

# DEDICATION

I would like to dedicate this work to my family who have been by my side every step of the way, and who always believed in me and supported me throughout my studies.

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# ABSTRACT

The purpose of this randomized controlled clinical trial was to investigate the relative effectiveness of proprioceptive neuromuscular facilitation (PNF) versus ultrasound therapy for the treatment of Temporomandibular joint (TMJ) dysfunction caused by masticatory myofascial trigger points, in terms of subjective and objective clinical findings.

This study included sixty patients who were randomly divided into two groups, namely group A or group B. Each group consisted of thirty patients each, with group A receiving PNF of the affected TMJ muscles, namely the masseter, temporalis, lateral pterygoid and medial pterygoid muscles, and group B receiving ultrasound over the TMJ area. Both groups received three treatments with a fourth consultation for data collection. The consultations were within a three week period.

The subjective measurements were the Numerical Rating Scale- 101 questionnaire and the Temporomandibular Disorder questionnaire, and the objective measurements were the digital algometer readings, visual range of motion readings and the myofascial diagnostic scale scores. These measurements were taken prior to the first and second visits and again at the fourth visit.

The data was then statistically analysed using a 95% ( $\alpha = 0.05$ ) confidence level. Inter-group analysis was performed by the use of the Mann-Whitney U test and the two-sample unpaired t-test. Intra-group analysis was performed by the use of the two sample paired t-test and the Friedman's test.

Inter-group analysis revealed no difference between the groups for the subjective measures, but there was a statistically significant difference between the two groups when the objective measurements, namely the myofascial diagnostic scale scores and the visual range of motion readings were analysed. This difference favoured group A, the PNF treatment group.

Intra-group analysis revealed a statistically significant improvement in both treatment groups with regards to most of the subjective and objective measurements.

The results demonstrated that both treatments were beneficial in the treatment of TMJ dysfunction caused by masticatory myofascial trigger points, but statistically there was a significant improvement favouring the PNF group, making it the more effective treatment between the two groups for the treatment of this condition.

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# DEFINITION OF TERMS

## **Bruxism**

Rhythmical, purposeless, habitual tooth clenching or grinding motions which take place while a person is awake or sleeping (Jagger et al., 1994:23).

## **Contra-indication**

Any type of condition, particularly a condition of disease, which renders one specific form of treatment unsuitable or undesirable (Gatterman, 1990: 407).

## **Joint Dysfunction**

A characteristic of a loss of one or more movements within the normal range of motion (Schaefer and Faye, 1990: 27).

## **Myofascial Trigger Point**

A hypersensitive palpable nodule in a taut band, that is associated with a hyperirritable area in skeletal muscle which causes pain on compression and can cause referred pain, referred tenderness, autonomic phenomena and motor dysfunction (Travell et al., 1999:5).

## **Proprioceptive Neuromuscular Facilitation**

A technique that strengthens neurologically weakened muscles, with the focus of releasing muscle spasticity associated with these muscles (Chaitow, 1996:2).

## **Referred (Trigger point) Pain**

Pain that is felt from a distance or entirely remote from the source, and has its origin from a trigger point. The referral pain pattern is reproducibly related to the origin site of the muscle (Travell et al., 1999: 6).



# .....CHAPTER ONE

## 1.1 INTRODUCTION

Temporomandibular joint (TMJ) dysfunction is a group of related disorders of the muscles of mastication and the TMJ, but excludes non-musculoskeletal disorders in the orofacial region such as neoplastic, vascular or infectious diseases that produce very similar symptoms (Jagger et al., 1994:1). TMJ dysfunction predominates in the 20-40 age group (Hertling and Kessler, 1996:468) and is more prevalent in women (McNeill, 1993:20). Travell et al. (1999:383) state that most patients with TMJ dysfunction suffer primarily from a muscular disorder caused by masticatory myofascial trigger points. This is supported by statistics from a U.S.A. based study which revealed that out of 164 patients referred to a dental clinic for chronic head and neck pain, 55% were diagnosed as having a primary diagnosis of myofascial pain syndrome (Friction et al., 1985:615). No statistical evidence of the incidence and prevalence of TMJ dysfunction could be acquired in South Africa.

The aetiology of TMJ dysfunction caused by masticatory myofascial trigger points is multifactorial and includes stress, trauma and occlusal abnormalities (Jagger et al., 1994:22). Occlusal abnormalities, such as malocclusion, is one of the most common causes of TMJ dysfunction caused by masticatory myofascial trigger points (Good et al., 2000:70,72).

There are a wide variety of signs and symptoms of TMJ dysfunction caused by masticatory myofascial trigger points, ranging from TMJ pain, limited TMJ movement, TMJ clicking, bruxism, headaches, tenderness and/or trigger point pain from the muscles of mastication (O'Reilly and Pollard, 1996:127; Talaat et al., 1986:225).

Proprioceptive neuromuscular facilitation (PNF) is used for the treatment of myofascial trigger points and is an effective way of restoring full stretch length as well as for the relief of any pain originating in these muscle spasms (Lewit and Simons, 1984:455). Findings in research studies have shown that PNF is effective in the treatment of myofascial pain and associated dysfunction, but no studies have shown the effectiveness of PNF for the treatment of TMJ dysfunction caused by



masticatory myofascial trigger points (Sady et al., 1982:261; Lewit and Simons, 1984:452; Cornelius et al., 1992:311).

Ultrasound therapy is also used to inactivate myofascial trigger points, by a less clearly understood mechanism of tissue heating and molecular excitation (Travell et al., 1999:146). Talaat et al. (1986:225-227) performed a randomized controlled clinical trial to investigate the effectiveness of physical therapies for myofascial pain dysfunction syndrome of the TMJ. Results revealed that patients responded best to ultrasound therapy when compared to muscle relaxants and shortwave diathermy. A study by Esposito et al. (1984:106), also indicated that ultrasound is successful in relieving muscle symptoms of the TMJ.

This study therefore proposes to evaluate the effectiveness of PNF and Ultrasound therapy in the treatment of TMJ dysfunction caused by masticatory myofascial trigger points. Travell et al. (1999:383) have stressed the issue of effective treatment to the masticatory muscles due to the common occurrence of misdirected treatment to the TMJ and teeth, which results when masticatory myofascial trigger points have been overlooked or ineffectively treated.

## **1.2 AIM**

The purpose of this study is to evaluate the relative effectiveness of proprioceptive neuromuscular facilitation versus ultrasound therapy for the treatment of Temporomandibular joint dysfunction caused by masticatory myofascial trigger points, in terms of subjective and objective clinical findings.

## **1.3 OBJECTIVES**

The first objective is to evaluate the relative effectiveness of proprioceptive neuromuscular facilitation versus ultrasound therapy for the treatment of Temporomandibular joint dysfunction caused by masticatory myofascial trigger points, in terms of subjective clinical findings.

The second objective is to evaluate the relative effectiveness of proprioceptive

neuromuscular facilitation versus ultrasound therapy for the treatment of Temporomandibular joint dysfunction caused by masticatory myofascial trigger points, in terms of objective clinical findings.

## **CHAPTER TWO**

## **2 LITERATURE REVIEW**

### **2.1 INTRODUCTION**

The purpose of this chapter is to highlight relevant literature regarding information on TMJ dysfunction and the management of this disorder. The literature is limited in that it fails to explain the effectiveness of PNF or Ultrasound therapy for the relief of TMJ dysfunction caused by masticatory myofascial trigger points. This study will therefore propose to address this issue.

TMJ dysfunction is a group of related musculoskeletal disorders of the muscles of mastication and the TMJ, and therefore excludes neoplastic, vascular or infectious diseases in the orofacial region that produce similar symptoms (Jagger et al., 1994:1). It is estimated that 85% to 90% of the population will develop some symptoms of TMJ dysfunction during their life (Souza, 1997:55). Patients with TMJ dysfunction commonly present with pain localised in the muscles of mastication, the preauricular area, and/or the TMJ, which is usually aggravated by any jaw function such as chewing (Okeson, 1996:116). Muscle pain is the most common TMJ symptom which results in local and referred pain, and is usually caused by macrotrauma (e.g. blunt injury), microtrauma (e.g. bruxing) or myofascial dysfunction (Good et al. 2000:78).

The treatment options for TMJ dysfunction caused by masticatory myofascial trigger points are extensive, but the most frequently used treatment options available are the pharmacological and occlusal therapeutic options, where treatment is directed to the origin of the pain, namely the muscles (Okeson, 1995:291). Trigger point pain from masticatory muscles refer pain to the TMJ region and cause altered occlusion due to shortening of muscles from trigger point tension. This is a regular occurrence when the critical role played by masticatory trigger points have been ineffectively treated or overlooked (Travell et al., 1999:383).

PNF and Ultrasound therapy are two forms of treatment options available to inactivate myofascial trigger points (Travell et al., 1999:146,138). Their effectiveness in the treatment of TMJ dysfunction caused by masticatory myofascial trigger points are addressed in this research study.

### **2.2. EPIDEMIOLOGY**

TMJ dysfunction predominates in patients between 20 and 40 years of age (Hertling

and Kessler, 1996:468), and there is a woman to man ratio of 3:1 to 9:1 in persons seeking treatment for TMJ dysfunction (McNeill, 1993:20). It is estimated that 85% to 90% of the population will develop some symptoms of TMJ dysfunction during their life (Souza, 1997: 55). There are approximately 17,800,000 work days lost every year for every 100,000,000 full time working adults in the United States as a result of debilitating TMJ dysfunction (Okeson, 1996:117). Travell et al. (1999:383) state that most patients with TMJ dysfunction suffer primarily from a muscular disorder caused by masticatory myofascial trigger points. This is supported by statistics from a U.S.A.-based study, which revealed that out of 296 patients referred to a dental clinic for chronic head and neck pain, 55,4% were diagnosed as having a primary diagnosis of myofascial pain syndrome (Fricton et al., 1985:616). A study of the prevalence of TMJ disorders in 269 female student nurses from the U.S.A., revealed a high prevalence of trigger points in masticatory muscles, with 54% in right lateral pterygoid muscles, 45% in right masseter, 43% in right temporalis and 40% in the right medial pterygoid muscle (Schiffman et al., 1990:295). Subjects in this study were distributed and categorized in these following groups: 31% normal, 23% had a muscle disorder, 19% had a joint disorder and 27% had a joint/muscle disorder (Schiffman et al. 1990:299). No evidence of the incidence and prevalence of TMJ dysfunction could be acquired in South Africa.

### **2.3 AETIOLOGY**

The aetiological factors of TMJ dysfunction are multifactorial, and include various emotional and mechanical factors (Jagger et al., 1994:22).

Stress and anxiety play an important role in the development of TMJ dysfunction due to the associated muscle tension related with stress (Travell et al., 1999:335). Stress is associated with habitual teeth clenching and bruxism, both of which lead to facial pain and increase demand on the teeth and masticatory muscles (Gramling et al., 1997: 301, Kraus, 1994:460). Clenching and/or bruxism causing overuse of TMJ muscles will result in pain in the TMJ muscles with the patient compensating TMJ movement, resulting in abnormal TMJ motion (Gibilisco et al., 1994:16).

Trauma to the TMJ and masticatory muscles, such as sustained/repetitive strain type injuries, direct trauma to the TMJ and muscles and hyperextension/hyperflexion

(whiplash) injuries may cause masticatory muscle spasms with associated TMJ dysfunction (Travell et al., 1999:335). Sustained or repetitive abusive jaw habits such as clenching or bruxism, nail biting, gum chewing, thumb sucking and significant occlusal disharmony may activate and perpetuate masticatory myofascial trigger points (Travell et al., 1999:335). Direct trauma to the TMJ and masticatory muscles, such as sports injuries, violent blows to the face and/or jaw and unexpected biting on hard food or particles (eg. Cherry pit, popcorn kernel) result in muscle injury and incorrect TMJ motion with associated symptoms (Gibilisco et al., 1994:16). Whiplash injuries may produce TMJ dysfunction in addition to cervical symptoms due to the following possible mechanisms:

- Direct traumatic damage to the masticatory muscles and the TMJ's
- Symptom referral from damaged cervical nerves to the distribution of the trigeminal nerve
- or hyperactive masticatory muscles due to the effect of post-traumatic stress syndrome.

(Jagger et al., 1994:26)

Occlusal factors, such as malocclusion, abnormal incisor relationship (eg: overbite) and occlusal deficiencies/abnormalities may place excessive forces on the TMJ and masticatory muscles and will also exacerbate symptoms after the onset of TMJ dysfunction (Pertes and Gross, 1995:60-61). One of the most common causes of TMJ dysfunction is malocclusion, which results in secondary muscle spasm or bruxism, which will cause muscle fatigue, muscle spasm and masticatory myofascial trigger points (Good et al., 2000:70).

## **2.4 SIGNS AND SYMPTOMS**

Signs and symptoms of TMJ dysfunction caused by masticatory myofascial trigger points are TMJ pain, limited TMJ movement, TMJ clicking, bruxism, headaches, tenderness and/ or trigger point pain from the muscles of mastication (O'Reilly and Pollard, 1996:127; Talaat et al., 1986:225). Other peripheral symptoms include vertigo, tinnitus, pain in the ears, burning sensation on the tongue/throat and tender palpation in the neck and back muscles (Moore 1981:129). Myofascial pain is the most common symptom in TMJ conditions (Travell et al., 1999:24; Good et al., 2000:78), and the most common clinical signs of TMJ dysfunction are tender

palpation to more than three masticatory muscles, TMJ sounds, and tenderness on lateral palpation of the TMJ (Kampe et al., 1997: 581). Tension type or (temporalis) muscle contraction headaches is also evident with masticatory trigger points (Jagger et al., 1994:7). Reik and Hale (1981:151) support this viewpoint when they state that 30 per cent of headaches are a result of TMJ dysfunction. These tension type headaches are described as a constant, dull aching pain over the temporal and frontal regions, and is felt bilaterally, and are likely to be secondary to myofascial trigger point pain from head and neck muscles (Okeson, 1995:280).

Active trigger points in the temporalis muscle cause temporal headache and maxillary toothache, with referred pain over the temporal region, eyebrow, upper teeth, maxilla and TMJ. The teeth can become hypersensitive to temperature changes (Travell et al., 1999:349). Restricted TMJ opening is usually caused by masseter muscle trigger points, with associated TMJ dysfunction and referred pain to the eyebrow, maxilla, mandible, deep in the ear, to the region of the TMJ and upper and lower molar teeth. The molar teeth can also become hypersensitive to pressure and temperature changes (Travell et al., 1999:329). Trigger points in the medial pterygoid muscle refer to the back of the mouth and pharynx, below and behind the TMJ, and also deep into the ear, with symptoms of throat pain, difficulty in swallowing and painful restricted jaw opening (Travell et al., 1999:365). The active trigger points in the lateral pterygoid muscle refer pain to the maxilla and TMJ region, while it causes TMJ dysfunction with abnormal incisal path during TMJ opening and closing (Travell, 1999:379).

## **2.5 ANATOMY**

The TMJ joint is described as a ginglymoarthrodial synovial joint with a very well vascularized and innervated joint capsule with synovial membrane linings over all compartments of the joint (Saghafi and Curl, 1995:99). Fibrous connective tissue lines the articular surfaces, rather than the usual hyaline cartilage of synovial joints. This allows the TMJ to be less vulnerable to degeneration and more capable of regeneration, which is important due to repetitious compressive forces (Good et al., 2000:68). There is an articular disc which is made up of dense, fibrous collagen tissue with two articulating surfaces. One of these surfaces is the superior surface which articulates with the temporal bone, permitting linear articulation (sliding and translatory movements) with the mandibular condyle, whilst the other surface is the

inferior surface permitting rotary movement of the condyle around a horizontal axis (Good et al., 2000:68).

The periosteum, muscles and tendons of the TMJ receive blood supply from small branches of the superficial temporal and deep auricular arteries, while the deep auricular artery supplies the anterior border of the capsule, and mandibular condyle through the nutritional foramina (Jagger et al., 1994:16).

The TMJ is innervated by the auriculotemporal nerve which is a branch of the posterior trunk of the mandibular nerve dividing off the trigeminal nerve, while the posterior deep temporal nerve, which comes from the anterior trunk of the mandibular nerve, also supplies the anterior aspect of the TMJ (Kraus, 1994:24).

The temporalis, masseter and the medial and lateral pterygoid muscles are the primary muscles of mastication (Jagger et al., 1994:17).

The temporalis muscle attaches superiorly to the temporal fossa and to the temporal fascia, and inferiorly to the coronoid process of the mandible. Primarily this muscle elevates (closes) the TMJ, while its posterior and middle fibres also assist retrusion when acting bilaterally, but acting unilaterally deviates the mandible to the same side (Travell et al., 1999:349, Kraus, 1994:25).

The masseter muscle attaches superiorly on the zygomatic arch and zygomatic process of the maxilla, and inferiorly on the exterior surface of the ramus and angle of the mandible. Its primary function is to elevate the mandible, while its deep posterior fibres help retrusion (Travell et al., 1999:329).

The medial pterygoid muscle runs between the angle of the mandible and the lateral pterygoid plate, and then forms a sling with the masseter muscle on the outside of the jaw. This muscle causes lateral deviation of the mandible to the opposite side on unilateral contraction, and it also assists in elevation and protrusion of the mandible on bilateral contraction (Travell et al., 1999:365).

The lateral pterygoid muscle has a superior division which attaches to the sphenoid bone anteriorly, and to the medial surface of the neck of the mandible just below the articular disc posteriorly. Its inferior division attaches to the lateral pterygoid plate anteriorly, and to the mandible neck next to the superior division posteriorly (Travell et al., 1999:379). The major function of the lateral pterygoid muscle is protrusion with or without opening through the use of the inferior fibres. The superior fibres act

as a stabilizing force to the joint capsule and articular disc as the condyle moves during full opening (Kraus, 1994:29).

## **2.6. TREATMENT**

### **2.6.1 OCCLUSAL TREATMENT**

Patients with signs and symptoms from the TMJ and masticatory muscles can benefit from the use of an intraoral acrylic bite appliance (splint), which reduces habitual clenching and bruxism, eliminates occlusal interferences, reduces force of muscle contraction and also alters the relationship between the mandibular condyle, articular disc and articular fossa (Jagger et al., 1994:78).

Moore et al. (1986:137) performed a double blinded study on 11 university football players to examine the effect of the mandibular orthopaedic repositioning appliance (MORA) on power production in these athletes. The MORA is an acrylic mouthpiece which is used for the treatment of TMJ dysfunction by repositioning of the mandible and then relieving the associated muscle tension in the head and neck. This was believed to improve an individual's neuromuscular efficiency and dynamic balance, but analysis revealed no significant improvement for either the placebo mouthpiece group, or the MORA mouthpiece group (Moore et al., 1986:138).

### **2.6.2 PHARMACOLOGICAL TREATMENT**

Pharmacological agents used for the treatment of TMJ dysfunction include analgesics, nonsteroidal anti-inflammatory drugs (NSAID's), corticosteroids, anxiolytics, muscle relaxants and low-dose antidepressants (Okeson 1996:145), but should be used in conjunction with other methods of treatment (Jagger et al., 1994:84). Muscle relaxants in small doses and NSAIDS are the most frequently used agents, and can provide relief in some patients with TMJ dysfunction caused by myofascial trigger points, throughout the day (Kraus, 1994:136,137).

A randomised controlled study to reveal the effectiveness of physical therapy for patients with myofascial pain dysfunction with associated TMJ dysfunction was performed on 120 patients by Talaat et al. (1986:225-227). Patients were randomly allocated in three equal groups treated by shortwave diathermy, ultrasonic therapy



and muscle relaxant drugs, respectively. Results revealed considerable reduction of pain, muscle tenderness and TMJ clicking in the two physical therapy groups, namely ultrasound and shortwave diathermy, especially in the ultrasonic therapy group. The muscle relaxant group revealed mild reduction of pain and muscle spasm, but there was no effect on TMJ clicking (Talaat et al., 1986:227).

### **2.6.3 PHYSICAL TREATMENT**

Physical treatment for TMJ dysfunction associated with myofascial pain syndrome includes trigger point therapy, soft tissue therapy, manipulation, ice, ultrasound, and electrotherapy. Patients are also instructed to rest from aetiological abusive factors, use a soft diet, administer home exercises and to consider dental consultation for a mouth appliance to achieve mild stretching and relaxation for hypertonic TMJ muscles (Good et al., 2000:78).

### **2.6.4 PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF)**

Proprioceptive neuromuscular facilitation (PNF) is used for the treatment of myofascial trigger points and as an effective way of restoring full stretch length as well as for the relief of any pain originating in these tense muscles (Lewit and Simons, 1984:455). Findings on the effectiveness of PNF indicate that it could also be used as an acceptable form of treatment for TMJ dysfunction caused by masticatory myofascial trigger points. This is supported by results from a randomized controlled clinical trial performed by Sady et al. (1982:261), who compared the effects of ballistic, static and PNF on the flexibility of shoulder, trunk and hamstring muscles on 43 subjects. The results revealed that PNF is the preferred technique for promoting flexibility ( $p < 0.05$ ). This was corroborated by Lewit and Simons (1984:452,455) who did a study on 244 patients who presented with pain of musculoskeletal origin. A total of 351 muscles or muscle groups were treated with PNF, and results confirmed that pain and dysfunction caused by muscle tension or myofascial trigger points are relieved by this technique. The masticatory muscles were not assessed in this study. Cornelius et al. (1992:311) performed a randomized controlled clinical trial on 120 male subjects to determine the effects of modified PNF techniques on hip joint flexibility and to determine if local cold application compliments these techniques. Analyses revealed that PNF techniques resulted in a greater range of motion than passive stretching, and cold application does not influence the effectiveness of these stretching techniques ( $p < 0.05$ ). No

studies could be acquired for the effectiveness of PNF on the masticatory muscles, however, Travell et al. (1999:343, 360, 373, 387) state that the release of trigger point tension in tight jaw muscles can be achieved by PNF techniques directed to each specific jaw muscle, namely the masseter, temporalis, medial pterygoid and lateral pterygoid muscle. PNF exercises can also be included in a home care regime for patients suffering from TMJ dysfunction with associated myofascial pain (Good et al., 2000:78).

### **2.6.5 ULTRASOUND THERAPY**

Travell et al. (1999:146) state that the application of ultrasound is an effective way of inactivating myofascial trigger points, by causing tissue heating, and by a less clearly understood mechanism of chemical effects from molecular excitation. Ultrasound therapy is successful in alleviating muscle symptoms related to the TMJ and can be used to alleviate discomfort of TMJ dysfunction caused by masticatory myofascial trigger points which does not respond to occlusal splint therapy (Esposito et al., 1984:106). Talaat et al. (1986:225-227) examined the effectiveness of physical therapy for patients with myofascial pain dysfunction syndrome (MPDS) of the TMJ. This randomized controlled clinical trial consisted of a sample of 120 patients, who were randomly divided into three groups. Group 1 received muscle relaxants, group 2 shortwave diathermy and group 3 ultrasound therapy. The data revealed significant symptom relief by the use of these physical therapies, with the best results obtained by the use of ultrasound therapy. This was also acknowledged by Esposito et al. (1984:106) who performed a study on 28 patients to evaluate the effectiveness of ultrasound in the treatment of TMJ dysfunction. Results revealed that ultrasound is successful in reducing TMJ muscle symptoms and least effective in reducing TMJ disc symptoms.

### **2.7 CONCLUSION**

Masticatory myofascial trigger points cause referred pain to the TMJ and alter occlusion and position of the condyle, due to shortening of these muscles and redistribution of stress on the TMJ (Chaitow, 1996:33). This has resulted in

treatment being commonly misdirected to the TMJ and teeth, and often happens when masticatory myofascial trigger points have been overlooked or ineffectively treated (Travell et al., 1999:383). The literature is limited in that it fails to explain the effectiveness of PNF or Ultrasound therapy for the relief of TMJ dysfunction caused by masticatory myofascial trigger points. This study therefore proposes to address this issue.

## **CHAPTER THREE**

### **3. MATERIALS AND METHODOLOGY**

### **3.1 STUDY DESIGN AND PROTOCOL**

This study included 60 patients with TMJ dysfunction caused by masticatory myofascial trigger points who presented to the Durban Institute of Technology Chiropractic Day Clinic. Information pamphlets requesting the public to assist in this study, were placed on Durban Institute of Technology noticeboards and in contact sport clubs, such as boxing, karate, or rugby clubs. Advertisements were also placed in local newspapers, and pamphlets were distributed by a local distribution company.

Patients who responded to the advertisements, were interviewed telephonically or as they presented to the Chiropractic Day Clinic, to determine whether they complied with the selection criteria.

#### **3.1.1 STANDARD OF ACCEPTANCE**

The potential candidates who agreed to participate in the research study were then scheduled for an initial appointment where they received a covering letter (Appendix A), explaining the inclusion and exclusion criteria, and informing them of the research in which they were to participate. At the initial consultation, the candidates for the study underwent a Case history (Appendix B), relevant Physical examination (Appendix C) and Regional examination of the Temporomandibular joint (Appendix D).

The 60 participants were randomly divided into two groups of 30. This was achieved by placing 30 pieces of paper marked "A" and 30 pieces of paper marked "B" in a box. A third party pre-drew the selection order from the box to plan the sequence of treatment in this study, as the patients entered the research (Chettiar, 2001:49). The patients that were randomly selected in group "A" received the PNF technique, while patients who were selected in the "B" group, received Ultrasound therapy.

#### **3.1.2 INCLUSION CRITERIA**

Only patients who met the following inclusion criteria were included in the study:

- 1) The patient must have had at least two or more of the following signs and

symptoms of TMJ dysfunction caused by masticatory myofascial trigger points:

- \* Constant/Periodic dull ache over the joint, ear, temporal fossa, angle of mandible or around and behind the eye. The pain is usually elicited or intensified by mandibular movement.
- \* Palpatory tenderness of the TMJ's and the muscles of mastication.
- \* Deviation of the mandible on mouth opening.
- \* Limitation of mandibular movement.
- \* Audible TMJ sounds (clicking).
- \* Bruxism or other habitual clenching activities.
- \* Tension type or (temporalis) muscle contraction headaches.
- \* Subjective ear symptoms (tinnitus, vertigo, itching in the ear and/or a blocked feeling).

(Jagger et al., 1994: 2-8)

2) Patients had to be between and including the ages of 20 and 50 years old, due to the predominance of TMJ dysfunction in this age group (Hertling and Kessler, 1996:468).

3) Patients were required to sign an informed consent form (Appendix E) before the commencement of the treatment.

### **3.1.3 EXCLUSION CRITERIA**

Patients were excluded from the study if any of the following exclusion criteria were present:

1) Patients with contra-indications to masticatory muscle stretches and painful internal derangement of the TMJ or TMJ disc were excluded from the study. The following indicate the presence of either of these occurrences:

- \* Painful reciprocal clicking with reduction, of either of the TMJ joints (a loud painful click on mandibular opening, followed by a more subtle painful click occurring during mandibular closing).
- \* Significant episodes of locking (the presence of frequent incidents of inability to open the mouth without manipulation first).
- \* Significant history of open dislocations (a history of frequent open dislocations).

(Travell et al., 1999:258, Hertling and Kessler, 1996:459).

2) Patients were excluded from the study if they had or were using any functional appliances in their mouths (eg: dentures, braces or bite appliances) which were altered or prescribed and fitted within 12 weeks prior to their participation in the study. This is indicated by Melsen (1991:123 -124) who states that there is a stimulation of orofacial musculature following the use of functional appliances, and an adaptative response and normal muscle activity occurs within 12 weeks.

3) Patients were excluded from the study if they were receiving any other form of treatment for their TMJ dysfunction.

4) Patients were excluded if radiographs were necessary to confirm a diagnosis.

5) Any patient with a systemic or local pathology were excluded from the study. This included any known neoplastic, vascular or infectious diseases in the orofacial region (Jagger et al., 1994:1). These pathologies are also the contraindications to ultrasound therapy (Kitchen and Bazin,1996:265).

### **3.1.4 INTERVENTION**

Before commencement of treatment, the patients received an explanation of the beneficial effects of the treatment for their condition. Group A received PNF only over the symptomatic Masseter, Temporalis, Lateral and/or Medial Pterygoid muscles, because these muscles are the major muscles contributing to the signs and symptoms of TMJ dysfunction and are the primary movers of the mandible (Travell et al.,1999: 330; Pertes and Gross, 1995: 6; Hertling and Kessler, 1996:468).

Patients who took part in the study received three treatments with a fourth consultation for data collection. The patients did however receive treatment after data collection on the fourth consultation, but the fourth treatment was not statistically analysed. The consultations were within a period of three weeks. The number and frequency of treatments was based on results from studies by Sady et al. (1982:261) and McCarthy et al. (1997:137) for PNF and through recommendations by Kitchen and Bazin (1996:260) for ultrasound therapy and its

treatment frequency and intervals. Objective and subjective data were obtained prior to the first and second visits and again at the fourth visit.

The PNF technique was performed as follows:

\*Masseter and Temporalis muscles: The patient was supine, with the researcher standing either side of the patient, facing the patient. The researcher then placed his thumbs (using sterile gloves) over the superior aspect of the lower back teeth. The muscle was stretched gently to the point just before pain or to the onset of resistance to further movement, by passively pulling the mandible inferiorly. The patient was then instructed to isometrically contract the muscle, by trying to close the jaw against resistance of the researcher's fingers. This was followed by a relaxation phase during which the patient was instructed to relax ("let go"), while the muscle was stretched to the point of the new resistance. From this new position, the procedure was then repeated (Chaitow, 1996:139, Travell et al., 1999: 343,360). The technique was slightly adapted by the researcher due to his fingers getting caught by the patients back teeth. A towel was placed over the lower front teeth, and the index fingers of both hands were placed over the lower front teeth, with the researchers thumbs placed over the upper front teeth. This prevented the researcher's thumbs getting caught, and also prevented the patient flexing his neck on contracting the muscle by closing of the jaw.

\*Lateral pterygoid muscles: The patient was supine, with the mouth slightly open and relaxed. The researcher stood at either side of the patient, facing the patient. The muscle was stretched to the point of resistance or just before pain, by the researcher pushing the mandible posteriorly and superiorly with the patient's teeth separated slightly, with the web of the researcher's hands over the mental protuberance and his fingers resting over the angles of the mandible. A gentle side ways rocking motion was added to ensure maximum retrusion. The patient was then instructed to isometrically contract the muscle by trying to protrude his/her chin against the resistance of the researcher's web of his hands. The patient was then instructed to relax ("let go") while the muscle was stretched to the point of the new resistance or just before pain. The procedure was then repeated from this position (Travell et al., 1999:387-388).

\*Medial pterygoid muscles: The patient was seated with the head turned to one side, for example the left side, if the left pterygoid muscles was being treated. The researcher stood behind the patient and stabilised the patient's head against his

chest. The patient was instructed to open his/her mouth slightly and relax the jaw, while the researcher held the mandible with his left hand, with his palm and fingers over the angle of the mandible, pointing towards the ear. The researcher then stretched the muscle by pulling it in a left laterotrusion direction, by pulling the angle of the TMJ towards his chest, and at the point of resistance, the patient was instructed to perform an isometric contraction against the researcher's left hand, laterally, by pushing the TMJ in a right laterotrusion direction. The patient was then instructed to relax ("let go"), while the muscle was gently stretched further laterally in a left laterotrusion direction by taking up any muscle slack that had developed to the point of the new resistance. From this new position, the procedure was then repeated (Chaitow, 1996:139-140, Travell et al., 1999:373).

Each contraction was held for 10 seconds, and each stretch (relaxation phase) was allowed to continue as long as the muscle tension continued to give away, for  $\pm$  5-10 seconds. The procedure was repeated three times for each affected muscle. This is a contract-relax method of PNF as described in Travell et al. (1999:139) and Lewit and Simons (1984:452).

Masticatory myofascial trigger points are usually found bilaterally, and because the mandible is connected across the midline, one side cannot be treated by PNF without an effect on the other side. Therefore, Travell et al. (1999:359) state that treatment to the muscles and TMJ should be directed to both sides, even if only one side is symptomatic. It was decided therefore that every patient would receive treatment to both sides of the mandible.

Group B received ultrasound therapy (3 MHz) for 5 minutes over each affected TMJ and masseter area, with the mouth in a slightly open position. This resulted in keeping the masticatory muscles lengthened and in a mild stretch for enhanced ultrasound effect. A water soluble ultrasound transmission gel was used in this study. Patients with acute TMJ dysfunction (onset of pain within 1 week of presentation) received pulsed mode ultrasound at 0,8 W/cm<sup>2</sup> for 5 minutes, while patients with chronic TMJ dysfunction (onset of pain after 1 week of presentation) received continuous mode ultrasound at 1,5 W/cm<sup>2</sup> for 5 minutes (Talaat et al., 1986:226; Kraus, 1994:285, 294; Pertes and Gross, 1995:228-229).



## **3.2 MEASUREMENT AND OBSERVATION**

### **3.2.1 THE DATA**

This study made use of the following primary and secondary data:

#### **3.2.1.1 THE PRIMARY DATA**

The subjective measurements for this study were:

- the Temporomandibular Disorder Disability Questionnaire which provided scores and information on many of the disabilities and symptoms with which patients with TMJ disorders presented,
- and the Numerical Rating Scale (NRS) -101 Questionnaire that described patients perceived level of pain intensity.

The objective measurements for this study were:

- visual range of motion (VROM) analysis to interpret the mandibular gait,
- algometer readings to measure pain threshold,
- and the myofascial diagnostic scale which measured the extent of which the patients suffered from myofascial pain.

#### **3.2.1.2 THE SECONDARY DATA**

This was obtained from journal articles, text books and any other literature related to TMJ dysfunction and its treatment.

## **3.2.2 METHOD OF MEASUREMENTS**

### **3.2.2.1 SUBJECTIVE MEASUREMENTS**

The first subjective measurement was the Temporomandibular Disorder Disability Questionnaire which consists of a Temporomandibular Disorder Disability Index (Appendix F), a Temporomandibular Disorder symptom intensity scale (Appendix G), a Temporomandibular Disorder symptom frequency scale (Appendix G) and also a Pain drawing record (Appendix H). The Temporomandibular Disorder Disability Index provides scores and information on many of the disabilities and symptoms with which patients with TMJ disorders can present. It consists of 10 questions with 5 possible answers, rating a 0 to 4 score level for each of the answers. The points of each question are then added and divided by the total number possible (If all 10

questions were completed, the maximum score possible is 40: 10 questions x 4 (top score level), and then multiplied by 100 to give the percentage. The Temporomandibular Disorder symptom intensity scale and the Temporomandibular Disorder symptom frequency scale are two visual analogue scales which address the frequency and intensity of a patient's TMJ symptoms and consist of 7 sections for each scale where the patient must rate his/her intensity and frequency of symptoms on a scale of 0 to 10 score level. The score for each scale is added and then divided by the maximum score possible (7 sections x 10 maximum score possible = 70) and then multiplied by 100 to give a percentage. The Pain Drawing sheet is used by the patients to capture pain location and quality, and is also included in this questionnaire. This questionnaire has not been tested or validated in any retrospective or prospective study, but has however face validity, as it is based on information published in a peer review study involving 43 patients who, after enduring surgery to their TMJ, had a considerable decline in neck pain, shoulder pain, TMJ pain and headache, within 24 hours after the surgery (Steigerwald *et al.*, 1996). This questionnaire was adapted and modified by Yeomans (2000:82) with permission from the original authors (Steigerwald and Maher, 1997:86-91).

The second subjective measurement was the Numerical Rating Scale (NRS)- 101 questionnaire (Appendix I) which was measured in written form, by asking the patient to indicate a number between 0 and 100 on a horizontal line, that best described his/her perceived level of pain intensity when it is at its worst and when it is at its least (Jensen *et al.*, 1986). The average of these two totals indicates the average pain experienced by the patient as a percentage.

According to Jensen *et al.* (1986) the NRS-101 questionnaire is regarded as a superior measuring instrument and is extremely simple to administer and score, and could be measured either in written or verbal form. Jensen *et al.* (1986) evaluated six different methods to determine pain intensity, and came to the conclusion that the NRS-101 is the most practical index.

### **3.2.2.2 OBJECTIVE MEASUREMENTS**

The first objective measure was the visual range of motion (VROM) which were documented on a cross-hair diagram for analysis of the mandibular gait (Appendix J). Measurements (in mm) were made with the aid of a Modified Boley-Vernier

Caliper (Macromed CC, P.O. Box 626, Umhlanga, 4320). The horizontal x-axis indicated the lateral movement of the mandible to the left and right from a starting position of neutral, by using the maxillary dental midline for reference. The vertical or y-axis indicated maximum opening distance between the incisal edges of the maxillary and mandibular central anterior teeth. Clicking or pain occurrence was documented by placing X's next to the lines. The vertical line on the diagram above the intersection point was the z-axis and represented the degree of protrusion of the jaw. Any deviation of the mandible during the mandibular gait cycle were also interpreted and documented on the z and y-axis. The VROM scale has been indicated as a valuable and uniform method of recording and evaluating mandibular gait for screening or diagnostic purposes in a chiropractic setting (Curl, 1992:115-119; Souza 1997:59). Curl (1992:115) created and presented this method of analyzing mandibular gait in a chiropractic setting with the present understanding of the pathomechanics and biomechanics of the TMJ and its articulations. It is used as a uniform method of analyzing mandibular gait, but no studies testing the validity of this method could be acquired. The Boley-Vernier Caliper was used for more accurate measurement of the distances of mandibular end range of motion (Travell et al., 1999: 337; Gelb,1977:104).

The second objective measure was the digital algometer. This measured any changes in trigger point sensitivity over the masseter and temporalis muscles, throughout the study (Appendix K). The algometer used in this study was the Algometer commander and Digitrack commander (Jtech Medical Industries, 4314 ZEVEX Park Lane, Salt Lake City, UT 84123, USA). This instrument gives objective measurements for pain threshold, which is described as the minimum pressure that induces pain or discomfort (Fischer 1986:207). Kraus (1994:110) also indicated that algometer pressure readings is a valid and reliable assessment technique for changes of temporomandibular muscle tenderness (Kraus, 1994:110). Fischer (1986:207-214) performed a study on pressure threshold measurements for the diagnosis and evaluation of treatment results of trigger points in 24 male and 26 female participants. He concluded that the algometer is a useful method for diagnosis of tender spots and trigger points and especially in the assessment of treatment results.

The pressure threshold for each patient was obtained in the following manner:

The most tender area of pain over the masseter and temporalis trigger points were detected, and the tip of the algometer was placed over that area. Patients were instructed before the test to respond by saying “stop” as soon as they felt the pain. The pressure was gradually increased at a rate of 2 newtons per second. Each muscle trigger point had to be recorded three times to give an average of the three readings.

The Myofascial diagnostic scale (Appendix L) was the third objective measure that were used. No reliability studies testing the validity of this scale have been performed, but this scale has however “face validity” and was developed and used by Chettiar (2001). This scale measured the extent to which the patients suffered from myofascial pain, and also enabled the researcher to obtain intra-group and inter-group change in terms of clinical signs (Chettiar, 2001:53-54). The Myofascial diagnostic scale is made up of four indicators, with the first indicator consisting of five grades of soft tissue tenderness. This was scored as follows: grade 0 - no tenderness = 0, grade 1 - tenderness to palpation without grimace or flinch = 1, grade 2 – tenderness with grimace and/or flinch to palpation = 2, grade 3 – tenderness with withdrawal = 3, grade 4 – withdrawal to non-noxious stimuli = 4.

The second and third indicators classified the presence of the local twitch response and the taut band respectively, and were given a value of 4 each. The last indicator was the presence of referred pain which is the strongest indicator of an active trigger point, and therefore was given a value of 5.

### **3.3 STATISTICAL ANALYSIS**

A random sample of 60 patients was used, 30 patients per group. Group A consisted of the PNF treatment group, while group B consisted of the Ultrasound treatment group.

The following five readings were taken prior to the first and second visits and again at the fourth visit: Temporomandibular Disorder Questionnaire, NRS-101 questionnaire, VROM readings, Algometer readings and the Myofascial Diagnostic Scale readings.

The inclusion of continuous (NRS-101 questionnaire, VROM readings, Myofascial Diagnostic Scale and the Algometer readings) variables, and an ordinal (the Temporomandibular Disorder Questionnaire) scale necessitated the use of parametric and non-parametric tests respectively.

The statistical package SPSS (SPSS Inc.,1999) was used to analyse the data obtained from the above mentioned questionnaires and readings. The Durban Institute of Technology research statistician was consulted with regards to the statistical aspect of this study (Appendix M).

### **3.3.1 INTER-GROUP COMPARISON (PNF GROUP VERSUS ULTRASOUND GROUP)**

The Mann-Whitney U test, a non-parametric test, was used to compare the PNF group and Ultrasound group with regard to the Temporomandibular Disorder Questionnaire.

The two-sample unpaired t-test was used to compare the PNF group and Ultrasound groups with regard to the NRS-101 questionnaire, VROM readings, Myofascial Diagnostic Scale and the Algometer readings.

The above tests were used to determine whether there was any statistically significant difference between the two groups at the 1<sup>st</sup>, 2<sup>nd</sup> and 4<sup>th</sup> consultations for each variable.

For each test, the null hypothesis (Ho) states that there was no difference between the PNF group and the Ultrasound group with respect to each variable.

The alternative hypothesis (H1) states that there was a difference. The level of significance ( $\alpha$ ) was set at 0.05.

Ho: There was no difference between the groups

H1: There was a difference between the groups

$\alpha = 0.05$  = level of significance of the test

#### **Decision rule:**

For a two tailed test:

The null hypothesis ( $H_0$ ) is rejected at the  $\alpha$  level of significance if  $p < \alpha$  where  $p$  is the observed significance level or p-value. Otherwise the null hypothesis is accepted at the same level ( $p \geq \alpha$ ).

### **3.3.2 INTRA-GROUP COMPARISON (PNF GROUP AND ULTRASOUND GROUP)**

The following tests were done within the PNF group and the Ultrasound group to determine whether there were any statistically significant changes of the readings taken prior to the first and second visits and again at the fourth visit.

\* The two sample paired t-test was utilised to determine whether there was any statistically significant improvement within each group with regard to the NRS-101 questionnaire, VROM readings, Myofascial Diagnostic Scale and the Algometer readings.

In the above mentioned test, the null hypothesis states that there was no improvement between the consultations being tested, at the  $\alpha=0.05$  level of significance. The alternative hypothesis states that there was an improvement between the consultations.

$H_0$ : There was no improvement between consultations

$H_1$ : There was an improvement between consultations

$\alpha = 0.05$  = level of significance of the test

#### **Decision rule:**

For a one-tailed test:

The null hypothesis is rejected at the  $\alpha$  level of significance if  $p < \alpha$  where  $p$  is the observed significance level or p-value. Otherwise the null hypothesis is accepted at the same level ( $p \geq \alpha$ ).

$P = \text{reported p-value} / 2$ .

\* The Friedman's T test, is a non-parametric test that compares three or more paired groups, and was utilised to determine whether there was any statistically significant improvement within each group with regard to the Temporomandibular Disorder Questionnaire. If the p-value is small (e.g.  $p=0.05$ ), one can conclude that at least

one of the treatments differs from the rest. It is therefore necessary to look at post-hoc tests to determine which consultation differs from the other consultation. The post-hoc test used was the multiple comparison procedure called the Dunn's test to see which one of the consultations differed. The Friedman's T test was used within the PNF group and the Ultrasound group to determine if there was any statistically significant improvement of the Temporomandibular Disorder Questionnaire scores taken prior to the first and second visits and again at the fourth visit.

In the above mentioned test, the null hypothesis states that there was no improvement between consultations, at the  $\alpha=0.05$  level of significance. The alternative hypothesis states that there was an improvement between consultations.

Ho: There was no improvement between consultations.

H1: There was an improvement between consultations.

$\alpha = 0.05 =$  level of significance of the test

**Decision rule:**

For a one-tailed test:

The null hypothesis is rejected at the  $\alpha$  level of significance if  $p < \alpha$  where p is the observed significance level or p-value. Otherwise the null hypothesis is accepted at the same level ( $p \geq \alpha$ ), where:

$P = (\text{reported p-value}) / 2$  if H1 is of form  $<$  and z is negative  
H1 is of form  $>$  and z is positive

$P = 1 - (\text{reported p-value}) / 2$  if H1 is of form  $<$  and z is positive  
H1 is of form  $>$  and z is negative

If the null hypothesis is rejected for Friedman's T-test, then the Dunn's procedure will have to be applied to determine which of the consultations were statistically significantly different.

### **3.3.3 COMPARISON USING BAR-CHARTS**

Visual summaries of analytical findings were given by the use of bar-charts to compare the PNF group and the Ultrasound group with respect to the variables of the study. Average values were used to construct bar-charts.



# CHAPTER FOUR

## 4. THE RESULTS

### 4.1 INTRODUCTION

This chapter deals with a short description of the patients excluded from the research study, and also a comparison of the demographic data between the two groups. The raw data of this study was subjected to statistical analysis, as summarized in chapter 3, and the results and their interpretations are included in this chapter.

### 4.2. CRITERIA GOVERNING THE ADMISSIBILITY OF DATA

Only data from patients who met the research criteria stated previously was included. The objective measurements, namely the digital algometer readings, MFDS scores and the VROM scale readings, were taken by the researcher and used for analysis. The subjective readings, namely the NRS-101 and the Temporomandibular Disorder questionnaire were also included, and were completed under the researcher's supervision.

There were some patients who had to be excluded from the research study, due to them not meeting the research criteria. Examples were as follows:

- Patients under the age of 20, and over the age of 50.
- Patients with teeth or gum diseases causing similar symptoms.
- Patients with internal derangement of the TMJ, and with a history of dislocation.

There were also a few patients who had to be excluded from treatment, after treatment had already begun. Examples of reasons were as follows:

- One patient, who was in the PNF group, felt the treatment was not beneficial.
- Three patients did not complete the treatment due to time constraints.
- Two patients had family emergencies and could not complete treatment.

Key for abbreviations used in the following tables:

Group A: PNF group

Group B: Ultrasound group

V. : Visit

### 4.3 DEMOGRAPHIC DATA

**Table 1: Age distribution within sample of 60 patients**

<b>AGE</b>	<b>GROUP A</b>	<b>GROUP B</b>	<b>TOTAL %</b>
20 - 29	20	15	58%
30 - 39	5	11	27%
40 - 50	5	4	15%

**Table 2: Gender distribution within sample of 60 patients**

<b>GENDER</b>	<b>GROUP A</b>	<b>GROUP B</b>	<b>TOTAL%</b>
male	10	9	32%
female	20	21	68%

**Table 3: Race distribution within sample of 60 patients**

<b>RACE</b>	<b>GROUP A</b>	<b>GROUP B</b>	<b>TOTAL %</b>
ASIAN	6	8	23%
BLACK	0	2	3.5%
CAUCASIAN	24	18	70%
COLOURED	0	2	3.5%

**Table 4: Occupation within sample of 60 patients**

<b>OCCUPATION</b>	<b>GROUP A</b>	<b>GROUP B</b>	<b>TOTAL %</b>
student	9	10	32%
secretary	0	2	3%
receptionist	3	0	5%
housewife	1	3	7%
unemployed	1	1	3%
admin staff	1	1	3%
lecturer	2	1	5%
executive director	1	2	5%
beautician	1	0	2%
PR officer	1	0	2%
analyst	1	0	2%
manager	0	2	3%
self employed	2	1	5%
hydrotherapist	1	0	2%
sales personnel	0	2	3%
psychometrist	1	0	2%
technician	0	1	2%
info specialist	1	0	2%

horticulturist	0	1	2%
police force	1	0	2%
driver	0	1	2%
building advisor	0	1	2%
property planner	1	0	2%
cashier	0	1	2%
chiropractor	1	0	2%
project officer	1	0	2%

**Table 5: Muscles affected within sample of 60 patients**

<b>MUSCLE</b>	<b>GROUP A</b>	<b>GROUP B</b>	<b>TOTAL %</b>
lateral pterygoid	30	28	97%
medial pterygoid	27	18	75%
masseter	30	30	100%
temporalis	18	21	65%

## **4.4 RESULTS OF DATA ANALYSIS**

### **4.4.1 INTER-GROUP ANALYSIS (GROUP A VERSUS GROUP B)**

#### **4.4.1.1 ANALYSIS OF THE TEMPOROMANDIBULAR DISORDER QUESTIONNAIRE**

The Temporomandibular Disorder questionnaire consists of four subsections, namely: The Temporomandibular Disorder Disability Index, Temporomandibular Disorder Usual Symptom intensity scale, Temporomandibular Disorder Severe

Symptom intensity scale and Temporomandibular Disorder Symptom frequency scale. Each of these four subsections will be analysed separately.

**Table 6:** Inter-group comparison of group A versus group B using the Mann-Whitney U test to analyse results obtained from the Temporomandibular Disorder Disability Index at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	17.851	0.075	13.7397
<b>V. 2</b>	15.6487	0.063	11.4533
<b>V. 4</b>	7.713	0.333	9.3337

The null hypothesis is accepted for the Temporomandibular Disorder Disability Index questionnaire, indicating that at the  $\alpha = 0.05$  level of significance, there was no difference between the two groups.

**Table 7:** Inter-group comparison of group A versus group B using the Mann-Whitney U test to analyse results obtained from the Temporomandibular Disorder Usual symptom intensity scale at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	18.617	0.847	20.024
<b>V. 2</b>	16.5793	0.706	16.1307
<b>V. 4</b>	11.1547	0.167	15.8413

The null hypothesis is accepted for the Temporomandibular Disorder Usual symptom intensity scale, indicating that at the  $\alpha = 0.05$  level of significance, there was no difference between the two groups.

**Table 8:** Inter-group comparison of group A versus group B using the Mann-Whitney U test to analyse results obtained from the Temporomandibular Disorder Severe symptom intensity scale at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	39.809	0.412	44.0557
<b>V. 2</b>	35.627	0.790	38.393
<b>V. 4</b>	25.309	0.066	36.619

The null hypothesis is accepted for the Temporomandibular Disorder Severe symptom intensity scale, indicating that at the  $\alpha = 0.05$  level of significance, there was no difference between the two groups.

**Table 9:** Inter-group comparison of group A versus group B using the Mann-Whitney U test to analyse results obtained from the Temporomandibular Disorder Symptom Frequency scale at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	29.6663	0.900	30.7617
<b>V. 2</b>	26.0065	0.492	28.4757
<b>V. 4</b>	17.4283	0.071	23.9587

The null hypothesis is accepted for the Temporomandibular Disorder Symptom Frequency scale, indicating that at the  $\alpha = 0.05$  level of significance, there was no difference between the two groups.

#### 4.4.1.2 ANALYSIS OF THE NRS-101 QUESTIONNAIRE

**Table 10:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the NRS-101 questionnaire at visits 1, 2 and 4.

	GROUP A		GROUP B
	MEAN	P-VALUE	MEAN
V. 1	41.033	0.195	34.467
V. 2	39.45	0.088	30.883
V. 4	23.017	0.612	25.483

The null hypothesis is accepted for the NRS-101 questionnaire, indicating that at the  $\alpha = 0.05$  level of significance, there was no difference between the two groups.

#### 4.4.1.3 ANALYSIS OF THE VROM READINGS

**Table 11:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the VROM - opening readings at visits 1, 2 and 4.

	GROUP A		GROUP B
	MEAN	P-VALUE	MEAN

<b>V. 1</b>	35.917	0.910	36.133
<b>V. 2</b>	38.783	0.218	36.433
<b>V. 4</b>	42.583	0.006	37.667

The null hypothesis is rejected for the VROM - opening readings between the two groups at visit 4, indicating that at the  $\alpha = 0.05$  level of significance, there was a statistically significant difference between the two groups.

**Table 12:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the VROM - left laterotrusion readings at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	5.233	0.720	5.417
<b>V. 2</b>	6.417	0.030	5.433
<b>V. 4</b>	7.217	0.003	5.8

The null hypothesis is rejected for the VROM- left laterotrusion readings between the two groups at visits 2 and 4, indicating that at the  $\alpha = 0.05$  level of significance, there was a statistically significant difference between the two groups with regards to VROM - left laterotrusion readings.

**Table 13:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the VROM-right laterotrusion readings at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>



<b>V. 1</b>	4.917	0.346	5.383
<b>V. 2</b>	6.300	0.140	5.633
<b>V. 4</b>	7.267	0.004	5.950

The null hypothesis is rejected for the VROM- right laterotrusion readings between the two groups at visit 4, indicating that at the  $\alpha = 0.05$  level of significance, there was a statistically significant difference between the two groups with regards to VROM - right laterotrusion readings.

**Table 14:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the VROM- protrusion readings at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	2.433	0.303	2.783
<b>V. 2</b>	2.833	0.923	2.8
<b>V. 4</b>	3.65	0.046	3

The null hypothesis is rejected for the VROM- protrusion readings between the two groups at visit 4, indicating that at the  $\alpha = 0.05$  level of significance, there was a statistically significant difference between the two groups with regards to VROM - protrusion readings.

#### 4.4.1.4 ANALYSIS OF THE MFDS SCORES

**Table 15:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the MFDS for the lateral pterygoid muscle at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	5.6	0.808	5.43
<b>V. 2</b>	4.53	0.207	5.43
<b>V. 4</b>	1.73	< 0.001	5.04

The null hypothesis is rejected for the MFDS for the lateral pterygoid muscle between the two groups at visit 4, indicating that at the  $\alpha = 0.05$  level of significance, there was a statistically significant difference between the two groups with regards to the MFDS for the lateral pterygoid muscle.

**Table 16:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the MFDS for the medial pterygoid muscle at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	3.07	0.424	3.67
<b>V. 2</b>	2.56	0.098	3.67
<b>V. 4</b>	1.07	< 0.001	2.89

The null hypothesis is rejected for the MFDS for the medial pterygoid muscle between the two groups at visit 4, indicating that at the  $\alpha = 0.05$  level of significance, there was a statistically significant difference between the two groups with regards to the MFDS for the medial pterygoid muscle.

**Table 17:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the MFDS for the masseter muscle at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	11.67	0.479	11.27
<b>V. 2</b>	9.23	0.010	11.2
<b>V. 4</b>	4.37	< 0.001	10.37

The null hypothesis is rejected for the MFDS for the masseter muscle between the two groups at visit 2 and 4, indicating that at the  $\alpha = 0.05$  level of significance, there was a statistically significant difference between the two groups with regards to MFDS for the masseter muscle.

**Table 18:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the MFDS for the temporalis muscle at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	8.78	0.360	7.57
<b>V. 2</b>	7.11	0.721	7.57
<b>V. 4</b>	3.72	0.022	6.76

The null hypothesis is rejected for the MFDS for the temporalis muscle between the two groups at visit 4, indicating that at the  $\alpha = 0.05$  level of significance, there was a statistically significant difference between the two groups with regards to the MFDS for the temporalis muscle.

#### 4.4.1.5 ANALYSIS OF THE ALGOMETER READINGS

**Table 19:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the left masseter algometer readings at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	16.63	0.250	18.31
<b>V. 2</b>	16.973	0.905	17.152
<b>V. 4</b>	18.273	0.853	17.993

The null hypothesis is accepted for the left masseter algometer readings, indicating that at the  $\alpha = 0.05$  level of significance, there was no difference between the two groups.

**Table 20:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the right masseter algometer readings at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	16.661	0.495	17.739
<b>V. 2</b>	16.068	0.524	17.061
<b>V. 4</b>	17.918	0.852	18.179

The null hypothesis is accepted for the right masseter algometer readings, indicating that at the  $\alpha = 0.05$  level of significance, there was no difference between the two groups.

**Table 21:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the left temporalis algometer readings at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	18.1	0.667	19.04
<b>V. 2</b>	17.772	0.999	17.775
<b>V. 4</b>	19.239	0.669	19.995

The null hypothesis is accepted for the left temporalis algometer readings, indicating that at the  $\alpha = 0.05$  level of significance, there was no difference between the two groups.

**Table 22:** Inter-group comparison of group A versus group B using the Two-sample unpaired t-test to analyse results obtained from the right temporalis algometer readings at visits 1, 2 and 4.

	<b>GROUP A</b>		<b>GROUP B</b>
	<b>MEAN</b>	<b>P-VALUE</b>	<b>MEAN</b>
<b>V. 1</b>	16.971	0.363	18.963
<b>V. 2</b>	16.835	0.378	18.537
<b>V. 4</b>	19.359	0.941	19.216

The null hypothesis is accepted for the right temporalis algometer readings, indicating that at the  $\alpha = 0.05$  level of significance, there was no difference between the two groups.

#### 4.4.2 INTRA-GROUP ANALYSIS

##### 4.4.2.1 ANALYSIS OF THE NRS-101 QUESTIONNAIRE

**Table 23:** Intra-group analysis of the results obtained from the NRS- 101 questionnaire at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

NRS- 101 QUESTIONNAIRE						
	GROUP A			GROUP B		
	V.1→ V.2	V.2→ V.4	V.1→ V.4	V.1→ V.2	V.2→ V.4	V.1→ V.4
<b>MEAN</b>	1.583	16.433	18.017	3.583	5.4	8.983
<b>P-VALUE</b>	0.127	<0.001	<0.001	0.023	0.018	<0.001

The null hypothesis is rejected for the NRS- 101 scores, indicating that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement between the 1<sup>st</sup> & 2<sup>nd</sup>, 2<sup>nd</sup> & 4<sup>th</sup> and 1<sup>st</sup> and 4<sup>th</sup> visits for the NRS scores taken at these visits for both group A and B. There is one exception in group A, where the null hypothesis is accepted for the NRS scores taken at visits 1 and 2, indicating that there was no improvement between these visits for the NRS scores.

##### 4.4.2.2 ANALYSIS OF THE VROM READINGS

**Table 24:** Intra-group analysis of the results obtained from the VROM opening readings at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

<b>VROM - OPENING READINGS</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>
<b>MEAN</b>	-2.867	-3.8	-6.667	-0.3	-1.233	-1.533
<b>P-VALUE</b>	<0.001	<0.001	<0.001	0.179	0.002	<0.001

The null hypothesis is rejected for the VROM- opening readings, indicating that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement between the 1<sup>st</sup> & 2<sup>nd</sup>, 2<sup>nd</sup> & 4<sup>th</sup> and 1<sup>st</sup> & 4<sup>th</sup> visits for the VROM- opening readings taken at these visits for both group A and B. There is one exception in group B, where the null hypothesis is accepted for the VROM- opening readings taken at visits 1 and 2, indicating that there was no improvement between these visits for the VROM- opening readings.

**Table 25:** Intra-group analysis of the results obtained from the VROM left laterotrusion readings at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

<b>VROM - LEFT LATEROTRUSION READINGS</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>
<b>MEAN</b>	-1.183	-0.8	-1.983	-0.1667	-0.367	-0.383
<b>P-VALUE</b>	<0.001	<0.001	<0.001	0.469	0.006	0.059

The null hypothesis is rejected for the VROM- left laterotrusion readings taken at visits 1 & 2, 2 & 4, and 1 & 4, for group A. This indicates that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement within group A when comparing the VROM- left laterotrusion readings taken at visits 1 & 2, 2 & 4, and 1 & 4. The null hypothesis is accepted for the VROM- left laterotrusion readings taken at visits 1 & 2 and 1 & 4 for group B, indicating that there was no improvement between these visits. The null hypothesis is however rejected for group B at visits 2 and 4, indicating that the VROM- left laterotrusion readings taken at visits 2 and 4 improved.

**Table 26:** Intra-group analysis of the results obtained from the VROM right laterotrusion readings at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

<b>VROM - RIGHT LATEROTRUSION READINGS</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>
<b>MEAN</b>	-1.383	-0.967	-2.35	-0.25	-0.317	-0.567
<b>P-VALUE</b>	<0.001	<0.001	<0.001	0.089	0.054	0.019

The null hypothesis is rejected for the VROM- right laterotrusion readings taken at visits 1 & 2, 2 & 4, and 1 & 4, for group A. This indicates that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement within group A when comparing the VROM- right laterotrusion readings taken at visits 1 & 2, 2 & 4, and 1 & 4. The null hypothesis is accepted for the VROM- right laterotrusion readings taken at visits 1 & 2 and 2 & 4 for group B, indicating that there was no improvement



between these visits. The null hypothesis is however rejected for group B at visits 1 and 4, indicating that the VROM- right laterotrusion readings taken at visits 1 and 4 improved.

**Table 27:** Intra-group analysis of the results obtained from the VROM protrusion readings at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

VROM - PROTRUSION READINGS						
	GROUP A			GROUP B		
	V.1→ V.2	V.2→ V.4	V.1→ V.4	V.1→ V.2	V.2→ V.4	V.1→ V.4
<b>MEAN</b>	-0.4	-0.817	-1.217	-0.167	-0.2	-0.217
<b>P-VALUE</b>	<0.001	<0.001	<0.001	0.420	0.035	0.043

The null hypothesis is rejected for the VROM-protrusion readings, indicating that there was a statistically significant improvement between the VROM- protrusion readings taken at visits 1 & 2, 2 & 4, and 1 & 4, for both group A and B ( $\alpha = 0.05$  level of significance). There is one exception in group B, where the null hypothesis is accepted

for the VROM- protrusion readings taken at visits 1 and 2, indicating that there was no improvement between these visits for the VROM- protrusion readings in group B.

#### 4.4.2.3 ANALYSIS OF THE MFDS SCORES

**Table 28:** Intra-group analysis of the results obtained from the Lateral pterygoid MFDS scores at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

MFDS - LATERAL PTERYGOID MUSCLE	

	GROUP A			GROUP B	
	V.1→ V.2	V.2→ V.4	V.1→ V.4	V.2→ V.4	V.1→ V.4
<b>MEAN</b>	1.07	2.8	3.87	0.39	0.39
<b>P-VALUE</b>	0.001	< 0.001	< 0.001	0.035	0.035

The null hypothesis is rejected for the Lateral Pterygoid MFDS scores taken at visits 1 & 2, 2 & 4, and 1 & 4 for group A, and also visits 2 & 4 and 1 & 4 for group B. This indicates that at the  $\alpha = 0.05$  level of significance, there was a statistically significant improvement within group A and group B when comparing the Lateral Pterygoid MFDS scores taken at these visits. The means and p-value for differences between visits 1 and 2 in group B could not be computed, due to the means for the readings for those visits being equal, therefore the difference is 0. This shows that there was no improvement between the readings taken at visits 1 and 2 in group B.

**Table 29:** Intra-group analysis of the results obtained from the Medial pterygoid MFDS scores at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

MFDS - MEDIAL PTERYGOID MUSCLE					
	GROUP A			GROUP B	
	V.1→ V.2	V.2→ V.4	V.1→ V.4	V.2→ V.4	V.1→ V.4

<b>MEAN</b>	0.52	1.48	2	0.78	0.78
<b>P-VALUE</b>	0.016	<0.001	< 0.001	0.042	0.042

The null hypothesis is rejected for the Medial Pterygoid MFDS scores taken at visits 1 & 2, 2 & 4, and 1 & 4 for group A and visits 2 & 4 and 1 & 4 for group B. This indicates that at the  $\alpha = 0.05$  level of significance, there was a statistically significant improvement within group A and group B when comparing the Medial Pterygoid MFDS scores taken at these visits. The means and p-value for differences between visits 1 and 2 in Group B could not be computed, due to the means for the readings for those visits being equal, therefore the difference is 0. This shows that there was no improvement between the readings taken at visits 1 and 2 in group B.

**Table 30:** Intra-group analysis of the results obtained from the Masseter MFDS scores at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

<b>MFDS - MASSETER MUSCLE</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>
<b>MEAN</b>	2.43	4.87	7.3	0.667	0.83	0.9
<b>P-VALUE</b>	< 0.001	< 0.001	< 0.001	0.081	0.002	0.002

The null hypothesis is rejected for the Masseter MFDS scores taken at visits 1 & 2, 2 & 4, and 1 & 4, for group A. This indicates that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement within group A when comparing the Masseter MFDS scores taken at visits 1 & 2, 2 & 4, and 1 & 4. The null hypothesis is accepted for the Masseter MFDS scores taken at visits 1 and 2 for group B, indicating that there was no improvement between these visits. The null hypothesis is however rejected for group B at visits 2 & 4 and 1 & 4, indicating that the Masseter MFDS scores taken at visits 2 & 4 and 1 & 4 improved.

**Table 31:** Intra-group analysis of the results obtained from the Temporalis MFDS scores at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

<b>MFDS - TEMPORALIS MUSCLE</b>					
	<b>GROUP A</b>			<b>GROUP B</b>	
	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>
<b>MEAN</b>	1.67	3.39	5.06	0.81	0.81
<b>P-VALUE</b>	0.007	<0.001	< 0.001	0.054	0.054

The null hypothesis is rejected for the Temporalis MFDS scores taken at visits 1 & 2, 2 & 4, and 1 & 4, for group A. This indicates that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement within group A when comparing the Temporalis MFDS scores taken at visits 1 & 2, 2 & 4, and 1 & 4.

The means and p-value for differences between visits 1 and 2 in group B could not be computed, due to the means for the readings for those visits being equal, therefore the difference is 0. This shows that there was no improvement between the readings taken at visits 1 and 2 in group B. The null hypothesis is accepted for the Temporalis MFDS scores taken at visits 2 & 4 and 1 & 4 for group B, indicating that there was also no improvement between these visits.

#### **4.4.2.4 ANALYSIS OF THE ALGOMETER READINGS**

**Table 32:** Intra-group analysis of the results obtained from the left Masseter algometer readings at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

<b>ALGOMETER READINGS - LEFT MASSETER</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>
<b>MEAN</b>	-0.343	-1.3	-1.643	1.159	-0.841	0.317
<b>P-VALUE</b>	0.291	0.040	0.021	0.033	0.070	0.311

The null hypothesis is rejected for the left masseter algometer readings taken at visits 2 & 4 and 1 & 4, for group A. This indicates that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement within group A when comparing the left masseter algometer readings taken at visits 2 & 4 and 1 & 4. The null hypothesis is also rejected for group B at visits 1 and 2, indicating that the left masseter algometer readings taken at visits 1 and 2 also improved. The null hypothesis is accepted for the left masseter algometer readings taken at visits 1 and 2 for group A and visits 2 & 4 and 1 & 4 for group B, indicating that there was no improvement within group A and group B at these visits for the left masseter algometer readings.

**Table 33:** Intra-group analysis of the results obtained from the right Masseter algometer readings at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

<b>ALGOMETER READINGS - RIGHT MASSETER</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>

<b>MEAN</b>	0.593	-1.85	-1.257	0.679	-1.118	-0.439
<b>P-VALUE</b>	0.228	0.018	0.114	0.124	0.042	0.276

The null hypothesis is rejected for the right masseter algometer readings taken at visits 2 & 4, for group A and group B. This indicates that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement within group A and group B when comparing the right masseter algometer readings taken at visits 2 & 4. The null hypothesis is accepted for the right masseter algometer readings taken at visits 1 & 2 and 1 & 4 for group A and group B, indicating that there was no improvement within group A and group B at these visits for the right masseter algometer readings.

**Table 34:** Intra-group analysis of the results obtained from the left Temporalis algometer readings at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

<b>ALGOMETER READINGS - LEFT TEMPORALIS</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>
<b>MEAN</b>	0.328	-1.467	-1.139	1.265	-2.22	-0.955
<b>P-VALUE</b>	0.400	0.025	0.136	0.134	0.008	0.158

The null hypothesis is rejected for the left temporalis algometer readings taken at visits 2 & 4, for group A and group B. This indicates that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement within group A and group B when comparing the left temporalis algometer readings taken at visits 2 & 4. The null hypothesis is accepted for the left temporalis algometer readings taken at visits 1 & 2 and 1 & 4 for group A and group B, indicating that there was no

improvement within group A and group B at these visits for the left temporalis algometer readings.

**Table 35:** Intra-group analysis of the results obtained from the right Temporalis algometer readings at visits 1, 2 and 4. The two sample paired t-test was used for this analysis.

<b>ALGOMETER READINGS - RIGHT TEMPORALIS</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>	<b>V.1→ V.2</b>	<b>V.2→ V.4</b>	<b>V.1→ V.4</b>
<b>MEAN</b>	0.135	-2.524	-2.388	0.426	-0.679	-0.253
<b>P-VALUE</b>	0.430	0.002	0.022	0.295	0.171	0.391

The null hypothesis is rejected for the right temporalis algometer readings taken at visits 2 & 4, and 1 & 4, for group A. This indicates that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement within group A when comparing the right temporalis algometer readings taken at visits 2 & 4 and 1 & 4. The null hypothesis is accepted for the right temporalis algometer readings taken at visits 1 and 2 for group A and visits 1 & 2, 2 & 4 and 1 & 4 for group B, indicating that there was no improvement within group A and group B at these visits for the right temporalis algometer readings.

#### 4.4.2.5 ANALYSIS OF THE TEMPOROMANDIBULAR DISORDER QUESTIONNAIRE

The Temporomandibular Disorder questionnaire consists of four subsections, namely: The Temporomandibular Disorder Disability Index, Temporomandibular Disorder Usual Symptom intensity scale, Temporomandibular Disorder Severe Symptom intensity scale and Temporomandibular Disorder Symptom frequency scale. Each of these four subsections will be analysed separately.

**Table 36:** Intra-group analysis of the results obtained from the Temporomandibular Disorder Disability Index at visits 1, 2 and 4. The Friedman’s T test was used for this analysis.

TEMPOROMANDIBULAR DISORDER DISABILITY INDEX						
	GROUP A			GROUP B		
	V. 1	V. 2	V. 4	V. 1	V. 2	V. 4
<b>MEAN</b>	17.851	15.6487	7.713	13.7397	11.4533	9.3337
<b>P-VALUE</b>	< 0.001			< 0.001		

For both groups the null hypothesis is rejected, indicating that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement in the



Temporomandibular Disorder Disability Index scores between the three consultations in each group.

**Table 37:** Intra-group analysis of the results obtained from the Temporomandibular Disorder Usual Symptom Intensity scale at visits 1, 2 and 4. The Friedman's T test was used for this analysis.

<b>TEMPOROMANDIBULAR DISORDER USUAL SYMPTOM INTENSITY SCALE</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V. 1</b>	<b>V. 2</b>	<b>V. 4</b>	<b>V. 1</b>	<b>V. 2</b>	<b>V. 4</b>
<b>MEAN</b>	18.617	16.5793	11.1547	20.024	16.1307	15.8413
<b>P-VALUE</b>	< 0.001			0.176		

The null hypothesis is rejected for group A, indicating that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement in the Temporomandibular Disorder Usual Symptom Intensity scale scores between the three consultations in group A. For group B the null hypothesis is accepted, indicating that at the  $\alpha = 0.05$  level of significance there was no improvement in the Temporomandibular Disorder Usual Symptom Intensity scale scores between the three consultations in group B.

**Table 38:** Intra-group analysis of the results obtained from the Temporomandibular Disorder Severe Symptom Intensity scale at visits 1, 2 and 4. The Friedman's T test was used for this analysis.

<b>TEMPOROMANDIBULAR DISORDER SEVERE SYMPTOM INTENSITY SCALE</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V. 1</b>	<b>V. 2</b>	<b>V. 4</b>	<b>V. 1</b>	<b>V. 2</b>	<b>V. 4</b>
<b>MEAN</b>	39.809	35.627	25.309	44.0557	38.393	36.619

<b>P-VALUE</b>	< 0.001	0.037
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For both groups the null hypothesis is rejected, indicating that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement in the Temporomandibular Disorder Severe Symptom Intensity scale scores between the three consultations in each group.

**Table 39:** Intra-group analysis of the results obtained from the Temporomandibular Disorder Symptom Frequency scale at visits 1, 2 and 4. The Friedman's T test was used for this analysis.

<b>TEMPOROMANDIBULAR DISORDER SYMPTOM FREQUENCY SCALE</b>						
	<b>GROUP A</b>			<b>GROUP B</b>		
	<b>V. 1</b>	<b>V. 2</b>	<b>V. 4</b>	<b>V. 1</b>	<b>V. 2</b>	<b>V. 4</b>
<b>MEAN</b>	29.6663	26.0065	17.4283	30.7617	28.4757	23.9587
<b>P-VALUE</b>	< 0.001			0.004		

For both groups the null hypothesis is rejected, indicating that at the  $\alpha = 0.05$  level of significance there was a statistically significant improvement in the Temporomandibular Disorder Symptom Frequency Scale scores between the three consultations in each group.

#### **4.4.2.6 DUNN'S PROCEDURE (Multiple Comparison Test)**

If the null hypothesis ( $H_0$ ) is rejected for the Friedman's T test, then this multiple comparison procedure will have to be applied to determine between which visits a significant improvement occurred.

The null hypothesis was rejected for certain subsections of the Temporomandibular Disorder questionnaire in Group A and Group B. It was therefore necessary to apply Dunn's procedure as described below to these sections, to determine which of the visits were significantly different.

Let  $R_j$  and  $R_j^1$  be the  $j^{\text{th}}$  and  $j^1{}^{\text{th}}$  consultations rank totals.

Let  $\alpha$  be the experiment-wise error rate.  $\alpha = 0.10$

**Decision rule:**

If  $|R_j - R_j^1| \geq z \sqrt{\frac{b}{k(k+1)}}$ , then  $R_j$  and  $R_j^1$  are declared significant.

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In the above formula:

$b$  = the number of blocks

$k$  = the number of readings

$z$  = value in inverse normal distribution corresponding to  $(1 - [\alpha/k (-1)])$

In this case,  $b=30$ ,  $k=3$ ,  $\alpha=0.10$  and  $z=2.12$

i.e. If the difference of rank totals  $\geq 16.42$  then  $R_j$  and  $R_j^1$  are declared significant.

For the purpose of this study, V.1 is the 1<sup>st</sup> visit, V.2 is the 2<sup>nd</sup> visit and V.4 is the 4<sup>th</sup> visit.

**Table 40:** Dunn’s procedure for the Temporomandibular Disorder Disability Index (GroupA ).

	Rank Total	Difference	Rank Total	
V. 1	78	14.4	63.6	V. 2
V. 2	63.6	25.2	38.4	V. 4
V. 1	78	39.6	38.4	V. 4

$V.1 - V.2 = 14.4 < 16.42$ , therefore between consultations **1 and 2**, the result is declared **statistically insignificant**.

$V.2 - V.4 = 25.2 > 16.42$ , therefore between consultations **2 and 4**, the result is

declared **statistically significant**.

$V.1 - V.4 = 39.6 > 16.42$ , therefore between consultations **1 and 4**, the result is declared **statistically significant**.

This implies that a significant improvement exists between visits 2 & 4, and 1 & 4, but no improvement can be demonstrated between visits 1 and 2 with regard to the Temporomandibular Disorder Disability Index scores taken at these visits for group A.

**Table 41:** Dunn's procedure for the Temporomandibular Disorder Disability Index (Group B ).

	<b>Rank Total</b>	<b>Difference</b>	<b>Rank Total</b>	
<b>V. 1</b>	75	18	57	<b>V. 2</b>
<b>V. 2</b>	57	9	48	<b>V. 4</b>
<b>V. 1</b>	75	27	48	<b>V. 4</b>

$V.1 - V.2 = 18 > 16.42$ , therefore between consultations **1 and 2**, the result is declared **statistically significant**.

$V.2 - V.4 = 9 < 16.42$ , therefore between consultations **2 and 4**, the result is declared **statistically insignificant**.

$V.1 - V.4 = 39.6 > 16.42$ , therefore between consultations **1 and 4**, the result is declared **statistically significant**.

This implies that a significant improvement exists between visits 1 & 2, and 1 & 4, but no improvement can be demonstrated between visits 2 and 4 with regard to the Temporomandibular Disorder Disability Index scores taken at these visits for group B.

**Table 42:** Dunn’s procedure for the Temporomandibular Disorder Usual Symptom Intensity Scale (Group A ).

	Rank Total	Difference	Rank Total	
V. 1	72	7.5	64.5	V. 2
V. 2	64.5	21	43.5	V. 4
V. 1	72	28.5	43.5	V. 4

$V.1 - V.2 = 7.5 < 16.42$ , therefore between consultations **1 and 2**, the result is declared **statistically insignificant**.

$V.2 - V.4 = 21 > 16.42$ , therefore between consultations **2 and 4**, the result is declared **statistically significant**.

$V.1 - V.4 = 28.5 > 16.42$ , therefore between consultations **1 and 4**, the result is declared **statistically significant**.

This implies that a significant improvement exists between visits 2 & 4, and 1 & 4, but no improvement can be demonstrated between visits 1 and 2 with regard to the Temporomandibular Disorder Usual Symptom Intensity Scale scores taken at these visits for group A.

**Table 43:** Dunn’s procedure for the Temporomandibular Disorder Severe Symptom Intensity Scale (Group A ).

	Rank Total	Difference	Rank Total	
V. 1	78	16.5	61.5	V. 2
V. 2	61.5	21	40.5	V. 4
V. 1	78	37.5	40.5	V. 4

$V.1 - V.2 = 16.5 > 16.42$ , therefore between consultations **1 and 2**, the result is declared **statistically significant**.

$V.2 - V.4 = 21 > 16.42$ , therefore between consultations **2 and 4**, the result is declared **statistically significant**.

$V.1 - V.4 = 37.5 > 16.42$ , therefore between consultations **1 and 4**, the result is declared **statistically significant**.

This implies that a significant improvement exists between visits 1 & 2, 2 & 4, and 1 & 4, with regard to the Temporomandibular Disorder Severe Symptom Intensity Scale scores taken at these visits for group A.

**Table 44:** Dunn’s procedure for the Temporomandibular Disorder Severe Symptom Intensity Scale (Group B ).

	Rank Total	Difference	Rank Total	
<b>V. 1</b>	70.5	14.1	56.4	<b>V. 2</b>
<b>V. 2</b>	56.4	2.4	54	<b>V. 4</b>
<b>V. 1</b>	70.5	16.5	54	<b>V. 4</b>

$V.1 - V.2 = 14.1 < 16.42$ , therefore between consultations **1 and 2**, the result is declared **statistically insignificant**.

$V.2 - V.4 = 2.4 < 16.42$ , therefore between consultations **2 and 4**, the result is declared **statistically insignificant**.

$V.1 - V.4 = 16.5 > 16.42$ , therefore between consultations **1 and 4**, the result is declared **statistically significant**.

This implies that a significant improvement exists between visits 1 and 4, with regard to the Temporomandibular Disorder Severe Symptom Intensity Scale scores taken

at these visits for group B.

**Table 45:** Dunn’s procedure for the Temporomandibular Disorder Symptom Frequency Scale (Group A ).

	Rank Total	Difference	Rank Total	
V. 1	74.4	9	65.4	V. 2
V. 2	65.4	25.5	39.9	V. 4
V. 1	74.4	34.5	39.9	V. 4

$V.1 - V.2 = 9 < 16.42$ , therefore between consultations **1 and 2**, the result is declared **statistically insignificant**.

$V.2 - V.4 = 25.5 > 16.42$ , therefore between consultations **2 and 4**, the result is declared **statistically significant**.

$V.1 - V.4 = 34.5 > 16.42$ , therefore between consultations **1 and 4**, the result is declared **statistically significant**.

This implies that a significant improvement exists between visits 2 & 4, and 1 & 4, but no improvement can be demonstrated between visits 1 and 2 with regard to the Temporomandibular Disorder Symptom Frequency Scale scores taken at these visits for group A.

**Table 46:** Dunn’s procedure for the Temporomandibular Disorder Symptom Frequency Scale (Group B ).

	Rank Total	Difference	Rank Total	
V. 1	72	12.6	59.4	V. 2
V. 2	59.4	10.8	48.6	V. 4

V. 1	72	23.4	48.6	V. 4
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V.1 - V.2 = 12.6 < 16.42, therefore between consultations **1 and 2**, the result is declared **statistically insignificant**.

V.2 - V.4 = 10.8 < 16.42, therefore between consultations **2 and 4**, the result is declared **statistically insignificant**.

V.1 - V.4 = 23.4 > 16.42, therefore between consultations **1 and 4**, the result is declared **statistically significant**.

This implies that a significant improvement exists between visits 1 & 4, but no improvement can be demonstrated between visits 1 & 2 and 2 & 4 with regard to the Temporomandibular Disorder Symptom Frequency Scale scores taken at these visits for group B.

## 5. BAR- CHARTS

Figures 1 - 8 are visual illustrations of the mean value changes of Group A and Group B found during the 1<sup>st</sup>, 2<sup>nd</sup> and 4<sup>th</sup> consultations. These bar-charts illustrate trends within the 2 groups.

**Figure 1:** This figure illustrates the changes of mean VROM opening readings over



the duration of the study evaluation.

**Figure 2:** This figure illustrates the changes of mean VROM Left Laterotrusion readings over the duration of the study evaluation.

**Figure 3:** This figure illustrates the changes of mean VROM Right Laterotrusion readings over the duration of the study evaluation.

**Figure 4:** This figure illustrates the changes of mean VROM Protrusion readings over the duration of the study evaluation.

**Figure 5:** This figure illustrates the changes of mean Lateral Pterygoid MFDS scores over the duration of the study evaluation.

**Figure 6:** This

figure illustrates the changes of mean Medial Pterygoid MFDS scores over the duration of the study evaluation.

**Figure 7:** This figure illustrates the changes of mean Masseter MFDS scores over the duration of the study evaluation.

**Figure 8:** This figure illustrates the changes of mean Temporalis MFDS scores

over the duration of the study evaluation.

## **CHAPTER FIVE**

### **5.1. INTRODUCTION**

This chapter deals with the discussion of the demographic data, subjective data and the objective data obtained in the research study. The subjective data consisted of the NRS-101 questionnaire and the Temporomandibular Disorder Questionnaire. The objective data consisted of the VROM readings, MFDS scores and the

Algometer readings.

## 5.2 DEMOGRAPHIC DATA

The largest percentage of male and female patients who participated in this study were between 20 - 29 years old (58%) (Table 1). This correlates well with a study performed by Talaat et al. (1986: 227) who examined the effectiveness of muscle relaxants, shortwave diathermy and ultrasound therapy for the treatment of myofascial pain dysfunction syndrome of the TMJ. In this study, 120 patients between the ages of 13 and 57 years were treated, of which the largest percentage (52.5%) fell between the ages of 21 and 30 years.

There was also a predominance of female patients (68%) in this study (Table 2). These findings correlate with literature stating that TMJ dysfunction predominates in females (McNeill, 1993:20). Esposito et al. (1984: 106) also performed a study on 28 patients to evaluate the effectiveness of ultrasound therapy in the treatment of myofascial pain dysfunction syndrome of the TMJ. A predominance of females was also noted in this study (96%).

Caucasian patients made up the greatest percentage (70%) of patients participating in this research study (Table 3). This could be attributed to the areas in which the research advertisements were distributed. No studies could be acquired to compare race distribution in patients presenting with TMJ disorders.

The majority of patients who participated in this study were students (32%), when the occupation distribution was analysed (Table 4). This could also be attributed to the areas where the advertisements were distributed and placed around Durban Institute of Technology campus. The age range of students are also more prevalent around the 20 - 29 age group, which was also the age group that is more prevalent in this study and in the study by Talaat et al. (1986: 227).

The muscles affected with trigger points in this study were involved in the following decreasing frequency of prevalence: Masseter (100%), lateral pterygoid (97%), medial pterygoid (75%) and temporalis muscles (65%) (Table 5). A study by Schiffman et al. (1990:295) on the prevalence of TMJ disorders in 269 female student nurses revealed a high prevalence of trigger points in masticatory muscles,



with a decreasing frequency of prevalence in the following muscles: right lateral pterygoid (54%), right masseter (45%), right temporalis (43%) and right medial pterygoid muscles (40%). Statistics from a study by Friction et al. (1985: 616) revealed that out of 296 patients referred to a dental clinic for chronic head and neck pain, 55.4% were diagnosed as having a primary diagnosis of myofascial pain syndrome, with a high prevalence of trigger points in the following masticatory muscles: Lateral pterygoid (92.7%), medial pterygoid muscles (81.7%), superficial masseter (76.8%) and temporalis muscle (68.8%). There was therefore some correlation between these studies of trigger point prevalence in masticatory muscles, especially for trigger point prevalence in the masseter and lateral pterygoid muscles. The high prevalence of trigger points in the masseter muscle in these studies could be attributed to the fact that masseter myofascial trigger points are easier to palpate and therefore more clinically responsive than the other masticatory muscles.

### **5.3 INTER-GROUP COMPARISON**

#### **5.3.1 THE TEMPOROMANDIBULAR DISORDER QUESTIONNAIRE**

The Temporomandibular Disorder questionnaire consists of four subsections, namely: The Temporomandibular Disorder Disability Index, Temporomandibular Disorder Usual Symptom intensity scale, Temporomandibular Disorder Severe Symptom intensity scale and Temporomandibular Disorder Symptom Frequency scale. Each of these four subsections was analysed separately by the use of the Mann-Whitney U test.

An improvement was noted in the scores of each subsection of this questionnaire in both groups. The scores for group A did however reveal a greater improvement when compared to group B (Table 6, 7, 8, and 9), especially in the Temporomandibular Disorder Severe Symptom intensity scale scores at the 4<sup>th</sup> visit ( $p = 0.066$ ). The null hypothesis was however accepted for each subsection of this questionnaire, therefore a statistically significant difference between the two groups for this questionnaire could not be declared. Both treatments were therefore equally effective in reducing the patients perception of symptoms related to the TMJ.

The scores did however reveal an improvement in group A, indicating that PNF is a more effective treatment protocol when evaluating patients perception of their TMJ

symptoms. This was however not statistically significant. The reason for this is that the results might have been affected by patients not completely understanding the questionnaires. Patients may also have recorded false results to please the researcher, resulting in the scores not being a true reflection of the patients perception of their symptoms. This could explain the improvement in both groups A and B which were however not statistically significant.

### **5.3.2 NRS- 101 QUESTIONNAIRE**

The NRS scores were statistically analysed using the Two-sample unpaired t-test. A comparison of the scores taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit also revealed no statistically significant difference between the two groups. The null hypothesis, which states that there is no significant difference between the groups, is therefore accepted (Table 10). This indicates that in terms of pain intensity, either treatment was equally effective.

The limitations of the NRS- 101 questionnaire could be ascribed to it not being a very descriptive questionnaire and it not being designed purely for this condition. This could therefore account for the fact that there was no statistically significant improvement between the two groups when comparing the scores for this questionnaire. The researcher is of the opinion that a questionnaire like the Temporomandibular Disorder questionnaire is more satisfactory, because of the specific questions and inclusion of visual analogue scales for each specific TMJ symptom. The NRS- 101 questionnaire was therefore an unnecessary inclusion in this study.

### **5.3.3 VROM READINGS**

The VROM readings for opening, left laterotrusion, right laterotrusion and protrusion were individually statistically analysed using the two sample unpaired t-test.

A statistically significant difference between the two groups was noted at the 4<sup>th</sup> visit for opening readings (Table 11), the 2<sup>nd</sup> and 4<sup>th</sup> visits for left laterotrusion readings (Table 12), the 4<sup>th</sup> visit for right laterotrusion readings (Table 13) and the 4<sup>th</sup> visit for protrusion readings (Table 14). The null hypothesis is therefore rejected for the readings taken at these visits. The mean values for Group A increased more than

Group B, therefore Group A was more effective in improving range of motion of the TMJ.

PNF is a well known technique for increasing restricted range of motion of a joint (Lewit and Simons, 1984: 452), as can be seen also in the results of the VROM readings of the TMJ in this study. One of the effects of therapeutic ultrasound is that it is a useful way of inactivating myofascial trigger points by causing tissue heating (Travell *et al.*, 1999:146) and that it also alters the physical properties of fibrous tissues resulting in an increase in stretching of these fibres (Refshauge, Gass and Twomey, 1995:174). Ultrasound therefore indirectly increases range of motion of a joint. This could be the reason why ultrasound did not reveal such significant results for the VROM readings as compared to the PNF group, because PNF has a more direct effect on range of motion than ultrasound therapy.

#### **5.3.4 MFDS SCORES**

The MFDS scores for the Lateral Pterygoid, Medial Pterygoid, Masseter and Temporalis muscles were individually statistically analysed using the two sample unpaired t-test.

A statistically significant difference between the two groups was noted at the 4<sup>th</sup> visit for the Lateral Pterygoid MFDS scores (Table 15), the 4<sup>th</sup> visit for Medial Pterygoid MFDS scores (Table 16), the 2<sup>nd</sup> and 4<sup>th</sup> visit for Masseter MFDS scores (Table 17) and the 4<sup>th</sup> visit for Temporalis MFDS scores (Table 18).

The null hypothesis is therefore rejected for the scores taken at these visits. The mean values for group A improved more than group B, therefore group A was more effective in improving the myofascial signs.

Group B did however reveal an improvement in the MFDS scores, but they were not statistically significant enough to declare ultrasound a more effective treatment protocol for masticatory myofascial trigger points. Ultrasound therapy probably took longer to demonstrate a therapeutic effect on trigger points, while PNF has an immediate therapeutic effect on trigger points (Travell *et al.*, 1999:139). This could account for group A, the PNF group, revealing a marked improvement in their myofascial signs compared to ultrasound.

In order to add to the strength of this scale, an element of blinding can be included

to eliminate observer bias which could occur in obtaining scores of this scale. A neutral member can obtain these scores at each visit, to prevent the occurrence of this.

### **5.3.5 ALGOMETER READINGS**

The Algometer readings for the Masseter and Temporalis muscles for each side were individually statistically analysed using the Two-sample unpaired t-test.

A comparison of the readings taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit revealed no statistically significant difference between the two groups. The null hypothesis, which states that there is no significant difference between the groups, is therefore accepted (Table 19, 20, 21 and 22). This indicates that in terms of palpatory tenderness, either treatment was equally effective.

The ability of the researcher to find the same trigger points over the muscles on subsequent visits must be taken into account, and can be seen as a limitation of this objective tool. It is very difficult to get subsequent measurements of the digital algometer on exactly the same spot, unless the spot is marked. This human error could have had an effect on results obtained from these readings.

## **5.4 INTRA-GROUP ANALYSIS**

### **5.4.1 NRS- 101 QUESTIONNAIRE**

The NRS scores were taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit for Group A and Group B, and were statistically analysed using the two sample paired t-test.

An analysis of the NRS scores taken at visits 1, 2 and 4 of group A, revealed a statistically significant improvement between visits 2 & 4 ( $p < 0.001$ ) and 1 & 4 ( $p < 0.001$ ). Table 23 depicts these results, and indicates a decrease in the level of subjective pain perception at these visits.

An analysis of the NRS scores taken at visit 1, 2 and 4 of group B, revealed a statistically significant improvement between visits 1 & 2 ( $p = 0.023$ ), 2 & 4 ( $p = 0.018$ ) and 1 & 4 ( $p < 0.001$ ). Table 23 depicts these results, and indicates a decrease in the level of subjective pain perception at these visits.

Both treatment protocols therefore cause a decrease in the level of subjective pain perception. As mentioned earlier, this questionnaire is not specifically designed for TMJ studies and could therefore account for the fact that there was no statistically significant improvement between visits 1 and 2 in group A.

#### **5.4.2 VROM READINGS**

The VROM readings for opening, left laterotrusion, right laterotrusion and protrusion were individually statistically analysed using the two sample paired t-test.

An analysis of the VROM readings taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit of group A, revealed a statistically significant improvement between visits 1 & 2 ( $p < 0.001$  for each motion), 2 & 4 ( $p < 0.001$  for each motion) and 1 & 4 ( $p < 0.001$  for each motion) for opening, left laterotrusion, right laterotrusion and protrusion individually. Table 24, 25, 26 and 27 depict these results, and indicate an increase in range of motion of the TMJ at these visits.

An analysis of the VROM readings taken prior to visits 1, 2 and again at visit 4 of group B, revealed a statistically significant improvement between visits 2 & 4 for opening ( $p = 0.002$ ), left laterotrusion ( $p = 0.006$ ), and protrusion ( $p = 0.035$ ) and also between visits 1 & 4 for opening ( $p < 0.001$ ), right laterotrusion ( $p = 0.019$ ), and protrusion ( $p = 0.043$ ). Table 24, 25, 26 and 27 depict these results, and indicate an increase in these ranges of motion of the TMJ at the stated visits.

Ultrasound therapy may not have affected TMJ range of motion as much as the PNF technique, because ultrasound does not work directly at restoring the loss in joint motion, as discussed earlier. That is probably why PNF was more successful in improving TMJ range of motion between treatments than ultrasound, especially when comparing the readings taken at visits 1 and 2, where no improvement of all ranges of motion was noted in the ultrasound group.

#### **5.4.3 MFDS SCORES**

The MFDS scores for the Lateral Pterygoid, Medial Pterygoid, Masseter and Temporalis muscles were individually statistically analysed using the two sample paired t-test.

An analysis of the Lateral Pterygoid MFDS scores taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit of group A revealed a statistically significant improvement between visits 1 & 2 ( $p=0.001$ ), 2 & 4 ( $p<0.001$ ) and 1 & 4 ( $p<0.001$ ). Group B revealed a statistically significant improvement between visits 2 & 4 ( $p=0.035$ ) and 1 & 4 ( $p=0.035$ ) for the Lateral Pterygoid MFDS scores. Table 28 depicts these results.

An analysis of the Medial Pterygoid MFDS scores taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit of group A revealed a statistically significant improvement between visits 1 & 2 ( $p=0.016$ ), 2 & 4 ( $p<0.001$ ) and 1 & 4 ( $p<0.001$ ). Group B revealed a statistically significant improvement between visits 2 & 4 ( $p=0.042$ ) and 1 & 4 ( $p=0.042$ ) for the Medial Pterygoid MFDS scores. Table 29 depicts these results.

An analysis of the Masseter MFDS scores taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit of group A revealed a statistically significant improvement between visits 1 & 2 ( $p<0.001$ ), 2 & 4 ( $p<0.001$ ) and 1 & 4 ( $p<0.001$ ). Group B revealed a statistically significant improvement between visits 2 & 4 ( $p=0.002$ ) and 1 & 4 ( $p=0.002$ ) for the Masseter MFDS scores. Table 30 depicts these results.

An analysis of the Temporalis MFDS scores taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit of group A revealed a statistically significant difference between visits 1 & 2 ( $p=0.007$ ), 2 & 4 ( $p<0.001$ ) and 1 & 4 ( $p<0.001$ ). Group B revealed no statistically significant difference between visits for the Temporalis MFDS scores. Table 31 depicts these results.

These results indicate an improvement between treatments in the degree of which they suffered with myofascial trigger point signs, mainly of the Lateral Pterygoid, Medial Pterygoid, Masseter and Temporalis muscles in group A, and of the Lateral Pterygoid, Medial Pterygoid and Masseter muscles in group B.

The ultrasound was applied over the TMJ area, where the masseter, medial pterygoid and lateral pterygoid muscles will probably have the most effect from the ultrasound due to it being so close to the area of ultrasound application. This could account for the fact that the temporalis muscle in group B did not reveal a

statistically significant intra-group improvement.

#### **5.4.4 ALGOMETER SCORES**

The Algometer readings for the Masseter and Temporalis muscles were individually statistically analysed using the two sample paired t-test.

An analysis of the Masseter algometer readings taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit of group A revealed a statistically significant improvement on the left side between visits 2 & 4 ( $p=0.040$ ) and 1 & 4 ( $p=0.021$ ), and on the right side between visits 2 & 4 ( $p=0.018$ ). Group B revealed a statistically significant improvement on the left side between visits 1 & 2 ( $p=0.033$ ) and on the right side between visits 2 & 4 ( $p=0.042$ ) for the Masseter algometer readings. Table 32 and 33 depict these results.

An analysis of the Temporalis algometer readings taken prior to the 1<sup>st</sup> and 2<sup>nd</sup> visits and again at the 4<sup>th</sup> visit of group A revealed a statistically significant improvement on the left side between visits 2 & 4 ( $p=0.025$ ) and on the right side between visits 2 & 4 ( $p=0.002$ ) and 1 & 4 ( $p=0.022$ ). Group B revealed a statistically significant difference on the left side between visits 2 & 4 ( $p=0.008$ ), and no significant change between treatments on the right side.

These results indicate an improvement between treatments in the amount of tenderness associated with myofascial trigger points over the Masseter and Temporalis muscles in group A and group B.

These results could have been affected by the inaccuracy of the digital algometer due to the same spot not being tested at subsequent visits.

#### **5.4.5 TEMPOROMANDIBULAR DISORDER QUESTIONNAIRE**

The Temporomandibular Disorder questionnaire consists of four subsections, namely: The Temporomandibular Disorder Disability Index, Temporomandibular Disorder Usual Symptom intensity scale, Temporomandibular Disorder Severe Symptom intensity scale and Temporomandibular Disorder Symptom frequency scale. Each of these four subsections was analysed separately for each group by the use of the Friedman's T test. If the Friedman's T test revealed a statistically

significant change, the Dunn's procedure was then performed to determine at which point the treatment made a difference.

An analysis of visits 1, 2 and 4 of the Temporomandibular Disorder Disability Index revealed a statistically significant difference in group A ( $p < 0.001$ ) and group B ( $p < 0.001$ ), indicating a decrease in patients perception of TMJ symptoms in both groups. Table 36 depicts these results. Dunn's procedure established that a significant improvement occurred between visits 2 & 4 and 1 & 4 in group A (Table 40) and between visits 1 & 2 and 1 & 4 in group B (Table 41) for the Temporomandibular Disorder Disability Index.

An analysis of visits 1, 2 and 4 of the Temporomandibular Disorder Usual Symptom Intensity Scale revealed a statistically significant difference in Group A ( $p < 0.001$ ), but not in Group B, indicating a decrease in patients perception of TMJ symptoms in group A. Table 37 depicts these results. Dunn's procedure established that a significant improvement occurred between visits 2 & 4 and 1 & 4 in Group A (Table 42).

An analysis of visits 1, 2 and 4 of the Temporomandibular Disorder Severe Symptom Intensity Scale revealed a statistically significant difference in group A ( $p < 0.001$ ) and in group B ( $p = 0.037$ ), indicating a decrease in patients perception of TMJ symptoms in both groups. Table 38 depicts these results. Dunn's procedure established that a significant improvement occurred between visits 1 & 2, 2 & 4 and 1 & 4 in group A (Table 43) and between visits 1 and 4 in group B (Table 44).

An analysis of visits 1, 2 and 4 of the Temporomandibular Disorder Symptom Frequency Scale revealed a statistically significant difference in group A ( $p < 0.001$ ) and group B ( $p = 0.004$ ) indicating a decrease in patients perception of the frequency of their TMJ symptoms in both groups. Table 39 depicts these results. Dunn's procedure established that a significant improvement occurred between visits 2 & 4 and 1 & 4 in group A (Table 45) and between visits 1 & 4 in group B (Table 46) for the Temporomandibular Disorder Symptom Frequency Scale.

Group A therefore revealed a statistically significant improvement between visits for each of the subsections of this questionnaire, indicating that the patients in this



group perceived an improvement of their TMJ symptoms between consultations. A statistically significant improvement was also noted between visits for group B for each of the subsections, except for the Temporomandibular Disorder Usual Symptom Intensity Scale. An improvement was however noted for the Temporomandibular Disorder Usual Symptom Intensity Scale, but this was however not statistically significant.

Statistically, group B did not improve as much as group A, indicating that the ultrasound treatment protocol does not improve patients' perceptions of their TMJ symptoms as much as the PNF group. This could be caused by the ultrasound not directly working at restoring joint loss of motion, and it probably took longer to have an effect than PNF, causing patients to have a lower perception of improvement of their TMJ symptoms.

## **5.5 CONCLUSION**

This study revealed that both treatments were beneficial in the treatment of TMJ dysfunction caused by masticatory myofascial trigger points, but statistically there was a significant improvement favouring the PNF group, making it the most effective treatment between the two groups for the treatment of this condition.

## **5.6 COMPARISON OF THE RESULTS WITH OTHER STUDIES**

There are studies that examined the effectiveness of ultrasound therapy for the alleviation of myofascial pain associated with the TMJ, but no studies could be acquired for the effectiveness of PNF for the treatment of TMJ dysfunction caused by masticatory myofascial trigger points. This is therefore the first study to compare the effectiveness of PNF versus Ultrasound therapy in the treatment of TMJ dysfunction caused by masticatory myofascial trigger points.

Talaat et al. (1986: 225-227) performed a study to evaluate the effectiveness of muscle relaxants, shortwave diathermy and ultrasound therapy for the treatment of myofascial pain dysfunction syndrome of the TMJ. The 120 patients in this study were randomly divided into three groups with 40 patients in each group. Group 1 received muscle relaxants, Group 2 received shortwave diathermy and Group 3 received ultrasound therapy (5min, 1,5W/cm<sup>2</sup>). The patients were treated daily for 2

weeks. The incidence of this myofascial pain dysfunction syndrome of the TMJ was higher in males (63.33%) than in females (36.67%), but the study indicated that this result, opposing the literature, stating a higher incidence in females, could be due to the fact that more than 50% of the patients enrolled in the study represented the developmental projects in Saudi Arabia, consisting only of males. The data revealed significant symptom relief in the 2<sup>nd</sup> and 3<sup>rd</sup> groups, with marked alleviation of pain, muscle tenderness and TMJ clicking. Ultrasound therapy revealed the best results (Talaat et al. 1986: 227).

Esposito et al. (1984:106) performed a study on 28 patients to evaluate the effectiveness of ultrasound therapy in the treatment of Myofascial pain dysfunction syndrome of the TMJ. Patients received 4 - 8 treatments, or until they become asymptomatic over a 2 - 3 week period, with a pulsed Ultrasound (0.75W/cm<sup>2</sup>-2W/cm<sup>2</sup>, 3-5 minutes). There was a decline of myofascial pain dysfunction syndrome symptoms in 82% of the patients who participate in the study. The study investigated only one treatment, and a control was therefore not used, but did however indicate that ultrasound alleviates the symptoms of myofascial pain dysfunction syndrome.

No studies could be acquired for the effectiveness of PNF on the masticatory muscles, therefore no comparisons could be made of this protocol.

## **CHAPTER SIX**

### **6.1 RECOMMENDATIONS**

Should this study be repeated, the following improvements are recommended by the researcher.

#### **Follow-up study**

A follow-up period of 3-6 months is recommended to determine the long term effects of both treatment protocols.

#### **Accuracy of measurements**

The instrumentation, especially the digital algometer, should be more specific and sensitive to detect small but significant changes, which could influence the results of

the study. The exact point where the algometer is placed should be permanently marked during the study, because this can also result in incorrect readings being used in the study. A henna marker could be used to mark the point where the algometer was placed at the first reading.

### **Placebo Group**

A third placebo group should be included into the study, to give more conclusive evidence towards the outcome of the treatments and also the natural progression of the disorder.

### **Cross-over design**

A cross over design study can be considered with the two groups, so that patients who do not respond to the one treatment can be changed over to the opposite group to see if any improvement occur. There was an improvement noted in both treatment groups, therefore a cross-over study would allow the researcher to more effectively compare the therapies and thus provide more data.

### **Stages of disorder**

Patients in the study should be limited to either acute, sub-acute or chronic stage of the disorder, due to the possibility of differences in outcome of treatment to different stages of this disorder.

### **Treatment schedules**

The treatments should be scheduled in a more consistent and shorter time frame, to allow for a more accurate comparison of the treatment protocol. Treatment frequencies should also be re-evaluated, especially for the ultrasound treatment groups.

### **Blinding**

An independent examiner should be considered for the measurement of the objective data, especially the myofascial diagnostic scale, to eliminate observer bias which could occur.

## **6.2 CONCLUSION**

This was a randomised controlled clinical study, which consisted of 60 patients. The patients were diagnosed with TMJ dysfunction caused by masticatory myofascial

trigger points , according to certain criteria, and were randomly allocated to two groups of 30 patients each. The one group, group A, received PNF to the affected TMJ muscles, and the other group, group B, received Ultrasound therapy. Both groups received three treatments with a fourth consultation for data collection. The consultations were within a three week period.

Inter-group analysis of the subjective data, namely the Temporomandibular Disorder Questionnaire and the NRS-101 questionnaire revealed that both treatments were equally effective in the treatment of TMJ dysfunction caused by masticatory myofascial trigger points. Inter-group analysis of the objective data suggests that the use of PNF is more effective in improving the patients range of motion of the TMJ, seen in the analysis of the VROM readings, and also more effective in the treatment of masticatory myofascial trigger points, seen in the analysis of the MFDS readings. The Algometer readings however did not show any inter-group improvement.

Intra-group analysis of the subjective data (NRS-101 and Temporomandibular disorder questionnaire) and the objective data (VROM readings, Algometer readings and MFDS scores) revealed that each treatment showed some improvement between treatments in each group.

Both groups revealed an improvement in the condition being studied, but the PNF group showed a more favourable improvement, indicating that PNF is the recommended treatment protocol compared to ultrasound therapy for the treatment of TMJ dysfunction caused by masticatory myofascial trigger points.

In conclusion, it has been established that the use of PNF is the most effective treatment protocol compared to ultrasound therapy in the treatment of TMJ dysfunction caused by masticatory myofascial trigger points, and the use of PNF plays an important part in the treatment protocol of this condition.

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