A comparative point prevalence study of Temporomandibular Joint Dysfunction in recreational SCUBA divers as opposed to non-divers, - a pilot study.

A dissertation submitted to the Faculty of Health Services, Durban Institute of Technology, in partial compliance with the requirements for the Master's Degree in Technology: Chiropractic

By

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I, Lee Ann Hall, do hereby declare that this dissertation is representative of my own work, both in concept and execution, except where otherwise indicated by the text.

18/7/2002

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DEDICATION

I would like to dedicate this dissertation to Dr B.R. Lewis, without whom this dissertation would never have been possible.
Thank you for all your help and support.

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ABSTRACT

The aim of this point prevalence study was to compare the prevalence of temporomandibular joint dysfunction in recreational scuba divers and snorklers, as opposed to non-divers, in terms of subjective findings.

The Durban Metropolitan area diving population consisted of approximately 2500 divers and therefore the population size decided on was 200 divers and 200 non-divers. A total of 400 questionnaires were filled in with the participant's subjective data about their pain, limited mouth opening, and jaw joint noises. The divers were asked about their dive certification, and the number of dives done in order to establish whether they had dived within three months prior to participating in the study.

The results were statistically analysed using chi-squared tests with the p-value of $\alpha = 0.05$. Tables and bar charts were constructed to visually represent the data and allow for descriptive analysis.
The overall prevalence of TMJD in divers was 46.5% and in non-divers 54%. The chi-squared analysis shows no significant difference between the two groups.

Among other findings, the relationship between the use of diving mouthpieces and TMJD was considered and it was established that 20% of divers, in this

study, found their mouthpieces caused fatigue and pain in the jaw joint and surrounding muscles.

It must be emphasised that caution should be exercised in generalising the findings of this survey, as the findings were based on the participant's subjective evaluations. This study was not designed to establish cause and effect between mouthpieces and TMJD in divers.

DEFINITIONS

Bruxism:	grinding of the teeth especially during sleep.
Discomfort:	any feeling of irritation, not pain, for example: irritation caused by a mouthpiece.
Equalize:	to restore the balance of pressures in the inner and outer ear during diving (scuba or snorkelling).
Malocclusion:	improper relation of apposing teeth when the jaws are in contact.
Non-divers:	those participants who did not take part in the sport of diving. A general population was not used in this study as the study was to compare a diver population versus a non-diver population.
Onychophagia:	biting of the nails.
Postauricular:	behind the ear.
Preauricular:	in front of the ear.
Protrusion:	extension of the jaw in forward translation.
Retrusion:	extension of the jaw in backward translation.
Scuba:	self-contained underwater breathing apparatus.
Snorkel:	breathing pipe with a mouthpiece for free diving.
Tinnitus:	ringing in the ears.
TMJD:	for this study: At least one of the following criteria had to present to diagnose TMJD: decreased range of motion of the jaw, pain in the jaw joint and around the jaw joint, and / or noises in the jaw joint consisting of crepitus, clicking or popping.
Translation:	gliding or sliding motion in one plane.
Vertigo:	any form of dizziness.

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CHAPTER ONE

Introduction

Temporomandibular dysfunction encompasses a variety of musculoskeletal disorders that may manifest as one or more of the following: pain in the temporomandibular joint, preauricular or postauricular pain, joint sounds, limitation of jaw movement, local muscle tenderness, headache, vertigo, tinnitus and malocclusion (Gregory, 1993:256; Kraus, 1994:94; Jagger, Bates and Kopp, 1994:1; O'Reilly and Pollard, 1996).

The factors influencing temporomandibular joint dysfunction (TMJD) are not well understood, and it is generally agreed (Jagger et al., 1994: 23 – 28; Souza, 1997:59; Kraus, 1994:49 – 59) that the aetiology of temporomandibular dysfunction is multifactorial. These include: stress, bruxism, trauma, oral habits such as onychiophagia, abnormalities in the contact of the teeth either acquired or congenital, general anaesthetic extraction of teeth and/or molar dental work, and the use of mouthpieces in sports (Pocock, Mamandras and Bellamy, 1992; Shelanski, 2001).

Anecdotal evidence suggests that pain in the TMJ is fairly common amongst divers. In divers with an already existing TMJD, the condition may be exacerbated by diving with conventional mouthpieces (Shelanski, 2001).

The strategy for its treatment is poorly defined (O'Reilly and Pollard, 1996). Current methods of treatment for TMJD consist of: Open joint surgery, closed joint surgery, orthotics, occlusal treatment, pharmacological pain control, physiotherapy, chiropractic treatment including manipulation of the cervical spine and temporomandibular joints (TMJ) as well as PNF stretching, stress management and acupuncture (Saghafi, Darryl and Curl, 1995:100; Travell and Simons, 1994:165; O'Reilly and Pollard, 1996).

Research on the prevalence of TMJD in different groups, or populations, needs to be done in order to determine a possible basis for chiropractic management of the condition.

The design of this research is that of a point prevalence pilot study based on a questionnaire received from the participants (400), in order to determine the prevalence of TMJD in the non-diver population (200), in comparison to recreational scuba divers and snorklers (200). All participants that meet the inclusion criteria will be asked to fill in the questionnaire, the data analysis will then be done by χ^2 tests and p-values will be used to draw conclusions. All tests will be carried out at the $\alpha = 0,05$ level of significance.

Bar graphs will be constructed for visual comparison, and visual summaries of analytical findings will be given by use of bar charts to compare groups one and two with respect to the continuous variables. The average mean readings will be used to construct bar charts.

CHAPTER TWO

Review of related literature

2.1 INTRODUCTION

Temporomandibular joint dysfunction (TMJD), is considered common and has been shown to cause patients' pain, limited range of motion and joint sounds (Jagger, Bates and Kopp, 1994: 1).

This literature review presents an outline of the known aetiologies, classification, biomechanics and related anatomy, clinical characteristics of TMJD, and a review of current research on TMJD and TMJD in divers will be presented. Continued critical review of the literature will expose what is not known about TMJD, thus providing a rationale for this study.

2.2 CLASSIFICATION OF TEMPOROMANDIBULAR JOINT DYSFUNCTION

The clinical conditions usually classified as TMJD include those with pain or dysfunction in the joint or contiguous structures (O'Reilly and Pollard, 1996).

The American Academy of Orofacial pain has published a TMJD classification system that has received general acceptance in the medical field.

1.) TMJD

a) Deviation in form
   i) Articular surface defects
   ii) Disc thinning and perforation

b) Disc displacement
   i) Disc displacement with reduction
   ii) Disc displacement without reduction

c) Displacement of disc-condyle complex
   i) Hypermobility
   ii) Dislocation

d) Inflammatory conditions
   i) Capsulitis and synovitis
   ii) Retrodiscitis

e) Degenerative disease
   i) Osteoarthrosis
   ii) Osteoarthritis
   iii) Polyarthritis

f) Ankylosis
   i) fibrous
   ii) bony

2.) Masticatory muscle disorders

a) Acute
   i) myositis
   ii) reflex muscle splinting
   iii) muscle spasm

b) Chronic
   i) myofascial pain
   ii) muscle contracture
   iii) hypertrophy
   iv) myalgia secondary to systemic disease

3.) Congenital and developmental disorders

a) Condylar hyperplasia
b) Condylar hypoplasia
c) Aplasia
d) Condylolysis
e) Neoplasms
f) Fractures

2.3 PREVALENCE

Few reports on the incidence of TMJD and the associated signs and symptoms are available so, for this study, the emphasis will be put on prevalence. Due to the paucity of South African statistics, extrapolations will be made from American statistics.

Cross-sectional epidemiological studies of a non-patient population show approximately 75% of that population had at least one sign of joint dysfunction (movement abnormalities, joint noises, and tenderness on palpation, etc.), and approximately 33% had at least one symptom (face pain, joint pain, etc.) (Mc Neill, 1992).

Some presenting symptoms and signs in a population of patients with TMJD in order of prevalence:

Pain	89%
Noise	85%
Limited opening	40%
Ear symptoms	28%
Difficulty chewing	26%
Joint locking	24%
Dislocation	4%

(Mc Neill, 1992)

Signs and symptoms of TMJD generally increase in frequency and severity from the second decade of life. The majority of 3 428 patients in a recent study were between the ages of 15 and 45 years, Mc Neill (1993) suggests, with these findings, that older subjects are less bothered by their symptoms.

Although osteoarthritis of the TMJ is more prevalent in the elderly, signs and symptoms of TMJD tend to decrease from the sixth decade (Souza, 1997:55).

2.4 DIVING AND JAW PAIN:

Pain in the TMJ is fairly common among divers and non-divers alike and probably results from one of two causes:

1. Mechanical dysfunction due to congenital deformity or trauma.
2. Muscular pain and TMJ pain secondary to strain or overexertion of the jaw, leading to inflammation of the joint.

The second form is the condition that usually affects divers, though the first type may be exacerbated by diving with conventional mouthpieces. Conventional mouthpieces are thought to correlate to temporomandibular joint dysfunction (TMJD) by forcing the jaw into an anatomically awkward position. (Shelanski, 2001)

Very few people have top and bottom teeth that line up directly on top of one another. Usually the top teeth overlap the bottom by a small amount (1-2mm) anteriorly. Most regulators and /or mouthpieces force the lower jaw anteriorly when placed in the mouth – a position that is thought to contribute to TMJD. The length of the biteplate is also a contributing factor, as the jaw is most comfortable when the stress to the jaw is distributed through the molars and few biteplates of mouthpieces extend as far back as the molars. (Shelanski,2001)

The factor of the mouthpiece design coupled with anxiety, rough water, cold water and jaw clenching is thought to increase the likelihood of the diver suffering from TMJD. Multiply this stress by the number of dives made and it is clear to see how the dysfunction can be compounded, but no research has been done on this factor.

2.4.1 Ancillary TMJ factors:

Besides jaw pain, diving presents other problems for TMJD sufferers. Because of the position of the Eustachian tubes to the TMJ, the local inflammation caused as a result of TMJD could result in a narrowing of the Eustachian tubes, which may lead to difficulty equalizing (pg vi). If severe this inflammation may lead to vertigo, disorientation and vomiting which are obviously serious problems especially under water and may even result in death. (Hobson,1996) No studies have been done on TMJD as a cause of death whilst diving so it is difficult to comment on the fact of death being a result of these serious conditions.

2.5 FUNCTIONAL ANATOMY AND BIOMECHANICS OF THE TMJ

The Temporomandibular joint (TMJ) provides articulation between the movable mandible and the fixed temporal bone of the cranium to allow for chewing, opening and closing of the mouth, and speaking (Pertes and Gross, 1995). The resting positon of the jaw is with the molars 2mm apart and the bottom teeth slightly further back than the upper teeth by 1 – 2 mm, this is the most comfortable position for the jaw at rest. When chewing the muscles of the jaw are most comfortable when the load is distributed over the back molars (Shelanski, 2001).

The TMJ is situated at the base of the skull and is formed by parts of the Temporal and Mandibular bones, separated by an inter-articular disc. The midline fusion of the two mandibular bodies, and the occlusion of the teeth provide a connection between the two joints so movement in one temporomandibular joint influences the other. (Pertes and Gross, 1995)

2.5.1 The Bony Anatomy:

The first bony part to be discussed is the mandible. The mandible has both a horizontal and a vertical part, which meet at the mandibular angle, the horizontal part being the mandibular body and the vertical the ramus.

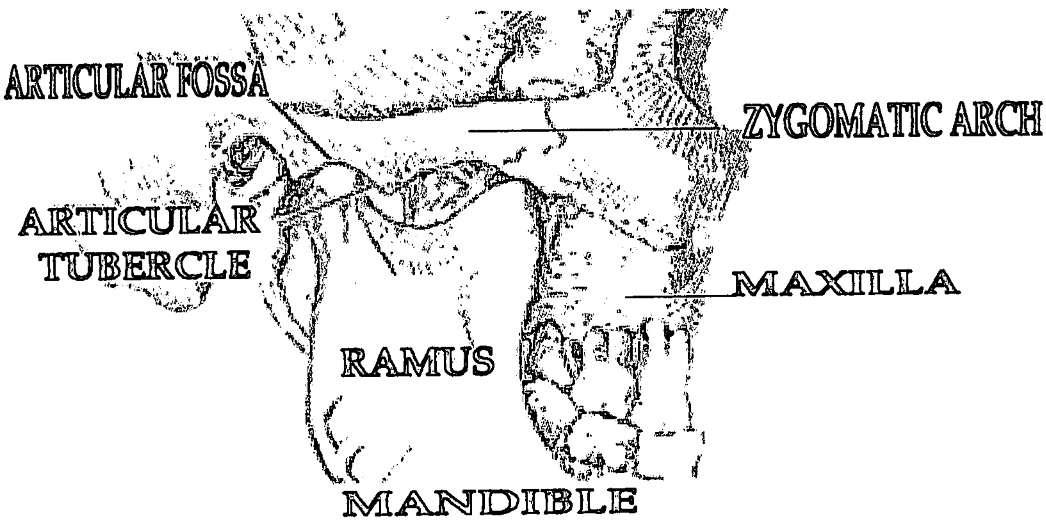


Fig: 2.5.1.1 Temporomandibular joint: the bony anatomy.
Adapted from Grays Anatomy, 1918.

Teeth implanted on the mandibular body, come into contact with those above implanted in the maxilla. (Ombregt, Bisschop, Ter Veer and van de Velde, 1995)

There are two processes present on the cranial end of the ramus: the coronoid process anteriorly and the posterior process with the mandibular head and the condyle at its most cephalad point. (Pertes and Gross, 1995)

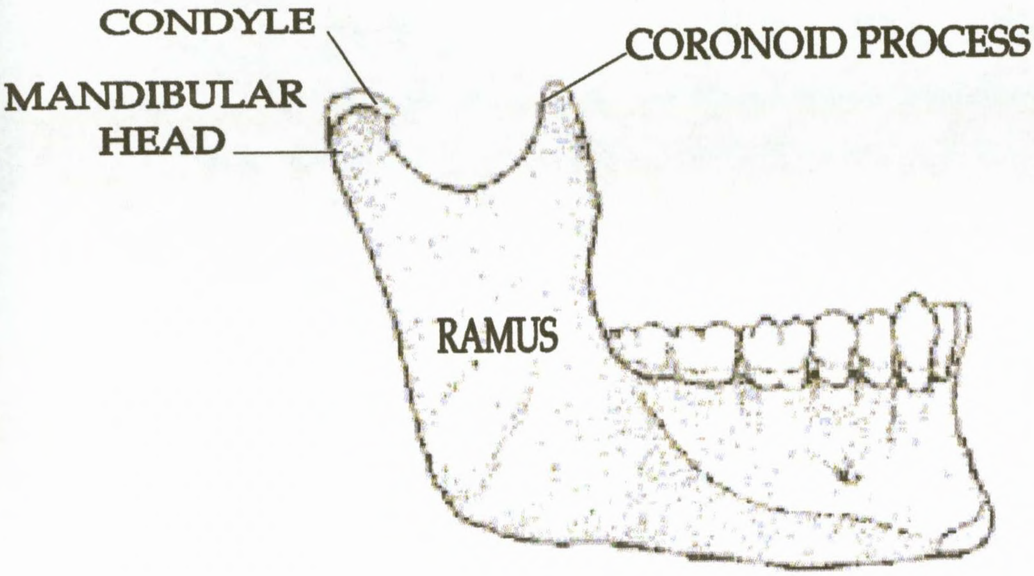


Fig: 2.5.1.2 Mandible: Mandibular head, coronoid and condyle.
Adapted from Grays' Anatomy, 1918.

The second bony part of the joint to be discussed is formed by the mandibular fossa at the base of the temporal bone. The mandibular head with the condylar process sits in the mandibular fossa of the temporal bone to make up the articular surfaces. (Ombregt et al., 1995)
The articular tubercle, a bony part of the temporal bone, is situated anterior to the mandibular fossa and makes up one third of the superior articular surface of the temporomandibular joint (Pertes and Gross, 1995).

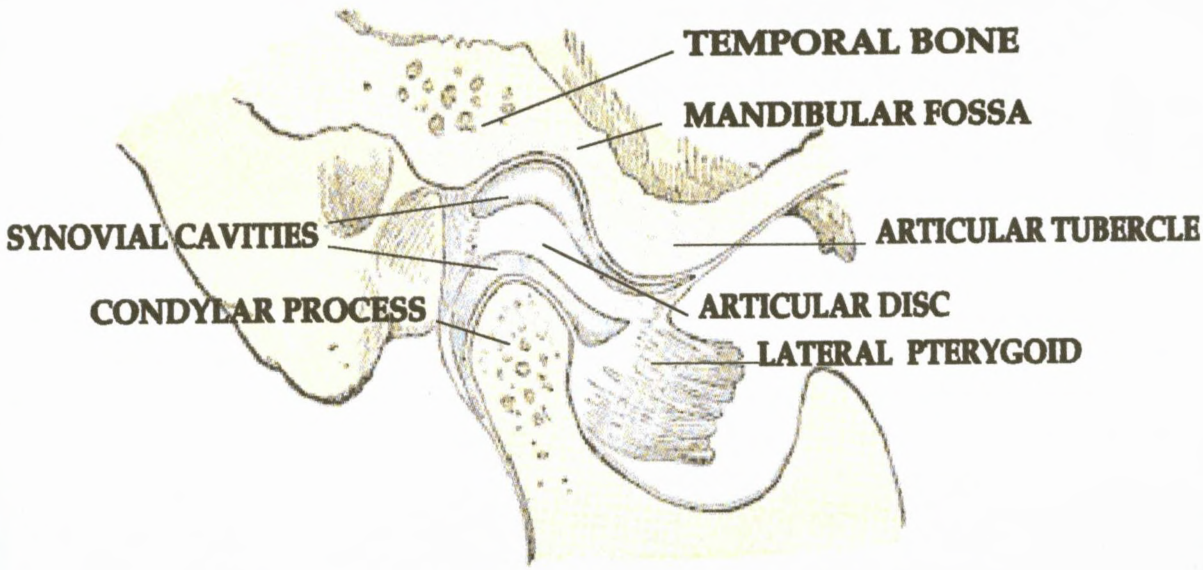


Fig: 2.5.1.3 The articular surfaces of the temporomandibular joint.
Adapted from Grays' Anatomy, 1918.

2.5.2 The articular surface:

Owing to the articular tubercle, the articular surface is three times as large as the mandibular head and condylar process, and is covered by fibrocartilage. This layer functions like articular hyaline cartilage but is more resistant to degenerative changes and has a greater capacity for repair and regeneration (Pertes and Gross,1995).

The articular space contains a small amount of viscous fluid for lubrication during motion; this synovial fluid also provides a medium for nutrients to the non-vascular, non-innervated dense fibrous connective tissue (Mc Neill, 1993).

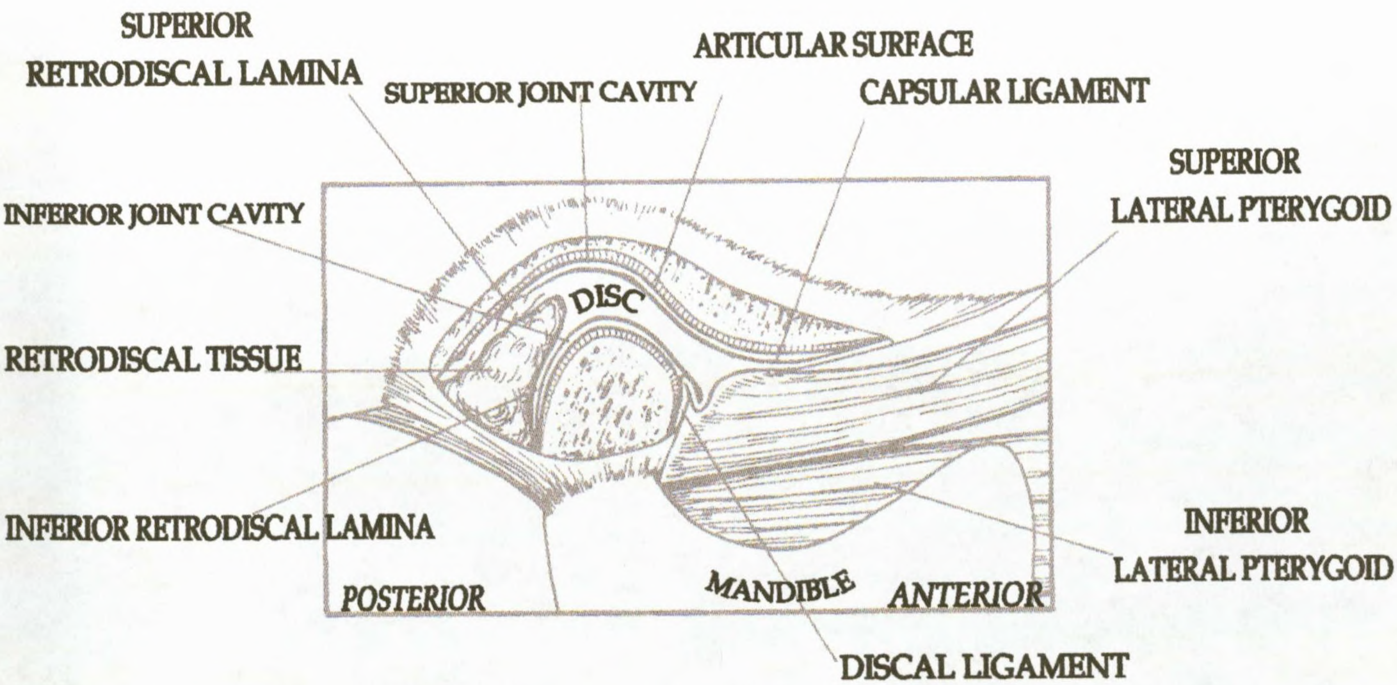


Fig: 2.5.2.1 Anatomic components of the temporomandibular joint.
Adapted from Mc Neill, 1993.

2.5.3 The inter-articular disc:

The temporomandibular joint is a highly complex synovial hinge with both anterior and posterior gliding and rotational movement, the disc (meniscus) divides the joint cavity into both upper and lower parts – the upper for rotational motion and the lower for gliding motion (Pertes and Gross,1995).

When viewed laterally the condyle is convex in the anteroposterior direction, however the articular tubercle is also convex in the saggittal plane, the disc is present in order to get stability between these two incongruous surfaces. The disc is a biconcave oval structure with thick posterior and anterior borders and a thin intermediate area. (Souza, 1995)

The contour of the disc helps prevent displacement of the mandibular condyle during forward gliding on the inferior aspect of the disc (Souza,1995).

The disc also serves as a shock absorber to counteract forces acting on the joint during functional and parafunctional activity (eg. when the teeth are clenched). (Pertes and Gross,1995)

Short, non-elastic discal ligaments attach firmly to the medial and lateral borders of the disc and then to the corresponding poles of the condyle. Their primary function is to restrict side-to-side motion of the disc and to allow passive movement anterior and posterior during condylar translation. The entire circumference of the disc is attached to the joint capsule. The anterior aspect of the disc is also connected to the Lateral Pterygoid muscle (fig. 2.4.2.1), while its posterior aspect is attached to the condyle by loose connective tissue, which is fused to the posterior capsule. The superior surface of the disc relates to the mid third of the articular tubercle, and the inferior surface to the superior portion of the condyle (fig. 2.4.2.1). The disc always follows the motion of the condyle. When the mandible glides anteriorly on protrusion the disc moves anteriorly, when it moves back on retrusion so does the disc. (Pertes and Gross, 1995)

2.5.4 The articular capsule:

The articular capsule and the temporomandibular ligaments reinforce the temporomandibular joint and help confine the synovial fluid to the joint space, to provide both nutrition and lubrication to the avascular articular surfaces. The capsule is wide and loose around the mandibular fossa and then diminishes to a funnel shape at the mandibular neck. This laxity prevents rupture of the capsule, even after dislocation of the joint. (Souza, 1995)

Laterally, the capsule is reinforced by the **lateral collateral ligament**, which originates at the zygomatic arch and then makes its way obliquely down and back to the posterior rim of the mandibular ramus. At its posterior aspect, it is in close relation to the joint capsule and prevents over-widening of the joint. Medially the **medial collateral ligament** reinforces the capsule. (Pertes and Gross, 1995)

The two extra-capsular ligaments, the **sphenomandibular** and **stylomandibular ligaments** prevent over stretching of the capsule (Souza, 1995). The temporomandibular ligaments also help prevent inferior distraction and limit movement of the condyle posteriorly into the retrodiscal space and tissues, superior retrodiscal lamina and inferior retrodiscal lamina (Mc Neill, 1993).

2.5.5 The nerve supply of the TMJ:

The articular cartilage, synovial tissues and inner portion of the disc have no pain receptors (nociceptors) and therefore cannot give rise to pain. The capsule and some intra-articular structures do have nociceptors, the disc mainly on the outer edge but less anteriorly than posteriorly. These nociceptors are activated by high mechanical stress, trauma or chronic inflammation.

The **trigeminal nerve**, or fifth cranial nerve, is the principal sensory nerve to the head, especially the face. It is also the motor nerve to the muscles of mastication. The trigeminal nerve divides early into three main divisions.

These being:

- V1 - The ophthalmic branch is primarily sensory to the supra-orbital area.
- V2 - The maxillary branch is primarily sensory to the infra-orbital area.
- **V3 - The mandibular branch** is:
    1. Sensory to the face and mandible.
    2. **Sensory to the TMJ via the auriculotemporal nerve which runs posteriorly to the blood vessels supplying the TMJ and the parotid gland. It follows the vessels cranially.**
    3. **Motor to the muscles of mastication.**

    (Moore, 1990)

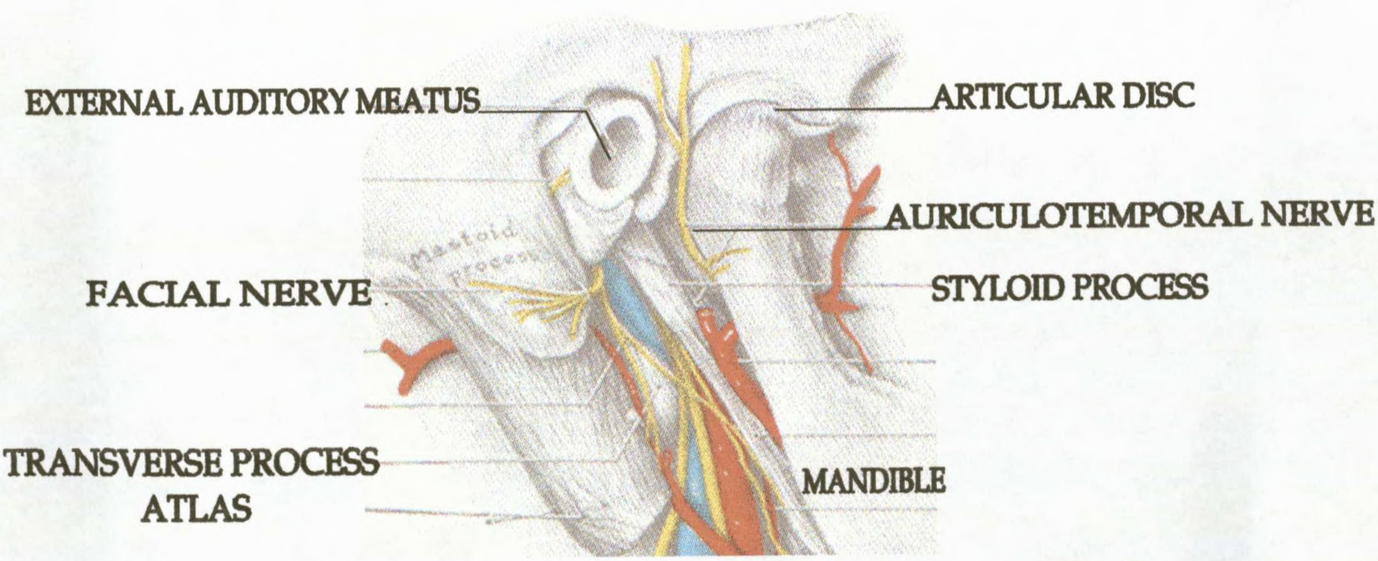


Fig: 2.5.5.1 Nerve supply to the TMJ: Auriculotemporal nerve.
Adapted from Moore, 1990.

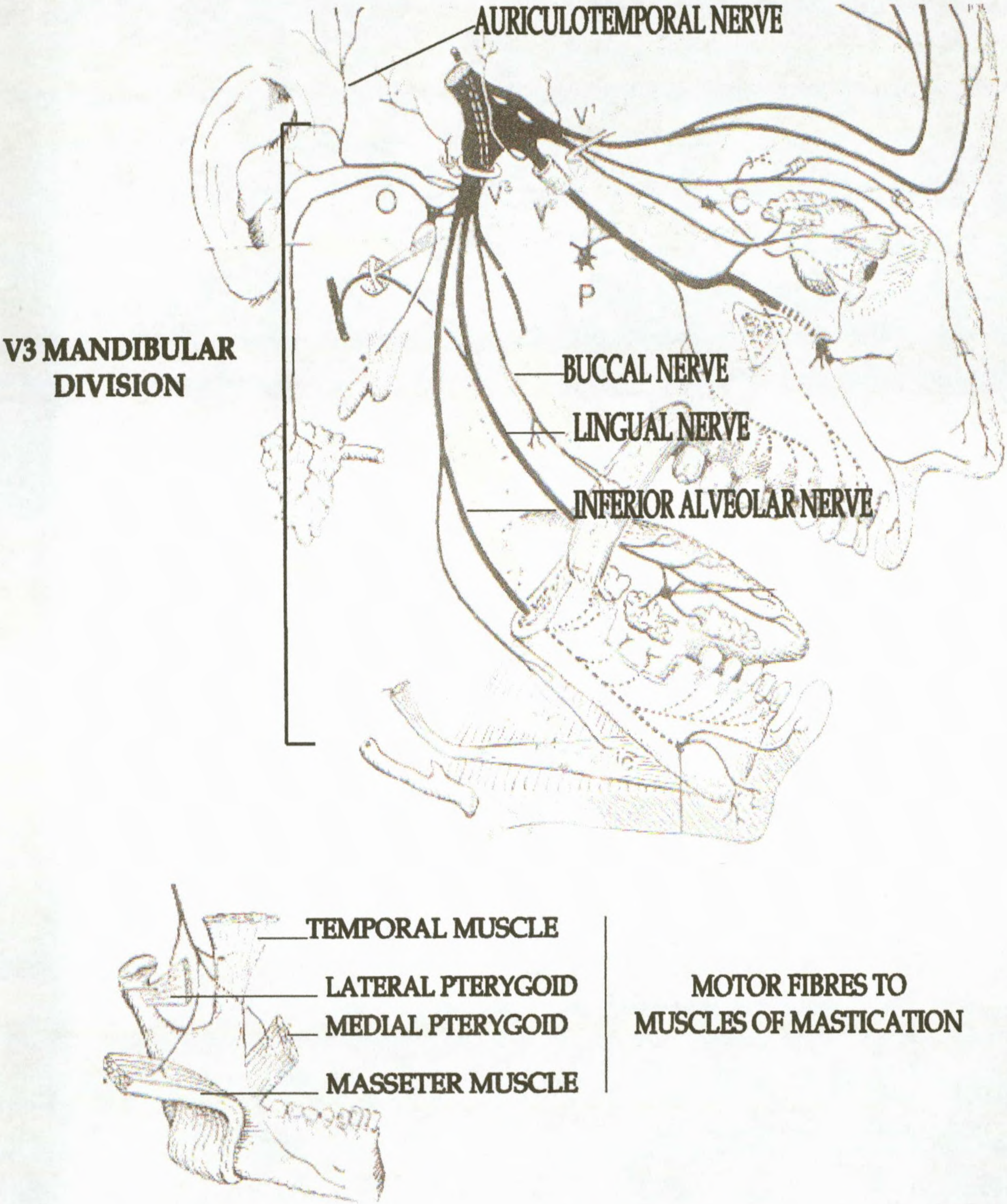


Fig: 2.5.5.2 Nerve supply to the TMJ: Trigeminal nerve – mandibular division (V3). Adapted from Moore, 1990.

2.5.6 The blood vessels of the TMJ:

The external carotid artery provides the main vascular supply to the TMJ, masticatory muscles, and the associated soft tissues. This artery divides into the superficial temporal and the internal maxillary arteries. The superficial temporal artery supplies the temporal and scalp areas while the internal maxillary artery supplies the teeth, maxilla, mandible and the muscles of mastication. (Pertes and Gross, 1995, Ombregt et al., 1995)

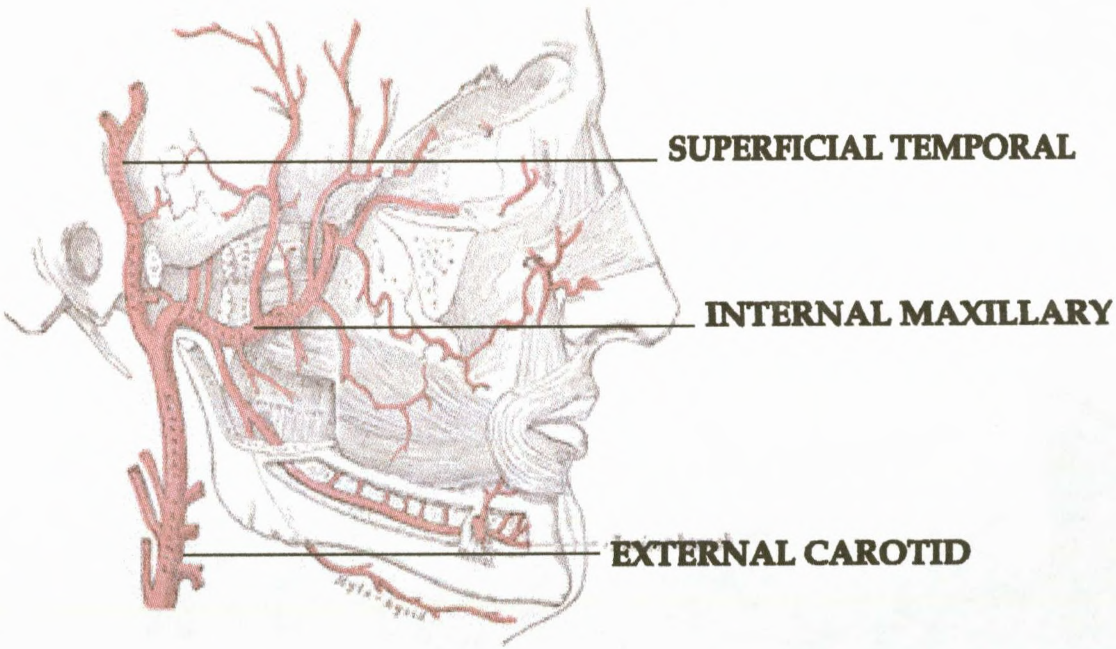


Fig: 2.5.6.1 The arterial blood supply to the face and TMJ. Adapted from Grays' Anatomy, 1918.

2.5.7 The muscles:

A. The Primary muscles of mastication:

The most important contractile structures of the TMJ are the masseter, temporal and pterygoid muscles.

1. The **masseter** originates at the lower edge and the deep aspect of the zygomatic arch and the temporal fascia. It courses superficially from the mandibular ramus towards the angle, where it has broad insertions. The masseter's primary action is to elevate the mandible and bring the teeth into contact for chewing.

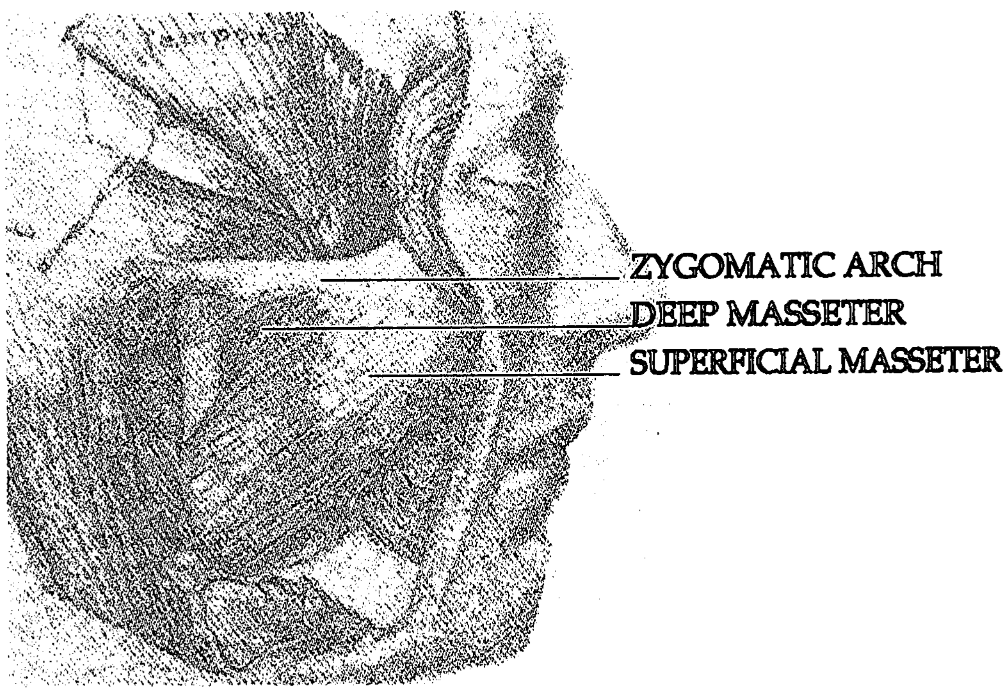


Fig: 2.5.7.1 Masseter muscle. Adapted from Moore, 1990.

2. The **temporalis** muscle is a large fan shaped muscles that originates in the temporal fossa. It stays deep to the zygomatic arch and inserts into the coronoid process of the mandible.

Its primary function is elevation of the mandible but also aids in retrusion, and is therefore a significant positioner of the mandible. (Pertes and Gross, 1995)

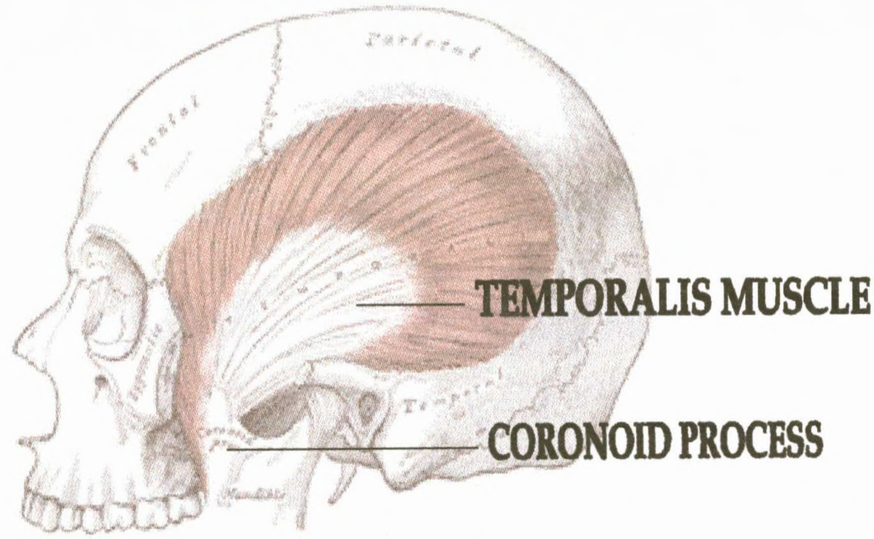


Fig: 2.5.7.2 The temporalis muscle.
Adapted from Grays' Anatomy,1918.

3. The **medial pterygoid** originates in the pterygoid fossa at the base of the skull and inserts into the deep aspect of the mandibular angle. The medial pterygoid is an accessory of the masseter, and acts primarily as an elevator muscle.

4. The **lateral pterygoid** muscle lies on the deep aspect of the mandibular neck. It has two heads: one originates at the sphenoid bone, the other at the lateral aspect of the pterygoid process. The two heads course laterally and posteriorly and join each other as they insert into the pterygoid fossa of the mandibular condyle, the joint capsule and the disc. The attachments of both heads is medial and therefore acts to pull the condyle and the disc in a medial direction during mandibular opening and protrusion. (Pertes and Gross, 1995)

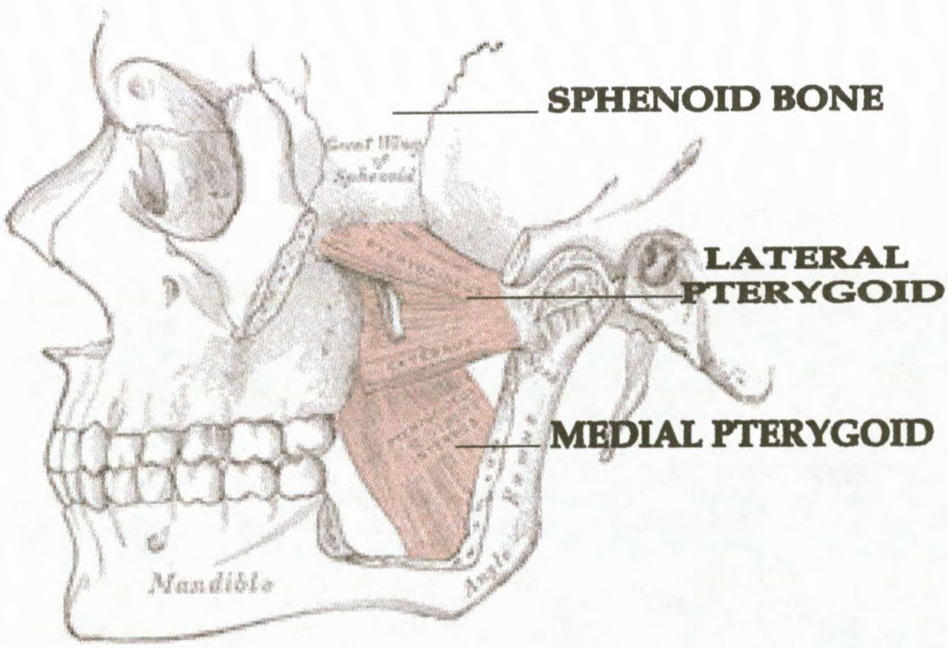


Fig: 2.5.7.3 The pterygoid muscles. Adapted from Grays' Anatomy, 1918.

The **opening** of the TMJ and mouth is accomplished by the lateral pterygoid muscles pulling the disc forward and the joint forward and down.

The **closure** of the joint is achieved by the temporalis, masseter and the medial pterygoids pulling the condyle and the joint up and back.

A summary of the function of the primary muscles of mastication is:

The **masseter's** primary action is to elevate the mandible and bring the teeth into contact for chewing.

The **temporalis** muscle acts in both elevating and retruding the mandible for the grinding action needed when crushing food.

The **medial pterygoid** is an accessory to the masseter and acts as a sling for the jaw on opening by cradling the mandible so the mouth doesn't fall open.

The **lateral pterygoid** acts to pull the condyle and disc in a medial direction and thereby support the TMJ. Therefore the masseter and medial pterygoids are for chewing and the temporalis and lateral pterygoids are for the circular motions needed when crushing particles of food.

B. The Secondary muscles of mastication:

The **suprahyoid** , **anterior digastric**, **posterior digastric**, **mylohyoid**, and **infrahyoid** muscles are secondary muscles of mastication which pull the mandible down and back and cause rotation in the temporomandibular joint in the first third of jaw opening. These muscles allow for opening of the jaw in order to insert food into the mouth. (Pertes and Gross,1995, Ombregt et al.,1995)

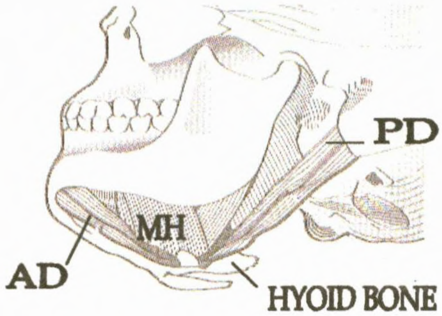


Fig 2.5.7.4 The Hyoid muscles: mylohyoid (MH), anterior digastric (AD) and posterior digastric (PD). Adapted from Pertes and Gross, 1995.

2.5.8 Biomechanics of the TMJ:

Mandibular movements can be complex, involving rotation and translation in both temporomandibular joints simultaneously. Voluntary movements of the TMJ include: opening, closing, protrusion, retrusion and lateral excursions.

During opening, closing, and protrusion the same translatory cycle occurs at the same time in both joints, whereas during lateral excursions, a disc-condyle complex pivots on the same side of excursion and translates on the opposite side. (Pertes and Gross, 1995)

Protrusion:

The lateral pterygoids act together to pull the mandible forward. During this process the mandible moves downward as the condyle is pressed down on the articular tubercle. Both lateral pterygoids contract bilaterally to achieve this motion.

Retrusion:

Retrusion of the mandible is achieved by the temporalis and suprahyoid muscles with some assistance from the deep masseter muscle. (Ombregt et al.,1995; and Pertes and Gross, 1995)

Opening:

Because the TMJ contains a disc, two movements are possible: rotation and translation. From the onset to the mid point of opening, the mandibular head rotates on the undersurface of the articular disc. At the same time the collateral ligaments are tightened. On translatory movement the disc glides posteriorly on the condyle because of contraction of the lateral pterygoids and stretching of the superior retrodiscal lamina. No further rotation occurs once the anterior translatory movement has begun. (Friedman and Weisberg, 1984; and Souza,1997)

Closing:

Closing the mandible is primarily due to the bilateral activity of the masseter, temporalis, and medial pterygoid muscles acting together. The disc-condyle complex is returned to rest by moving upward and back along the eminence.

Lateral excursions:

The mandible rotates around a vertical axis through the contralateral mandibular head by a unilateral contraction of the lateral pterygoid muscle. This is followed by a contraction of the posterior fibres of the temporal muscle, which repositions the head of the condyle. When this occurs on alternate sides, a typical grinding motion results. If at the same time the other masticatory muscles contract the food will be crushed. (Souza, 1997)

Discussing normal opening and closing of the jaw will help clarify the need for a balance among the structures surrounding the jaw to get a smooth and painless movement.

According to Perthes and Gross (1995), when the jaw is in the rest position, the thin intermediate zone of the disc is maintained between the condyle and the eminence, and the superior retrodiscal lamina is relaxed. On forward movement of the disc-condyle complex on the eminence the superior retrodiscal lamina becomes active, retracting the disc posteriorly on the condyle, preventing the disc from displacing anteriorly. During the forward phase, the lateral pterygoid muscle is inactive, but in the return phase the superior retrodiscal lamina becomes inactive and the lateral pterygoid contracts to rotate the disc anteriorly on the condyle.

According to Souza (1997), as the mouth opens the closing muscles relax (temporalis and masseter), after approximately one centimetre of opening, the lateral pterygoid muscle pulls on the disc and the condyle moving the disc-condyle complex down and forward.
Whereas during closure, the lateral pterygoid stabilizes the disc, whilst the temporalis and masseter muscles cause movement of the mandible, forward, up, and then back.

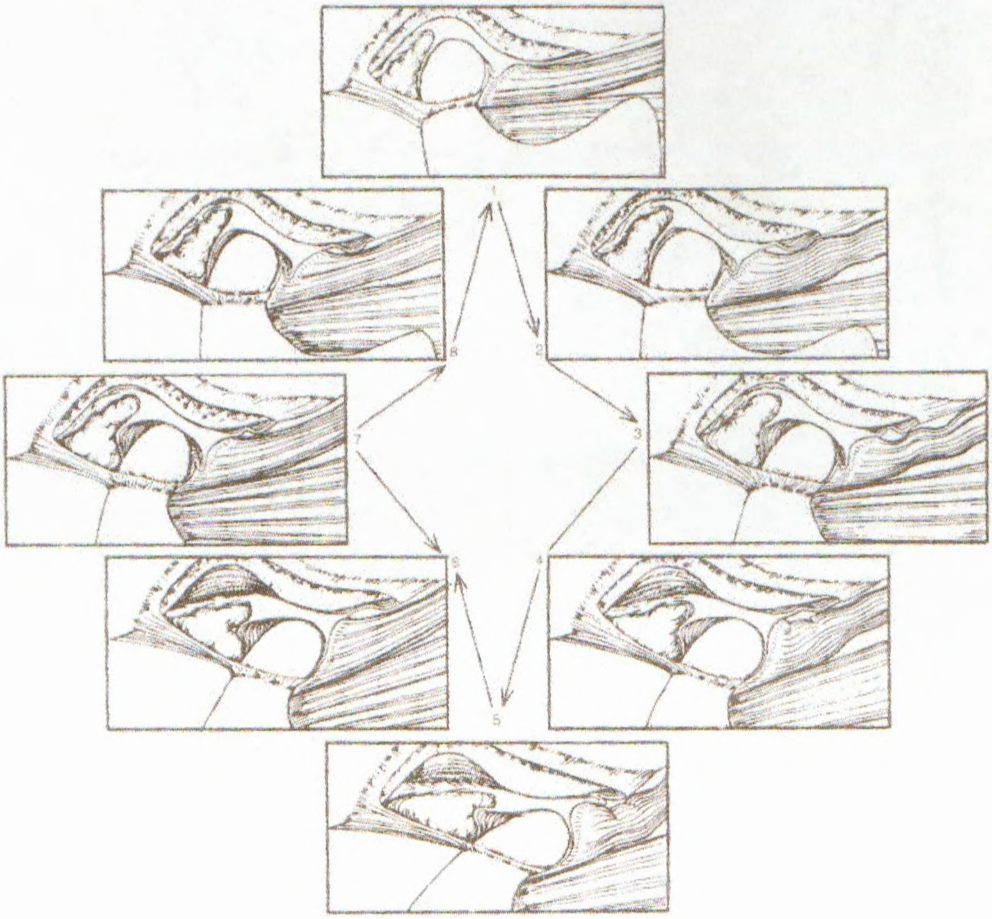


Fig: 2.5.8.1 Normal functional movement of the temporomandibular joint during opening and closing the mouth.
The movement cycle begins at rest, it consists of a forward phase (1-5) in which the disc-condyle complex moves down and forward along the eminence and a return phase (6-1) in which the disc-condyle complex moves upward and back to the rest position. Adapted from McNeill, 1993.

If there was abnormal movement in one TMJ, the opening and closure of the jaw would be assymetrical, there would be loss of range of motion and popping, clicking and pain may be present. (Souza, 1997)

2.5.9 Injury to the TMJ:

The TMJ, like other joints, can adapt to functional demands and can remodel if damaged. The articular cartilage covering the condyle and the glenoid fossa have a greater adaptive capability than the discal ligaments and the joint capsule and, because of its avascular nature, the disc has little capacity for remodelling. (Souza, 1997)

Remodelling of the joint differs from person to person and to their functional activity, factors such as the loading of the joint, the presence or absence of systemic disease, and age play a large role. If compressive forces happen at a greater rate than remodelling then deterioration and degeneration occur in the joint. Any changes to the joint structures in turn will interfere with normal function and cause dysfunction. When pain, noises and loss of range of motion are present the patient can be considered to have TMJD. (Souza,1997, Ombregt et al.,1995)

In this chapter I would also like to discuss some of the dysfunctions mentioned in chapter 2.2:

Articular surface defects: these may occur either in the upper or lower compartments of the TMJ. The upper compartment will be discussed but the lower will not as it does not normally require any treatment and is often assymptomatic. Upper compartment defects occur on the eminence and the superior surface of the disc, which cause an impediment to translatory motion. These defects may be caused by trauma to the mandible whilst the teeth are separated, inflammation or structural anomalies and present as a mechanical dysfunction, meaning a deviation of the mandible during opening.

Disc thinning or perforation: Overloading the joint with the teeth together may result in thinning of the central disc. Continued pressure on an area of thinning may result in perforation of the disc in that area. Thinning or perforation will both cause crepitus and pain especially during translation and this will increase with the severity of the dysfunction.

Disc displacement with or without reduction: this is characterized by an abnormal relationship between the articular disc, mandibular condyle, and articular eminence. The disc is most often displaced anteriorly but less often posteriorly. In order for disc displacement to occur there must be elongation of the disc attachments and deformation of the posterior or anterior border of the disc that allows the disc to slide. There are several causes of disc displacement; excessive pressure on the joint with clenching, hard biting, or trauma. The most characteristic feature of disc displacement is clicking or popping in the joint on translation and, often, a reduced mandibular range of motion.

Muscle disorders: muscular pain is diffuse and is generally described as deep, dull, aching, tightness or pressure, but can also be characterized by its variability in that the site of the pain may not be the true source of the pain. Dysfunction in the TMJ can cause local muscle tightness, restricted range of motion in the mandible, pain with movement and a feeling of muscle weakness. (Pertes and Gross, 1995)

The other dysfunctions will not be discussed as they were not relevant to this study.

2.6 CLINICAL SIGNS AND SYMPTOMS

Major signs and symptoms of TMJD:

Local effects	**Remote effects**
• Mandible deviates to one side when mouth is opened • Joint clicking • Facial pain • Post-auricular and /or pre-auricular pain • Pain aggravated by chewing • Crepitus of involved joint • Tenderness at the proximal mandible • Muscle spasm • Bruxism • Malocclusion	• Tenderness of posterior cervical muscles • Pain radiating from TMJ to temporal area or neck • Earache / headache • Tinnitus (ringing in the ears) • Vertigo

(Mc Neill, 1994)

Of the above signs and symptoms, questions were asked about joint noises (clicking, popping and crepitus), pain in the face and TMJ and loss of range of motion, as these were found to be the most prevalent in patients with TMJD as was shown in paragraph 2.3.

Joint noises are found in certain types of TMJD and these noises will help with accurate diagnosis. The most commonly heard sounds are clicking and crepitus. A click is a single noise of a short duration at any point in the range of mandibular motion, whereas crepitus is a grating or gravely noise heard at any time during the range of mandibular motion.

Clicking and popping noises found on opening and closing the mandible are found mostly in patients with disc displacement without reduction (repositioning of the disc). These noises are caused by the disc displacing and the condyle moving under the posterior band of the disc. Crepitus is caused by degenerative disease of the articular cartilage and is heard as a grating sound as the joint opens and closes. (Pertes and Gross,1995)

Loss of range of motion is due to numerous causes. The main causes are: spasm of the elevator muscles, displacement of the disc-condyle complex and inflammatory reactions in the joint. The normal range for full opening is between 40 – 55 millimetres, but with displacement of the disc the most characteristic finding is decreased range of motion to between 20 – 30 millimetres. In general a mandibular opening of less than 40 millimetres is considered as restricted motion. (Pertes and gross,1995)

In the questionnaire for this study the participants were asked to insert their knuckles between their teeth. Two and a half to three knuckles is considered normal, anything less than two was considered a decreased range of motion.

Pain in the TMJ or surrounding tissues is often felt as aching in character, but sometimes as stabbing or burning in quality. The areas where pain in the TMJ manifests, is at the joint site, around the ear and in the teeth. Often a patient will describe the feeling they get around or at the joint as "discomfort or tenderness". (Pertes and Gross, 1995)

CHAPTER THREE

OBJECTIVES OF THE STUDY

The objective of this study is to determine the prevalence of TMJD in the recreational scuba divers and snorklers, in comparison to the non-diver population, using subjective data from a questionnaire.

3.1 STUDY DESIGN AND PROTOCOL

The design was that of a point prevalence pilot study based on a questionnaire received from the participants in order to determine the prevalence of TMJD in recreational scuba divers and snorklers in comparison to non-divers.

For the purposes of this study a standard question format (Appendix D) was followed and a questionnaire was developed (Appendix C). To establish the face validity, the questionnaire was piloted on twelve individuals, six divers and six non-divers, reviewed and the appropriate changes made.

A single questionnaire was used on 400 participants, 200 divers and 200 non-divers, in the Durban Metropolitan area.

The questionnaire was broken down into categories:

Questions 1, 2 and 3 were diagnostic questions regarding mobility of the jaw;

Questions 4, 5 and 14 were diagnostic questions regarding the participant's pain;

Questions 6 and 7 were diagnostic questions regarding the sounds the jaw joints make and will determine cartilage or disc damage.

Questions 8 and 9 were demographic questions regarding the number of people who have their condition treated and by whom.

Question 10 was a certification question to determine the level of experience the diver had obtained.

Questions 11 and 12 were aetiological questions to determine if there was any relation between the number of dives done and TMJD. These questions were also demographic questions to determine the number of dives done in the past three months.

Question 13 was an aetiological question to find if there was any relation between the diver's mouthpiece and TMJD.

Each answer was counted on an individual basis, therefore if there were twelve "yes" answers to a question it was scored as 12.

The researcher approached each of the participants individually, and randomly. A percentage of the 200 diving participants was taken from each dive club in the Durban Metropolitan area in proportion to their diving population and stratified according to their age group, 18 – 30, 31 – 40 and 41 - 50. The non-diving population (200) was approached on the beaches and at the clubs in the Durban Metropolitan area and stratified into the age groups determined by the diving group discussed earlier.

In order to facilitate the rapid answering of the questionnaire, the questions were limited to tick off brackets and yes-or-no brackets.

3.1.1 INCLUSION CRITERIA

1. Participants had to be between the ages of 18 and 50 years to be included in the study, as this was the age group with the highest prevalence of TMJD (Mc Neill, 1993).
2. The diving population (Group 1) were required to have dived within three months of participating in the study, and the scuba divers were required to have a valid dive certificate.
3. Participants with **at least one** of the following criteria were diagnosed as having TMJD: decreased range of motion of the jaw, pain in the jaw joint and around the jaw joint, and / or noises in the jaw joint consisting of crepitus, clicking or popping (Mc Neill, 1992).
4. Participants were excluded if they were below the age of 18 or above the age of 50, if they had any infection, neoplastic disease or fractures of the jaw or jaw joint, or systemic disease that affected the jaw (Mc Neill, 1993).

3.1.2 INTERVENTION

Subjects found suitable for the study were given a letter of information (Appendix B) and were asked to complete an informed consent form (Appendix A). All participants were also requested to read a standard patient format letter (Appendix D) stating the inclusion and exclusion criteria before answering the questionnaire (Appendix C), which had been designed by the researcher for the purpose of this study.

3.1.3 ETHICAL CONSIDERATIONS

The rights and welfare of the participants were protected as follows:

- informed consent was gained.
- the participant was not coerced into participating in the study.
- information was given to the participants in an understandable language.
- the research involved no risk for the participants.
- confidentiality was maintained and no names were recorded.
- participation was voluntary and did not involve financial benefits
- participants were free to withdraw from the study at any stage.

3.2 THE MEASUREMENT AND OBSERVATION

3.2.1 THE DATA

The data of this study consisted of two kinds: primary and secondary data.

3.2.1.1 The primary data

This consisted of the response of the divers and non-divers to the questionnaire.

3.2.1.2 The secondary data

This consisted of published data concerning TMJD: pain, loss of range of motion and TMJ noises; diving and TMJD, the relationship between TMJD in divers and the use of a mouthpiece.

3.3 LOCATION OF THE DATA

The data needed for testing the objective will be obtained from the questionnaires completed by the divers and non-divers (Appendix C).

The data required will include information on:

a) Diving status and certification.

b) Ages of participants.

c) Pain symptoms.

d) Loss of range of motion.

e) Noises made by the jaw.

f) Comfort of the mouthpiece worn (for divers only).

g) Dive certification (for divers only).

h) Previous diagnosis of TMJD.

Only the responses from those divers and non-divers who met the requirements as set out in the delimitations were used.

3.4 THE METHOD OF MEASUREMENT

The Chi-squared tests will be used to measure the dependence or independence of Group 1 (divers) and Group 2 (non-divers) after all the questions on the questionnaire (Appendix C) have been answered by each of the participants in each group and the data extracted from the questionnaires.

3.5 STATISTICAL ANALYSIS

The statistical evaluation is aimed at measuring the dependence or independence between Group 1 and Group 2 in respect to the prevalence of TMJD.

The responses to the questionnaire (Appendix C) will be used to construct tables and bar graphs for visual comparison. Visual summaries of analytical findings will be given by use of bar charts to compare groups one and two with respect to their continuous variables. Chi-squared tests will be used for data analysis and p-values will be used to draw conclusions.

The data will be interpreted by means of analysing the responses to the questions through the use of tables and bar charts. The subsequent analysis to compare the two groups will be done using chi-squared tests.

The chi-squared analysis procedure allows one to analyse qualitative data arranged in a table to determine whether or not the populations are statistically independent. Chi-squared tests will be used for the data analysis and the p-values will be used to draw the conclusions where $\propto = 0.05$ (or 5%).

By $\propto = 5\%$ we mean that we are willing to take a 5% chance of rejecting the null hypothesis when in fact it is true. This implies a Type I error.

Alpha norms are as follows: 1% level of significance is used by the medical research councils where large funding is usually available; 5% level of significance is normally used by consulting statisticians; 10% level of significance is used only when the sample size is very small.

The statistical package SPSS (Version 9.0) will be used for data entry and analysis (Fisher and van Belle, 1993: 315 – 319).

The results of these tests will be used to discuss and draw conclusions as to the dependence or independence between the diving group (Group 1) and the non-diving group (Group 2) with reference to the prevalence of temporomandibular joint dysfunction in divers as opposed to non-divers.

CHAPTER FOUR

4.1 INTRODUCTION

This chapter deals with the results accompanied by statistical interpretation obtained after analysing the data from the subjective data obtained through the questionnaire (Appendix A).

4.2 CRITERIA GOVERNING THE ADMISSIBILITY OF DATA

Data collected from participants who met with the criteria of the study were used. Only responses to the questionnaire completed under the researchers supervision were utilized.

4.3 THE STATISTICAL HYPOTHESES

Integrating the data from the two groups required an independent null hypothesis and an alternate hypothesis, which is described below:

Ho: The prevalence of TMJD (temporomandibular joint dysfunction) in the non-diver population and recreational diving are independent.

Ha: The prevalence of TMJD in the non-diver population and recreational diving are dependent.

4.4 THE DECISION RULE

The data was analysed at the 5% level and the decision rule was as follows:

For the Chi-squared tests

If $P < 0.05$, reject the null hypothesis

If $P \geq 0.05$, accept the null hypothesis

4.5 The prevalence of Temporomandibular joint dysfunction (TMJD) in Divers as opposed to Non-divers in the Durban metropolitan area.

Table 4.1.1 (Based on Questions 2,3,4,5,6, and 7)

	Divers	Non-divers	Total
TMJD	93	109	202
No TMJD	107	91	198
Total	200	200	400

CHI-SQUARE TESTS					
	Value	df	Asymp. Sig. (2-sided)	Exact 2-sided	Exact 1-sided
Pearson Chi-Square	2.56	1	0.1095276		
Continuity Correction	2.25	1	0.1335367		
Likelihood Ratio	2.56	1	0.1093377		
Fisher's Exact Test				0.13343657	0.06671828
N of Valid Cases	400				

0 cells (.0%) have expected count less than 5.
The minimum expected count is 99.00.
The P-value is 0,1

Level of significance: $\propto = 0.05$

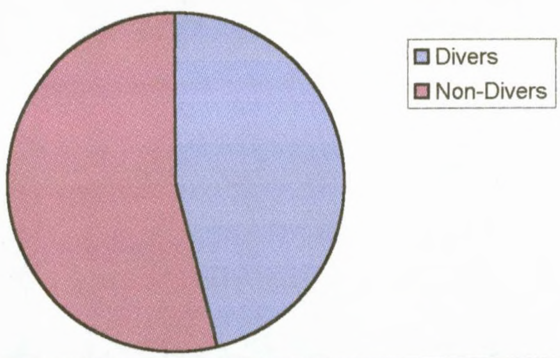
Decision rule: reject Ho if $P < 0.05$ and if χ^2 cal < $\chi^2 \propto, 1$

Conclusion: χ^2 cal = 2.56 which is < 3,82

P-value is 0.1 Accept the Ho.

This shows there is no association (or dependence) between the occurrence of TMJD in the non-diving and recreational diving populations.

fig.4.1.1.1 Prevalence of TMJD in Divers as opposed to Non Divers
46.5% Divers and 54% Non Divers



The overall prevalence of Temporomandibular joint dysfunction in Divers is 46,5% (N=93) whereas in Non-divers it is 54% (N=109).

Chi squared tests showed there was no association between the two groups.

In addition to Chi-squared tests, the test for proportions is also carried out to examine whether there is any significant difference.

Test for proportions of divers and non-divers with TMJD.

π_1 – proportion of TMJD occurrence in the population of divers.

π_2 – proportion of TMJD occurrence in the population of non-divers.

P_1 = Sample proportion of TMJD in divers.

P_2 = Sample proportion of TMJD in non-divers.

$\alpha = 0,05$

Ho: $\pi_1 = \pi_2$

H1: $\pi_1 \neq \pi_2$

P1 = 0,465

P2 = 0,545

q = 1 –P = 0,495

Test statistic = 1.6 < 1.96

The test statistic shows there was no significance at $\alpha = 0,05$

Therefore there is no significant difference between the two proportions

4.6 The relationship between age and the prevalence of TMJD in divers as opposed to non-divers.

Ho: ∝ = 0,05

Ha: ∝ > 0,05

Table 4.1.2 (Based on Q 2,3,4,5,6, and 7)

	PRESENCE OF TMJD	18-30	31-40	41-50
DIVERS (200)	Yes	44	31	18
	No	32	40	35
NON-DIVERS (200)	Yes	46	41	22
	No	30	30	31
	TOTAL	152	142	106

CHI -SQUARE TESTS			
Divers and Non-divers	Value	df	Asymp. Sig. (2-sided)
Pearson chi squared test	7.24	2	0.27008
Likelihood ratio	8.82	2	0.27008
N of valid cases	400		

0 cells (.0%) have expected count less than 5.
The minimum expected count is 98.0
P-value is 0.2

Level of significance: $\alpha = 0.05$

Decision rule: reject the null hypothesis if $\chi 2 > \chi 2_{\alpha,\kappa-1} = 11{,}0705$

Conclusion: Since $\chi 2$ tests = 7,24< 11,0705, accept the null hypothesis.

Since the null hypothesis has been accepted this shows that there is no significant correlation between the ages of divers and non-divers and the prevalence of TMJD.

Fig. 4.1.2.1 The Age of Subjects and the prevalence of TMJD in Divers

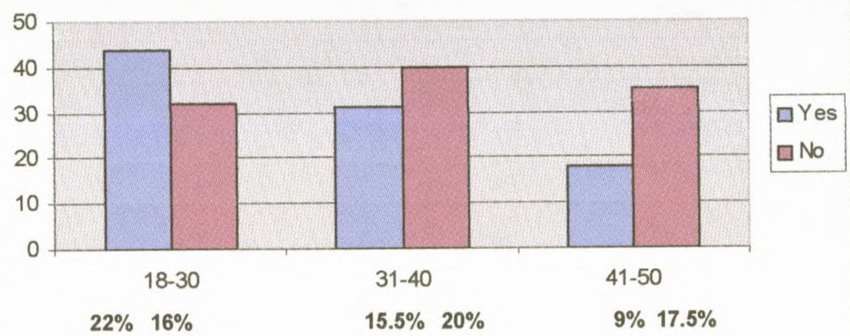
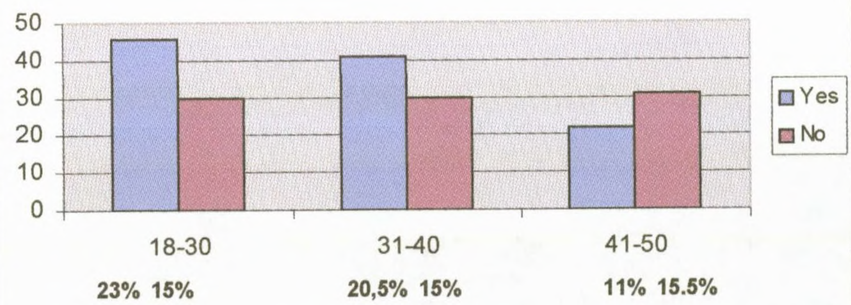


Fig.4.1.2.2 The Age of Subjects and the prevalence of TMJD in Non divers



Cross-tabulation between the age of the subjects and the presence of TMJD, in both divers (22%) and non-divers (23%), revealed that the highest percentage of subjects withTMJD are in the 18 - 30 age group from the total of 200 in each group.

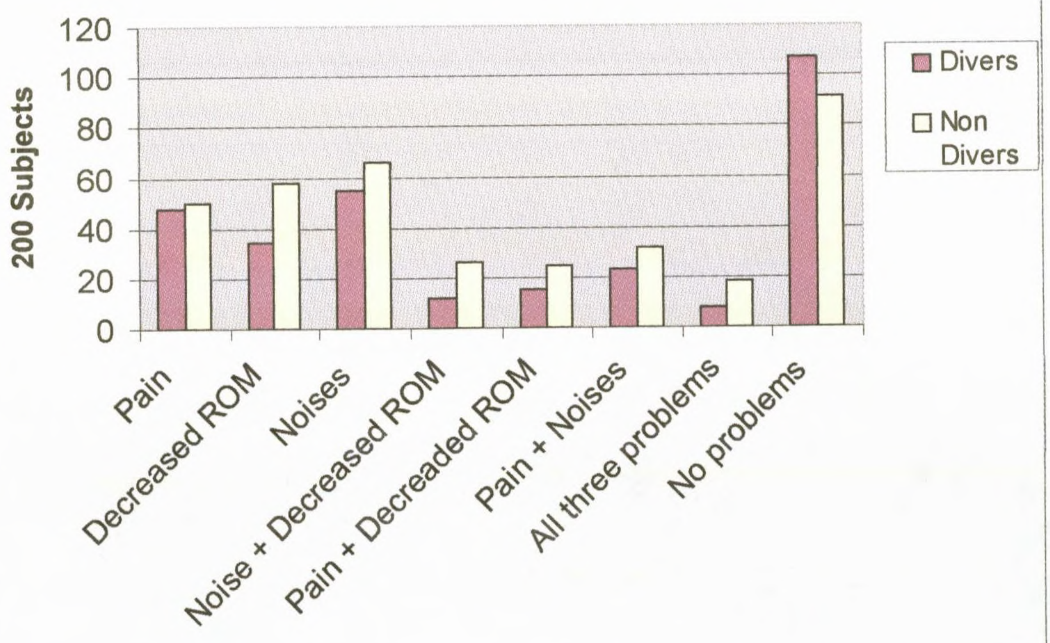
Chi squared tests showed there was no association between the two groups.

4.1.3 The Prevalence of TMJD symptoms in divers as opposed to non-divers.

Table 4.1.3
(Based on Q 2,3,4,5,6, and 7)

SYMPTOMS	Divers (200)	Non-Divers (200)
Pain	48 (24%)	50 (25%)
Decreased ROM	34 (17%)	58 (29%)
Noises	55 (27,5%)	66 (33%)
Noise + Decreased ROM	12 (6%)	26 (13%)
Pain + Decreased ROM	15 (7,5%)	25 (12,5%)
Pain + Noises	23 (11,5%)	32 (16%)
All three problems	8 (4%)	18 (9%)
No symptoms	107 (53,5%)	91 (45,5%)

Fig.4.1.3.1 Prevalence of symptoms of TMJD in Divers as opposed to Non divers



From table 4.1.3 it can be deduced that non-divers suffer with more pain (25%), decreased range of motion (29%), jaw joint noises (33%), and combinations of these than do divers. The divers' pain (24%), decreased range of motion (17%), jaw joint noises (27,5%), and combinations of these were marginally less than the non-divers.

Jaw joint noises were found to have a high prevalence in both groups whereas decreased range of motion was found to have a low prevalence. Divers appear to have greater range of motion in their jaw joints than the non-divers.

The most prevalent combination of symptoms was pain and jaw joint noises at 11,5% in divers and 16% in the non-divers. There was a low prevalence of all three symptoms with 4% in divers as opposed to 9% in the non-divers.

4.1.4 Prevalence of subjective findings in subjects with decreased range of motion.

Table 4.1.4 Based on Q2 and 3

SUBJECTIVE FINDINGS	Divers	Non-Divers
Difficulty opening wide	33 (16,5%)	57 (28,5%)
Difficulty opening at all	0 (0%)	0 (0%)
Jaw locking	3 (1,5%)	5 (2,5%)
Difficulty moving side to side	2 (1%)	0 (0%)
Difficulty chewing some foods	2 (1%)	1 (0,5%)

In table 4.1.4, the most prevalent subjective finding was difficulty in opening the mouth wide, experienced by 16,5% of divers and 28,5% of non-divers.

The other subjective findings had a very low prevalence.

4.1.5 Prevalence of subjective findings in subjects with pain.

Table 4.1.5 Based on Q4 and 5

SUBJECTIVE FINDINGS	Divers	Non-Divers
Pain around jaw joint	37 (18,5%)	47 (23,5%)
Pain in front of ear	23 (11,5%)	37 (18,5%)
Pain below the ear	3 (1,5%)	4 (2%)
Pain in the back teeth	10 (5%)	4 (2%)
Pain on chewing	2 (1%)	3 (1,5%)
Pain at rest	1 (0,5%)	0 (0%)
Pain on opening the mouth	5 (2,5%)	8 (4%)
Pain after a dive	8 (4%)	0 (0%)

In table 4.1.5, the most prevalent subjective findings were pain around the jaw joint (18.5% divers; 23,5% non-divers) and pain in front of the ear (11,5% divers; 18,5% non-divers) in divers and non-divers respectively. 5% of divers and 2% of non-divers experienced pain in the back teeth and 4% of divers experienced pain in the jaw after diving.

4.1.6 Prevalence of subjective findings in subjects with jaw joint noises.

Table 4.1.6 Based on Q6 and 7

SUBJECTIVE FINDINGS	Divers	Non-Divers
Clicks on opening	36 (18%)	45 (22,5%)
Clicks on chewing	18 (9%)	35 (17,5%)
Noises after a dive	7 (3,5%)	0 (0%)
Pain with clicking	4 (2%)	6 (3%)
Grating	4 (2%)	0 (0%)
Popping	2 (1%)	3 (1,5%)

In table 4.1.6 the most prevalent findings were clicking of the jaw joint on opening of the mouth (18% divers, 22,5% non-divers) and clicking of the jaw joint on chewing (9%divers, 17,5% non-divers). The other subjective findings were of low prevalence.

4.1.7 The prevalence of subjects previously diagnosed with TMJD.

Table 4.1.7 Based on Q9

DIAGNOSED BY:	Divers	Non-Divers
G.P.	1	1
Dentist	0	2
Orthodontist	1	0
Maxillofacial	1	3
Other	3	0
Total	6	6

In Table 4.1.7 the prevalence of subjects who were previously diagnosed as having TMJD was very low. Those diagnosed by their General Practitioners was 1%, only one diver and one non-diver; only two were diagnosed by their Dentists and both were non-divers (1%). One diver was diagnosed by his Maxillofacial surgeon (0.5%), as were three non-divers (1,5%). Three divers were diagnosed by other professions. The total prevalence therefore for divers and non-divers alike, previously diagnosed with TMJD, was 3% each. It was interesting to observe that all those that answered other in this question had their TMJD diagnosed by their chiropractors.

4.1.8 Dive certifications and the prevalence of TMJD.

Table 4.1.8 Based on Q10

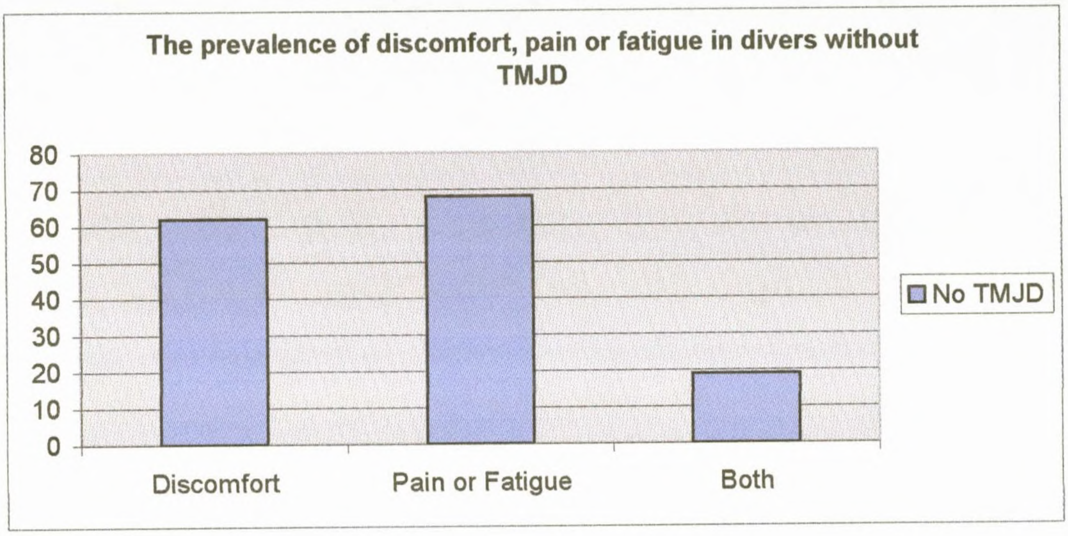
	DIVE CERTIFICATION	Divers with TMJD	Total divers in this category
	Snorklers	9 (75%)	12
In order of experience	**1 Star (underwater 1)**	35 (53,8%)	65
	2 Star (advanced)	24 (38,7%)	62
	3 Star (master diver)	5 (21,7%)	23
	Dive master	14 (58,3%)	24
	Instructor	6 (42,8%)	14
	Totals	93 (46,5%)	200

Table 4.1.8 shows a difference between the less experienced divers and the slightly more experienced divers and the prevalence of TMJD. In those divers with a 1star certification 53,8% suffered with TMJD, in those with a 2 star certification 38,7% suffered with TMJD, whereas those with a slightly higher certification of 3 star 21,7% suffered with TMJD.

4.1.9 The prevalence of discomfort, pain and fatigue in divers without TMJD

Table 4.1.9 Only whilst diving Based on Q13 and 14

MOUTHPIECE	No TMJD
Discomfort	62
Pain and Fatigue	68
Both	19
Total	149



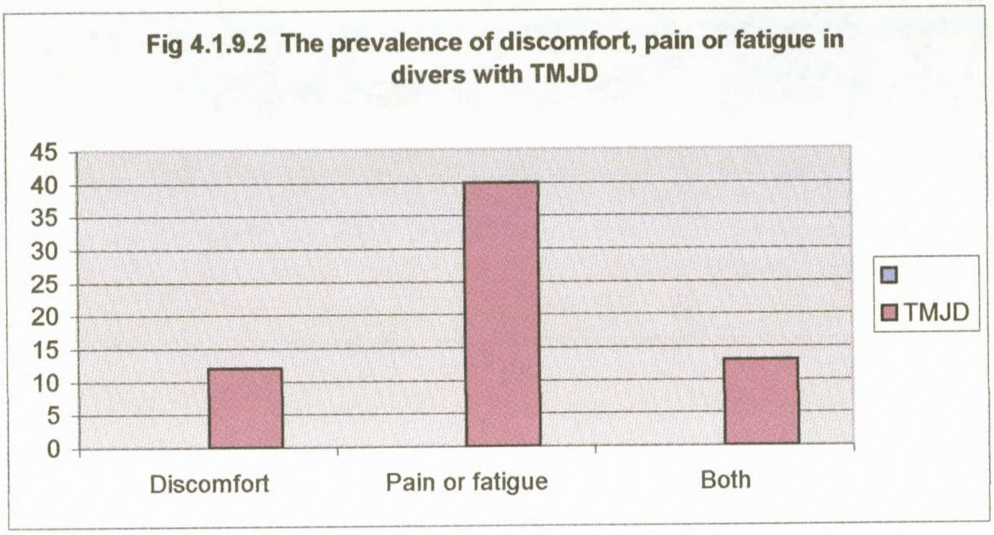
In table 4.1.9, and the corresponding graph, it is plain to see that the prevalence of a combination of discomfort (definition on page vi) and fatigue when wearing a mouthpiece is low in divers without TMJD (9,5%).

This graph also shows that fatigue with the use of a mouthpiece is more prevalent than discomfort caused by the mouthpiece although this is not a large difference.

4.1.10 The prevalence of discomfort, pain or fatigue in divers with TMJD

Table 4.1.10 Only whilst diving Based on Q13 and 14

MOUTHPIECE	TMJD
Discomfort	12
Pain or fatigue	40
Both	13
Total	65



In table 4.1.10 and its corresponding graph it is shown that pain or fatigue during a dive is far more prevalent than just discomfort. Pain or fatigue may be compounded by using the mouthpiece whilst diving as this graph seems to construe.

CHAPTER FIVE

CONCLUSIONS:

In this South African survey of the Durban Metropolitan area the 46.5% prevalence of TMJD in divers as opposed to non-divers (54.5%) was substantially lower than the 75% prevalence of TMJD in a general population as found by Mc Neill (1993). Mc Neill used a much larger population size of 3 428 as against 200 in this survey. In his study he also used objective and subjective findings, whereas in this survey only the patients subjective findings were used for the data analysis. Mc Neill also used **one or more** of the following criteria to diagnose TMJD: joint sounds, limitation of jaw movement, muscle tenderness, joint tenderness and pain (especially pre-auricular). Due to the lack of statistical material on the prevalence of divers suffering with TMJD it is not feasible to make comparisons here with any other statistics.

My initial hypothesis was that divers would have a higher prevalence of temporomandibular joint dysfunction (TMJD) than non-divers due to the use of mouthpieces on their breathing apparatus. The results of the survey on the other hand show there is no significant difference between the two groups.

The knuckle test was used for Question one and later disregarded due to the fact that it was an objective test and not a subjective test for loss of range of motion in the jaw and the study states that only subjective tests were used for data collection. It was interesting to note that the majority of those who had a positive test also said they had difficulty in opening their jaws wide, therefore it shows that the knuckle test may be a reliable test to use in further studies.

The questions that relate to tables 4.1.9 and 4.1.10 were rather misleading as they asked the participant if their mouthpiece was comfortable during a dive and whether their mouthpiece made their jaw tired or **sore**. The reason for these questions being misleading is that in a previous question it was asked of the participant whether they got facial or jaw **pain.** By using sore in the one question and pain in another the participants may have read the questions differently and therefore answered differently. In a future study it would be prudent to split the question, "Does your mouthpiece ever make your jaw tired or sore?" into two questions so as to not have further ambiguity when setting out your results, for example: "Does your mouthpiece ever make your jaw tired?" and "Does your mouthpiece ever make your jaw painful?"

The participants may have answered no to the question about getting facial and jaw pain as this was a general question and implied that they usually got facial or jaw pain. The question asking about whether the mouthpiece ever made their jaw tired or sore may then have been answered as yes as they only ever felt pain whilst diving and using their mouthpiece.
Therefore the best way to explain this is to say that those who answered no to the question "Do you get facial or jaw pain?" and yes to the question "do not qualify as having TMJD.
The reason being that if they don't usually get jaw or facial pain and only have temporary pain during a dive when the mouthpiece
is causing fatigue of the muscles of the jaw rather than dysfunction in the

TMJ. A possible reason for those participants answering yes to jaw and facial pain and yet no to pain while they are diving may be that those who do normally have jaw pain do not register an increase in the pain during a dive as they have become conditioned to continual jaw pain.

The Canadian statistics for TMJD in divers was approximately 25% of a total of 691 divers, whereas this survey showed a total of 46.5% of a total of 200 divers had TMJD. This difference in statistics may be due to the fact that the Canadian study was looking at more than just TMJD. They were also looking at the prevalence of other disorders related to diving, for example sinusitis, ear infections, the Eustachian tubes etc. Their study also used both subjective and objective findings, whereas in this survey only subjective findings were used.

Aside from the main objective, certain other points were found to be of importance in this survey. Statistically when comparing the divers and the non-divers in the three age groups, in relation to TMJD, there was no significant difference in the prevalence.

Of the presenting symptoms in an American group of TMJD sufferers: The difference in the prevalence findings between the American and this surveys findings is due to the fact that the American statistics were taken from a group of TMJD sufferers, whereas this survey used two populations from a normal group.

In the American group the pain prevalence was 89%, noise prevalence was 85% and limited opening 40% (Mc Neill, 1992).

As these were the most prevalent criteria for diagnosis, these were used in this survey. The prevalence in this study for pain was 24% in divers and 25% in non-divers, noises constituted 27,5% in divers and 33% in non-divers, and limited opening17% in divers and 29% in non-divers.

This survey shows that there is no significant difference between a non-diver population and a diving population for the prevalence of TMJD.

CHAPTER SIX

The conclusions and recommendations

6.1 Great caution should be exercised in attempting to generalise the findings in this survey, since the individual factors associated with TMJD were based on the respondent's subjective evaluations alone.

6.2 The prevalence of TMJD in the Durban Metropolitan area for divers was 46.5% and for non-divers 54%. The prevalence in this survey of TMJD in the non-divers population were not as high as those of Mc Neill's (1993) perhaps due to the differences in sample size and that Mc Neill used both objective and subjective findings, whereas this survey only used subjective findings.

6.3 There was no significant difference between TMJD in divers as opposed to non-divers.

6.4 Age did not seem to be significantly associated with having TMJD.

6.5 This study was not designed to establish the cause and effect relationships between mouthpieces and the prevalence of TMJD.

The following recommendations can be made:

6.6 Since question one was recognised after the completion of the questionnaires as an objective test it was not used for the results. It was interesting to note that those participants with a positive knuckle test found difficulty in opening their mouths wide (question two).

6.7 A factor which adversely affected this survey was the small sample size (N=200).

Therefore, an under-representation of the results possibly occurred. Depending on the statistical methods chosen, in order for increased significance to be demonstrated, many hundreds of respondents would be needed for example a group of 1000.

6.8 If this questionnaire is done again in the future a number of changes should be implemented beforehand:

The questions should be more to the point eg: instead of " do you get jaw pain ?" it should read " do you ever suffer with jaw joint pain and if so how often and how long does it last?".

6.9 There should be a shorter time frame between the participants last dive and their answering the questionnaire. It should be less than three months as this would give a more accurate picture of the relationship between diving and TMJD.

6.10 A discrepency was found between questions 4 and 14 as some participants answered "no" to do they get facial or jaw pain, and "yes" to the question "does your mouthpiece ever make your jaw tired or sore?". A clearer distinction needs to be made on the frequency of pain and the nature of pain that constitutes a diagnosis for TMJD: can temporary pain of a few hours be considered a dysfunction?
I recommend that in future research on this subject the distinction is made before drawing up the questionnaire.

6.11 A closer relationship between the diver's certification and TMJD should be considered. In table 4.1.8 and its corresponding graph a difference is shown between the less experienced divers and the slightly more experienced divers in terms of the prevalence of TMJD. In those divers with a 1star certification 53,8% suffered with TMJD; in those with a 2 star certification 38,7% suffered with TMJD; whereas in those with a slightly higher certification of 3 star 21,7% suffered with TMJD. Although this was noted the slightly higher qualifications of dive master and instructor had a prevalence that was closer to the 50% mark and may therefore show that the earlier observation was incorrect. Therefore this should be considered as a future research topic.
On the one hand the decrease in prevalence of TMJD could be related to the decrease in the amount of stress felt by the divers as they become more experienced.
On the other hand it could be related to the fact that many dental biteplates have been found to have a beneficial effect on TMJD, so the

use of a mouthpiece may be behaving as a substitute for a biteplate and therefore providing a similar beneficial effect.

6.12 The non-diver group was not a true representation of a general population and therefore it should be considered that in future the study be done with a general population group.

6.13 The most important factor that has not been taken into account in this and most other studies into TMJD and certain causes of the disorder is the inadequate definition. This research project neither proved nor disproved my original question and it never will until there is an adequate definition for TMJD. The frequency, intensity and type of pain, joint noises and loss of range of motion are important factors in whether or not a person suffers from TMJD.

For example: if a person has one click or pop in their jaw joint does it mean that person has TMJD, or if a patient has pain for two to five minutes after a dive does it mean they have TMJD?

Therefore I propose these models that may be used in further research as alternative diagnostic criteria:

1. The sufferer should have two or more of the criteria, or have pain with one or more of the other criteria.
2. The sufferer should have had pain for at least 2 to 6 weeks following the causative activity with joint noises or loss of range of motion.
3. The sufferer finds the pain, noises and / or loss of range of motion debilitating.

These models are purely subjective and need further discussion before any conclusion can be made on the definition and diagnosis of TMJD, but this is necessary in order to validate any further research.

CHAPTER 7

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