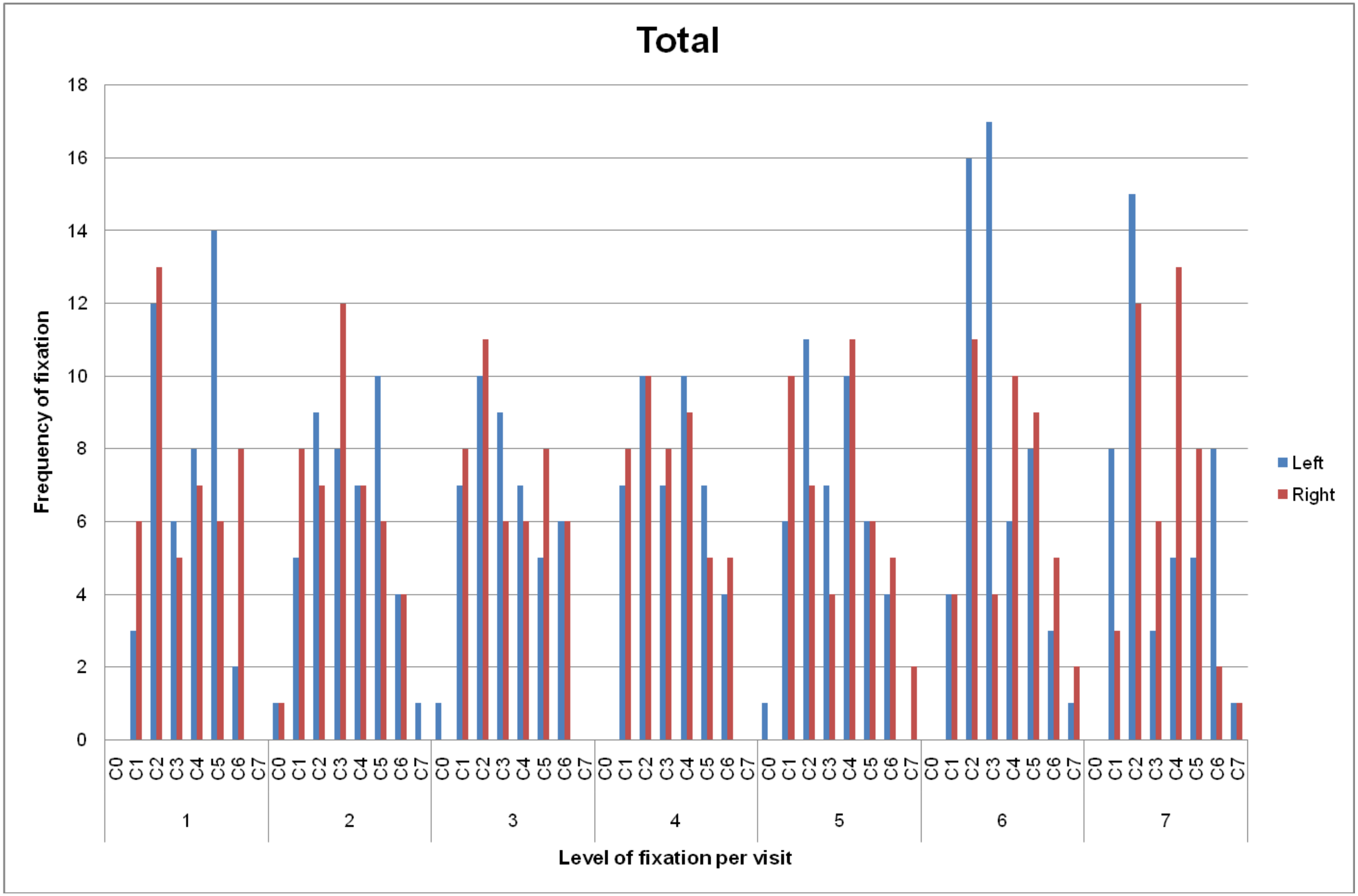


Figure 4.42 Total frequency and level of fixations per visit

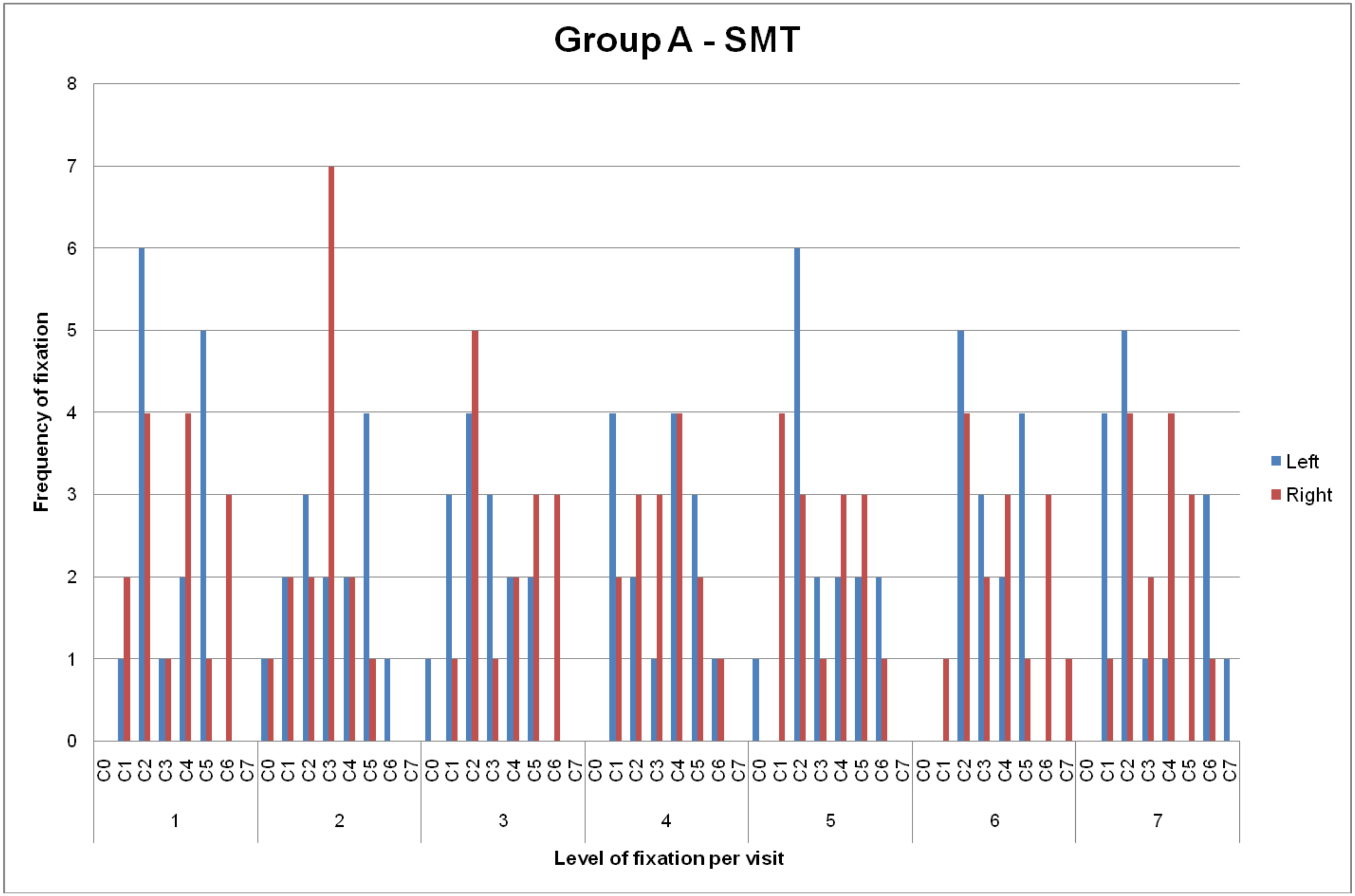


Figure 4.43 Frequency and level of fixation in SMT group

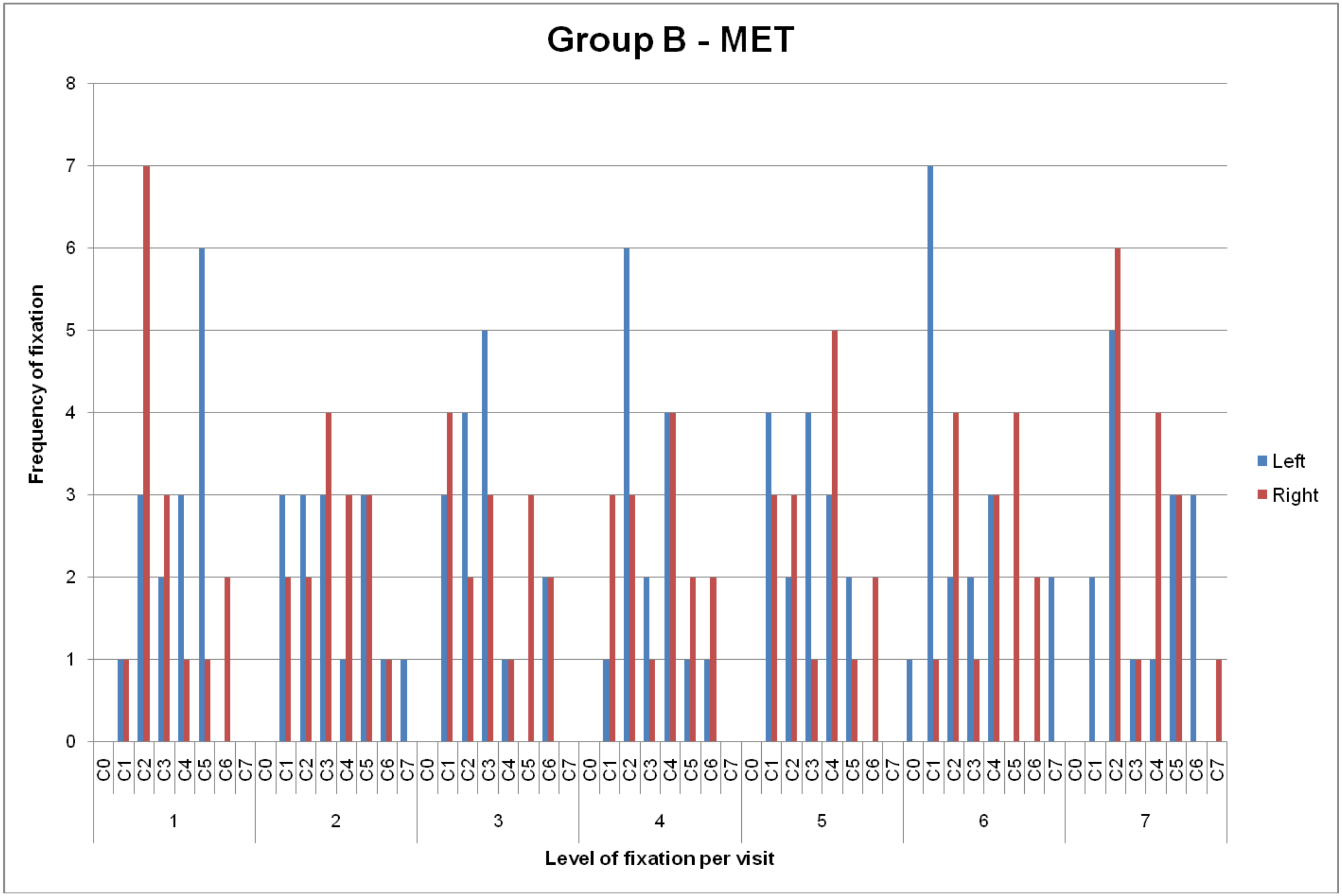


Figure 4.44 Frequency and level of fixation in MET group

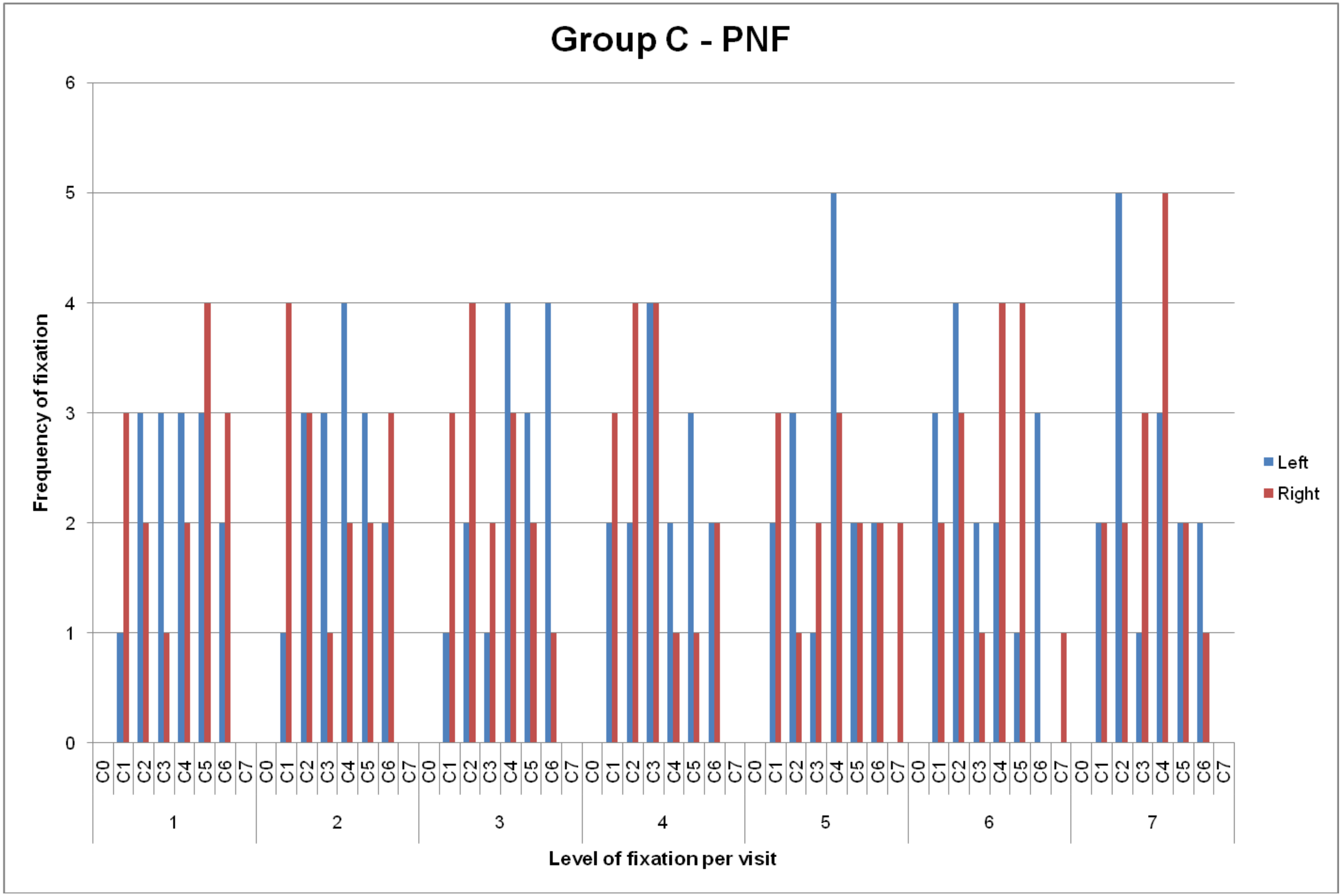


Figure 4.45 Frequency and level of fixation in PNF group

CHAPTER FIVE
DISCUSSION OF RESULTS

5.1 INTRODUCTION

This chapter involves the discussion of the results of the demographic, objective and subjective data that was presented in chapter four. The discussion of data will follow objective one to three, with an additional descriptive analysis of most commonly occurring fixation levels.

5.2 DEMOGRAPHICS

5.2.1 Age

The age distribution across the groups was similar (Table 4.1) with the overall mean age (p = 0.348) of the participants being 25.8 years. This can be accounted for by the fact that 71% of the participants were students, due to the research study taking place at the Chiropractic Day Clinic which situated on Durban University of Technology (DUT) campus and, therefore, more readily accessible to people of a younger age group.

5.2.2 Sex

Of the 45 participants, 33 were female and 12 were male (Table 4.2). However, the ratio of male to female remained the same for each group (p = 0.711). This is in keeping with research done by Côte *et al.* (2003) and Guez *et al.* (2002) who stated that neck pain is more common among women.

5.2.3 Race

There were similar percentages of race groups within each treatment group (p = 0.0344), therefore, the groups were comparable in terms of race (Table 4.3). The coloured population was the least represented in this study and this may be due to coloureds making up only 1.4% of the race distribution in KwaZulu-Natal (Statistics South Africa, 2007).

5.2.4 Occupation

Figure 4.1 highlights that student was the most common ‘occupation’. This could partly be because the researcher set up screening clinics at the DUT library to recruit potential patients and partly because the Chiropractic Day Clinic is on DUT campus and, therefore, more readily accessible to students.

5.2.5 Conclusion

The demographics of age, sex and race were comparable across all three groups since there was no statistical significance between the groups for these variables. However, it must be acknowledged that there was a predominance of white, female's participants who were mostly students. The implication of this is that the level of degenerative joint disease in this group would be less than an older population therefore they may have responded better than an older population

5.3 OBJECTIVE ONE: TO DETERMINE THE EFFECTIVENESS OF EACH TREATMENT IN TERMS OF OBJECTIVE MEASUREMENTS

5.3.1 Group A – SMT

5.3.1.1 CROM measurements and Algometer readings

The CROM data was analyzed in Figure 4.2 to 4.7. A statistically significant increase ($p < 0.05$) was seen in all ranges of motion (ROM) except extension. The left and right algometer readings were analyzed in Figure 4.8 and 4.9 respectively. Both sides showed a statistically significant increase ($p < 0.05$) over the course of the treatment.

5.3.1.2 Discussion and similar studies

The increases in range of motion and algometer readings is supported by Peterson and Bergman (2002), who attribute the effects of manipulation to the stretching of periarticular tissues, release of intra-articular and extra-articular adhesions and stimulation of joint nociceptors and mechanoreceptors resulting in a decrease of muscle spasm, soft tissue inextensibility and muscle fatigue. Curl (1994) also states that manipulation causes stimulation of the nervous system resulting in reflex inhibition of pain.

The findings of this study are also in keeping with Whittingham and Nilsson (2001) who conducted a double-blind randomized controlled trial (n = 105) to study the effect of spinal manipulation on cervical ROM. The authors concluded that after receiving spinal manipulation, active range of motion in the cervical spine increased significantly ($p < 0.0006$).

Regarding the algometer readings, Vernon *et al*. (1990) in a pilot study ($n = 9$) to evaluate the effect of spinal manipulation on chronic neck pain in terms of pressure threshold, concluded that in the group receiving manipulation, pressure pain threshold increases were between 40 – 56% (mean = 45%). The control group showed no change.

Cassidy *et al*. (1992b), assessed the immediate effects of cervical spine manipulation in the treatment of mechanical neck pain (MNP) ($n = 50$) and found an increase in all planes of post-treatment ROM and a decrease in post-treatment pain scores (NRS – 101). A similar study ($n = 36$) by Pikula (1999) on the effect of manipulation in acute unilateral neck pain, concluded that following a single manipulation ipsilateral to the neck pain, there was increased ROM and less pain intensity (according to the Visual Analog Scale). Whilst an unpublished study ($n = 30$) by Van Schalkwyk and Parkin-Smith (2000) revealed very similar findings when comparing the efficacy of two different types of manipulation in the treatment of MNP.

The results of this study are in keeping with the current body of literature which states that cervical manipulation increases ROM and decrease in neck pain sufferers.

5.3.2 Group B – MET

5.3.2.1 CROM measurements and Algometer readings

The CROM data was analyzed in Figure 4.10 to 4.15. A statistically significant increase was seen in all ranges of motion from visit one to seven. The left and right algometer readings were analyzed in Figure 4.16 and 4.17 respectively. The left algometer reading showed a statistically significant increase ($p = 0.012$) over time. However, the right algometer reading did not improve as dramatically ($p = 0.068$).

5.3.2.2 Discussion and similar studies

The effectiveness of MET to increase range of motion and algometer readings lies within the concentric isotonic contraction. Concentric isotonic contractions are made against a progressive increasing counter-force (resistance), resulting in increased strength and tone of a muscle. This will also cause inhibition of the antagonistic muscle activity if it is to be performed throughout the range of motion of the muscle. These concentric isotonic contractions of the muscle are also used to mobilize joint fixations (Greenman, 1996).

The following studies, using MET as a manual therapy, have found results comparable to this study. Schenk *et al*. (1994) investigated the effect of MET on cervical range of motion in asymptomatic subjects (n = 18) and found after six treatments over a period of four weeks, all six planes of motion increased; however, in contrast to the current study the only statistically significant ($p < 0.05$) increase was seen in left and right rotation.

Burns and Wells (2006) found that MET improved the overall active cervical ROM among young to middle aged asymptomatic adults ($p < 0.001$); whilst a clinical trial by Boodhoo (2002), where chronic MNP sufferers received six treatments of MET, found a global increase in cervical ROM, as was found in the current study.

The results of this current study shows that MET, specifically joint mobilization, is effective in the treatment of chronic mechanical neck pain by increasing ROM and decreasing pain and that it can be used with equal effectiveness when manipulation is contra-indicated.

5.3.3 Group C – PNF

5.3.3.1 CROM measurements and Algometer readings

The CROM data was analyzed in Figure 4.18 to 4.23. A highly significant increase was seen in all range of motion over time. The left and right algometer readings were analyzed in Figure 4.24 and 4.25 respectively. Both showed a statistically significant increase over time.

5.3.3.2 Discussion and similar studies

According to Prentice (1983) and Guyton (1997) PNF works through the following two mechanisms: a) Reciprocal inhibition is the mechanism of action by which PNF increases muscle length and relaxation and b) Autogenic inhibition occurs if the stretch is continued over a prolonged period, the inhibitory signals from the Golgi tendon will override excitatory impulses causing relaxation of the muscle. According to Liebenson

(1996), PNF stretching treats muscles primarily by relaxing overactive muscles and stretching shortened muscles, thus, it has a positive effect on both pain and ROM.

There is a paucity of literature regarding the use of PNF (CRAC) stretching technique as a manual therapy for chronic mechanical neck pain. However, an unpublished study at the DUT - by Wilson (2002) - comparing (n = 60) a combination of PNF (CRAC) and cervical manipulation to cervical manipulation alone, found that although both groups improved only the former treatment group showed a clinically significant improvement in pain and ROM.

McCarthy *et al*. (1997) in a similar study on asymptomatic males (n = 40) found an increase in active ROM which was statistically significant during a seven day PNF stretching protocol. However, the effects wore off rapidly after protocol was discontinued to the extent that seven days after treatment, ROM was back to pre-stretching values. In comparison to the current study the increased ROM was sustained at the one week post-treatment follow-up consultation. This could be because the patients in this study were symptomatic.

In this study a significant improvement was seen in ROM and pain within the PNF group which adds to the scares literature regarding the use of PNF stretching in chronic MNP.

5.3.4 Conclusion

Baseline values were fairly similar across all three groups (Table 4.4). The extension range of motion showed a highly significant improvement in the PNF group, a significant improvement in the MET group but there was a lack of statistical significance within the SMT group. A possible explanation may be attributed to the nature of the manipulation carried out - only rotary and lateral flexion manipulation were administered with no extension manipulations. These results could also be attributed to the muscular component associated with MET and PNF techniques. The primary action of the Posterior Cervical muscles is neck extension and secondary action is lateral flexion and rotation. Unilateral activation of upper fibers of Trapezius muscle results in lateral flexion to the same side and extreme rotation, and acting bilaterally causes neck extension (Travell *et al.,* 1999). Contraction of these muscles will allow the muscles to lengthen and allow a greater neck ROM (Greenman, 1996). It should also be noted that a larger sample size may show a difference in this variable. Algometer readings showed a consistent improvement across all three groups throughout the treatment period.

Therefore, results of this study are in keeping with previous clinical trials (Pikula, 1999, Whittingham and Nilsson, 2001 and Boodhoo, 2002) that have shown that SMT and MET increase ROM and decrease pain. This study has shown PNF to be equally effective in increasing ROM and decrease pain (point tenderness) to a similar degree as SMT and MET in patients with chronic MNP. In clinical practise, according to the results of this study, PNF stretching could be used if either SMT or MET is contra-indicated.

5.4 OBJECTIVE TWO: TO DETERMINE THE EFFECTIVENESS OF EACH TREATMENT IN TERMS OF SUBJECTIVE MEASUREMENTS

5.4.1 Group A – SMT

5.4.1.1 NDI and NRS-101 scores

The NDI score was analyzed in Figure 4.26. It showed a statistically significant decrease over time ($p = 0.002$) which indicates an improvement in the patients' perceived state of wellness (Vernon and Mior, 1991). The NRS-101 disability score was analyzed in Figure 4.27. It also showed a highly statistically significant decrease over time ($p = 0.001$)

5.4.1.2 Discussion and similar studies

According to Peterson and Bergman (2002), the decrease in pain disability scores could be due to the neuromechanical and/or the neurological effects of manipulation.

The results of this study are in keeping with Giles and Muller (1999) who conducted a prospective, independently assessed pre-intervention and post-intervention pilot study of the different treatments of chronic spinal pain syndromes (neck and back) and found that the manipulation group ($n = 36$) (after a treatment period of 4 weeks) was the only group that showed a statistically significant improvement ($p = < 0.001$). More specifically patients who received neck manipulations had a 25 % improvement on the NDI scores and pain reduction according to the visual analogue scale was 33% for the neck. Similar improvement was seen in the current study – 33% NDI (NDI visit one = 27; NDI visit seven = 9) and NRS-101 38% improvement (NRS-101 visit one = 47; NRS-101 visit seven = 18). Slightly greater pain and disability improvements were noted by McMorland and Suter (2000) which were 53.8% and 48.4% respectively. These patients, however, had 12 treatments over a four week period.

Similar decreases were seen in a pilot study (*n* = 50) done by Cassidy *et al*. (1992b), who measured the NRS–101 pain scores after a single manipulation and found a mean improvement of 12.6 points on this scale between pre and post-treatment scores. In comparison to this study the NRS-101 pain scores decreased from a mean 47 points at the first consultation, to a mean of 18 points at the seventh consultation. That is an improvement of 29 points. This significantly greater improvement could be attributed to the fact that in this study, patients received a course of six treatments compared to a single manipulation.

5.4.2 Group B – MET

5.4.2.1 NDI and NRS-101 scores

Both the NDI and NRS scores showed a statistically significant improvement of $p = 0.001$ and $p = 0.008$ respectively over time. This can be seen in Figure 4.28 and Figure 4.29.

5.4.2.2 Discussion and similar studies

Few studies were found using MET together with these subjective measurement tools, however, the study of Boodhoo (2002) described earlier, found that inter-group analysis of the NRS–101 showed that there was no statistical difference between the treatment group and the control group ($p > 0.05$) prior to the first treatment. However, following the last treatment, a statistically significant difference was noted between the treatment and control group ($p < 0.05$) indicating that the treatment group showed a greater reduction in the perception of pain intensity than the control group.

In a randomized controlled clinical trial, Schwerla *et al*. (2008) tested an osteopathic intervention, including MET, on participants suffering with chronic neck pain (*n* = 41). The main outcome parameter was pain intensity measured by numerical pain rating scale (range 0-10). In the treatment group, the average pain intensity decreased from 4.7 to 2.2, which is comparable to the MET group of this study which had a decrease of 47 to 17 on the NRS-101 scale.

In another study, Hoving *et al*. (2002) found that when mobilization was compared to exercise therapy and continued general practitioner care, the results indicated a statistically significant improvement in NDI scores of at least 5.9 points. However, the differences among the group were not statistically significant. In this study the MET group (which is a type of mobilization technique) NDI scores decreased by 14 points over the course of the seven treatments.

The finding of this study is comparable with the current literature, stating that MET is effective in decreasing pain and relieving disability due to neck pain.

5.4.3 Group C – PNF

5.4.3.1 NDI and NRS-101 scores

Both NDI disability and NRS scores showed a highly statistically significant decrease over time ($p < 0.001$). This can be seen in Figure 4.30 and Figure 4.31 respectively.

5.4.3.2 Discussion and similar studies

The only study that was found comparable to this one in terms of both subjective measurement tools was that of Wilson (2002). Intra-group statistical analysis of the NDI revealed an improvement in both the manipulation only (group A) ($p = 0.001$) as well as the manipulation and PNF (group B) ($p = 0.001$). Similar improvements were seen in the NRS scores - the p-value for group A was $p = 0.001$ and for group B it was $p = 0.001$. However, inter-group data analysis reveals that in terms of the NDI there was no statistically significant difference ($p = 0.84$) between the groups. The NRS also showed no statistically significant difference ($p = 0.894$) between the groups. Therefore, this indicates that both groups responded equally well to their respective treatment protocols.

5.4.4 Conclusion

Baseline scores for pain and disability were similar across all three groups (Table 4.5). It was noted that the SMT group had the highest disability scores but it was not statistically significant when compared to the other two groups. At visit seven, the PNF group had the lowest score, but at visit one the mean score was the lowest compared to the other groups. The change was not significant. In contrast the pain scores were consistent across the groups and all groups improved uniformly.

The results of the SMT and MET groups of this study are in keeping with the current literature (McMorland and Suter, 2000, Boodhoo, 2002 and Schwerla *et al*., 2008) which shows an improvement in pain and disability scores. There is a paucity of literature regarding the use of PNF in chronic MNP, hence the same conclusion could not be drawn. However, in view of the results of the current study, the PNF group showed similar improvements regarding pain and disability than both the SMT and MET groups. This clinical improvement shows promising results for future use of PNF stretching in chronic MNP however, it warrants further investigation.

5.5 OBJECTIVE THREE: TO COMPARE THE THREE TREATMENTS IN TERMS OF THE OBJECTIVE AND SUBJECTIVE MEASURES.

5.5.1 Objective measurements

5.5.1.1 CROM measurements and Algometer readings

CROM inter-group comparisons of the treatment effect were done in Figure 4.32 to Figure 4.37. There was no significant difference in the treatment effects of the three groups, however, extension and left lateral flexion improved at slightly faster rate in the PNF group compared to the other two groups, but the differences were marginal and not statically significant. Inter-group analysis of the algometer reading can be seen in Figure 4.38 and Figure 4.39 and shows that all three treatments responded at a similar rate over the treatment period.

5.5.2 Subjective measurements

5.5.2.1 NDI and NRS-101 scores

The inter-group analysis of the NDI and NRS shows that there was no statistical difference between the treatments with $p = 0.519$ and $p = 0.709$ respectively. This can be seen in Figure 4.40 and Figure 4.41.

5.5.3 Discussion and similar studies

At present no studies exist that compare SMT, MET and PNF as treatment protocols for chronic mechanical neck pain. In the current literature, most studies compare SMT with passive or active (MET) mobilization. In an unpublished study done by Scott-Dawkins

(1996) (*n* = 60) comparing SMT and MET in the treatment of mechanical neck pain, results concluded that initially the SMT group showed a greater reduction in pain, whereas the MET group improved gradually over the three week treatment period. However, after the sixth treatment there was no statistical difference between the two groups. This was also the finding of Cassidy *et al*. (1992b) who compared the immediate effect of SMT versus MET in mechanical neck pain (*n* = 100). Both groups showed an increase in range of motion but 85% of the SMT group and 69% of MET group reported a pain reduction immediately after treatment. The decrease in pain intensity was more than 1.5 times greater in the SMT group ($p = 0.05$).

Martinez-Segura *et al*. (2006) analyzed the immediate effects on neck pain and active cervical range of motion after a single cervical high-velocity low-amplitude (HVLA) manipulation or a control mobilization procedure in mechanical neck pain subjects (*n* = 70). They found that the SMT group obtained a greater improvement than the control group in all the outcome measures (pain and range of motion) ($p < 0.001$). This could explain why the MET group performed the poorest in terms of the algometer readings.

In contrast to the above mentioned studies, Hamilton *et al*. (2007) did a study (*n* = 90) on the effects of SMT and MET in suboccipital tenderness in asymptomatic patients. Data analysis revealed significantly greater pain pressure threshold in both SMT and MET groups ($p < 0.01$) but not in the control group ($p = 0.35$) five minutes post treatment. However, thirty minutes post treatment only the MET group showed a significant change ($p < 0.03$) compared to the SMT ($p = 0.29$) and control group ($p = 0.21$).

Hurwitz et al. (2002) compared the relative effectiveness of SMT and passive mobilization in patients with neck pain and concluded that in both these treatment protocols there was a mean reduction in pain and disability throughout the six months and that neither was superior.

Throughout the literature PNF (CRAC) stretching technique is positioned to be the most effective stretching technique for increasing range of motion, especially in the short term (Sharman *et al.,* 2006) and when compared to ballistic or static stretching (Shrier and Gossal 2000, and MacDougall 1999). A decrease in muscle stiffness is said to increase joint range of motion (Shrier and Gossal, 2000). The primary function of the Posterior

Cervical and Trapezius muscle is extension and lateral flexion respectively. The slightly faster rate of improvement (in terms of ROM) in the PNF group can be attributed to the fact that these muscles were specifically targeted (Travell *et al.,*1999). The differences were not statistically significant but this could be an area for further research in terms of using a larger sample size.

5.5.4 Conclusion

All three manual therapy techniques responded similarly in both objective and subjective measurements over the treatment period. However, when comparing the results of the SMT and MET groups it was noted that the SMT group had a greater disability score than the MET group at the initial consultation which was 27 and 22 respectively. At the one week post-treatment follow-up consultation, the disability scores were within one point of each other (SMT = 9 and MET = 8). These results were deemed as statistically insignificant but it seems to be in line with a trend (Cassidy *et al*., 1992(b), Scott-Dawkins, 1996 and Martinez-Segura *et al*., 2006) that when SMT is compared to MET, SMT responds with a greater pain reduction than MET. Due to the paucity of published literature regarding the use of PNF stretching in chronic MNP in terms of disability and pain, there was no means of comparing the results of this study with others. This study, however, recorded favourable results comparable to that of the SMT and MET treatments groups.

The overall results of this study are in keeping with the review of current literature by Haldeman *et al*. (2008) and Aker *et al*. (1996) who supported the use of neck manipulations, mobilizations, education, acupuncture analgesics, massage, low-level laser and exercise therapy in the treatment of "non-specific" (simple) neck pain. They concluded that none of these active treatments were superior to any other in the short or long term and that no one treatment has been studied in enough detail to assess its efficacy or effectiveness adequately.

5.6 A DESCRIPTIVE ANALYSIS OF THE MOST COMMONLY OCCURRING FIXATIONS

In total the most common fixations occurred at C2 and C4 on the left and right side. There are no other studies which documented the fixation levels, therefore, no correlation between other studies could be made.

5.7 THE FINAL HYPOTHESES

- The first and the second hypotheses are accepted since there are statistically significant changes in most objective and subjective measurements for all three treatment groups.
- The third hypothesis is also accepted since no one manual therapy technique was found to be statistically more effective than the next.

CHAPTER SIX
RECOMMENDATIONS AND CONCLUSION

6.1 RECOMMENDATIONS

Mechanical neck pain is variable by nature; therefore, subsequent studies should consider methods of producing a more uniform sample group, taking into account the patient's age, gender, chronicity of neck pain and emotional stress levels.

There was no blinding procedure used in this study. It is recommended for future studies to use a single-blind study design. Assessments of the objective measurements should be done by someone other than the researcher and would eliminate researcher bias and, therefore, increase the validity of the study.

A sample size of 45 patients was used, with each group containing 15 patients. A larger sample size should be used in future studies as it would allow the use of parametric testing which enables the detection of subtle changes in the data. This would minimize the possibility of a Type II error. The error of failing to reject a null hypothesis when it is in fact not true. In other words, this is the error of failing to observe a difference when in truth there is one.

To ensure consistency, each treatment should be scheduled as strictly as possible giving validity to the treatment protocol. For example, this study allowed six treatments over a period of 3 weeks, with a follow-up visit within the following week. There was no specification as to when the treatments were to be administered. The only stipulation was that patients were to be treated twice a week. The follow-up consultation did not take place at a specific time period after the last treatment was administered. In an ideal setting all consultations could be set at consistent interval however; clinical practice does not work like this.

Further research could focus on manipulation and MET with algometer readings at a single joint dysfunction level as opposed to multiple levels used in this study, to asses if similar outcomes are achieved.

Follow-up consultations are also recommended at one and six month intervals to compare the intermediate and long term effects of these three types of manual therapy.

For the purpose of further research it would be interesting to note if similar fixation levels occur in other studies, what the dominant hand of the patient is, as well as the researcher to see if one side is favoured by the researcher during motion palpation.

6.2 CONCLUSIONS

The purpose of this study was to compare three manual therapy techniques in terms of objective and subjective findings.

- This study is in agreement with the large body of evidence suggesting that SMT and MET techniques have a positive effect on mechanical neck pain. Statistically significant changes were noted for all objective and subjective measurements over the time period assessed for each individual therapy.

- There is currently no published literature available comparing the effects of PNF to SMT and/or MET; however, the results of this study have shown PNF to be equally effective as SMT and MET in terms of pain, range of motion and disability scores.

- This study shows that no one technique was superior to the next in terms of either objective or subjective measurements ($p > 0.05$). It must be noted that in the PNF group extension and lateral flexion improved slightly faster than with any other technique. However, it was not statistically significant.

- In closing, the results of the current study are in keeping with the current literature by Haldeman *et al.* (2008) who advocates that all forms of manual therapy are of value when treating MNP since it was found that SMT, MET and PNF were equally effective.

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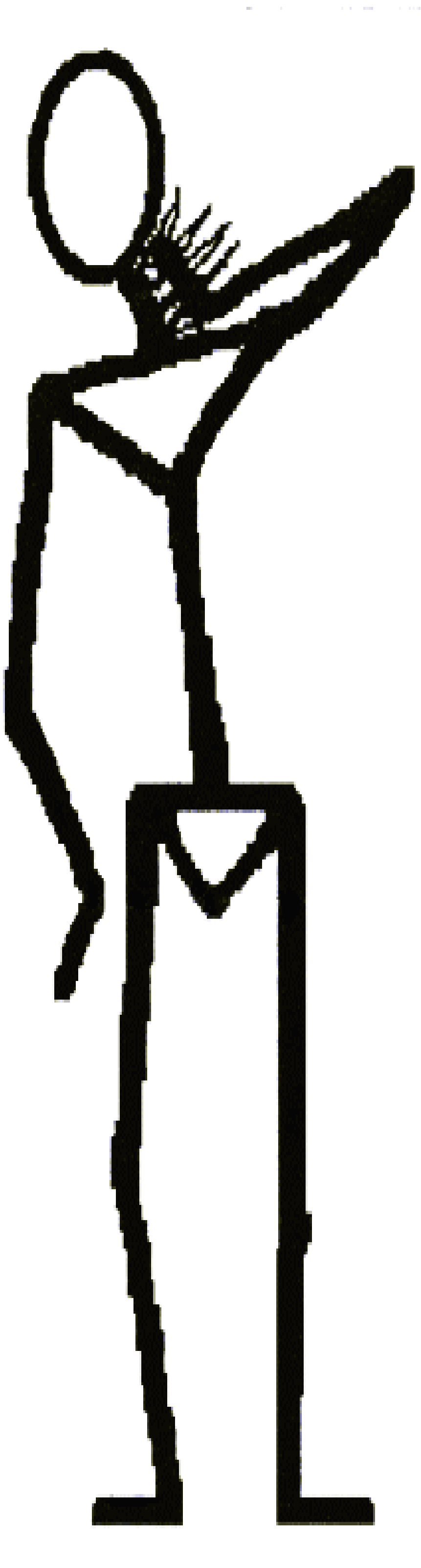
APPENDIX A
ADVERT



DO YOUR SUFFER FROM

NECK PAIN

Are you between the ages of 18-45

Research is currently being carried out at the Durban University of Technology

Chiropractic Day Clinic

FREE TREATMENT

Is available to those who qualify to take part in this study

For more information contact Marlise on (031) 373 2205 / 2512

APPENDIX B
LETTER OF INFORMATION AND INFORMED CONSENT

DURBAN UNIVERSITY of TECHNOLOGY

DATE:

Dear Participant, welcome to my research project.

Title of Research:

A comparative study of three different types of manual therapy techniques in the management of chronic mechanical neck pain.

NAME OF RESEARCH STUDENT

Marlise Roodt Contact Number (031) 2042205

NAME OF RESEARCH SUPERVISORS

Dr. Laura Wilson Contact Number (031) 373 2923
[M.Tech:Chiropractic]

Dr. Nikki de Busser Contact Number (031) 373 2094
[M.Tech:Chiropractic; MMedSci(Sports Med)]

Introduction

Neck pain is a common public health problem in the general population and often associated with disability. There are many treatments available however there is controversy about which treatment is the most effective. Therefore by comparing three treatments, the aim is to see if one of these three treatments is superior to the next.

Procedure

A telephonic interview will take place to schedule an appointment at the Durban University of Technology Chiropractic Day Clinic. On the initial visit, you the subject will be asked to sign a consent sheet. A full case history, physical and cervical (neck) orthopaedic examination will be done to ensure that subject is eligible for study.

There is also an inclusion and exclusion criteria that must be met by subjects before participating in the study. *Please try not to alter your normal lifestyle or daily activities in any way* as this could interfere with the results of the study. Those taking part in the study must be between the ages of 18 and 45. If you are taking any pain medication, a 3-day washout period is required before taking part in the study. This is because medications may have an effect on your symptoms. If you are currently undergoing any other form of treatment for your neck pain or have received chiropractic treatment for neck pain in the last three months, you may be excluded from the study. Any contra-indication to manual therapy will result in exclusion of this study. Patients that are found to be dishonest in the history provided by themselves, those that require further clinical testing for diagnosis and all patients that fail to comply with the informed consent form will be excluded from the study.

Before treatment commences, subject will be asked to fill out two questionnaires pertaining to their neck pain. Range of motion measurements of cervical (neck) will also be done. This data collection will also be done before first and fourth and after sixth treatments. A follow up visit will be scheduled one week later to take final readings. Subject will be allocated in one of three treatment groups through a randomized computer table.

The treatment groups are:

Spinal Manipulative Therapy (SMT): This therapy is also known as manipulation or adjustments.

Muscle Energy Technique (MET): This therapy is also known as active joint mobilization.

Proprioceptive Neuromuscular Facilitation (PNF): This is a specialized stretching technique.

This research study includes 6 treatments within three weeks and a follow up consultation within the fourth week.

Risks and discomfort:

Cervical SMT is a safe treatment however there are risk factors that may predispose you to an adverse reaction. An assessment of your risk profile would be done during the consultation and discussed with you individually. A clinical decision would be made whether SMT would be contra-indicated. If you have any further questions, please do not hesitate to ask. Transient (lasting 1-2 days) muscle stiffness may occur after MET or PNF treatments. If you experience any discomfort/side effects after the treatment, please do not hesitate to call me on number given above.

Benefits of the study:

All three of these treatments have been shown to relieve neck pain and increase range of motion in the neck. On completion of this study the student will obtain a Masters degree in Chiropractic which will allow her to practise. Your full co-operation will assist the Chiropractic profession in expanding its knowledge of this condition and thus making future treatment of patients suffering from chronic mechanical neck pain more successful.

Implications for withdrawal from the research:

You are free to withdraw at any stage without any adverse consequences and your future health care will not be compromised.

Remuneration and costs:

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

Confidentiality and ethics:

All patient information will be kept confidential and will be stored in the Chiropractic Day Clinic for 5yrs, after which it will be shredded.

Please don't hesitate to ask questions on any aspect of this study. Should you wish you can contact my research supervisor on the above details or alternatively you could contact the Faculty of Health Sciences Research and Ethics Committee as per Mr. Vikesh Singh (031) 373 2701.

Statement of Agreement to Participate in the Research Study:

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

Subject's name (print)............................... Subject's signature......................... Date.................

Student' name (print)................................ Student's signature.......................... Date................

Witness name (print)................................ Witness signature............................. Date................

APPENDIX C
CASE HISTORY

DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: ______________________ Date: __________
File # : __________ Age: __________
Sex: __________ Occupation: __________
Intern : __________ Signature: __________

FOR CLINICIANS USE ONLY:
Initial visit
Clinician: Signature :

Case History:

Examination:
Previous: Current:
X-Ray Studies:
Previous: Current:
Clinical Path. lab:
Previous: Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL: Reason for Conditional:
Signature: Date:

Conditions met in Visit No:	Signed into PTT:	Date:

Case Summary signed off:	Date:

Intern's Case History:

1. Source of History:

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

3. Present Illness:

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

4. Other Complaints:

5. Past Medical History:

< General Health Status

< Childhood Illnesses

< Adult Illnesses

< Psychiatric Illnesses

< Accidents/Injuries

< Surgery

< Hospitalizations

6. Current health status and life-style:

< Allergies

< Immunizations

< Screening Tests incl. x-rays

< Environmental Hazards (Home, School, Work)

< Exercise and Leisure

< Sleep Patterns

< Diet

< Current Medication
Analgesics/week:

< Tobacco

< Alcohol

< Social Drugs

7. Immediate Family Medical History:

< Age
< Health
< Cause of Death
< DM
< Heart Disease
< TB
< Stroke
< Kidney Disease
< CA
< Arthritis
< Anaemia
< Headaches
< Thyroid Disease
< Epilepsy
< Mental Illness
< Alcoholism
< Drug Addiction
< Other

8. Psychosocial history:

< Home Situation and daily life
< Important experiences
< Religious Beliefs

9. Review of Systems:

< General

< Skin

< Head

< Eyes

< Ears

< Nose/Sinuses

< Mouth/Throat

< Neck

< Breasts

< Respiratory

< Cardiac

< Gastro-intestinal

< Urinary

< Genital

< Vascular

< Musculoskeletal

< Neurologic

< Haematologic

< Endocrine

< Psychiatric

APPENDIX D
SENIOR PHYSICAL EXAMINATION

Durban University of Technology
PHYSICAL EXAMINATION: SENIOR

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

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

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

SYSTEM SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION

NEUROLOGICAL EXAMINATION

COMMENTS

Clinician: **Signature :**

APPENDIX E
CERVICAL ORTHOPEADIC EXAMINATION

DURBAN UNIVERSITY OF TECHNOLOGY
REGIONAL EXAMINATION - CERVICAL SPINE

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

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

Clinician: .... Sign: ....

OBSERVATION:

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

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

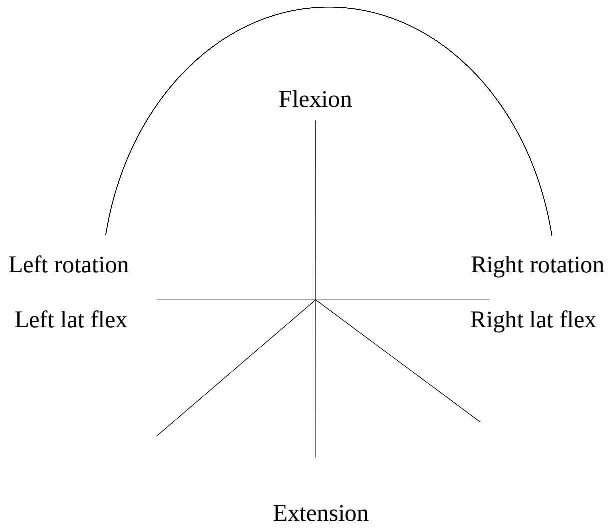
RANGE OF MOTION:

Extension (70º):

L/R Rotation (70º):

L/R Lat flex (45º)

Flexion (45º):



PALPATION:

Lymph nodes
Thyroid Gland
Trachea

ORTHOPAEDIC EXAMINATION:

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

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

NEUROLOGICAL EXAMINATION:

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

Cerebellar tests:	Left	Right
Disdiadochokinesis		

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

MOTION PALPATION & JOINT PLAY:

Left: Motion Palpation:
Joint Play:

Right: Motion Palpation:
Joint Play:

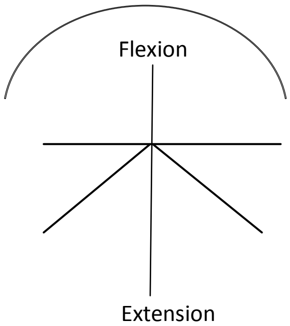
BASIC EXAM: SHOULDER:

Case History:

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

BASIC EXAM: THORACIC SPINE:

Case History:



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

APPENDIX F
SOAPE NOTE

DURBAN UNIVERSITY of TECHNOLOGY

Patient Name: **File #:** **Page:**

Date: **Visit:** **Intern:**
Attending Clinician: **Signature:**

S: **Numerical Pain Rating Scale (Patient)** ☐ **Intern Rating** **A:**
Least 0 1 2 3 4 5 6 7 8 9 10 Worst
0: **P:**

E:

Special attention to: **Next appointment:**

Date: **Visit:** **Intern:**
Attending Clinician: **Signature:**

S: **Numerical Pain Rating Scale (Patient)** ☐ **Intern Rating** **A:**
Least 0 1 2 3 4 5 6 7 8 9 10 Worst
0: **P:**

E:

Special attention to: **Next appointment:**

Date: **Visit:** **Intern:**
Attending Clinician: **Signature:**

S: **Numerical Pain Rating Scale (Patient)** ☐ **Intern Rating** **A:**
Least 0 1 2 3 4 5 6 7 8 9 10 Worst
0: **P:**

E:

Special attention to: **Next appointment:**

APPENDIX G
CROM DATA SHEET

CROM DATA COLLECTION

PATIENT NAME:____

FILE NUMBER:____________________

			1	2	AVG
DATE	VISIT 1	FLEXION			
		EXTENSION			
		LEFT LAT FLEX			
		RIGHT LAT FLEX			
		LEFT ROTATION			
		RIGHT ROTATION			
			1	2	AVG
DATE	VISIT 4	FLEXION			
		EXTENSION			
		LEFT LAT FLEX			
		RIGHT LAT FLEX			
		LEFT ROTATION			
		RIGHT ROTATION			
			1	2	AVG
DATE	VISIT 6	FLEXION			
		EXTENSION			
		LEFT LAT FLEX			
		RIGHT LAT FLEX			
		LEFT ROTATION			
		RIGHT ROTATION			
			1	2	AVG
DATE	VISIT 7	FLEXION			
		EXTENSION			
		LEFT LAT FLEX			
		RIGHT LAT FLEX			
		LEFT ROTATION			
		RIGHT ROTATION			

APPENDIX H
ALGOMETER READINGS
DATA SHEET

Algometer Readings

Patient Name: ____________________________

File No: __________________________________

		Algometer Readings	
Treatment Number	**Date**	**Left – Level**	**Right - Level**
1			
4			
6			
7			

APPENDIX I

CMCC NECK DISABILITY INDEX

CMCC NECK DISABILITY INDEX

Patient Name: ______________________________ File no.: ________ Date: ____________

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

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

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

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

☑	**Section 4 - Reading**
	I can read as much as I want to without 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 with moderate pain in my neck.
	I cannot read as much as I want because of moderate pain in my neck.
	I can hardly read at all because of severe pain in my neck.
	I cannot read at all.

☑	**Section 5 - Headaches**
	I have no headaches at all.

☑	***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 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 do only 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 like 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 at all.

☑	**Section 9 - Sleeping**
	I have no trouble sleeping.
	My sleep is slightly disturbed (<1 hour sleep loss).
	My sleep is mildly disturbed (1-2 hours sleep loss).
	My sleep is moderately disturbed (2-3 hours sleep loss).
	My sleep is greatly disturbed (3-5 hours sleep loss).
	My sleep is completely disturbed (5-7 hours sleep loss).

☑	**Section 10 - Recreation**
	I am able to engage in all my recreation activities with no neck pain at all.

	I have slight headaches which come infrequently.		I am able to engage in all my recreation activities, with some pain in my neck.
	I have moderate headaches which come infrequently.		I am able to engage in most, but not all of my usual recreation activities because of pain in my neck.
	I have moderate headaches which come frequently.		I am able to engage in a few of my usual recreation activities because of pain in my neck.
	I have severe headaches which come frequently.		I can hardly do any recreation activities because of pain in my neck.
	I have headaches almost all the time.		I cannot do any recreation activities at all.

Vernon/Hagino, modified from Foubister et al.,Physiotherapy, 1980

APPENDIX J

NUMERICAL RAITING

SCALE -101

Numerical Pain Rating Scale 101

Date:____________ File No:____________ Visit No:__________

Patient Name____

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience **when it is at its worse**. A zero (0) would mean “no pain at all”, and one hundred (100) would mean “pain as bad as it could be”
Please write only one number ___________________________

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

JOURNAL ARTICLE FOR PEER REVIEW

ABSTRACT

Title: A comparative study of three different types of manual therapy techniques in the management of chronic mechanical neck pain.

Purpose: To compare three different manual therapy techniques (SMT, MET and PNF) which are commonly used in the treatment of chronic mechanical neck pain in terms of range of motion, disability and pain.

Objectives: To establish if these three commonly used manual therapy techniques yield comparable outcomes and if one technique is superior to the next.

Method: This study was conducted at an outpatient teaching clinic. Forty-five patients were diagnosed with mechanical neck pain and randomly allocated into one of three treatment groups. Each group received six treatments over a period of three weeks with a follow up consultation the following week. Pain and disability were measured with the NDI and NRS-101. Ranges of motion and point tenderness were measured with the CROM goniometer and the algometer respectively. These measurements were taken at the first and third consultation (before the treatment), after the sixth treatment and at a follow up consultation the following week. SPSS version 15.0 (SPP Inc., Chicago, Illinois, USA) was used to analyse the data. A *p* value of <0.05 was considered as statistically significant. One-way analysis of variance (ANOVA) testing was used to compare mean age between the three treatment groups. Pearson's chi square test was used to compare percentages of demographics between the three treatment groups. Intra-group analyses, repeated measures ANOVA testing was used to assess the time effect for each outcome separately. In inter-group analyses the time x group interaction effect was assessed using repeated measures ANOVA testing, and profile plots were used to assess the trend and direction of the effects.

Results: Intra-group analysis of the results revealed that all three groups improved significantly between the first and the final consultation, for all measures. Inter-group analysis of the data did not show any difference between the three groups by the end of the final consultation. However, extension range of motion appeared to improve slightly faster in the PNF group but it was not significant when compared to the other two groups. Therefore

there was no statistical significance between the three groups in terms of subjective and objective measurements.

Conclusion: This study demonstrates that all three these manual therapy techniques are beneficial in the treatment of chronic mechanical neck pain. These treatments have been shown to be equally effective thus suggesting that MET or PNF techniques can be used if SMT is contra-indicated.

INTRODUCTION

The prevalence of neck pain in musculoskeletal practice is second only to that of low back pain (1). There has been a slow but constant increase in the amount of attention paid to neck pain due to its escalating costs and burden on society (3). The prevalence of neck pain has been shown to range from 34% – 55% in various studies and the incidence of neck pain increases with age and is more common among woman (3-5).

Due to the multi-factorial aetiologies of neck pain the majority of patients are diagnosed with "non-specific simple neck pain" (6) with the most frequent cause being mechanical joint dysfunctions or postural (2,6,7). After reviewing more than a 1000 studies the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Associated Disorders (9) concluded that there was sufficient evidence to support the use of neck manipulations, mobilizations, education, acupuncture analgesics, massage, low-level laser and exercise therapy in the treatment of neck pain which was classified into Grade 1 (neck pain with no or minor interference with daily activities) and Grade 2 (neck pain with major interference on activities of daily living). They concluded that none of these active treatments were superior to any other in the short or long term. A systematic overview and meta-analysis on conservative management of mechanical neck pain (MNP) (10) stated that no one treatment has been studied in enough detail to assess its efficacy or effectiveness adequately.

The aim of manual therapy in the treatment of MNP is to increase ROM and decrease pain. In view of the current literature, both SMT (11-16) and MET (8,17-19) are effective in the treatment of chronic MNP but it is ambiguous to which treatment is superior. The contract-relax, antagonist-contract (CRAC) technique of PNF stretching is advocated to be the most effective stretching technique to increase ROM (20-22) but has not been studied with regards to pain in the cervical spine nor has it been compared to SMT or MET. Proprioceptive stretching is often used as part of a treatment protocol and not in isolation; therefore the treatment effect is unknown in chronic mechanical neck pain. The purpose of the current study is to compare these three commonly used manual therapy techniques in terms of ROM, pain and disability scores.

METHODS

Ethical clearance certificate was issued (FHSEC 028/08) in accordance with the Declaration of Helsinki (Amended 2000) prior to start of study. Fifty-two patients (between the ages of 18 – 45 years) enrolled into the study however only forty-five patients completed the program. All patients presented with unilateral or bilateral neck pain (lasting longer than three months) which is aggravated by movement and associated paraspinal tenderness. The diagnosis was consistent with the criteria of non-specific/mechanical neck pain. As an further inclusion criteria, patients were to not to have any manual therapy to the cervical region three months prior to taking part in this study.

After initial history taking, examination and diagnosis the patient was given a letter of information with an opportunity to ask any further questions and was asked to sign an informed consent form. Each patient was asked to complete a CMCC Neck Disability Index (NDI) and a Numerical Rating Scale (NRS – 101) form followed by the researcher measuring active cervical range of motion (ROM) with the CROM goniometer and point tenderness (over joint dysfunction) with algometer. Patients were then randomly allocated into either SMT, MET of PNF treatment groups. This study consisted of six treatments within three weeks with a follow-up consultation in the following week. All four above mentioned measurements were repeated before the fourth treatment, after the sixth treatment and at the follow-up consultation.

The NDI is a measurement tool designed to evaluate the effects of neck pain on activities of daily living [23]. It has shown a high degree of validity, test-retest reliability and internal consistency [24,25]. The NRS – 101 is the preferable tool in the assessment of pain intensity [27] and exhibits fair to moderate test-retest reliability in patients with MNP [25]. The cervical goniometer (The Performance Attained Associates Model CROM, 3600 Labore Road, Suite 6, St. Paul, MN 55110-41144) measure active cervical ROM: extension, flexion, right and left rotation, right and left rotation. It has a high degree of reliability [26] and good validity in terms of measuring flexion, extension and lateral flexion in patients with neck pain [28]. The algometer quantify levels of tenderness and pain sensitivity [29] and has shown excellent reliability and reproducibility with pressure threshold measurement [30].

Spinal manipulative therapy and MET treatments were applied to joint dysfunctions that were identified through motion palpation [7] and PNF treatment was applied to the upper Trapezius and Posterior Cervical muscles [39].

The manipulation involved a high velocity, low amplitude thrust in the direction of the restricted joint movement [32]. This is usually accompanied by a “crack” due to the synovial fluid cavitation in the facet joint [7]. Muscle energy technique is done by the researcher placing the joint in a specific position and asking the patient to contract against the unyielding force imposed by the researcher. This isometric contraction allows the muscle to pull on its bony attachment of the segment that is not being stabilized by the operator’s counterforce therefore causing movement in relation to its articulating counterpart [31]. The contraction was held for five seconds and the process was repeated three times [33]. The PNF treatment used the CRAC technique which involved placing the agonist (Posterior Cervical and upper Trapezius muscles) in a stretched position (forward flexion and left or right lateral flexion) and followed by an isometric contraction for eight seconds. The patient returns the neck to neutral thereby causing activation the antagonist muscles. This is followed by a brief rest period before the agonist is passively placed in stretched position till stretched is felt. The next set of PNF stretches start with isometric contraction of agonist [34,35].

RESULTS

SPSS version 15.0 (SPP Inc., Chicago, Illinois, USA) was used to analyse the data. A *p* value of <0.05 was considered as statistically significant. Each group had 15 patients who received treatment without complication. The mean (SD) age was 27.60 (7.179) years for the SMT group, 24.27 (4.480) years for the MET group and 25.47 (6.844) years for the PNF group. Baseline measurements were equal across the groups.

Range of motion in all six planes of motion improved similar for all three treatment groups (Table 1) throughout the treatment protocol. The PNF group achieved the greatest gain in extension ROM but it was not significant when compared to the SMT or MET groups (Table 2).

Table 1: Mean goniometer and algometer values per visit

	VISIT 1						VISIT 4					
	FLEXION	EXTENSION	LEFT LAT FLEXION	RIGHT LAT FLEXION	LEFT ROTATION	RIGHT ROTATION	FLEXION	EXTENSION	LEFT LAT FLEXION	RIGHT LAT FLEXION	LEFT ROTATION	RIGHT ROTAION
SMT	40°	49°	37°	36°	50°	52°	44°	52°	42°	40°	59°	58°
MET	42°	48°	38°	38°	52°	54°	46°	53°	42°	44°	57°	59°
PNF	43°	51°	38°	36°	56°	55°	47°	55°	43°	41°	61°	59°

	VISIT 6						VISIT 7					
	FLEXION	EXTENSION	LEFT LAT FLEXION	RIGHT LAT FLEXION	LEFT ROTATION	RIGHT ROTATION	FLEXION	EXTENSION	LEFT LAT FLEXION	RIGHT LAT FLEXION	LEFT ROTATION	RIGHT ROTATION
SMT	50°	52°	46°	44°	68°	64°	52°	53°	47°	47°	69°	70°
MET	50°	53°	46°	49°	63°	64°	53°	55°	48°	48°	68°	70°
PNF	50°	57°	49°	47°	66°	68°	51°	61°	50°	49°	71°	72°

Table 2: Gains in ROM achieved per group from consultation one to seven

ROM variable	Gain scores		
	SMT	**MET**	**PNF**
Flexion	12°	11°	8°
Extension	4°	7°	10°
Left lateral flexion	10°	10°	12°
Right lateral flexion	11°	10°	13°
Left rotation	19°	16°	15°
Right rotation	18°	16°	17°

The NDI and NRS – 101 scores together with the algometer readings that were taken throughout the study are seen in Table 3 and the change of these measurement tools are seen in Table 4 from visit one to seven.

It is evident that the disability score of SMT group initially was slightly higher than either the MET of PNF group however, it was not statistically significant. At visit seven, the PNF group had the lowest score, but at visit one the mean score was the lowest compared to the other groups. The change was not significant. In contrast the pain scores and algometer readings were consistent across the groups and all groups improved uniformly.

Table 3: Mean algometer, NDI and NRS-101 scores per visit

	VISIT 1				VISIT 4			
	Algometer		NDI	NRS-101	Algometer		NDI	NRS-101
	L	R			L	R		
SMT	1.5	1.6	27	47	1.8	1.8	17	39
MET	1.6	1.4	22	47	1.8	1.7	11	37
PNF	1.4	1.5	21	46	1.7	1.8	11	32

	VISIT 6				VISIT 7			
	Algometer		NDI	NRS-101	Algometer		NDI	NRS-101
	L	R			L	R		
SMT	2	2	13	30	2.2	2.3	9	18
MET	1.9	1.9	9	31	2	1.9	8	17
PNF	2	2	7	24	2.1	2.1	4	17

Table 4: Change in measurement tools from visit one to seven

		Change in measurement tool		
		SMT	**MET**	**PNF**
Algometer	L	0.7	0.4	0.7
	R	0.7	0.5	0.7
NDI		18	14	17
NRS-101		25	30	29

All three treatment groups had a positive result in increasing ROM and decreasing pain. Overall, the three treatment groups improved to the same extent as the baseline and end measurements were of a similar value making no one treatment superior to the next.

DISCUSSION

This study to compare SMT, MET and PNF as isolated treatment protocols in chronic MNP. The extension range of motion showed a highly significant improvement in the PNF group ($p < 0.001$), a significant improvement in the MET group ($p = 0.020$) but there was a lack of statistical significance within the SMT group. A possible explanation may be attributed to nature of the manipulation carried out, only rotary and lateral flexion manipulation were administered with no extension manipulations. These results could also be attributed to the muscular component associated with MET and PNF techniques. The primary action of the Posterior Cervical muscles is neck extension and secondary action is lateral flexion and rotation. Unilateral activation of upper fibers of Trapezius muscle results in lateral flexion to the same side and extreme rotation, when acting bilaterally they causes neck extension [(36)]. Contraction of these muscles will allow the muscles to lengthen and allow a greater neck ROM [(33)]. It should also be noted that a larger sample size may show a difference in this variable and this is an area for further research.

When comparing the results of the SMT and MET groups it was noted that the SMT group had a greater disability score than the MET group at the initial consultation which was 27 and 22 respectively. At the one week post-treatment follow up consultation, the disability scores were within one point of each other (SMT = 9 and MET = 8). These results were deemed as statistically insignificant but it seems to be in line with a trend [(11,37,38)] that when SMT is compared to MET, SMT responds with a greater pain reduction than MET. Due to the paucity of published literature regarding the use of PNF stretching in chronic MNP in terms of disability and pain, there was no means of comparing the results of this study with others. This study however recorded favourable results comparable to that of the SMT and MET treatments groups.

CONCLUSION

The overall results suggest that all three these treatments are equally effective in ROM, disability and decreasing pain. However, none of these active treatments were superior to any other in the short term and that no one treatment has been studied in enough detail to assess its efficacy or effectiveness adequately.

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