A Study to Determine the Frequency of Headache Disorders in Patients Attending an Orofacial Pain Clinic.

A thesis submitted to the University of Dublin in partial fulfilment of a Doctorate in Dental Surgery D.Ch.Dent. (Prosthodontics)

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Declaration

I declare that this thesis has not been submitted as an exercise for a degree at this or any other university and it is entirely my own work. I agree to deposit this thesis in the university’s open access institutional repository or allow the library to do so on my behalf, subject to Irish copyright legislation and Trinity College library conditions of use and acknowledgement.

Tashia Moodley
Summary

Introduction: The multifactorial origin of headache and temporomandibular disorders (TMD) coupled with the fact that they exhibit similar and overlapping signs and symptoms make differential diagnosis and treatment planning challenging. The purpose of this study was to evaluate the association between patient complaints and perceptions relative to the definitive diagnosis of Headache Disorders or TMD in a population referred to an Orofacial Pain Clinic for management of possible TMD.

Methods: The descriptive cross-sectional study involved a sample of convenience utilising a questionnaire given to 150 patients prior to clinical examination. The questionnaire, completed by the participants, recorded their pain history and location which was then compared to the definitive diagnosis reached by a single Orofacial Pain Specialist. Cross tabulations were completed between categorical variables like gender, age, location of pain and occurrence of TMD pain, headache and other orofacial pain. Associations were subjected to the Chi-square test and Fischer’s exact test. The odds ratio and 95% confidence interval (CI) were calculated. A significance level of 0.05 was used and all the statistical tests were two-tailed which followed data analysis using SPSS version 26 (SPSS Inc., Chicago, USA) and Excel (Microsoft, USA).

Results: Of the participants, 115 (76.7%) were female and 35 (23.3%) were male. In this study, 55 (36.7%) of patients were in the 50+ age groups. Twenty-nine participants (19.3%) were between 19 and 29 years of age. TMD diagnosis was most common with 68 diagnoses (45.4%). In decreasing order, the other diagnoses were headache in 33 patients (22%), neuropathic pain in 33 (15.3%), muscular pain in 9 patients (6%). TMD combined with headache was recorded in 8 patients (5.3%), TMD and odontogenic pain in 5 patients (3.3%), and TMD together with muscular pain was observed in two patients (1.5%). The patient’s location of the pain showed that pain arising in the TMJ area was the most frequently selected area of pain with 127 of the 150 participants (84.6%). Of these patients that indicated pain in the TMJ area, 50%
of the patients were accurate in locating the pain and had a definitive diagnosis of TMD. Of the patients that located pain in the frontal head zone, 67% were accurate in locating the head as the area of pain relative to the definitive diagnosis of headache. Of the group of patients who had dental pain, 47% were diagnosed as neuropathic pain, 35% had headache and 18% were diagnosed with TMD. A total of 33 patients were diagnosed with headache disorders. Of these patients that presented with symptoms associated with the TMJ, 21 patients (63.3%) had a definitive diagnosis of headaches and did not have a diagnosis of TMD. The findings from this study showed that there was a relationship between TMD symptoms and the diagnosis of TMD. The odds ratio with a 95% confidence interval showed that those patients with TMD symptoms were 2.2 times more likely to have a diagnosis of TMD, with statistical significance using a Pearson Chi Square test (P< 0.001). From a patient perspective, jaw joint pain was the most frequently self-reported pain with 90 of the 150 participants (60%) perceiving it as the source of their pain. For patients diagnosed with TMD, the 80.9% of the patients perceived their pain to be TMJ related. Of those patients diagnosed with TMD, 13.2% of patients perceived their pain as odontogenic. In patients diagnosed with headache disorders, 54.4% of these patients perceived their pain originated from the jaw joint and 39.4% of these headache patients believed their pain was of odontogenic origin.

Conclusion: This study demonstrated that the majority of patients referred to the Orofacial Pain Clinic were female. The majority of patients were in the 50+ age groups. The most common diagnosis amongst the patients attending the clinic was TMD. In patients attending the Orofacial Pain Clinic, TMD patients were accurate in locating and identifying the area of pain relative to the definitive diagnosis. This study highlighted that patients attending this clinic were often unable to differentiate between headache and TMD pain as well as pain of non-odontogenetic origin, often confusing it for odontogenic pain. This study proposed the use of a facial diagram for the patient to more accurately illustrate their location of pain, thereby assisting the referring clinician in making a more accurate distinction between the various types of Orofacial pain.
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CHAPTER 1
Introduction and Literature Review

1.1 Introduction

Pain is an unpleasant sensory and emotional experience that can impede an individual’s quality of life, daily activities and psychosocial functioning. The correct clinical diagnosis and management of pain is a primary concern for health care professionals. Orofacial pain refers to pain associated with the soft and hard tissues of the head, face, and neck. The potential origin of orofacial pain includes pulpal, periodontal, vascular, glandular, muscular, bony, sinus, and joint structures (De Rossi, 2013). These various structures in the facial region alongside their complex innervation present an extensive range of diagnostic options for patients with orofacial pain (De Rossi, 2013). Orofacial pain can be acute or chronic. Acute pain arises suddenly and is generally short-lived. Chronic pain is persistent and often lasts weeks to months. Chronic pain can be episodic and may or may not be in association with a chronic disorder, such as cancer, diabetes, or fibromyalgia (Arnold et al., 2012). In addition, pain can be further divided into somatic and neuropathic pain. Somatic pain results from stimulation of nociceptors due to tissue injury, such as inflammation. Somatic pain terminates when the underlying inflammation has been resolved. The two features of somatic pain include hyperalgesia and allodynia (Garland, 2012). Hyperalgesia is defined as an increased perception of the painful stimulus after receptor sensitisation. Allodynia is the perception of pain in response to non-noxious stimuli. Neuropathic pain is considered pain that is initiated or caused by a primary lesion or dysfunction in the nervous system (Baron et al., 2010). The most common
neuropathic pain condition affecting the orofacial area is trigeminal neuralgia (Ananthan and Benoliel, 2020). Trigeminal neuralgia (TN) is a paroxysmal, episodic, short-lasting facial pain (Christoforou, 2018). The diagnosis for TN is based on clinical presentation, which is accompanied by trigger zones in over 50% of patients (Maarbjerg et al., 2014). Trigeminal neuropathy is a chronic neuropathic orofacial pain condition caused by trauma to the branches of the trigeminal nerve and persistent pain can follow dental procedures (Ananthan and Benoliel, 2020).

Temporomandibular disorders (TMDs) involve pathology (disease or trauma) of the temporomandibular joint (TMJ), muscles of mastication and associated surrounding structures (Di Paolo et al., 2017). Clinical manifestations of this disorder often overlap with other medical disciplines such as neurology. Headache disorders are one of the most common painful conditions and is estimated that in the region of 90% of the general adult population suffers from at least one headache attack per month (Di Paolo et al., 2013). TMDs and headache disorders are strongly linked. A study by Ciancaglini and Radaelli (2001) demonstrated that there is a correlation between headache and TMD (Ciancaglini and Radaelli, 2001).

Orofacial pain or non-dental pain often presents to dental practitioners where patients seek solutions to their symptoms which may closely mimic toothache. As a result, the overlapping signs and symptoms make the diagnostic process and planning of treatment challenging resulting in misdiagnosis and completion of inappropriate treatment (List and Jensen, 2017). In a population-based cross-sectional study, 83% of subjects with pain in the TMD area reported one comorbid pain condition and 59%
reported at least two (Dominick et al., 2012). The most commonly reported conditions in the subjects with TMD pain were headache, neck pain and back pain (Dominick et al., 2012).

Correct identification of patients suffering from orofacial pain may be challenging and may occur only after irreversible treatment. Therefore, the first step in managing these patients is to correctly diagnose the nature of the pain prior to initiating any treatment (Dawson, 2007).

1.2 Epidemiology of Headache Disorders and TMD

There is a close relationship between headache disorders and TMDs. Headache disorders are very common in the general population. The prevalence of headache in adults ranges from 77-91.3% (Steiner et al., 2008; Stovner and Andree, 2010). The most common type of headache is the tension type headache (TTH) with a prevalence of 62.6% followed by migraine at 14.7% (Stovner and Andree, 2010). In addition, a positive association was found in patients who suffered from headache and musculoskeletal disorders (Hagen et al., 2002). In that study it was demonstrated that patients who suffered from musculoskeletal pain had approximately twice the prevalence of migraine (Hagen et al., 2002). A study by Ashina and co-workers demonstrated that patients with TTH (88%), migraine (76%) or both (89%) also suffered from neck pain (Ashina et al., 2015). A systematic review and meta-analysis indicated that neck pain was more frequent in patients with chronic migraine compared to episodic migraine (Al-Khazali et al., 2022). The authors concluded that
neck pain was 12 times more prevalent in migraine patients compared to non-headache controls and twice as prevalent in patients with chronic migraine compared to episodic migraine (Al-Khazali et al., 2022).

TMDs are another common orofacial pain disorder that affects the general population. The aetiology of the TMD is not clearly known (Wadhokar and Patil, 2022). In a recent systematic review and meta-analysis, the authors concluded that the global prevalence of TMD was in the region of 31% for adults and 11% for children (Valesan et al., 2021). Additionally, the most prevalent TMD was disc displacement with a reduction, which was present in 26% in adults and 7.5% of children (Valesan et al., 2021). It has been reported that TMD affects women more frequently than men and is most common in the ages between 20–40 years old (List and Jensen, 2017). In adults, the gender ratio is approximately 2:1 (women: men) in population-based studies and showed a 4:1 in clinical cases of TMD (LeResche, 1997).

Several studies have shown a close relationship between headache disorders and TMDs (Ciancaglini and Radaelli 2001; Kemper and Okeson 1983). In a clinical blinded study investigating the overlap of headache disorders and TMDs the prevalence of TMD in a headache population was 56.1% (Ballegaard et al., 2008). The high prevalence of TMD in patients with migraine and tension-type headaches may suggest that this could be a risk factor for TMD or that TMD could be a risk factor for occurrence of several types of headache disorders (Ballegaard et al., 2008). The prevalence of headache disorders in a study of TMD patients was reported at 78 - 85.5%, with migraine being the most common type of headache disorder (Fernandes
et al., 2013). In addition, bruxism and painful TMD greatly increased the risk for episodic migraine and episodic tension-type headache which demonstrated an association among painful TMD, migraine and tension-type headache (Fernandes et al., 2013).

In patients who suffered from both TMD and headache disorders, the headache typically occurred simultaneously with TMD, localised to the temporal area and aggravated by movement of the mandible (Van Der Meer et al., 2017). Although studies have reported an association between TMDs and headache disorders, this association is not well understood (Fernandes et al., 2013). According to research and clinical findings, there are several factors that influence the link between TMDs and headache disorders (Di Paolo et al., 2017). It has been shown that both disorders are more common in females and in the 20-50 year old age range (Stovner and Andree, 2010). According to an observational study assessing the association between headache disorders and TMD, it was implied that there was a central mechanism overlapping these disorders and that it was the duty of health care professionals to be aware of the complex nature of the diagnostic and treatment process (Van Der Meer et al., 2017). This nociceptive input can lead to central sensitisation which can play a role in the pathology of both TMD and migraine (Plesh et al., 2012). However, Ciancaglini and Radaelli stated that any hypothetical causal relationship remained difficult to establish and the debate is still controversial (Ciancaglini and Radaelli, 2001). The proposed relationship has not been extensively explored (Réus et al., 2022). Thus, emphasis on a multidisciplinary approach has been recommended to
prevent incorrect and/or irreversible treatment (Liu and Steinkeler, 2013) as a result of an incorrect diagnosis.

In order to understand the mechanism of TMD, it is important to have a working knowledge of the masticatory apparatus including the TMJ, the muscles of mastication and associated anatomy. Movement of the mandible is not only determined by the shape of the bones, muscles, and ligaments but also by the occlusion of the teeth, since both joints are joined by a single bone and cannot move independently (Alomar et al., 2007). Understanding how these systems work in normal function may aid in the proper diagnosis of any pathology that may exist (Tanaka et al., 2008).

1.3 The Temporomandibular Joint

The TMJ functions as an important component of mandibular movement during swallowing, verbal communication and mastication. In human anatomy, a joint is a point of union of two or more bones. In general, joints may be classified as either synarthrodial joints in which the bone surfaces are joined by white collagen bundles forming a union of bones (examples are the sutures between the bones of the skull) or diarthrodial in which junctions are discontinuous and allow for functional movement between bones (Stocum and Roberts, 2018).

The temporomandibular joint is the only articulation in the body with two joint compartments which are separated by a fibrocartilaginous disc (Purcell et al., 2009).
The articular surface is composed of modified periosteum that can form an underlying, supporting zone of fibrocartilage which subsequently mineralises to form the endochondral trabecular bone of the condylar metaphysis (Roberts and Goodacre, 2020). The TMJ is a ginglymoarthrodial joint. A term that is derived from “ginglymus” meaning a hinge joint, permitting movement in a backward and forward direction (in one plane). “Arthrodia” indicates joint of which allows for gliding movement (Alomar et al., 2007). The development of the TMJ is a unique sequence of craniomandibular formation that evolves under dynamic loading conditions (Stocum and Roberts, 2018). The structures that make this joint unique and differentiates it from other joints is that the articular surfaces are covered by fibrocartilage instead of hyaline cartilage. This allows for a wide range of symmetric and asymmetric movements that reflects the differential hinge and translational actions of each mandibular condyle (Roberts and Goodacre, 2020). Fibrocartilage is better able to withstand sheer forces than hyaline cartilage, which makes it superior for enduring the large amount of load that is placed on the TMJ (Wadhwa and Kapila, 2008).

The mandibular component of the TMJ represented in Figure 1.1, is made up of an ovoid condylar process with a narrow mandibular neck, flattened in the frontal plane, and a semi-cylindroid condyle (McDevitt, 1989).
Posteriorly, the process is positioned to act as a pivot for mandibular movement and this fulcrum action provides a third class lever system (McDevitt, 1989). In an average adult, the condyle dimensions are approximately 15 to 20 mm mediolaterally and 8 to 10 mm anteroposteriorly.

The long axes of the two condyles are extended medially and intersect at the basion on the anterior limit of the foramen magnum, forming an angle ranging from 145° to 160° (Alomar et al., 2007). The condylar process of the mandible is considered to support and position the articular surface so that it can operate efficiently. It also provides a suitable attachment point for muscle tissue which can protract the mandible (McDevitt, 1989).
Between the condyle and temporal bone is the articular disc which consists of dense collagenous connective tissue and in the central area is avascular, hyalinised, and devoid of nerves (Ash, 1993).

The cranial portion of the TMJ is housed in the squamous portion of the temporal bone anterior to the tympanic area, and is concave mediolaterally and antero-posteriorly (McDevitt, 1989). This is designed to form a fixed articulating surface of the TMJ. The articular surface is travelled by the condyle and disc as it translates in functional movements (Dawson, 2007). The synovial surfaces on the condyle and fossa are a modified periosteum that produces fibrocartilage when exposed to heavy loading (Smith et al., 1986). The surfaces of the joint, in which subjected directly to load-bearing pressure, is very smooth, specialised, tough, avascular layers of fibrous tissue which are highly resilient to shearing forces (McDevitt, 1989).

The TMJ has a unique load-bearing morphology (Hylander, 1979). The condyles serve as a bilateral fulcrum for the mandible, so the joints are always subjected to compressive force whenever the powerful elevator muscles contract (Dawson, 2007). The cushioning effect of the fibrocartilage is evidenced by the relatively low remodelling rate of trabecular bone in the mandibular condyle (Helm et al., 2010). The disc and subarticular fibrocartilage layers serve as TMJ shock absorbers via the non-rigid mechanical properties of the cartilage in addition to the transfer of interstitial fluid (Zimmerman et al., 2015). This cushioning mechanism enhances synovial lubrication and helps protect the heavily loaded articular periosteum (Roberts and Goodacre, 2020).
The space between the articular and bony surfaces of the joint is occupied by a continuous structure, the articular disc (McDevitt, 1989). The disc is closely adapted to the shape of the space. The thin intermediate band of the disc is situated in contact with the articular surface of the condyle and the thickest part (posterior band) is situated in the fossa over the posterosuperior part of the condyle. The disc, illustrated in Figure 1.2, is a biconcave fibrocartilaginous structure (Roberts and Goodacre, 2020). The TMJ disc is prone to degenerative change due to its lack of vascularity, high cell density and accelerated rate of nutrient consumption (Nickel et al., 2018). It functions to accommodate a hinging action as well as gliding actions between the temporal and mandibular articular bone (Alomar et al., 2007). Lubrication of the joint is through synovial fluid which arises from plasma by dialysis and also secretions from type A and B synoviocytes (Alomar et al., 2007). This allows for smooth mandibular movements through reducing friction around the articular surfaces.

Figure 1.2. The mid-sagittal section of the TMD. Adapted from Klineberg and Eckert (2015).
Ligaments are formed from white collagenous tissue specially developed and arranged to connect and strengthen the joints (Wadhwa and Kapila, 2008). The TMJ is enclosed in a capsule that is attached at the borders of the articulating surfaces of the mandibular fossa and eminence of the temporal bone and to the neck of the mandible (Figure 1.3). The sphenomandibular ligament protects the TMJ from excessive translation of the condyle. The stylomandibular ligament aids in limiting excessive protrusion of the mandible. The anterolateral side of the capsule may be thickened to form a band referred to as the temporomandibular ligament (Nelson and Ash, 2010). The disc is attached to the condyle anteriorly, posteriorly, medially and laterally. The arrangement allows for the condyle to rotate freely. The temporomandibular ligament is the main ligamentous reinforcement of the joint. This ligament is a well-developed, fan shaped structure located on the lateral aspect of the joint (Bordoni and Varacallo, 2022). When the condyle is seated in the fossa, the anterior fibres of the ligament become strained. This tension is one of the factors which induces the condyle to translate anteriorly as the mouth opens wider (Bordoni and Varacallo, 2022). The temporomandibular ligaments restrict the distal and inferior movements of the mandible and supports functional joint positions.
1.4 Muscles of Mastication

The primary masticatory muscles surrounding the joint are groups of muscles that contract and relax in harmony to facilitate jaw movement (Alomar et al., 2007). The muscles of mastication produce all the movements of the jaw. These muscles are fixed on the cranium extending between the cranium and the mandible on each side of the head to insert on the mandible (Figure 1.4). The muscles of mastication include abductors (jaw openers) and adductors (jaw closers). The temporalis, masseter, and medial pterygoids muscles are adductors, while the lateral pterygoids muscles are the primary abductors of the jaw. The muscles that facilitate protrusive mandibular movements are also used alternately for lateral movements. The principal and strongest muscle of mastication is the masseter, which stems from the temporal bone and extends down the outside of the mandible to its lower angle, with a broad insertion along the lateral border of the condyle (Alomar et al., 2007). The masseter is
a bulky, rectangular mass of muscle attached between the lateral surface of the ramus of the mandible and the zygomatic arch (McDevitt, 1989). The masseter is a powerful muscle used when heavy masticatory effects are required. It functions to elevate the mandible vertically and positions the condyle into the closed position in the joint (McDevitt, 1989). The masseteric branch of the fifth cranial nerve supplies motor innervation. The arterial blood supply comes from branches of the masseteric artery.

![Figure 1.4. The lateral view of the muscles of mastication. Adapted from Netter, 2019.](image)

The second primary elevator muscle is the medial pterygoid, which runs parallel to the masseter but on the medial aspect of the ascending ramus (Figure 1.5). The masseter and the medial pterygoid together creates a V-shaped sling which suspends the mandible on both sides (McDevitt, 1989). The medial pterygoid is innervated by the medial pterygoid branch of the mandibular division of the fifth cranial nerve. Its blood supply is derived from the medial pterygoid branches of the maxillary artery.
The third muscle involved in mandibular elevation is the temporalis muscle (Figure 1.6). It is a fan-shaped, flat, broad and voluminous muscle. There are three fascicles: anterior, medial and posterior. The temporalis originates from the superior aspect of the temporal fossa and inserts into the coronoid apophysis via a tendon. It plays an elevator role for its anterior and medial fascicles, and controls retraction for the posterior fascicle (Basit et al., 2022). The temporal branches of the mandibular division of the fifth cranial nerve carry motor innervation for the temporalis. The motor supply for the primary muscles of mastication are derived from the mandibular branch of the trigeminal nerve. The blood supply is derived from the temporal branches of the auriculo-temporal artery (Basit et al., 2022).
Figure 1.6. Lateral view illustrating the temporalis muscle with its attachments. Adapted from Duminil et al. (2016).

The lateral pterygoid muscle (Figure 1.7) has two origins: the inferior head originates on the outer surface of the lateral pterygoid plate, and the superior head originates on the greater wing of the sphenoid bone (Nelson and Ash, 2010). This muscle is considered to be involved in the movement of the articular disc and plays a distinctive, intricate role in the movement of the TMJ (Usui et al., 2008). The blood supply to the lateral pterygoid is derived from the maxillary artery and the venous plexus. The innervation is by the lateral pterygoid branches of the mandibular division of the fifth cranial nerve. The two subdivisions of the lateral pterygoid muscle are regarded as separate entities. The superior part of the lateral pterygoid is active during retrusion of the ipsilateral condyle. In addition, this muscle allows for rotation of the mandible around the hinge axis (McDevitt, 1989). Generally, the role of both parts is involved in positioning and stabilisation on the condyle disc assembly during functional movements (Antonopoulou et al., 2013). Due to its connection to the disc, the function of the superior head of the lateral pterygoid muscle contracts during
mandibular closing to control the disc position and avoids displacement. This allows for the stabilisation of the disc during mandibular function (Tuncer, 2020).

![Figure 1.7. The lateral pterygoid muscle depicting the position of the superior and inferior heads. Adapted from Duminil et al. (2016).](image)

In addition, the secondary cervical depressor muscles play a role in mandibular function and head posture (Figure 1.8). An elaborate balance is created between the skull, the neck and neck muscles to maintain head posture (Duminil et al., 2016). These muscles may be compared to rubber bands balancing the skull on the cervical spine (Duminil et al., 2016). Disharmony within the masticatory system may result in altered function with symptoms that may include jaw joint clicking, reduced mobility and pain with function. Disequilibrium between any of the parts of the system is a common trigger for pain (Dawson, 2007).
1.5 The Neuromuscular Regulation System

The orofacial tissues, that is the teeth, oral mucosa, facial skin, TMJ, and associated musculature are richly innervated by primary afferent (sensory) nerve fibres principally from the trigeminal nerve. These afferents terminate in the tissues as specialised cells, referred to as receptors. The interactions between the TMJ, muscles and the teeth are controlled by the central nervous system which collects the information (afferent) and responds through the efferent motor musculature (Duminil et al., 2016).

Different types of sensory receptors collect and send information to the brain. Within the articular capsule, mechanoreceptors respond to pressure and provide information about the movement and the position of the joint. The specialised endings in the oral mucosa, facial skin, and TMJ may also act as mechanoreceptors when the tissues are mechanically stimulated or can function as proprioceptors that provide sensory information from these tissues when they are activated during
orofacial muscle contractions, jaw or tongue movements, or condylar movements. This property may be especially important for the control of facial and jaw-opening muscles (Klineberg and Eckert, 2015).

Most primary afferents that supply peripheral tissues in the face and mouth have their primary afferent cell bodies in the trigeminal ganglion; from the ganglion, the central (proximal) component of each primary afferent projects into the brainstem and synapses onto second-order neurones within the trigeminal brainstem sensory nuclear complex (Klineberg and Eckert, 2015). The adjacent solitary tract nucleus receives not only cranial nerve VII, IX, and X visceral afferents (e.g., those supplying lingual, laryngeal, and pharyngeal taste buds) but also receives some trigeminal afferent inputs (Klineberg and Eckert, 2015).

The closing action of bringing the teeth together takes place through rotation of the condyles in the lower compartments of the TMJ (Granger, 1959). The mandible undergoes both translation and rotation in varying degrees from the initiation of jaw opening. At any moment, movement of the mandible can be described in this theory as a rotation around a single axis, but this centre continues to move as the jaw opens (Mapelli et al., 2009).

Occlusion should no longer be considered simply as the occlusal scheme determining the static or dynamic relationship between the dental arches or the jaw position. Rather, it should be regarded within a broader framework that considers the modulation of the somatosensory input from the periodontal, dental, and mucosal
mechanoreceptors by the central nervous system, as well as sensorimotor neuroplasticity (Klineberg and Eckert, 2015). Dental changes lead to neuro-plastic changes within the sensorimotor cortex. These neuroplastic changes may be structural or functional, may have a rapid or sudden onset, and may be short lived or long lasting (Citri and Malenka, 2007).

Changes to the occlusion may have an influence on the movements of the jaw and the TMJ and the function of the jaw muscles (Caldas et al., 2016). The earliest theories were that occlusal disharmony affected the position of the TMJ, and disorders of the masticatory musculature were one of the causes of TMJ dysfunction (Schuyler, 1935). An eminent panel of scientists for the National Institute of Health (NIH) in 1996, evaluated the evidence and concluded that there was no clinical trials validating that occlusal adjustment is a better treatment modality to non-invasive therapies (Tsukiyama et al., 2001). Over the years researchers have argued that the dentition caused a variety of damaging dental and muscular effects (Schuyler, 1967). Dental occlusion seems to strongly influence muscle and postural balance and has been the focus of much attention to improve muscle coordination and reduce discomfort. However, there is limited data to suggested that occlusal interferences produce jaw and muscle dysfunction (Clark et al., 1999). However, Dawson states that occlusal disharmony that affects the position of the TMJs, and disorders of the masticatory musculature were also included as specific types of TMDs (Dawson, 2007).

It has been stated that occlusal therapy may be justified for reasons for aesthetics, gross occlusal instability or dental disease. It was demonstrated that that the evidence
does not support occlusal adjustment as an acceptable therapy for nocturnal bruxism or TMD such as myofascial pain, TMJ arthritis and TMJ internal derangement (Tsukiyama et al., 2001). Condylar pathways, tooth guidance, and the neuromuscular control influence mandibular movements (Ahlgren, 1967). Therefore, the anatomic morphology of teeth should adapt to functional loading (Wiens and Priebe, 2014).

1.6 Pain and Dysfunction of the Temporomandibular Joint

Temporomandibular joint disorder (TMD) is an umbrella term used to describe various painful and non-painful conditions affecting the TMJ, masticatory muscles and tissue components with their associated structures (Liu and Steinkeler, 2013). The TMJ represents the articulation of the mandible to the temporal bone of the cranium. The bony components of the joint are separated by a structure composed of dense fibrous connective tissue called the articular disc. As in any mobile joint in the body, the functioning and limitations of the joint is supported by ligaments. These ligaments are comprised of collagenous fibres that have specific lengths and act to restrict certain types of movements while allowing other more functional movements. The definition of TMD that was presented by the National Institute of Health Technology Assessment Conference on Management of TMD in 1996 described it as: “the term TMD is used to characterise a wide range of conditions diversely presenting as pain in the face or jaw joint area, limited mouth opening, closed or open lock of the TMJ, abnormal occlusal wear, clicking or popping sounds in the jaw joints, and other complaints”. A more recent description of TMD is characterised by regional pain in the facial and preauricular area which may or may not be accompanied by restriction
in mandibular movement (Ohrbach and Dworkin, 2016). These disorders include displacement of one or both joints, misalignment of the disc(s), various diseases that affect bone or the articular surfaces, and other pathologic disorders, inflammation, or injuries to specific intracapsular structures. Disharmony to the occlusion that affects the TMJs are also included in this disorder (Dawson, 2007). TMD pain restricts functional activity which includes reduced mandibular range of movement, pain in the muscles of mastication, temporomandibular joint pain, associated jaw joint noise in function, myofascial pain, and a functional limitation or deviation of the jaw opening (Wadhwa and Kapila, 2008).

Patients with TMD symptoms present over a broad age range; however, there is a common incidence in age ranging between 20 and 40 years (Manfredini et al., 2011). TMD symptoms are higher in females than in men (Manfredini et al., 2011). This disequilibrium in pain is not entirely clear, however the literature has suggested a hormonal influence with elevated levels of oestrogen found in patients who suffer with TMD (Wadhwa and Kapila, 2008). To challenge these demographic findings, the OPPERA case-control study for TMD found that females had a marginally higher prevalence and that gender differences plays a minor role in the signs and symptoms of TMD (Slade et al., 2013). This study challenged the common view that TMD predominated in early adulthood females and the authors suggested that other factors could be considered aetiological factors in the risk of developing TMD (Slade et al., 2013). The OPPERA study’s relative risk assessment was calculated based on TMD incidence which confirmed growing gender differences with time. A systematic
review and meta-analysis assessing gender differences using odds ratio based on TMD prevalence found twice the risk of females developing TMD (Bueno et al., 2018).

TMD pain can be divided into that of articular origin, where symptoms are associated with the joint or surrounding structures including the hard and soft tissues of the TMJ and non-articular disorders which are derived from muscular origin, where the symptoms presented are related to the muscles of mastication (Valesan et al., 2021) and is depicted in Figure 1.9. Other non-articular disorders include neuropathic pain, fibromyalgia, muscle strain and other myopathies (Liu and Steinkeler, 2013). Myofascial pain and dysfunction have been proposed to develop from habits such as clenching and bruxism (Liu and Steinkeler, 2013). Stress and emotional distress predispose to tooth grinding (bruxism) habits which may contribute to myofascial pain (Rasmussen, 1981).

Figure 1.9. The musculoskeletal structures of the TMJ, lateral and medial views. Adapted from Liu and Steinkeler, 2013.
Articular disorders (internal derangement) can be subdivided into inflammatory and non-inflammatory conditions. Inflammatory conditions of the TMJ include capsulitis, synovitis, and polyarthritides. The rheumatologic processes, such as rheumatoid arthritis (RA), seronegative spondylopathies such as ankylosing spondylitis, psoriatic arthritis, gout and infectious arthritis are examples of inflammatory articular disorders. Non-inflammatory articular disc disorders include osteoarthritis, joint damage from prior trauma or surgery, or other cartilage or bone disorders (Liu and Steinkeler, 2013). Pain that is associated with inflammation is localised to the TMJ capsule and the intracapsular tissues (Valesan et al., 2021). The continued loading of the TMJ may result in adaptive changes in the hard and soft tissues (Dawson, 2007).

Progressive joint changes can be divided into stages. These stages apply to either lateral-pole derangements or total condyle-disc derangements. Lateral-pole derangements occurs when uncoordinated contraction of the superior lateral pterygoid muscle pulls the disc forward while elevator muscles move the condyle backwards and superiorly. This may result stretching of the posterior discal ligament and resultant displacement the disc anteriorly (Osborn, 1985). Forward derangement is initiated at the lateral aspect of the disc.

Typically, joint pain is dull, but in some cases throbbing may occur (Valesan et al., 2021). The pain frequently changes to a sharp pain upon jaw movements (al-Baghdadi et al., 2014). Articular disc displacement is the most common TMJ condition and is characterised by several stages of clinical dysfunction that involve the disc-condyle
relationship (Sanders, 1995). Disc displacements are characterised as disc displacement with reduction or disc displacement without reduction. The fibrocartilaginous disc is usually displaced anteromedially and rarely may be displaced laterally or posteriorly (Liedberg et al., 1990).

Anatomically, disc displacement with reduction is described when a misaligned disc reduces or re-establishes its correct structural relation with the condyle when mandibular translation occurs during opening. This obstruction may produce jaw joint sounds like clicking or popping, which can cause social embarrassment or discomfort. However, jaw joint noise is not diagnostic of articular disc displacement (Liu and Steinkeler, 2013). Disc displacement without reduction results in a closed lock where the condylar translation is physically blocked by the anteriorly displaced disc. Acute closed lock is associated with limited mandibular opening and severe pain (Blankestijn and Boering, 1985).

A thorough physical examination should consist of a general assessment of the head and neck. Palpation of the masticatory muscles, occlusal analysis, mandibular movement and palpation of the TMJ have been demonstrated to be the most effective physical examination methods (Liu and Steinkeler, 2013). Dental radiographs may be used to rule out dental pathologies as a cause of referred pain. Cone beam computed tomography scans provide detailed imaging of the joint’s hard tissue structures but not the articular disc. Panoramic radiography depicts only the lateral poles and central parts of the condyle and is only useful when there are marked
changes in osseous structures (Ahmad et al., 2009). When orofacial pain is thought to arise from an odontogenic cause, panoramic imaging may be very useful (Brooks et al. 1997).

Magnetic Resonance Imaging (MRI) has superior soft tissue differentiation as a result of its improved contrast resolution over conventional tomography and CBCT (Hunter and Kalathingal, 2013). Therefore, MRI is used to evaluate the soft tissue components of the TMJ. MRI may be used to evaluate the position of the disc, the shape of the disc, the presence/absence of fluid within the joint space (joint effusion), the marrow signal of the condyle, the presence of loose bodies within the joint, pannus formation (in the case of inflammatory arthritides), and osseous changes (Hunter and Kalathingal, 2013). MRI is preferred to CT scans for the evaluation of the cranial nerves in cases of vestibular schwannomas and in some cases is used to predict hearing loss after surgery (Hunter and Kalathingal, 2013).

Disc displacement without reduction is a permanently displaced disc that does not alter its relation with the condyle on translation. Disc displacement without reduction is associated with decreased range of mouth opening and occasional pain known as painful locking (al-Baghdadi et al., 2014). Management involves surgical or conservative interventions such as occlusal device (splint) therapy, physical therapy, arthrocentesis, or arthroscopy to restore and increase the range of movement and facilitate jaw function for the patient (Valesan et al., 2021).
1.7 TMD Diagnosis

TMD is highly prevalent in the population and the diagnostic process involves a thorough understanding of this compound joint (Wadhwa and Kapila, 2008). Despite the extensive research on this topic, diagnosis and management of orofacial pain, namely TMD, remains a challenge for clinicians. The Research Diagnostic Criteria for TMD (DC/TMD) is the world-wide accepted, gold standard diagnostic tool for diagnosing TMDs (Dubner et al., 2016). The DC/TMD protocol is meant for the use in both clinical and research settings. The DC/TMD is a diagnostic tool to allow for identification of patients with a range of simple to complex TMD presentations and was first published in 1992. The DC/TMD (1992) was proposed to be an initial stride toward a valid and reliable TMD classification. This offered evidence-based criteria for practitioners to apply when examining patients and to aid in communication regarding consultations, ongoing referrals and prognosis (Schiffman et al., 2014). It comprises of two axes: Axis I includes the physical examination for a specific clinical diagnosis of TMD with regards to the joint and/or musculature. This provides a validated, comprehensive assessment of the most common TMD conditions, based on the biopsychosocial model of chronic pain (Schiffman et al., 2014). Axis I describes the twelve most common diagnoses of TMD, which are further divided into painful conditions (myalgia, local myalgia, myofascial pain, myofascial pain with referral, arthralgia, headache attributed to TMD) and non-painful conditions (disc displacement with reduction, disc displacement with reduction with intermittent locking, disc displacement without reduction with limited opening, disc displacement without reduction without limited opening, degenerative joint disease and subluxation).
While axis I describes the physical examination for pain and joint diagnoses, Axis II describes the psychosocial status. Axis II is the psychosocial status and pain-related disability according to the biopsychosocial model of chronic pain assessing the psychological state of the patient (Schiffman et al., 2014). This tool identified and acknowledged that TMDs included a structural as well as a behavioural biopsychosocial component. The reliability and validity of this tool has been extensively studied (John et al., 2005). The DC/TMD demonstrates the diagnostic criteria for the most common pain-related TMDs. For a diagnosis of myalgia, the DC/TMD defines it as pain of muscular origin affecting jaw movement, function, or bruxism. This is examined by palpitation of the muscles of mastication assessing tenderness, which is achieved by anatomic location of the muscles at a standard pressure level (Park et al., 2011). The applied pressure employed should be approximately 2kg for 2 seconds (Park et al., 2011). A diagnosis is deemed positive if there is pain in the temporal/ear area and affects jaw movement. Pain from these aggravating tests should imitate the patient’s pain complaint. Proposed diagnostic accuracy is sensitivity ≥ 70% and specificity ≥ 95% (Dworkin and LeResche, 1992). The diagnostic algorithms for myalgia, myofascial pain with referral and arthralgia have acceptable levels of sensitivity and specificity for diagnosis. The patient should present with TMJ noises upon jaw movement and during function. This should be present for at least 30 days. Clicking and popping sounds are present on palpating the affected area during the examination. The jaw joint sounds are present on mouth opening and closing. When the diagnosis needs to be confirmed, TMJ MRI criteria should be prescribed to assess the disc position in maximum intercuspal position and
on full opening. Disc displacement with intermittent locking is when the disc is in the anterior position the condylar head in a closed mouth position (Young, 2015).

Disc displacement without reduction is defined in the DC/TMD as a disorder involving the condyle-disc complex. This disorder is diagnosed if there is positive mandibular locking with restricted mouth opening. This limitation should be severe enough to limit mandibular opening and hinder the ability to function normally. The diagnoses in the DC/TMD are organised into tables to make it easier for the clinician to follow and appropriately establish the workflow for management and treatment.

The DC/TMD provides a common language for all researchers and clinicians to predictably and reliably diagnose TMDs. Clinically, this tool provides an invaluable means of communication between clinicians. In addition, the research community benefits from the ability to apply well-defined and clinically relevant features ordered to simplify the complex nature of orofacial pain. The use of the same criteria and nomenclature, research or clinical questions can be clearly conveyed to better diagnose these patients (Schiffman et al., 2014).

1.8 TMD Management

The treatment objectives for TMD are decreasing pain, restoring normal ranges of movement and restoring masticatory and jaw function. Many TMDs can be recurrent and self-limiting, with periods of complete resolution of symptoms (Romero-Reyes and Uyanik, 2014). The management of TMJ articular inflammatory disorders can be
divided into 3 broad treatment strategies namely, non-invasive, minimally invasive, and invasive. The treatment plan is determined from the diagnosis and severity of the disorder (Liu and Steinkeler, 2013). These treatment objectives are pain management, increasing mandibular range and movement, preventing further damage and increasing quality of life (Liu and Steinkeler, 2013). A multidisciplinary approach should be employed involving multiple specialities including general practice, oral medicine, orofacial pain, orthodontics, oral surgery, endodontics, physical therapy and where necessary psychology and psychiatry (Liu and Steinkeler, 2013).

Home care should generally be the initial approach. Non-invasive management is recommended for most TMD patients (Wadhokar and Patil, 2022). A successful home care program consists of resting the masticatory muscles by limiting jaw movements, bruxing or grinding habit modification, emphasising a soft diet and in the use of moist heat and/or ice therapy (Romero-Reyes and Uyanik, 2014). Non-invasive treatment options for managing TMD conditions include the fabrication of intra-oral occlusal or stabilisation devices. Oral appliances are most commonly processed acrylic devices that have been used for the management of TMD for many years (Klasser and Greene, 2009). Previous results have demonstrated sufficient evidence to warrant their use for myalgia and arthralgia of the masticatory system (Clark, 1984). The use of occlusal devices have been common practice in the initial management of TMD (Liu and Steinkeler, 2013). Occlusal devices were proposed and designed to unload the condyle and as a consequence protect the joint and articular disc from further degeneration and excessive articular strain (Klasser and Greene, 2009). In a meta-analysis of randomised controlled trials evaluating the use of intraoral occlusal devices
for TMD management, it was found that hard stabilisation devices had good evidence of value in the treatment for TMD pain compared with non-occluding devices or no treatment (Fricton et al., 2010). However, a Cochrane Database review of stabilisation occlusal device therapy for TMJ pain revealed that there is insufficient evidence either for or against the use of stabilisation splint therapy (Al-Ani et al., 2004). Despite the universal prescription of oral splints in the treatment of TMDs or bruxism, the quality of the evidence supporting the mechanisms of action suggested for their presumed efficacy is questionable (Dao and Lavigne, 1998). It can be argued that improving the patient's perception and altering destructive habits through the application of non-invasive treatment strategy can be considered as an acceptable alternative (Dao and Lavigne, 1998). In contrast, there are no studies which test the efficacy of occlusal approaches in TMD prevention and therefore there is no reliable evidence demonstrating elimination of TMD using occlusal therapy (Tsukiyama et al., 2001).

Pharmacotherapy in combination with other treatment modalities play an integral role in management of articular joint disorders (Liu and Steinkeler, 2013). Pharmacotherapy can be divided into two main treatment goals. The first being in the treatment of underlying disease process or secondly, relieving the disease symptoms (Liu and Steinkeler, 2013). It is often indicated to use a combination of medications to treat both the pain as well as the inflammatory disease process, depending on the severity of disease. Conservative pharmacotherapy includes nonsteroidal anti-inflammatory drugs, muscle relaxants, benzodiazepines, antidepressants, and anticonvulsants in which mild to moderate temporomandibular joint disorder can be
managed safely and effectively to improve symptoms of pain and function of the temporomandibular joint (Andre et al., 2022).

Physical therapy is frequently utilised to alleviate musculoskeletal pain, diminish inflammation in an attempt to restore function (Liu and Steinkeler, 2013). The application of exercise therapy, heat or cold therapy, soft tissue techniques (massage) and mobilisation have been proven to be beneficial, since they stimulate analgesia and relaxation thus improving movement (Danzig and Van Dyke, 1983). Physical therapy has been demonstrated to be beneficial in restoring the normal function of the TMJ, muscles of mastication and cervical muscles, as well as in reducing inflammation, promoting repair and strength (Clark et al., 1990).

TMJ clicking caused by intracapsular abnormalities requires an exercise-avoidance regime (Messenger and Barghi, 1987). The goals of the exercise-avoidance regime are to teach the patient to avoid the click during function using a limited opening hinge-axis exercise, thereby reducing inadvertent click inducing jaw movements (Clark et al., 1990). Osseous changes to the TMJ evaluated on radiographs are indicative of a degenerative disease process. Physical therapy is commonly prescribed to provide symptomatic treatment for joint pain or related myogenic pain (Clark et al., 1990). A number of exercises are commonly used to treat TMJ associated muscle disorders, including N-stretch (placing the tip of the tongue on the roof of the mouth and stretching the jaw); chin to chest (gently pulling the head forward, bringing the chin toward the chest); and head tilt (turning the head to one side and then tilting it posteriorly). These exercises must be undertaken four to six times per day to be
effective (Romero-Reyes and Uyanik, 2014). In a systematic review and meta-analysis, it was concluded that physiotherapy demonstrated effectiveness in decreasing pain and improving range of mandibular motion (Paço et al. 2016). A prospective controlled trial demonstrated that exercise therapy reduced pain in patients diagnosed with anterior disc displacement without reduction (Nicolakis et al., 2001). In addition, that study demonstrated improvement in mandibular movement range and function (Nicolakis et al., 2001). Exercises have been shown to alleviate myofascial pain and improve jaw movement (O’Reilly et al., 1999).

Minimally invasive treatment options for the management of TMD includes an injection with local anaesthetic or corticosteroids directly into the TMJ space and allow for management of inflammation and joint derangement (Liu and Steinkeler, 2013). The superior joint space injection is a commonly used technique and is proposed to be effective in restoring joint function and decreasing associated pain (Li et al., 2012). Conservative intra-articular injection substances include non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroid or botulinum toxin (Morey-Mas et al., 2010). The results of a study assessing the outcomes of TMJ injection using hyaluronic acid in patients with internal disarrangement, demonstrated that after one year, there was a significant improvement in mandibular opening and pain (Yilmaz et al., 2019).

Arthrocentesis is a rapid, minimally invasive procedure that is used in patients who are resistant to more conservative treatment modalities (Monje-Gil et al., 2012). Intracapsular injection of corticosteroids significantly reduces TMJ pain and is
indicated for acute and painful arthritic TMJ that has not responded to other treatment modalities (Wenneberg et al., 1991). A treatment success rate of 83.5% in patients with internal derangement and osteoarthritis has been reported (Monje-Gil et al., 2012).

A study evaluated long-term success in patients suffering from internal derangement of the TMJ treated with arthrocentesis. Four years after the procedure 89% percent of these patients were still pain-free, and 88% had no or only a minimal amount of dysfunction (Carvajal and Laskin, 2000). The beneficial outcome of joint injection is attributed to the rinsing of inflammatory cells assisting the effects of the corticosteroid injection (Van Oosterhout et al., 2006). However, the reduction of pain does not indicate that treatment had been completely successful (Yilmaz et al., 2019).

TMJ arthroplasty is an invasive treatment modality which involves the reshaping of the articular surfaces to remove osteophytes, erosions, and irregularities found in painful osteoarthritis refractory to other treatment modalities (Tanaka et al., 2008). These patients frequently present with articular disc degeneration or displacement, which can be repositioned, repaired, or entirely removed. Disc repositioning was first introduced by McCarty and Farrar in 1979. Disc repositioning to a more normal anatomic relation with the condyle and fossa is usually undertaken when the disc is displaced but otherwise free of disease or structural deformity (Dolwick, 1997; McCarty and Farrar, 1979). All procedures should be performed by an experienced oral and maxillofacial surgeon under general anaesthesia (Liu and Steinkeler, 2013). Complications are rare but can include wound infection, facial nerve injury,
permanent occlusal changes, relapsing joint pain, and life-threatening vascular injuries (Liu and Steinkeler, 2013). Clinical studies have demonstrated a favourable outcome in terms of decreased pain and improved mandibular function in 80% to 94% of patients (McCarty and Farrar, 1979). For most patients, complications are rare and TMJ surgery can be successful (Hoffman and Puig, 2015). Success is categorized as decreased pain and increased mandibular movement. It has been demonstrated that success in TMJ arthroplasty to be approximately 79% to 93% (Dolwick, 1997). A systematic review measured and compared the efficacy of arthroscopic and open disc repositioning procedures and found that both arthroscopic and open disc repositioning showed significant improvements based on pain and range of opening (Askar et al., 2021).

TMJ replacement is intended primarily at restoration of form and function, and any pain relief gained is only a secondary benefit (Dimitroulis, 2011). The need for TMJ replacement typically indicates severely damaged joints with end-stage disease that has failed all other more conservative treatment modalities (Liu and Steinkeler, 2013). The use of alloplastic materials to reconstruct or replace the diseased tissues of the TMJ caused disastrous results in the 1980s and 1990s (Dolwick, 2007). Successful outcomes generally mean that the patient has reduced pain levels, increased range of motion, improved function, and an absence of surgical complications (Dolwick, 2007). The treatment for end-stage internal derangement and in cases such as rheumatoid arthritis is TMJ replacement, however the success rate decreases as the severity of disease increases (Tzanidakis and Sidebottom, 2013). Outcomes for TMJ surgery vary between studies and have decreased in years. However, surgery is rarely
being used due to its increased risk, long term outcomes and limited long-term data available.

1.9 Neuralgias

Neuralgias are localised, excruciating pains and commonly occur in the orofacial region. Neuropathic pain conditions in the orofacial region are divided into episodic pain disorders, including trigeminal and glossopharyngeal neuralgias, and continuous pain disorders that occur after injury in the peripheral or central nervous system, which is the case for neuromas and idiopathic trigeminal neuropathic pains (Romero-Reyes and Uyanik, 2014). Typically described characteristics of cranial neuralgia pain are electric shock like or lancinating (Hupp and Firriolo, 2013). There are two broad categories of cranial neuralgias: those that have episodic symptoms and those that produce continuous symptoms. The episodic or paroxysmal attacks last seconds to minutes, and may be frequent or separated by long periods of time of remission. Trigeminal neuralgia (TN) is the most common of the cranial nerve neuralgias. Classic TN usually affects the second or third division of the trigeminal nerve, affecting the cheek or chin on one side. There is sharp, stabbing pain with a sudden onset that can last less than a second to a few seconds, sometimes in a cluster of variable intensity up to two minutes (Obermann and Katsarava, 2009). The trigger may be a light touch on the skin, eating, shaving, washing, applying makeup, brushing of teeth, movement of the jaw or tongue or a thermal stimulus (Hupp and Firriolo, 2013). There are several theories in relation to the aetiology of cranial neuralgias. In some cases the nerve or ganglion of a cranial nerve may be compressed by a blood vessel in close proximity to
the nerve in some cases (Hupp and Firriolo, 2013). Other theories suggested that there is peripheral damage that leads to a paroxysmal discharge of the nerve that could lead to a reverberation of pain impulses along the track of the nerve (Aguggia, 2005). Pharmacotherapy is the first line of treatment of cranial neuralgias and the most successful medications are anticonvulsants (Hupp and Firriolo, 2013).

1.10 Headache Disorders

Headache disorders are among the most common complaints in general medical practice (Rizzoli and Mullally, 2018). The evaluation, diagnosis, treatment planning and management sets a challenge for the treating physician. Primary headaches are headaches for which there is no other contribution and the headache itself is the main complaint.

The International Headache Society in 2021 (IHS) presented an updated classification of headache disorders to validate the complex nature of orofacial pain for clinical as well as research consensus (Olesen et al., 2018). This classification consisted of 3 parts, namely (i) primary headache, (ii) secondary headache and (iii) neuropathies, facial pains and other headaches (Olesen et al., 2018). Primary headaches are subdivided into migraine, tension-type headache, trigeminal autonomic cephalalgias and other primary headache disorders. The diagnosis of primary headache is centred around the patient’s symptoms of previous episodes and exact symptom characteristics (Mier and Dhadwal, 2018). The diagnosis of a secondary headache is made if the underlying disease is thought to cause the headache or if a close temporal
relationship is present together with the occurrence of the headache (Schankin and Straube, 2012).

Migraine is a common type of primary headache disorders. Migraine headaches are usually an episodic unilateral, pulsatile and accompanied by photophobia and/or phonophobia (Benoliel and Eliav, 2013). Additionally, patients may present with a prodromal aura. Lovshin was the first to specify migraine as a facial pain disorder (Lovshin, 1977). The pain in facial migraine is described as dull, with superimposed throbbing that occurs once to several times per week. Each attack may last minutes to hours. All treatments should include an understanding that the disorder is genetic, and that the goals should be to reduce pain frequency and intensity, restore function, and provide a sense of self-control (Vetvik et al., 2014). Migraine attacks can be associated with cranial autonomic symptoms and symptoms of cutaneous allodynia (Goadsby, 2005). A marginal number of female patients have attacks of migraine correlated with their menstrual cycles in which most if these attacks are without aura (Vetvik et al., 2014). Migraines during the menstrual cycle are of longer duration and occur in conjunction with nausea. Frequent migraine attacks are classified as chronic migraine with at least 15 days of migraine headache per month for more than 3 months (Vetvik et al., 2014).

Tension type headaches are very common, with the prevalence in the general population ranging between 30-78% (Rasmussen et al., 1991). The term tension-type was devised by the first Classification Committee of the International Headache Society to provide a classification for headaches of uncertain pathogenesis (Ahmed,
2012). However, as the name suggests a mental or muscular tension may have a causative role (Fumal and Schoenen, 2008). Although the exact aetiology is still unknown, peripheral myofascial mechanisms and central dysregulation of pain processing structures are implicated but their relative weight in the pathogenesis of TTH varies with the frequency of headache and between patients (Fumal and Schoenen, 2008). Tension-type headaches are more diffuse, with dull aching pain, and in general are bilateral. In general, this headache was described as a dull pressure pain that often has a “cap” or “bandlike” spread around the head. Tension-type headache is generally less painful and debilitating than other primary and secondary headache disorders (Matthew and Garza, 2011). The clinical definition of tension-type headache has been chiefly that of exclusion of the cardinal symptoms of migraine (Schreiber, 2004).

Cluster headaches are located primarily in the orbital and temporal regions, with accompanying lacrimation, swelling of the forehead or eyelid, and possible rhinorrhoea. The current literature on cluster headache is based on key animal, clinical and neuroimaging studies (Wei and Goadsby, 2021). The trigeminovascular system is the major pain signalling pathway and is pivotal in the severe pain in the unilateral trigeminal distribution (Goadsby et al., 2017). The hypothalamus plays a role in the circadian and circannual pattern of attacks and probably contributes to attack generation (Hoffmann and May, 2018). The combination of these components is responsible for the unique presentation of cluster headache compared with other primary headache disorders (Wei and Goadsby, 2021).
The main clinical features that distinguish secondary headache from primary headache are duration of illness, measure of headache attacks, associated symptoms and physical signs (Schreiber, 2004). Secondary headache disorders are grouped as a symptom of a disease that can activate or trigger the pain-sensitive nerves of the head (Table 1.1). Primary headache disorders classically affect the frontal, temporal, parietal or occipital regions of the head, and may also include neck pain in a substantial amount of patients (Sharav et al., 2017). A minority of headache patients have a secondary headache disorder. Neurologists worldwide estimate that 18% of patients with a headache have a secondary headache disorder (Do et al., 2019). The International Classification of Headache Disorders 3 (ICHD-3) provides a list of 8 categories and 46 subcategories of potential secondary causes (Olesen et al., 2018).

<table>
<thead>
<tr>
<th>Secondary headache</th>
<th>Characteristic</th>
<th>Investigation</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinusitis-related headache</td>
<td>Usually more in the morning (frontal) or as the day goes on (maxillary) or deep-seated (sphenoid). May follow after respiratory tract infection. Local tenderness may be elicited.</td>
<td>X-ray paranasal sinuses</td>
<td>NSAIDs, antibiotics, ENT referral</td>
</tr>
<tr>
<td>Cerebral venous thrombosis</td>
<td>Recent onset headache accompanied by seizures/altering sensorium/papilledema/focal neurological deficits. Seen commonly in puerperium in women and alcoholics among men.</td>
<td>Work up of pro-coagulant states CT brain with contrast MRI brain.</td>
<td>Anticoagulant, Antiepileptics</td>
</tr>
<tr>
<td>Idiopathic intracranial hypertension</td>
<td>Headache accompanied by vomiting, double vision, vertigo, tinnitus, papilledema, 6th nerve palsy.</td>
<td>CSF opening pressure &gt;250 mmHg, MRI brain with MRV.</td>
<td>Weight reduction, oral glycerol, acetazolamide to reduce the intracranial pressure. CSF shunts.</td>
</tr>
<tr>
<td>Subarachnoid haemorrhage</td>
<td>Worst headache of lifetime accompanied by vomiting, neck stiffness, altered sensorium, and focal deficits. Ruptured aneurysm and trauma are common causes.</td>
<td>CT brain and angiogram</td>
<td>Coiling and clipping, management of raised pressure.</td>
</tr>
<tr>
<td>Brain tumours</td>
<td>Early morning worsening progressively deteriorating history of neoplasm with or without focal neurological deficits.</td>
<td>Imaging</td>
<td>Neurosurgical intervention for removal/tissue diagnosis of the lesion.</td>
</tr>
<tr>
<td>Meningitis</td>
<td>Headache accompanied by fever, altered sensorium and neck stiffness.</td>
<td>Lumbar puncture and CSF analysis with gram stain, protein, glucose, cells, culture, imaging.</td>
<td>Antibiotics based on the causative organism.</td>
</tr>
<tr>
<td>Headache secondary to intracranial hypotension</td>
<td>Commonly seen after LP. Can be spontaneous headache appearing in sitting position and improves on lying down.</td>
<td>CSF opening pressure imaging of the spine to look for sites of the leak.</td>
<td>Supportive measures- NSAIDs, caffeine, hydration, bed rest. Epidural patch if conservative measures fail.</td>
</tr>
</tbody>
</table>

Table 1.1. Details of secondary headaches. Adapted from Mailankody et al. (2021).
Headache disorders and TMD share common physiological pathways (Sharav et al., 2017). Presentations of headaches in the facial area are often misdiagnosed, and as a result incorrectly managed as dental or nasal pathology (Kohli and Thomas, 2021). Both headache disorders and other orofacial pain disorders, such as TMD, share peripheral inputs by means of the trigeminal nerve (Sharav et al., 2017). The sensory innervation of orofacial structures involve both cervical and trigeminal pathways (Kemp et al., 2012). The difficulty in differentiating headache and orofacial pain is due to the structures which are both innervated by divisions of the first branch of the trigeminal nerve. However, cranial innervation by the second and third trigeminal branches have been described, suggesting that there is a positive overlap between cranial and orofacial innervation (Sharav et al., 2017). Headache disorders accompanied by nausea, light and sound sensitivity, and fatigue are some noteworthy indications that pain in the face is appearing as part of a primary headache disorder (Sharav et al., 2017). Figure 1.10 illustrates the complex and overlapping structures that make it challenging to differentiate between TMD and headache disorders (Schreiber 2004). To understand and effectively treat orofacial pain, the clinician must have a sound knowledge of the neuroanatomy and physiology of orofacial structures. The primary sensory innervation of the orofacial structures is the trigeminal system. The trigeminal system oversees the efficacy and tissue integrity of highly integrative orofacial behaviours that are controlled by the cranial nerves and modulated by the autonomic nervous system and greater limbic system (Ter Horst et al., 1991). The largest of the cranial nerves is the trigeminal nerve, which consists of three peripheral branches namely, the ophthalmic, the maxillary, and the mandibular. The trigeminal nerve is the dominant nerve that relays sensory impulses from the orofacial area to
the central nervous system (De Rossi, 2013). The fifth cranial nerve is the common denominator for many headaches and facial pain pathologies. Projecting from the trigeminal ganglion, it connects to the brainstem and supplies various parts of the head and face with sensory innervation. From this one can begin to appreciate the complex nature of the overlapping signs and symptoms between TMD and headache disorders.

![Figure 1.10. Innervation of the face illustrating the complex and closely related structures. Adapted from Netter, 2019.](image)

**1.11 Headache Diagnosis**

Disease classifications serve many purposes when a gold standard biologic marker is not present. The main objective of a classification is to use a universal language when defining a disease. Primary headaches and TMDs are often confused for a number of reasons. They overlap in locations and they often occur simultaneously. Therefore, the International Headache Society developed a well-defined and validated international classification of headache disorders in order to facilitate the diagnoses
of the head, face or neck pain (Bigal et al., 2004). These criteria have become the diagnostic standard for headache diagnosis and research. In the 1980s, The International Headache Society aimed at developing a headache classification which built upon previous classifications that is globally accepted and the gold standard for Headache Disorder Classification (Olesen et al., 2018).

The rapid increase in headache research rendered the first IHS classification from 1988 deficient and requiring revision. The ICH-III separated the primary headache disorders from secondary headache disorders (Olesen et al., 2018). Table 1.2 represents part of the primary headache disorders of migraine and includes the subdivisions and diagnoses. Migraine is a common restricting primary headache disorder. In 2015, the Global Burden of Disease Study classified migraine as the third most prevalent disorder in the world and third-highest cause of disability in both males and females (Vos et al., 2016). Migraine has two major subtypes, migraine without aura which is a clinical syndrome characterised by specific features. This is a recurrent headache disorder which includes attacks that usually last approximately 4-72 hours. Distinctive features include location being of unilateral positioning, pulsating pain, moderate to severe pain intensity and association with nausea. Triggers include physical activity and in some cases light. The diagnostic criteria include five attacks lasting 4-72 hours and should include two of the characteristic symptoms. A positive migraine without aura should include either nausea/vomiting or photophobia. The second subtype of migraines include migraine with aura which includes recurrent attacks, lasting minutes and of a unilateral location. Visual, sensory or other central nervous system symptoms develop gradually and are usually followed
by migraine symptoms. The aura has complex neurological symptoms that occurs before the headache (Kallela et al., 1999). Diagnostic criteria include at least two attacks with one or more aura symptoms. Aura symptoms involve visual, sensory, speech, motor, brainstem or retinal disturbances. A diagnosis of aura should spread steadily over five minutes, symptoms occur in sequence and lasts approximately 5-60 minutes. At least one aura symptom should be unilateral and is usually accompanied or followed within 60 minutes by a headache. Visual aura is the most common type of aura (Lauritzen, 1994).

Chronic daily headache (CDH) is defined as the presence of a headache for 15 days or more per month, for at least three months (Stovner et al., 2007). CDH is a descriptive term applied to any number of headache types. The most common types of chronic daily headache are chronic migraines and chronic tension-type headaches (Yancey et al., 2014).
Table 1.2. Primary Headache Disorders: Migraine. Adapted from the ICHDIII (Olesen et al., 2018).
Tension type headache is considered a primary headache. Table 1.3 includes tension type headache and subtypes for an accurate diagnosis of universal nomenclature. The ICHD has classified tension type headache into episodic and chronic types. The episodic was further divided into infrequent type, with headache episodes less than once per month, and a frequent episodic which can be associated with disability and frequently necessitates treatment with medication. In contrast, infrequent episodic tension type headaches, occur in almost the entire population and requires no specific attention from the medical profession. Chronic tension type headache is a serious disease causing greatly decreased quality of life and a high level of disability. Expert clinicians vary in their opinion on chronic tension type headache with some suggesting that the term chronic migraine would be a more accurate description, given that migraine characteristics tend to be observed in many patients with chronic tension type headache (Ghadiri-Sani and Silver, 2016)
<table>
<thead>
<tr>
<th>Tension-type headache (TTH)</th>
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<tbody>
<tr>
<td><strong>1 Infrequent episodic tension-type headache</strong></td>
<td></td>
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<tr>
<td>1.1 Infrequent episodic tension-type headache associated with pericranial tenderness</td>
<td></td>
</tr>
<tr>
<td>1.2 Infrequent episodic tension-type headache not associated with pericranial tenderness</td>
<td></td>
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<tr>
<td><strong>2 Frequent episodic tension-type headache</strong></td>
<td></td>
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<tr>
<td>2.1 Frequent episodic tension-type headache associated with pericranial tenderness</td>
<td></td>
</tr>
<tr>
<td>2.2 Frequent episodic tension-type headache not associated with pericranial tenderness</td>
<td></td>
</tr>
<tr>
<td><strong>3 Chronic tension-type headache</strong></td>
<td></td>
</tr>
<tr>
<td>3.1 Chronic tension-type headache associated with pericranial tenderness</td>
<td></td>
</tr>
<tr>
<td>3.2 Chronic tension-type headache not associated with pericranial tenderness</td>
<td></td>
</tr>
<tr>
<td><strong>4 Probable tension-type headache</strong></td>
<td></td>
</tr>
<tr>
<td>4.1 Probable infrequent episodic tension-type headache</td>
<td></td>
</tr>
<tr>
<td>4.2 Probable frequent episodic tension-type headache</td>
<td></td>
</tr>
<tr>
<td>4.3 Probable chronic tension-type headache</td>
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</tbody>
</table>

Table 1.3. Details of tension type headache primary headache disorders. Adapted from the ICHDIII (Olesen et al., 2018).

Trigeminal autonomic cephalalgias (TACs) share clinical features of unilateral headache and also prominent cranial parasympathetic autonomic features, which are lateralised and ipsilateral to the headache (Table 1.4). Cluster headaches are the most frequent subtype of TACs. Cluster headaches are a subtype of TAC. Attacks are severely debilitating, strictly unilateral pain which is orbital, supraorbital, temporal or a combination of these sites lasting 15-180 minutes and occurring once every other day to eight times a day. The pain is associated with a variety of autonomic features
which may include ipsilateral conjunctival injection, lacrimation, nasal congestion, rhinorrhea, forehead and facial sweating, miosis, ptosis and/or eyelid oedema and/or with restlessness or agitation (Olesen et al., 2018). While some cluster headache patients may exhibit many of these autonomic features, this is not the case in all patients. The presence of some autonomic features is essential to the diagnosis.

Paroxysmal hemicrania (PH) is rare, with an estimated prevalence of 2 to 20 per 100,000 (Koopman et al., 2009). The mean age of onset is usually 34 to 41 years, but children aged 6 and adults aged 81 years have been reported, with an average illness duration of 13 years (Antonaci and Sjaastad, 1989). PH presents as a severe unilateral orbital or periorbital pain (Benoliel and Eliav, 2013). Referral pain can occur and travel to the shoulder, neck and arm. The pain generally lasts 2 to 30 minutes, in which the onset is rapid and peaks in less than 5 minutes. It is typically described as a sharp, excruciating pain that is usually accompanied by one of the autonomic signs such as conjunctival injection or lacrimation, nasal congestion or rhinorrhea, eyelid oedema, facial sweating, miosis or ptosis (Benoliel and Eliav, 2013).

Short lasting unilateral neuralgiform headache attacks with conjunctival injection and tearing (SUNCT) is generally a unilateral headache or facial pain in which the pain spreads across the midline and is described as stabbing or pulsating (Benoliel and Eliav, 2013). SUNCT may be triggered by light mechanical stimuli in the areas stimulated by the trigeminal nerve (Pareja and Cuadrado, 2005). By definition, SUNCT is accompanied by marked ipsilateral conjunctival injection and lacrimation that appear rapidly with onset of pain (Benoliel and Eliav, 2013). Nasal stuffiness and
rhinorrhoea are common; sweating may accompany attacks but is rare and often subclinical (Sjaastad et al., 1989). Attacks of SUNCT are brief lasting seconds at a time but may occur with great frequency throughout the day. Short lasting unilateral neuralgiform headache attacks with cranial autonomic symptoms (SUNA) as similar to SUNCT with less prominent absent conjunctival injection and lacrimation (Jiménez Caballero et al., 2011). There is a broader range of attack durations, between 2 seconds and 10 minutes, with an attack frequency of one or more per day (Williams and Broadley, 2008).

Hemicrania continua is a unilateral headache that persists for longer than three months (Benoliel and Eliav, 2013). The characteristic pain occurs in the frontal, temporal regions and periorbital areas (Benoliel et al., 1994). It is usually described as a throbbing pain accompanied by at least one of the following conjunctival injection or lacrimation, nasal congestion or rhinorrhoea, miosis or ptosis (Dodick, 2012). New daily persistent headache (NDPH) is rare and presents with a rapid onset which continues without remission within 24 hours (Yamani and Olesen, 2019). It is characterised by persistent headache in the temporal region and continues in a daily pattern (Yamani and Olesen, 2019). The continuous nature of hemicrania continua makes it difficult to distinguish from NDPH and on occasions it is misdiagnosed as tension type headache.
<table>
<thead>
<tr>
<th>Trigeminal autonomic cephalalgias (TACs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Cluster headache</strong></td>
</tr>
<tr>
<td>1.1 Episodic cluster headache</td>
</tr>
<tr>
<td>1.2 Chronic cluster headache</td>
</tr>
<tr>
<td><strong>2. Paroxysmal hemicrania</strong></td>
</tr>
<tr>
<td>2.1 Episodic paroxysmal hemicrania</td>
</tr>
<tr>
<td>2.2 Chronic paroxysmal hemicrania</td>
</tr>
<tr>
<td><strong>3 Short-lasting unilateral neuralgiform headache attacks</strong></td>
</tr>
<tr>
<td>3.1 Short-lasting unilateral neuralgiform headache attacks with conjunctival injection and tearing (SUNCT)</td>
</tr>
<tr>
<td>3.1.1 Episodic SUNCT</td>
</tr>
<tr>
<td>3.1.2 Chronic SUNCT</td>
</tr>
<tr>
<td>3.2 Short-lasting unilateral neuralgiform headache attacks with cranial autonomic symptoms (SUNA)</td>
</tr>
<tr>
<td>3.2.1 Episodic SUNA</td>
</tr>
<tr>
<td>3.2.2 Chronic SUNA</td>
</tr>
<tr>
<td><strong>4 Hemicrania continua</strong></td>
</tr>
<tr>
<td>4.1 Hemicrania continua, remitting subtype</td>
</tr>
<tr>
<td>4.2 Hemicrania continua, unremitting subtype</td>
</tr>
<tr>
<td><strong>5 Probable trigeminal autonomic cephalalgia</strong></td>
</tr>
<tr>
<td>5.1 Probable cluster headache</td>
</tr>
<tr>
<td>5.2 Probable paroxysmal hemicrania</td>
</tr>
<tr>
<td>5.3 Probable short-lasting unilateral neuralgiform headache attacks</td>
</tr>
<tr>
<td>5.4 Probable hemicrania continua</td>
</tr>
</tbody>
</table>

Table 1.4 Details of trigeminal autonomic cephalalgias. Adapted from the ICHD III (Olesen et al., 2018).
1.12 Headache Management

Although there is no cure, adequate control can be achieved for most headache disorders. The management of migraine consists of pharmacological and non-pharmacological approaches. It is important that the treatment approach to migraine includes a thorough medical evaluation performed by a neurologist to rule out any possible secondary cause of the headache, such as systemic disease, tumours, or cerebrovascular abnormalities (Romero-Reyes and Uyanik, 2014). Non-pharmacologic treatment includes patient education and accurate, comprehensible information on importance of contributing factors, such as sleep, diet, and other lifestyle practices which may precipitate attacks (Pryse-Phillips et al., 1998).

Pharmacological treatment includes abortive management which aims to rapidly relieve the headache with no recurrence or side effects. This treatment option is used when fewer than 4-8 attacks per month are resolved. Preventative management aims to reduce attack frequency, severity and duration. This is used when attacks are more frequent (greater than 4-8 attacks a month) or the attacks are debilitating (Olesen et al., 2018). Drugs with high efficacy and mild to moderate adverse effects include β-blockers, amitriptyline or topiramate (Benoliel and Eliav, 2013). Cluster headache management should avoid all triggers, avoiding daytime sleeping and alcoholic beverages. Non-pharmacological treatment includes rapid symptomatic relief with oxygen inhalation (Ashkenazi and Schwedt, 2011).

The management of tension type headaches also involves non-pharmacological and pharmacological approaches, as followed for migraine. Changes in lifestyle such as sleep hygiene, detection of triggers with a pain diary, as well as stress management
and relaxation techniques have been demonstrated to be beneficial (Romero-Reyes and Uyanik, 2014). Pharmacological approaches, such as the use of NSAIDs as well as tricyclic antidepressants in addition to botulinum toxin injections, have proved useful (Bendtsen and Jensen, 2011). The tricyclic antidepressant amitriptyline is the management that has been extensively studied and found to be most effective for TTH. Starting at a lower dose and incrementally increasing up to 75mg has been reported to be beneficial (Chowdhury, 2012).

Cluster headache, paroxysmal hemicranias, and short-lasting unilateral neuralgiform headache attacks with conjunctival injection and tearing are severe headaches that are not as common as migraine and are characterised by their powerful parasympathetic autonomic symptoms (Goadsby et al., 2007). These headaches require neurological evaluation and management. Therefore, it is of fundamental importance to make an appropriate differential diagnosis to avoid unnecessary dental treatments and misdiagnosis with other types of orofacial pain (Romero-Reyes and Uyanik, 2014).

In a previous study, the authors described the relationship between headache and symptoms of TMD in a general population and assessed whether specific symptoms were associated with headache disorders (Ciancaglini and Radaelli, 2001). They demonstrated that in the general adult population, there was an association between headache and symptoms of TMD. Headache disorders occurred significantly more frequently in females than males (Ciancaglini and Radaelli, 2001). Among symptoms of TMD, temporomandibular pain, temporomandibular joint sounds, and pain on
movements of the jaw showed a correlation of headache disorders (Ciancaglini and Radaelli, 2001).

A study by Mello and co-workers described the frequency of signs and symptoms of TMD in individuals with headache disorders (Mello et al., 2012). The authors demonstrated that TMD signs and symptoms were more frequent in individuals with headache, especially pain in TMJ area (Mello et al., 2012). Graff-Radford argued that TMD exacerbated headache disorders as a result of the overlap of innervations with the trigeminal nerve (Graff-Radford, 2007). TMDs and headache disorders may share similar pain pathways. Amongst the neuronal structures, the spinal trigeminal nucleus is central in the relationship between these disorders (Bendtsen, 2000). This area is responsible for the nociceptive inputs for the face and head (Conti et al., 2016).

In a population-based cross-sectional study, the prevalence of migraine, episodic tension-type headaches, and chronic daily headaches, as well as the presence of symptoms of TMD in the adult population were evaluated (Gonçalves et al., 2010). The authors concluded that TMD symptoms were more common in migraine relative to individuals without headache (Gonçalves et al., 2010). However, caution should be taken in interpreting the results of this study as it was questionnaire-based to assess TMD and patients were not clinically examined (Gonçalves et al., 2010).

Glaros and co-authors assessed the diagnostic and behavioural overlap of headache patients with TMD (Glaros et al., 2007). Individuals with self-reported headaches were compared with non-headache controls (Glaros et al., 2007). Headache patients
reported intense tooth contact, masticatory muscle tension, stress and more pain in the orofacial region compared to the non-headache controls. These results were comparable for patients with TMD. The authors suggested that there was a considerable overlap between headache and TMD patients with regard to the reported symptoms in the orofacial region (Glaros et al., 2007).

1.13 Statement of the Problem
The multifactorial origin of headaches and TMD coupled with the fact that they exhibit similar and overlapping signs and symptoms make the diagnostic process and planning of treatment challenging (Duminil et al., 2016). Understanding the pain neurobiology of the trigeminal system is key to the development of better and safer therapeutics. Primary headaches and TMDs are often confused for a number of reasons. They overlap in locations and they often occur simultaneously. Therefore, authors and clinicians have pointed out that headache and TMD may be associated, but any relationship remains difficult to establish. Patients have reported that they were often moved around between a number of professionals, and even abandoned with no referral options (Ciancaglini and Radaelli, 2001).

The complex relationship between headache and TMD can only be understood by an appreciation of the neurobiology of the trigeminal nervous system. To avoid unnecessary treatments and to improve patient care it is important that clinicians are made aware of the overlap between TMD and headache disorders. More accurate diagnosis will help alleviate the suffering of these patients and will help to reduce the
risk of patients receiving unnecessary treatment. A detailed clinical examination, history taking and special investigations are essential to forming an accurate diagnosis

1.14 Aims and Objectives

The aims of this study were to:

1. To evaluate the prevalence of TMD in patients attending an Orofacial pain clinic.
2. To evaluate the prevalence of headache disorders in patients attending an Orofacial pain clinic.
3. To evaluate the association between Headache Disorders and TMD in a population referred to an orofacial pain clinic for management of possible TMD.
4. To analyse the relationship between the patients perceived origin of pain and the actual diagnosis.
5. To describe diagnostic information to the clinician to better assist in identifying patients with TMD and/or headache disorders.

The objectives of this study were to:

1. To identify and diagnose patients with headache and TMD in an orofacial pain clinic.
2. To describe patients’ perceived pain. Frequently, patient’s discernment of pain in the orofacial region is commonly identified as odontogenic. However, due to the location of structures and innervation, it is important to differentiate between odontogenic and nonodontogenic pain.
3. To determine the relationship between TMD and Headaches in an Irish population.

The multifactorial origin of headache and TMD, and many different situations under
which subjects exhibit similar and/or overlapping symptoms making the diagnostic planning of treatment difficult.
CHAPTER 2

Methodology

2.1 Introduction

In an Orofacial Pain Clinic, patients may present with parallel and/or overlapping signs and symptoms of facial pain. The multifactorial origin of headache and TMD makes the diagnostic process and treatment planning challenging. Therefore, research evaluating the relationship between headache disorders and TMD is of clinical importance, for both practical and social reasons (Ciancaglini and Radaelli, 2001). Previous authors have pointed out the close association between the two orofacial pain conditions (Ciancaglini and Radaelli 2001). At present, the debate between headache and TMD remains a controversial subject. The possible associations between headache and TMD have been extensively investigated to date, however any causative relationship was difficult to ascertain (Réus et al., 2021). This study investigated patients referred to an Orofacial Pain Clinic primarily for TMD management and determined if their definitive diagnosis corresponded to TMD and/or headache disorders.

2.2 Study Design

The present study was designed as a descriptive cross-sectional study consisting of a sample of convenience utilising a self-administered questionnaire developed and disseminated to the participants by the primary researcher. The questionnaire was compared to the definitive clinical diagnosis of an Orofacial Pain Specialist. The specialist was DC/TMD calibrated and had completed a clinical examiner training...
program in the USA. There are multiple DC/TMD training and calibration centres worldwide including in Sweden, Denmark and the United States of America. These calibration centres are supervised by specific affiliated examiners from the DC/TMD committee. In addition, the Specialist has been trained to diagnose headache disorders in the University of California, Los Angeles, where he specialised in Orofacial Pain.

2.3 Ethical Approval

Ethical Approval was granted by the Tallaght Hospital/ St. James’ Hospital Joint Research Ethics Committee (JREC) in April 2021 (Appendix 1).

2.4 Sampling Size and Study Population

In this research project, all participants were adult patients attending the Northbrook Orofacial Pain Clinic in Dublin, Ireland under the care of Dr Dermot Canavan, a Specialist in Orofacial Pain and Lecturer in Orofacial Pain at the Dublin Dental University Hospital and Trinity College. A sample of convenience of 150 patients participated in the study, all of whom had orofacial pain, primarily TMD. From a statistical point of view, a sample size of more than 150 is large and precision of the results only improve slightly when a larger sample size is used (Charter, 1999). The study was undertaken between 2019 to 2022. Previous published studies used sample sizes ranging from 40-1000 (Ciancaglini and Radaelli 2001). However, the studies were heterogeneous in design and afforded poor guidance in relation to structure for this study. This study represented a cohort with orofacial pain in a referral population and was a sample of convenience.
2.5 Inclusion and Exclusion Criteria

Inclusion Criteria included:

- Patients who suffered from pain in the TMJ and head area.
- Patients seeking management for TMD (pain, restricted mouth opening, jaw joint noises, hypermobility).
- Adult patients over the age of 18 years of age.

Exclusion Criteria included:

- Patients who presented with other orofacial conditions (e.g. malignancies).
- Patients who presented with pain outside of the head or temporomandibular area.
- Patients who did not want to take part in the research project.
- Patients who were unable to provide consent.

2.6 Participant Recruitment

Research participants were recruited from sequential patients referred for management and treatment of TMD at the Northbrook Orofacial Pain Clinic, Dublin. Each patient received a Consent Form (Appendix 2). In addition, a Patient Information Leaflet was provided for more insight into the research project (Appendix 3). The main purpose of the leaflet was to inform the patient about the relevance of the project and to assess their interest in participating. In addition, this offered the participant an opportunity to contact the Gatekeeper or Primary Investigator with any questions related to the study and also indicate if they were willing to participate. The participants had seven days from receiving the information leaflet before informed
consent was sought. If the patient did not wish to participate in the study, it did not affect the nature of the consultation and treatment they received at the clinic. Patients were free to withdraw from the study at any time and this did not affect their care. The participants were assured in relation to confidentiality regarding their names and the information provided should they decide to take part. None of the patients approached declined participation in the study. Questionnaires were completed before any examination or treatment was undertaken by the Specialist.

2.7 Data Collection

The questionnaire used validated and standardised DC/TMD and ICHDIII based questions and consisted of twenty five interactive questions based on the type of pain. This was uploaded onto a digital software programme, Qualtrics XM Platform™ (Qualtrics 2020, Utah, USA), which allowed the researcher to design questionnaires online. A systematic approach was taken in relation to questions on TMJ pain, headache pain and then focused on patient perception. The questionnaire was specifically designed for insight into the patient’s pain perspective and involved patient engagement and interaction. Illustrations in the questionnaire were designed by the researcher using Adobe Photoshop CC 2023 (Adobe, USA). Qualtrics automatically collected data on the system and retained the data and the number of recorded responses digitally. This eliminated the risk of recording incorrect data or losing it due to human error. All the data storage was secure and compliant with GDPR. Data collection were pseudonymised and were collected at the Orofacial Pain Clinic only. The questionnaires were completed with the Principal Investigator, in a
separate room, prior to clinical examination by the specialist. The data was exported from Qualtrics to an Excel® (Microsoft Corp®) spreadsheet for data analysis.

2.8 Coding for Analysis and Data Entry

The Principal Investigator was involved in data collection for the study, keeping records, gathering and interpretation of data, thereby ensuring confidentiality and the standardised recording of information. The data set was entered, edited, and analysed using SPSS® version 26 (IBM, USA) software, Microsoft Excel® and STATA® Corp LLC software.

2.9 Study Questionnaire

Questionnaires were completed by the patients on a password protected iPad Pro (Apple Inc.) in the presence of the Primary Investigator prior to clinical examination by the Specialist, who was blinded from the results of the questionnaire. The questionnaire started with the patient’s chart number details in order to code the participants and later retrieve the definitive diagnosis (Figure 2.1). This was followed by details of the presenting complaint describing the type of pain in the orofacial area. Grading the pain intensity coding the responses of mild, moderate to severe pain, allowed for patient interaction and assessment of their level of pain. The face was coded with from a straight face for mild pain, sad face for moderate to a crying face represented severe pain (Figure 2.1).
Figure 2.1. Questionnaire as given to patients to indicate presence or absence of pain and intensity adapted from the DC/TMD (Schiffman et al., 2014).

The questionnaire focused on describing the patient’s pain. Questions assessed pain intensity by grading experienced pain. The literature has suggested that patients have difficulty in describing the exact location of their pain, making it challenging for the clinician to accurately identify between patients perceived symptoms and the exact location (Ciancaglini and Radaelli, 2001). In order to facilitate accurate localisation of the pain, an illustration of the head and neck was designed which allowed the patient to click on the exact location of the pain they experienced on an iPad – eliminating erroneous patient information for diagnoses (Figure 2.2). This was not only utilised for patient engagement but to understand the exact location of the pain. The illustration was designed by the researcher and included the frontal head, TMJ area or ear, back of the head, neck, oral, zygoma or periorbital on Qualtrics. The illustration was divided up into zones according to the anatomy in relation to each orofacial disorder. The
frontal head zone represented headache disorder. Migraine and cluster headaches are examples of headache disorders that would be located in the areas such as the forehead, zygoma, orbital and temporalis. The TMJ zone represented the entire preauricular, auricular and TMJ area. The odontogenic zone represented the lower third of the face, labium and mentalis. The back of the head zone represented muscular and headache-type pain such as TTH. The neck zone represented pain of muscular or cervical origin such as sternocleidomastoid muscle. Each click on the different zones was associated with a position which radiated a numerical value for each zone. These values were collated into an associated heatmap. The heatmap provided a data visualisation tool with a colour palette representing the high-intensity to the low intensity data sets.

Figure 2.2. A diagram illustrating the zones of the facial area as taken from the designed questionnaire or patients to indicate the area where pain was experienced the most.
The next set of questions addressed pain in the TMJ area. Patients detailed the duration and character of the pain and when it first developed (Figure 2.3). Aggravating factors were key in forming the diagnosis. Questions such as what triggered the pain, where the participant selected from the list of common activities, offered insight into the onset of the pain. These activities were specifically designed and associated with various diagnoses. Pain on mandibular movement can be associated with certain TMD diagnoses. For example, pain on mandibular movement such as eating or yawning, could be indicative of TMD. Restricted mouth opening, clicking and locking were assessed as indicative of derangement of the articular disc.

*Question 4.* How many years or months ago did your pain in the jaw, temple, in the ear, or in front of the ear first begin?

*Question 5.* In the last 30 days, which of the following best describe any pain in your jaw, temple, in the ear, or in front of the ear on either side?

- No pain
- Pain comes and goes
- Pain always present

*Question 6.* In the last 30 days, did the following activities change the pain in your jaw, temple, in the ear, or in front of the ear on either side?

- Chewing hard or tough food.
- Opening your mouth, or moving your jaw forward or to the side.
- Jaw habits such as holding teeth together, clenching/grinding teeth, or chewing gum.
- Other jaw activities such as talking, kissing, or yawning.

Figure 2.3. Part of questionnaire given to patients to describe pain in the TMJ area adapted from the DC/TMD (Schiffman et al., 2014).
There was a headache aspect to the questionnaire, including if the patient was aware of a headache, pain duration, aggravating factors and pain related questions (Figure 2.4). Symptoms accompanying headache disorders can assist in identifying the type of primary headache disorder. Headache disorders that are accompanied by nausea and worsened by physical activity were indicative of migraine.

Figure 2.4. Part of the questionnaire given to patients to indicate presence and absence of headache and related symptoms adapted from the DC/TMD (Schiffman et al., 2014).
TMJ symptoms such as jaw joint sounds or restricted mouth opening were common TMD symptoms and aided in determining the definitive diagnosis (Figure 2.5).

Figure 2.5. Part of the questionnaire given to patients to indicate presence and absence of TMD and related symptoms adapted from the DC/TMD (Schiffman et al., 2014).
The study also focused on patient’s perceived pain and the relation to the diagnosis (Figure 2.6). The perceived diagnosis was achieved by allowing the patient to choose the diagnosis which they thought was most appropriate to their pain. The patients were able to select from a list of diagnoses which they felt described their pain.

Figure 2.6. Part of the questionnaire given to patients to indicate self-reported origin of pain adapted from the DC/TMD (Schiffman et al., 2014).
To conclude the questionnaire, the remaining questions addressed stress levels to assess the patient’s emotional status (Figure 2.7). Demographics such as age and gender were recorded to assess if the patterns would correlate with those previously published in the literature.

Figure 2.7. Part of the questionnaire given to patients to indicate presence or absence of stress as well as demographic data adapted from the DC/TMD (Schiffman et al., 2014).

Once the questionnaire was completed, the patient returned to the waiting room, awaiting their examination with the specialist. The clinical examination was then initiated by the Orofacial Pain Specialist. The examination consisted of history taking and a standard physical examination of the patient. The examination followed guidelines from the DC/TMD and the ICHDIII. The specialist commenced examination with a thorough history taking, as both TMD and headache can be identified through the patient’s history of their pain. This first included a pain and medical history. The
next set of questions involved the presenting pain, assessing the timeline and duration of pain, aggravating factors and a detailed description of the type of pain.

If no pain or tenderness around the TMJ area or muscles of mastication were identified, the examiner assessed for headache disorders. The specialist questioned duration of the pain, with migraine attacks usually last for 4-72 hours and accompanied by pulsating, pressing pain, aggravated by physical activity (Russo et al., 2018). Tension type headache was assessed around the temporal region. This type of headache attack pain does not worsen during physical activity and is not associated with nausea (Chowdhury, 2012). The pain was described as pressing but non-pulsating pain. TACs such as cluster headaches were assessed by the location (around the orbital), being unilateral, and causing excruciating pain lasting for 15-180 minutes. Once the specialist had exhausted history taking, the clinical examination followed, which included inspecting the site of pain (Schiffman et al., 2014).

The first sites examined clinically were the TMJ areas, and included inspection of the preauricular area for swelling or erythema. Palpation was undertaken directly over the joint while the patient opened/closed the mandible and the condylar movement assessed. Tenderness or pain produced by this movement was associated with articular inflammation. A normal joint is considered silent and if any crepitus or clicking sounds presented it was noted by the examiner. The range of mandibular opening was measured as the distance between the incisal edges of the maxillary and mandibular incisor teeth using a dental ruler. Opening of less than 35mm was considered deviant from the normal limit (Schiffman et al., 2014). The clinician
observed if deviation on opening occurred. Deviation of the mandible often occurs toward the affected side during mandibular opening and is indicative of disc displacement. Through manually palpating facial structures causing discomfort, the specialist could differentiate between pain of articular (pain within the TMJ), non-articular (pain around the surrounding structures of the TMJ) or muscular origin (discomfort arising from the muscles involved in jaw movement). The DC/TMD determined that palpation of the masticatory musculature should be considered positive when a patient identified the pressure as a recognisable source of pain (Szyszka-Sommerfeld et al., 2020). The DC/TMD recommended an applied pressure of 1kg for two seconds for a muscular pain diagnosis (Schiffman et al., 2014).

The second stage of the clinical examination involved palpation of the masticatory and cervical muscles and associated structures. These areas were palpated for areas of tenderness and discomfort. The sternocleidomastoid and trapezius muscles were examined first as TMD, dental or sinus infection can often be referred to the neck. Secondly, the preauricular area was assessed. The masseter, zygomatic arch, angle of the mandible and temporalis were then inspected. Intra-orally, the medial pterygoid muscle was palpated around the vestibule in the retromolar region. The lateral pterygoid muscles were accessed by palpating intra-orally posterior to the maxillary tuberosity. The dental arches were visually examined for dental caries, dental abscesses or malocclusion and the skeletal relationship noted.

Neuropathic pain stems from injury or disease of sensory nerve fibres due to various causes including toxic, traumatic, infectious or compressive damage (Finnerup et al.,
2016). The diagnosis of neuropathic pain was based on patient history and physical examination. Symptoms included a neuropathic area, altered sensations (paraesthesia, dysesthesia) and pain (neuralgia or burning). The pain or altered sensation may be spontaneous or stimulated (allodynia and hyperalgesia) (Baad-Hansen and Benoliel, 2017). This was examined by the specialist by gently touching the area where the patient had pain or tenderness.

The specialist had routine panoramic radiographs recorded for new patients, if indicated. This eliminated any obvious dental related pain and observed a portion of the condylar structures. The definitive diagnosis of the specialist was recorded and compared to the questionnaire.

2.10 Statistical Analysis

Statistical analysis was performed on a statistical software SPSS version 26 (SPSS Inc., Chicago, USA) and Excel (Microsoft, USA). Data were analysed by examining frequencies with tables and charts generated. Cross tabulations were completed between selected categorical variables and occurrence of TMD pain and headache. Associations were subjected to the Chi square test and Fischer’s Exact Test. The odds ratio and related 95% confidence interval (CI) were calculated where appropriate. A significance level of 0.05 was used and all the statistical tests were two-tailed.
CHAPTER 3

Results

3.1 Population of the Study

A total of 150 participants took part in this study. The demographic data collected included gender and age (Table 3.1). Of these participants, 115 (76.7%) were female and 35 (23.3%) were male. In this study, 55 (36.7%) of patients were in the 50+ age groups. Twenty-nine participants (19.3%) were between 19 and 29 years of age.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Category</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
<td>115</td>
<td>76.7%</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>35</td>
<td>23.3%</td>
</tr>
<tr>
<td>Age groups</td>
<td>18-29 years</td>
<td>29</td>
<td>19.3%</td>
</tr>
<tr>
<td></td>
<td>30-39 years</td>
<td>35</td>
<td>23.3%</td>
</tr>
<tr>
<td></td>
<td>40-49 years</td>
<td>31</td>
<td>20.7%</td>
</tr>
<tr>
<td></td>
<td>50+ years</td>
<td>55</td>
<td>36.7%</td>
</tr>
<tr>
<td>Definitive diagnosis</td>
<td>TMD</td>
<td>68</td>
<td>45.3%</td>
</tr>
<tr>
<td></td>
<td>Headache</td>
<td>33</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>Neuropathic</td>
<td>23</td>
<td>15.3%</td>
</tr>
<tr>
<td></td>
<td>Muscular</td>
<td>9</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>Odontogenic</td>
<td>5</td>
<td>3.3%</td>
</tr>
<tr>
<td></td>
<td>TMD + Headache</td>
<td>8</td>
<td>5.3%</td>
</tr>
<tr>
<td></td>
<td>Neuropathic+ Headache</td>
<td>2</td>
<td>1.3%</td>
</tr>
<tr>
<td></td>
<td>TMD + Muscular</td>
<td>2</td>
<td>1.3%</td>
</tr>
<tr>
<td>Patient perception of</td>
<td>Jaw Joint</td>
<td>90</td>
<td>60%</td>
</tr>
<tr>
<td>pain origin</td>
<td>Odontogenic</td>
<td>44</td>
<td>29.3%</td>
</tr>
<tr>
<td></td>
<td>Headache</td>
<td>9</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>Neuralgia</td>
<td>7</td>
<td>4.7%</td>
</tr>
</tbody>
</table>

Table 3.1. Distribution of data based on gender, age groups, definitive diagnosis, patient perception of pain origin showing patient counts and percentages.
3.2 Frequency of the Definitive Diagnosis

The most common findings amongst the participants was a diagnosis of TMD with 68 diagnoses (45.4%) belonging to this group. The other diagnoses, in decreasing order, were headache in 33 patients (22%), neuropathic pain in 23 patients (15.3%), muscular pain in 9 patients (6%) and odontogenic pain in 5 patients (3.3%). TMD combined with headache was recorded in 8 patients (5.3%) and TMD together with muscular pain was observed in two patients (1.5%) as demonstrated in Table 3.1.

3.3 Patient Perceived Pain

From a patient perspective, jaw joint pain was the most frequent self-reported pain with 90 of the 150 participants (60%) perceiving it as the main source of their pain. In total, 44 patients perceived their pain to be dental related (odontogenic). Nine patients perceived that they presented with headache and seven patients indicated that the origin of their pain was nerve pain (Table 3.1).

In total, 68 patients had a definitive diagnosis of TMD. Of these TMD patients, 55 (80.9%) perceived they had jaw joint pain (Table 3.2). Nine patients (13.2%) had perceived it was odontogenic and four (5.9%) thought they had headache disorders.

A total of 33 patients received a diagnosis of headache disorders. Of these headache patients, 18 (54.4%) perceived they had pain in the jaw joint area. In total, 13 (39.4%) of these patients perceived it was of odontogenic origin. Only one patient (3%)
perceived that their pain was of neural origin and one patient correctly diagnosed a headache disorder (Table 3.2).

<table>
<thead>
<tr>
<th>Patient Perception</th>
<th>Diagnosis</th>
<th>Jaw Joint</th>
<th>Odontogenic</th>
<th>Headache</th>
<th>Neuralgia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Headache</td>
<td>18</td>
<td>13</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Muscular</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Neuropathic</td>
<td>4</td>
<td>12</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Neuropathic + Headache</td>
<td>55</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Odontogenic</td>
<td></td>
<td></td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>TMD</td>
<td></td>
<td></td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>TMD + Headache</td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>TMD + Muscular</td>
<td></td>
<td></td>
<td>90</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>90</td>
<td>44</td>
</tr>
</tbody>
</table>

Table 3.2. Number of patients with their perceived pain as compared to their definitive diagnosis of the pain.

A total of 23 patients had a definitive diagnosis of neuralgia. Of these patients twelve patients (52.2%) perceived they had odontogenic pain and six patients (26.1%) recognised it was of nerve origin. Four patients (17.4%) perceived that this pain was originating from the jaw joint with only one patient (4.3%) identifying their pain as a headache disorder, as illustrated in the bar chart in Figure 3.1.

![Bar chart showing the percentage of patients with their perceived pain as compared to their definitive diagnosis of the pain.](image-url)
3.4 Self-Reported Stress Levels of Patients

With regards to self-reported stress levels, of the total 150 patients, 69.3% of participants reported moderate stress levels. Of the remaining participants, 41 (27.3%) reported high stress levels and 5 (3.3%) reported mild levels of stress (Table 3.3).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Category</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress levels</td>
<td>Mild</td>
<td>5</td>
<td>3.3%</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>104</td>
<td>69.3%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>41</td>
<td>27.3%</td>
</tr>
<tr>
<td>Pain type</td>
<td>Episodic</td>
<td>90</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>Persistent</td>
<td>60</td>
<td>40%</td>
</tr>
</tbody>
</table>

Table 3.3. Distribution of data based on stress levels and pain type showing patient counts and percentages.

3.5 Type of Pain as Reported by the Patient

Describing the type of pain being continuous versus spontaneous pain, 90 participants (60%) reported their pain to be episodic and 60 patients (40%) reported persistent pain (Table 3.3).

3.6 Prevalence of Pain based on Demographics

Females reported headaches and TMD significantly more than males (Table 3.4). The descriptive analysis for the age groups that presented at the clinic ranged from of 18 to 85 years of age. No significant relationship was found for TMD among the age groups (Figure 3.2). There was a greater number of headaches with increased age.
with the highest prevalence of 13 in the 50+ age group and 11 in the 40-49-year group as illustrated in Figure 3.2. The prevalence of neuropathic pain peaked in the age group 50+ age group. Table 3.5 illustrates the distribution of gender for each age groups and specific diagnoses.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMD</td>
<td>53</td>
<td>15</td>
<td>68</td>
</tr>
<tr>
<td>Headache</td>
<td>26</td>
<td>7</td>
<td>33</td>
</tr>
<tr>
<td>Neuropathic</td>
<td>18</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>Muscular</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>TMD + Headache</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Odontogenic</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Neuropathic + Headache</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>TMD + Muscular</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>115</strong></td>
<td><strong>35</strong></td>
<td><strong>150</strong></td>
</tr>
</tbody>
</table>

Table 3.4. Distribution of diagnoses based on gender.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>18-29 years</th>
<th>30-39 years</th>
<th>40-49 years</th>
<th>50+ years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Female 1</td>
<td>Male 6</td>
<td>Female 9</td>
<td>Male 2</td>
</tr>
<tr>
<td>Muscular</td>
<td>Female 1</td>
<td>Male 3</td>
<td>Female 3</td>
<td>Male 1</td>
</tr>
<tr>
<td>Neuropathic</td>
<td>Female 3</td>
<td>Male 1</td>
<td>Female 3</td>
<td>Male 12</td>
</tr>
<tr>
<td>Neuropathic + Headache</td>
<td>Female 2</td>
<td>Male 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Odontogenic</td>
<td>Female 1</td>
<td>Male 1</td>
<td>Female 2</td>
<td>Male 1</td>
</tr>
<tr>
<td>TMD</td>
<td>Female 15</td>
<td>Male 5</td>
<td>Female 10</td>
<td>Male 5</td>
</tr>
<tr>
<td>TMD + Headache</td>
<td>Female 3</td>
<td>Male 1</td>
<td>Female 1</td>
<td>Male 1</td>
</tr>
<tr>
<td>TMD + Muscular</td>
<td>Female 1</td>
<td>Male 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>21</strong></td>
<td><strong>8</strong></td>
<td><strong>27</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>

Table 3.5. Distribution of diagnoses based on age groups and gender.
Figure 3.2. Bar chart showing the distribution of the diagnoses based on age groups.

3.7 Location of Pain as Indicated by the Patient

The location of pain was assessed by asking the patient to select the area that was most affected on the given diagram. The patient selected the affected area that they felt best reflected their pain on the illustration using the touch screen on the iPad Pro (Apple, USA). The areas selected the most by the patient generated a higher intensity red colour, whereas the least selected areas generated a blue scale – reflecting a rainbow scale pattern. The resultant heat map was generated by Qualtrics and illustrated the patients’ location of pain, shown in Figure 3.3. A qualitative colour palette quantified the pain using distinct colour patterns for each data set (Figure 3.3A). The warmer colours indicated the higher values or more pain that was located by the patient and the cooler colours indicated the lower values where the least pain
experienced by the patient. The majority of patients felt pain in the TMJ area and the ear extending to the maxillary posterior teeth as illustrated in the red to orange zones shown in Figure 3.3B. The blue to purple zones appeared in the frontal head and eye illustrates the areas least selected (Figure 3.3C). In addition, the TMJ and dental regions were least selected by the patients shown in Figure 3.3C.

A. The full heat map indicating all patient responses.
B. The red/yellow zones of most selected area of pain. The image indicated that majority of the patients selected this area in which they had felt the most pain.
C. The blue/green zones of least selected area of pain. The image indicated the least selected areas.

Figure 3.3. Heat map of patients’ location of pain sites based on most to least selected areas.
The heat map of pain location was projected to the diagnostic zones and the resultant images are shown in Figure 3.4. These images depict the heat map separated into diagnostic zones and describe the location of pain in each area according to patient selection. Figure 3.4A represents the TMJ diagnostic zone where the majority of patients selected the TMJ area where they felt most pain (red zone). Fewer patients selected the auricular area as indicated by the blue areas. Figure 3.4B represented the frontal head diagnostic zone. Of the patients who had pain in the frontal head zone, most of the patients selected the zygomatic region as depicted by the red zones (Figure 3.4B). The blue area was the least selected area which depicted the forehead. Figure 3.4C represents the odontogenic diagnostic zone. The majority of patients selected the maxillary teeth where they felt the most pain, which is evident in the red area. The blue area indicated that fewer patients selected the mandibular teeth as their region of pain (Figure 3.4C).

Figure 3.4. Heat map of patients’ location pain sites based on diagnostic zones.
A. TMJ diagnostic zone.
B. Frontal head diagnostic zone.
C. Odontogenic diagnostic zone.
The diagnostic zones were projected for each diagnosis and are represented in the series of bar charts shown below. Of the group of patients who located the region of pain in the jaw joint area (127 patients), 50% had a definitive diagnosis of TMD, 18% had headache disorder, 12% neuropathic, 7% muscular, 5.5% TMD and headache 4% odontogenic, 2% neuropathic and headache, and 1.5% TMD and muscular (Figure 3.5). Of the patients diagnosed with TMD, 94% had pain in the TMJ area.

![Bar graph illustrating the number of diagnoses related to the patient’s location of pain of the jaw joint diagnostic zone.](image)

Figure 3.5. Bar graph illustrating the number of diagnoses related to the patient’s location of pain of the jaw joint diagnostic zone.

Of the group of patients who located their pain arising from the frontal head diagnostic zone, 67% had headache, 16.5% had TMD and 16.5% had TMD and headache (Figure 3.6). The majority of the patients who had pain in the frontal head area had a diagnosis of headache.
Of the group of patients who had dental pain, 47% were diagnosed as neuropathic pain, 35% had headache, 18% TMD (Figure 3.7).

Figure 3.6. Bar graph illustrating the diagnoses related to the patient’s location of pain of the frontal head diagnostic zone.

Figure 3.7. Bar graph illustrating the diagnoses related to the patient’s location of pain of the odontogenic diagnostic zone.
The heat map of pain location was projected to the definitive diagnoses and the resultant images are shown in Figure 3.8. This assessed the area of pain as selected by the patient when compared to the definitive diagnosis. In the case of TMD diagnosis, the majority of patients located the pain in the TMJ area (Figure 3.8A). Of the patients diagnosed with TMD, fewer patients selected the frontal head or odontogenic pain as their main source of pain as illustrated in the blue areas of the heat map. Figure 3.8B represents the heat map of the definitive diagnosis of headache. Of the patients who were diagnosed with headache, most of the patients selected the preauricular region and TMJ area depicted by the red zones (Figure 3.8B). The blue area is the least selected area which depicted the forehead and dental origin. Figure 3.8C represents the definitive diagnosis of neuropathic and odontogenic pain. The majority of patients selected the maxillary teeth and maxillary sinus where they felt the most pain, which is evident in the red areas. The blue areas indicated that fewer patients selected the mandibular teeth and labium oris as their region of pain (Figure 3.8C).

Figure 3.8. Heat map of patients’ location pain sites based on the definitive diagnoses.
A: Areas of location of pain with the definitive diagnosis of TMD.
B: Areas of location of pain with the definitive diagnosis of headache.
C: Areas of location of pain with the definitive diagnosis of neuropathic and odontogenic pain.
3.8 Symptoms compared to the definitive diagnoses

A total of 68 patients had a definitive diagnosis of TMD (Table 3.6). Of these patients diagnosed with TMD, 35 had headache symptoms and which included pain around the head and temporal area. However, these patients were diagnosed with TMD and did not have a diagnosis of headache.

<table>
<thead>
<tr>
<th>Headache symptoms</th>
<th>TMD Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>33</td>
</tr>
<tr>
<td>Yes</td>
<td>35</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>68</strong></td>
</tr>
</tbody>
</table>

Table 3.6. Number of patients with a definitive diagnosis of TMD compared to those who had symptoms of headache.

A total of 33 patients were diagnosed with headache disorders (Table 3.7). Of these patients, 21 patients (63.3%) presented with symptoms associated with the TMJ and thought their pain originated from the TMJ. These patients had a definitive diagnosis of headaches and did not have a diagnosis of TMD.

<table>
<thead>
<tr>
<th>TMD symptoms</th>
<th>Headache Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>12</td>
</tr>
<tr>
<td>Yes</td>
<td>21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>

Table 3.7. Number of patients with a definitive diagnosis of headache compared to those who had symptoms of TMD.
3.9 Specific Diagnosis of TMD

The details of the participants specific diagnoses with TMD were tabulated in Table 3.8. In total, 23 participants had TMD with disc displacement without reduction, 15 with osteoarthritis, 12 participants had disc displacement with reduction and 8 presented with chronic capsulitis.

<table>
<thead>
<tr>
<th>Specific Diagnosis of TMD</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc displacement without reduction</td>
<td>23</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>15</td>
</tr>
<tr>
<td>Disc displacement with reduction</td>
<td>12</td>
</tr>
<tr>
<td>Chronic capsulitis</td>
<td>12</td>
</tr>
<tr>
<td>Hypermobility</td>
<td>4</td>
</tr>
<tr>
<td>Subluxation</td>
<td>1</td>
</tr>
<tr>
<td>Chronic capsulitis and myofascial pain</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>68</strong></td>
</tr>
</tbody>
</table>

Table 3.8. Specific diagnostic details of TMD per number of patients.
3.10 Specific Diagnosis of Headache

The specific details of the diagnoses of participants diagnosed with headache were tabulated in Table 3.9. Of the participants diagnosed with headache disorders, 18 participants had chronic daily headache and 10 participants had migraine.

<table>
<thead>
<tr>
<th>Specific Diagnosis of Headache</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic daily headache</td>
<td>18</td>
</tr>
<tr>
<td>Migraine</td>
<td>10</td>
</tr>
<tr>
<td>Chronic daily headache and intra oral sensory disorder (burning mouth syndrome)</td>
<td>2</td>
</tr>
<tr>
<td>Migraine and myofascial pain</td>
<td>2</td>
</tr>
<tr>
<td>Chronic daily headache and cervicogenic pain (muscular)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>

Table 3.9. Specific diagnostic details of headache per number of patients.
3.11 TMD Diagnosis

Among the patients diagnosed with TMD, 47 patients (69.1%) presented with episodic pain and 21 patients (30.9%) experienced persistent pain. Pain on mandibular movement were present in 67 patients (98.5%), along with 82.4% experiencing jaw joint noise and 61.8% had restricted mouth opening. In total, 51.5% of the patients diagnosed with TMD also experienced headache symptoms.

A Pearson Chi-Square and Fisher’s Exact Test showed that if the patients had a diagnosis of TMD, they were more likely to report TMD symptoms which was statistically significant (P< 0.001). There was a relationship between TMD symptoms and the diagnosis of TMD. The odds ratio with a 95% confidence interval showed that those patients with TMD symptoms were 2.2 times more likely to have a diagnosis of TMD, with statistical significance using a Pearson Chi Square test (P< 0.001).

A chi-square test indicated that patients diagnosed with TMD were more likely to experience pain on mandibular movement (P< 0.001). The odds ratio showed that with mandibular movement pain, the patient was 47 times more likely to have a diagnosis of TMD, which was statistically significant (P< 0.001). The patients who experienced jaw joint noise were 4 times more likely to be diagnosed with TMD. Patients with restricted mouth opening were 11 times more likely to have a diagnosis of TMD. The patients with headache symptoms were less likely to experience a diagnosis of TMD with an odds ratio value of 0.3.
3.12 Headache Diagnosis

For those patients diagnosed with headache disorders, 20 patients (60.6%) presented with episodic pain and 13 patients (39.4%) experienced persistent pain. In these headache patients, TMD symptoms presented in 63.3% of the cases, with 42.4% experiencing pain on mandibular movement, 42.2% had jaw joint noise and 6.1% had restricted mouth opening. Of the patients experiencing headache symptoms, 90.9% had a definitive diagnosis of headaches compared to those patients with no symptoms of headache. If the patient was experiencing TMD symptoms (pain on mandibular movement, jaw joint sounds and restricted mouth opening) they were less likely to have a final diagnosis of headache. Patients with headache symptoms were seven times more likely to have a diagnosis of headache, with statistical significance using a Pearson Chi Square test (P< 0.001).
CHAPTER 4
Discussion

This study assessed patients who presented to a Specialist Orofacial Pain Clinic. Due to the complex nature and overlapping anatomical structures, TMD and headaches are difficult to differentiate and challenging to diagnose. As a result, it makes the diagnostic process and treatment planning central to appropriate patient management. Guidelines have been developed which illustrates the depth and complex nature of these disorders, and have organised aspects of diagnostic workflow and treatment planning to a simplified universal criteria for clinicians and researchers to follow (Dubner et al., 2016). However, even with these guidelines, differentiating between TMD and headache disorders still remains difficult.

4.1 Study design
The present study was designed as a descriptive study consisting of a sample of convenience utilising a self-administered questionnaire developed and disseminated to the participants by the Primary Investigator to provide the study with patient related observations. The questionnaire was designed for comparison with the definitive diagnosis achieved by a single calibrated Orofacial Pain Specialist. All new patients attending the Orofacial pain clinic were invited to participate in the study.

4.2 The Questionnaire
The questionnaire was designed to be completed by the patient prior to examination. This was to determine if the patient’s symptoms, history and own observations
matched the clinical diagnosis and to observe if any screening questions could distinguish TMD or headache disorders or if there was an overlap between the two entities. This was important for clinical practice, as it is necessary to apply clinical diagnostic guidelines that can effectively identify patients with conditions that may require non-dentally related treatment (Lövgren et al., 2016).

The questionnaire was designed on a digital platform called Qualtrics XM Platform™ (Qualtrics 2020, Utah, USA). Qualtrics allowed the design of the questionnaire to be systematic and simplify the recording of responses. The software allowed to input “logic responses” for example, if a patient did not have a headache disorder it would not display the rest of the leading headache questions. The software automatically collected, retained and recorded the number of responses digitally. This eliminated the risk of recording incorrect data or loss due to human error. Data were stored on Qualtrics, which meant it was digitally backed up without the risk of losing files due to storage or mechanical error. The questionnaire was accessed on an Apple iPad Pro. The benefits of utilising the iPad Pro made it easy to access the digital link to the designed questionnaire. It was clear for patients to read and click on the answers that best described their pain. The illustrations engaged patient interaction and the iPad made it possible to achieve clear responses using just a screen tap. The iPad was an 11-inch size which made it easy to transport and for improved patient handling.

There are separate guidelines for TMD and headache disorders, namely the DC/TMD and the ICHD III. In this study, combining the important aspects of these guidelines made it efficient for the researcher to assess if a relationship existed between patient
reported symptoms and the definitive diagnosis. All questions were adapted and based from the guidelines of the DC/TMD and the ICHDIII (Potter et al., 2019; Schiffman et al., 2014).

4.3 Clinical Examination
In this study, a single specialist examined the patients after completion of the questionnaire to determine the definitive diagnosis. This examiner was DC/TMD trained and calibrated. The examiner had speciality training in Orofacial Pain and Headache Disorders. Having one examiner eliminated inter-examiner variability.

For TMD examination, the DC/TMD was utilised as the validated screening protocol. This study adopted the DC/TMD as it represented evidence-based protocols and was appropriate for use in both clinical and research settings (Leskinen et al., 2017; Schiffman et al., 2014). This tool provided a simple, reliable and validated template for history taking and examination. It is currently the most widely used criteria for TMD management for both clinical and research protocols (Leskinen et al., 2017). Other screening protocols exist, such as 3Q/TMD, which was introduced in 2010 (Lövgren et al., 2016). The aim of those screening questions was to recognise patients with severe TMD attending routine dental appointments. Two questions focused on pain frequency in the TMJ area and one focused on locking or catching of the TMJ during movement (Lövgren et al., 2016). The limitation of using the 3Q/TMD is in the broad range of the questions, leading to the potential of positive answers in patients who were not affected by TMD but had odontogenic pain (Lövgren et al., 2016). The
DC/TMD is a more refined screening test that is able to identify all true positives and negatives (Schiffman et al., 2014).

The headache examination followed the ICHDIII guidelines developed by the International Headache Society. The diagnostic guidelines follow a precise method, making practical and research protocols simple and validated. The international guideline for headache disorders is widely available. However, they are complex and designed for specialist clinicians who are familiar with the intricate details of diagnoses (Potter et al., 2019).

4.4 Population of the Study
This study included a total of 150 participants attending the Orofacial Pain Clinic for management and treatment of orofacial pain. The study aimed at collecting as many participants as possible within a set time frame. The majority of the patients attending the Orofacial Pain Clinic were females (76.7%). A previous retrospective study reported that pain in the joint region in the resting position and in the masseter muscle was significantly greater in females than males (Bagis et al., 2012). The authors concluded that the biological, anatomical, or hormonal factors in females could be related and that females had TMD signs and symptoms more frequently than males in the study population (Bagis et al., 2012). Evaluating this relationship and predisposing factors, the role of female hormones have become the subject of many studies (Bagis et al., 2012; Jedynak et al., 2021). TMJ symptoms such as clicking have been shown to be four times more frequent in females than males in patients who
have been referred (Bagis et al., 2012). As this study was undertaken in a limited population group of patients that were referred to a specific specialist clinic and completed as a sample of convenience, it may have limitations when being generalised to the population as a whole.

4.5 Frequency of the Definitive Diagnosis

The most common diagnosis amongst the participants was TMD with 68 diagnoses (45.4%) belonging to this group. The diagnoses of TMD for this patient group is related to jaw-linked problems. This is in general agreement with a previous study in which the authors assessed and diagnosed patients presenting in an Orofacial Pain Clinic population (Kang et al., 2009). Since this was an Orofacial Pain Clinic, the majority of patients that attended this clinic had pain in the TMJ area. Headache disorders were the second highest disorder to be diagnosed in 33 patients (22%) since it can very easily be confused with TMD as a result of overlapping symptoms. This group of patients ideally should have been referred to a Headache clinic. Hence, 22% of the total number of patients in this study had an incorrect referral. As these patients have been incorrectly diagnosed, meant that they now had to be redirected to the Headache Clinic instead wasting patients time and resources. A total of 3.3% of patients had pain of odontogenic origin which was not diagnosed by the referring dentist and referred to the Orofacial pain specialist perceiving it as TMD. These findings are consistent with those reported in a previous study (Reik, 1985). According to that retrospective study assessing prior and unnecessary dental treatment in TMD patients, the authors concluded that inappropriate referral by clinicians and incorrect
diagnosis by dentists led to unnecessary dental treatment in 20% of patients with an actual diagnosis of TMD (Reik, 1985). In addition, this retrospective study assessed headache and atypical facial pain patients and also found that 20% of these patients had been inappropriately dentally treated (Reik, 1985).

4.6 Patient Perceived Pain

Patient perceived pain was assessed by asking the patient what they believed their pain was. For patients diagnosed with TMD, the majority perceived their pain to be TMJ related and were correct in identifying their area of pain (80.9%). Of those patients diagnosed with TMD, 13% of patients perceived their pain as odontogenic. This could be explained by the neural innervation and closely related anatomical structures (De Rossi, 2013). Sensory and motor branches of the trigeminal nerve namely, mandibular, maxillary and ophthalmic nerves supplying the teeth as well as surrounding muscles and skin may account for the inability of patients to locate source of pain accurately. Also, similarities in signs and symptoms makes it harder for patients to differentiate origins of pain. Four of these patients perceived TMD as a headache disorder. This was in agreement with a previous study which suggested that headache occurred significantly more frequently in subjects with symptoms of TMD than in those without (Ciancaglini and Radaelli, 2001).

In patients diagnosed with headache disorders, 54.4% of these patients perceived their pain originated from the jaw joint and 39.4% of these headache patients believed their pain was of odontogenic origin. Patients who were correct in identifying
their pain as headache were only 3% of participants. The lower frequency in the accuracy of the identification of pain is possibly due to the fact that headaches are more difficult for patients to interpret because the pain is more diffuse as a result of the proximity of the overlying structures that may confuse the patients (Kang et al., 2009). Perception of facial pain appears to vary greatly from person to person (Russo et al., 2018). Identifying perception of pain is important as this may have an influence on the patient’s motivation for treatment. A previous review summarised the clinical and neuroimaging changes during migraine cycles and assessed patient pain thresholds and pain perceptions. The authors found that patient pain perceptions and pain thresholds were related to the severity of the disorder and drug intake level (Russo et al., 2018). This study was in agreement with very few studies on patient perception of pain as related to the diagnoses (Russo et al., 2018).

The paucity of published literature on this topic makes the comparison difficult. A fundamental aspect of this study assessed the relationship between patient perceived pain and the definitive diagnosis. It is difficult to differentiate between orofacial pains, however, patients have cited similar signs and symptoms. This study has shown that the majority felt pain in the TMJ and were correct in identifying their area of pain. For the operator, evaluating the source of pain can be difficult to locate, as the pain may occur within the joint or may be outside the joint area. In this study, patients were less accurate in differentiating their headache pain as well as their odontogenic pain. A possible explanation for this is central sensitisation characterized by chronic nonneuropathic and non-nociceptive pain and the degree of sensitisation may blur these symptoms (Monaco et al., 2017). This makes it difficult for the operator and can
often be misled by patient’s inability to accurately indicate the origin of pain. When assessing the patient’s perceived pain, a comprehensive screening of the patient's symptoms should be undertaken of the masticatory system and entire cranial area. Due to the lack of consistency in referrals presented at the clinic, assessing the association between patient perceived pain and the diagnoses could make strategies easier for the referring clinician. This study has shown that patient perception of TMD pain has proven beneficial to the definitive diagnoses as 80.9% of patients had perceived they had pain in the jaw joint area were correct and had a definitive diagnosis of TMD. It is thus essential to record the area in which the patient reports the pain, however clinicians need to be cognisant that this is based on patient perception and understanding that this may not truly reflect the area of which the pathology is present (Gremillion, 2002).

Clinically, due to the diversity of pain symptoms, it is challenging to distinguish between orofacial pain disorders and as a result either misdiagnosis, treatment delays or ineffective management can occur (Shrivastava et al., 2021). It becomes difficult for the patient when the pain is persistent and without clear cause (Shrivastava et al., 2021). Orofacial pain has been shown to be a contributing factor to psychosocial aspects such as stress and anxiety. In an attempt to manage pain, treatment delays or unnecessary treatment can occur thus affecting the patient’s psychosocial behaviour (Madland and Feinmann, 2001). Patients should feel that clinicians believe in their pain and that the patient’s perception of the pain is acknowledged. It is crucial that clinicians and patients reach an agreement about how to understand and manage the pain. This study shows an association between patients perceived pain and the
diagnoses. The importance of this association may help clinicians reduce the time taken to manage and treat the condition. Clinicians should be aware of the importance of patient pain perception as it has been demonstrated in this study that recognition of pain perception will provide the clinician with beneficial information from which to diagnose and manage patients (Zakrzewska, 2013).

4.7 Self-Reported Stress Levels of Patients

Psychological factors play a role in pain perception (Vlaeyen and Linton, 2000). In the current study, of the total 150 patients, 69.3% of participants reported moderate stress levels. Of the remaining participants, 41 (27.3%) reported high stress levels and 5 (3.3%) reported mild levels of stress. The findings from a previous population-based study found that there was a relationship between psychological distress and pain (Hotopf et al., 1998). The authors from that study concluded that there is a relationship between psychiatric disorders and physical symptoms (Hotopf et al., 1998).

Psychiatric disorders such as depression, anxiety and distress were common among patients with chronic TMD pain, as 50% of participants had mood disorders and 35% of participants had anxiety (Kight et al., 1999). In another previous study, it was demonstrated that there was a strong association between psychological factors in patients suffering from TMD, with anxiety present in 75% of the participants diagnosed with TMD (Resende et al., 2020). A previous study showed 82.5% of participants diagnosed with TMD had an impeded quality of life (Wan et al., 2012).
The authors from that study suggested that Orofacial Pain had a negative impact on daily life activities, demonstrating that high levels of stress can affect the quality of life (Wan et al., 2012). The current study was in agreement with the above listed studies. The Orofacial Pain Prospective Evaluation and Risk Assessment (OPPERA) illustrated that the prevalence of psychosocial aspects was higher in patients suffering from TMD compared to healthy individuals (Slade et al., 2016). The authors found the magnitude of pain was two-to-three fold higher in patients with stress (Fillingim et al., 2013; Slade et al., 2016).

4.8 Type of Pain as Reported by the Patient

Clinically, it is beneficial to divide pain into continuous or episodic pain as to aid in the diagnostic workflow. Episodic pain is defined as a transitory exacerbation of pain, whereas persistent pain is pain that is continuous despite medication or treatment. In this study, the questionnaire described the type of pain as persistent or spontaneous pain, in which the patients had to select which depicted their pain. In total, 90 participants (60%) reported their pain to be episodic and 60 patients (40%) reported persistent pain. Of this, patients diagnosed with TMD reported the highest incidence of episodic pain, followed by headache and neuropathic pain. Patients with muscular pain reported more persistent type of pain. Assessing patients reported pain aids in better understanding the type of pain and is therefore a significant factor in the diagnostic workflow to determine a definitive diagnosis. As previously shown in the literature, stating the description of pain can aid in the management of the patient.
as neuropathic pain, TMD and migraine are usually episodic in nature (Zakrzewska, 2013). This study is agreement with the scarce literature on this topic.

4.9 Prevalence of Pain based on Demographics

The current study found that females presented more frequently for all conditions diagnosed. A previous epidemiological study has shown a greater frequency and severity of TMD in females than in males (Roda et al., 2007). TMD has been demonstrated to affect mostly women with the potential effect of oestrogen has on TMD and headache disorders (Alexiou et al., 2009). The gender and age distribution of TMD in a previous study suggested a possible link between its pathogenesis and the female hormonal pattern with TMD being 1.5-2 times more prevalent in women (Warren and Fried, 2001). Changing hormone levels included fluctuating levels of oestrogen, which affected pain sensitivity (Fillingim et al., 2009). Reproductive hormones effects the central and peripheral nervous system, which influence the gender differences seen in pain (Fillingim et al., 2009). As noted in a previous study, prepubertal females and males have an equal prevalence of migraine, however the lifetime prevalence after puberty increases to 18% for women and 6% for men, suggesting a hormonal association between females and headache disorders (Lipton et al., 2001). Another study demonstrated that females tended to exhibit more signs and symptoms of TMD and required treatment more frequently compared to males, again linking fluctuating levels of female hormones (Shaefer et al., 2013). In a systematic review, studying the epidemiology of TMD, it was demonstrated that TMD was the most common orofacial pain condition with a two-to four-fold higher
prevalence of TMD in women (Ryan et al., 2019). Assessing demographics of headaches in females, a previous study showed that the 1-year incidence rates of migraine ranged from 3% to 33% for women (Fillingim et al., 2009). Females also demonstrated greater incidence of neuropathic pain of 6% compared with 3% in males (Fillingim et al., 2009). This study demonstrated that females peaked in all diagnoses, which was in agreement with previous literature.

The severity of symptoms and diagnosis was also related to the age of the patients. A previous cross-sectional study demonstrated that the overall prevalence of TMD was significantly higher in the 20-40 year age group compared to other age groups (Manfredini et al., 2010). The results from that cross-sectional study evaluated a population of patients seeking TMD treatment. The authors reported that of the 243 patients investigated, younger patients were more likely to have disc displacements (27.7% of the patients) and older patients (32.1% of the patients) more frequently presented with degenerative joint disorders such as osteoarthritis (Manfredini et al., 2010). In this study, TMD peaked at 18-29 years old and second highest incidence was in the 30-39 age group. This is consistent with the literature, showing that TMD was more common in young females, with the potential influencing role of fluctuating oestrogen levels and growth during this age group (Jedynak et al., 2021). In the current study, there were slight age groups peaks for TMD with a slightly higher prevalence in the youngest age group, which is consistent with the literature (Manfredini et al., 2010; Ryan et al., 2019). In addition to the biological factors, the gender differences may be due to a number of psychologic and social factors (Dao and LeResche, 2000). However, as this study was undertaken in a limited population
group of patients that were referred to a specific specialist clinic and completed as a sample of convenience, it may have limitations when being generalised to the population as a whole.

In an epidemiological review assessing the global prevalence of headache, it has been shown that females had a higher incidence between the ages of 20 and 64 years of age (Stovner et al., 2007). The findings of the current study demonstrated that headache peaked in the age 50+ group, however this was only slightly higher than the other age brackets. Headache and migraine are more likely to be diagnosed in the younger age groups (Antonaci et al. 2014). Due to the limited population size, the majority of headache patients was weighted toward the 50+ age group. Neuropathic pain occurs in approximately 1 in every 10 adults over age 30 years of age (Yawn et al., 2009). In the current study, neuropathic pain was markedly higher in the 50+ age bracket. These results were in agreement with previous literature on neuralgia (Stovner et al., 2007). However, as this study was undertaken in a limited population group of patients with a low sample size, it may have limitations when being extrapolated to the population as a whole.

4.10 Location of Pain as Indicated by the Patient

The location of the pain as indicated by the patients on the image provided in the questionnaire, showed that pain arising in the TMJ area was the most frequently selected area of pain. The TMJ area in the given diagram included the zygomatic arch and the attachment of the masseteric muscle. The TMJ area was located as the main
source of pain in 127 of the 150 participants (85%) as illustrated by the red zones on the heatmap. In decreasing frequency, 11% of patients selected the dental zone to be their main source of pain and 4% of the patients identified the frontal head zone.

The first part of this section discusses patient location of pain in relation to the diagnostic zones. A total of 127 patients identified the TMJ diagnostic zone. Of these patients, 50% had a definitive diagnosis of TMD, 18% had headache disorder, 12% neuropathic, 7% muscular, 5.5% TMD and headache, 4% odontogenic, 2% neuropathic and headache, and 1.5% TMD and muscular. In the current study, half the patients attending the Orofacial Pain Clinic were accurate and located their pain to be in the TMJ area having a definitive diagnosis of TMD. In addition, this study demonstrated that patients who located pain in the jaw joint area may have also had a diagnosis of headache. The use of a facial diagram, as done in this study, simplified the diagnostic workflow making it easier for patients to more accurately identify the location of pain.

Of the patients who had located their pain to be in the frontal head area, 67% had headache, 16.5% had TMD and 16.5% had TMD and headache. The majority of the patients who had pain in the frontal head area had a diagnosis of headache. In addition, a number of patients located pain in the frontal head area had diagnosis of TMD or a combination of both headache and TMD. Therefore, this study emphasises the co-existing symptoms of pain location between TMD and headache.
Of the patients who had located their pain to be of dental origin, 47% was neuropathic pain, 35% had headache, 18% TMD. The majority of patients who had dental pain were diagnosed with neuropathic pain. Fewer patients had incorrectly distinguished between dental and facial pain, thus inferring that those patients who have been diagnosed with headache and TMD located their pain in other areas that may mimic dental pain.

The second part of this section determined the relationship between the definitive diagnosis and the location of pain. Of the patients diagnosed with TMD, 94% had located their pain symptoms in the TMJ area. Of the patients who had a diagnosis of headache disorders, 12% of patients located the pain arising from the frontal head area as the main source of pain being related to the definitive diagnosis of headache disorder.

In the current study, 11% of patients located their pain to be dentally related (odontogenic origin) whereas the actual diagnosis of odontogenic pain was present in just 3.3% of the patients. This was possibly due to the closeness of facial structures and innervation leading to misinterpretation of symptoms by the patients. Another possible explanation for these results could be due to referred pain. It has been demonstrated that patients can experience toothache for non-dental origin of pain due to neuropeptide release from trigeminal nerve endings (Fukuda, 2016). Migraines and cluster headache pain can be referred to the teeth. Migraines causes episodic, pulsating pain and often occur in the maxillary and mandibular premolars, as well as in the maxillary canines (Fukuda, 2016).
This study showed an association between the location of pain as indicated by the patient and the definitive diagnosis, however the paucity of published literature on this topic makes comparison with other studies difficult.

4.11 Symptoms Compared to the Definitive Diagnoses

Pain on mandibular movement, jaw joint noises and restricted mouth opening were common patient reported symptoms. The results of this study showed that there was a statistically significant relationship between TMD symptoms and the diagnosis of TMD. The odds ratio showed that those patients with TMD symptoms were 2.2 times more likely to have a diagnosis of TMD. Pain on mandibular movement was shown to be 47 times more likely to have a diagnosis of TMD and restricted mouth opening was 11 times more likely to have a diagnosis of TMD.

Disc displacement was the most common presentation of TMD related clicking. A non-reducing disc is where the disc is permanently displaced and occasionally deformed as it results in permanent lock of the mandible causing a reduced range of movement (Dimitroulis, 2011). The results of this study demonstrated that TMD symptoms were related to the diagnosis of TMD, meaning patients with TMD symptoms were more likely to have a definitive diagnosis of TMD. The pain related questions given to the patient included pain on mandibular movement (such as eating or yawning) and jaw joint sounds. Symptoms of TMD related to a TMD diagnosis were noted in previous literature and is in accordance with this study (Liu and Steinkeler, 2013; Wiese et al., 2008). The authors found that jaw joint noises such as coarse crepitus and restricted
mouth opening were associated with TMD (Wiese et al., 2008). However, taking the results of the current study into consideration, the clinical diagnosis should not be based on a single sign or symptom.

For patients that were diagnosed with a headache disorder, 90.9% of patients experienced headache symptoms. If the patient had TMD symptoms (pain on mandibular movement, jaw joint sounds and restricted mouth opening), they were less likely to have a final diagnosis of headache with an odds ratio of 0.3. Patients with headache symptoms were seven times more likely to have a diagnosis of headache than patients with TMD symptoms. A thorough history taking of pain related questions need to be evaluated, as the results of this study demonstrated that patients with TMD symptoms were unlikely to have a headache disorder while patients that came in with headache symptoms were more likely to have a definitive headache diagnosis. The literature assessing TMD symptoms in relation to headache diagnosis however, is limited.

An added challenge for clinicians is to distinguish between TMD, primary and secondary headache disorders. TMD and headache disorders seem to be two separate disorders, however it remains unclear if headache attributed to TMD is an existing primary headache (Sharma et al., 2022). Headache attributed to TMD share a majority of features with primary headaches. In a previous community-based cross-sectional study assessing the frequency of headache attributed to TMD and headache that was comorbid with TMD, the authors found a large degree of overlap (Sharma et al., 2022). According to the authors, nearly all patients with painful TMD had
headache, while 44% of the patients with headache had TMD (Sharma et al., 2022). The authors indicated that there was a high number of patients in both the headache comorbid with TMD and headache attributed to TMD groups. They concluded that the more severe the TMD pain characteristics were the more likely that the TMD contributed to a secondary headache (Sharma et al., 2022). The DC/TMD described that headache attributed to TMD should include the temporalis muscle region, however the ICHD-III classification does not restrict this location for secondary headache (Olesen et al., 2018).

It has been previously demonstrated that patients with painful TMD and headache attributed to TMD, compared with patients with TMD only, describe greater pain intensity, pain related disability, depression and are more likely to have persistent pain (Reiter et al., 2021). The comorbidity of the two disorders increases the severity of the features. In this study, patients diagnosed with headache attributed to TMD was 5.3%. However, the comorbidity of the two was not further investigated. This study however showed an association between headache and symptoms of temporomandibular disorder. The results of this study highlighted that the signs and symptoms of headaches and TMD were closely related and can often lead to erroneous referrals. It was shown that some patients attending the Orofacial Pain Clinic for TMD should had been referred to a Headache Clinic instead.

Patient symptoms of pain in the odontogenic area was in 29.3% of all cases with only 3.3% of these patients actually having a dental related diagnosis. The complex innervation of the facial area may account for the misrepresentation of the actual
origin of the pain. The dull episodic spontaneous throbbing pain of irreversible pulpitis, with sensitivity to heat can mirror myofascial pain and migraine (Renton, 2020). Both TMD and headache disorders can refer pain to the second and third division of the trigeminal nerve representing tooth pain (Gil-Martínez et al., 2018), highlighting the need for clinicians to appreciate the likelihood of TMD or headache as a diagnosis rather than initiating unnecessary dental treatment in order to alleviate pain (Renton, 2020; Wright 2000). In order to avoid incorrect referrals and for patients to attend the appropriate clinic, it is recommended that a functional evaluation is also required in subjects with unexplained orofacial pain. By understanding the anatomy of facial structures, the referring clinician can differentiate between the presenting symptoms thereby referring to the appropriate clinic. The data in this study also reinforces the need to assess TMD disorders in patients complaining of headache pain. Patients that are referred correctly with headache or odontogenic pain would have saved time and resources avoiding an unnecessary visit to the Orofacial Pain Clinic.

Recommendations to referring clinicians include a thorough history taking of the patient’s pain and location, paying attention to patient perception, description of the type of pain they are experiencing and aggravating factors that may contribute to the pain. Physical examination of the masticatory system and palpation of the entire facial and neck muscles are required. Range of mandibular opening or deviations in opening should be measured as this is indicative of TMD. Although a small number attending the clinic had a definitive diagnosis of odontogenic origin, a high number of these patients had odontogenic symptoms. A thorough routine dental examination ruling
out any obvious signs of dental pathology is required. Due to the results of this study, the importance of diagnostic aids such as radiographs and sensibility tests are emphasised for routine dental examinations. This study demonstrated that there is a high number of patients presenting to the clinic with non-odontogenic origins of pain. As this is a worldwide challenge, authors have put together diagnostic aids and classifications to facilitate the management process for these patients. The TMD and headache classifications are widely available online for clinicians.

4.12 Specific Diagnosis of TMD

In total, 23 participants had TMD with disc displacement without reduction, 12 participants had disc displacement with reduction. A systematic review and meta-analysis that assessed observational studies of adult patients with TMD had demonstrated the prevalence of disc displacement was higher in disc displacement without reduction than in disc displacement with reduction (Silva et al., 2020). This was in agreement with this referral-based study. A total of 8 participants presented with chronic capsulitis and 15 with osteoarthritis. The prevalence of TMJ osteoarthritis reported in an epidemiologic study was 8–16% in the general population (Toller, 1973). Correct diagnosis is essential to management and clinicians should be able to identify the stages of TMJ degenerative diseases in order to provide suitable treatment (Kalladka et al., 2014).
4.13 Specific Diagnosis of Headache

A total of 33 patients were diagnosed with headache. In this study, chronic daily headache was the highest headache diagnosis, with 18 participants diagnosed with this condition. The prevalence of chronic daily headache in the general population is approximately 4% to 5% (Pascual et al., 2001). Of the participants diagnosed with headache disorders, 10 participants had migraine. Migraine and other headache disorders are among the most prevalent disorders worldwide with an estimated one year prevalence of approximately 15% in the general population (Stovner et al., 2022).

4.14 TMD Diagnosis

Among the patients diagnosed with TMD, 47 patients (69.1%) presented with episodic pain and 21 patients (30.9%) experienced persistent pain. This was in agreement with previous studies showing that TMD pain was typically described as episodic pain which can be aggravated by functional mandibular movement (Ahmad and Schiffman, 2016). Pain on mandibular movement was present in 67 patients (98.5%), along with 82.4% having jaw joint noise and 61.8% experienced restricted mouth opening. In total, 51.5% of the patients diagnosed with TMD also experienced headache symptoms. This was in agreement and has been shown in the literature that TMD, headache, and specific headache syndromes are prevalent in the population and may co-exist in the same patient (Stuginski-Barbosa et al., 2010).

A Pearson Chi-Square and Fisher’s Exact Test in this study showed that if the patients had a diagnosis of TMD, they were more likely to report TMD symptoms which was
statistically significant (P< 0.001). There was a relationship between TMD symptoms and the diagnosis of TMD. Pain around the TMJ and masticatory muscles was the most common symptom of TMD patients and the pain intensity varied from mild tenderness to extreme discomfort (Rammelsberg et al., 2003). The odds ratio with a 95% confidence interval showed that those patients with TMD symptoms were 2.2 times more likely to have a diagnosis of TMD, with statistical significance using a Pearson Chi Square test (P< 0.001).

A chi-square test indicated that patients diagnosed with TMD were more likely to experience pain on mandibular movement (P< 0.001). The results of this study showed that with mandibular movement pain, the patient was 47 times more likely to have a diagnosis of TMD, which was statistically significant (P< 0.001). This was in agreement with previous studies which showed that jaw pain ranged from 5.7% to 12.9% in the general population (Mobilio et al., 2011).

Jaw joint noises is a common TMD symptom. These noises can be self-reported or in some of the cases patients are often unaware of noises that clinicians detect. In this study, the patients who experienced jaw joint noise were four times more likely to be diagnosed with TMD and was in agreement with the literature. Previous studies demonstrated that the prevalence of TMJ clicking is 30.7% in the general population (Iodice et al., 2019; Ohrbach et al., 2011).

Normal mouth opening ranges from 35-55mm (Sarlani et al., 2005). Limited or restricted mouth opening can interfere with mastication, speech and oral hygiene.
procedures. This study demonstrated that patients with restricted mouth opening were 11 times more likely to have a diagnosis of TMD. The patients with headache symptoms were less likely to experience a diagnosis of TMD with an odds ratio value of 0.3. This was in agreement with previous literature showing the specific symptoms of restricted mandibular opening and TMJ clicking were the most common symptoms in patients that suffered from TMD (Stuginski-Barbosa et al., 2010). A cohort study demonstrated that TMJ noises and restricted mouth opening were prominent features in the clinical history of TMD (Ohrbach et al., 2011).

In order to avoid an incorrect diagnosis, it is advisable to also carry out a comprehensive functional evaluation of the masticatory muscles and assess mandibular movements for patients suffering from unexplained facial pain even when there are no obvious signs and symptoms of TMD. The results of this study demonstrated that TMD symptoms were related to the diagnosis of TMD, meaning patients with TMD symptoms were more likely to have a definitive diagnosis of TMD. Due to the closeness of facial structures and innervation, the clinician may misinterpret signs and symptoms leading to an incorrect referral. In this study, a total of 45.3% of patients were diagnosed with TMD, 22% had a diagnosis of headache, with 5.3% presenting with both conditions. The ability to recognise and diagnose TMD or headache will vary from clinician to clinician. These patients are often misdiagnosed resulting in an incorrect referral to the clinic (Renton, 2020). The data in this study also reinforces the need to assess TMD disorders in patients complaining of headache pain.
4.15 Headache Diagnosis

Headache disorders are one of the most common complaints of patients that present in all practices of medicine (Eghwrudjakpor and Essien, 2009). This constitutes a significant public health problem impacting both the individual sufferer and society (Ahmed, 2012). For patients diagnosed with headache in this study, 20 patients (60.6%) presented with episodic pain and 13 patients (39.4%) experienced persistent pain. Migraine was the most common headache diagnosed, and thus these results conform to the typical symptoms of migraine which were described as being episodic (Zakrzewska, 2013). In these headache patients, TMD symptoms were present in 63.3% of the cases, with 42.4% experiencing pain on mandibular movement, 42.2% had jaw joint noise and 6.1% had restricted mouth opening. In this study, TMD symptoms presented in participants diagnosed with headache, which emphasised the overlap in structures. Headache and facial pain are often manifestations of TMD and can be aggravated by mastication or other functional activities (Stuginski-Barbosa et al., 2010).

In a prospective study, signs of TMD dysfunction were common and more frequent in individuals with episodic migraine (Stuginski-Barbosa et al., 2010). There was a high prevalence of at least one TMD sign which suggested that the TMJ should be assessed during examinations (Stuginski-Barbosa et al., 2010). In addition, the authors suggested that headache patients may benefit from TMJ examination, specifically those who did not respond to headache treatment (Stuginski-Barbosa et al., 2010). Patients experiencing headache symptoms with definitive diagnoses of headaches were 90.9% of the population examined. Patients with headache symptoms were
seven times more likely to have a diagnosis of headache and should first be referred to a headache clinic. Headache patients which were referred correctly with headache, would have saved time and resources, avoiding an unnecessary visit to the Orofacial Pain Clinic.

4.16 Limitations

One of the limitations of this study included the fact that Covid-19 restrictions meant that the project focused on one Orofacial Pain clinic instead of two clinics that were originally intended to be part of the study, the latter being a Headache Clinic. Further studies will be required to examine patients with Orofacial Pain attending a Headache Clinic and comparing the findings from the Orofacial Pain Clinic, as there may be a correlation between patients attending the Headache Clinic and referral inaccuracies. It would also be beneficial to study other clinics, for an accurate indication of the relationship between TMD and headache disorders in another Irish population based group. Covid-19 impacted the time for data collection, waiting for the acceptable time to visit the clinic after the regulations were lifted, shortened the amount of time planned for data collection.

Secondly, the project was based in an Orofacial Pain Clinic which was a private practice in an affluent area. Patients are able to articulate their signs and symptoms, recognising their exact location of pain. The results of this study demonstrated that patients were more accurate in describing their TMD symptoms compared to the associated definitive diagnosis of TMD. Further studies will be required to compare
hospital based Orofacial Pain Clinics versus private clinics to assess if the results differ depending on area or cost of treatment.

This study was a sample of convenience of 150 participants experiencing pain. A limitation of this study will be the small sample size. Increasing the sample size may highlight a greater referral accuracy or inaccuracy.

4.17 Conclusions

This descriptive cross-sectional study consisted of a sample of convenience which investigated patients referred to an Orofacial Pain Clinic primarily for TMD management. In addition, this study determined whether the definitive diagnosis corresponded to patient’s signs and symptoms of TMD and /or headache disorders.

The most common diagnosis amongst the participants was TMD with 68 diagnoses (45.4%) belonging to this group. Headache disorders were diagnosed in 33 patients (22%), neuropathic pain was diagnosed in 23 patients (15.3%), muscular pain in 9 patients (6%) and odontogenic pain in 5 patients (3.3%).

When the diagnoses were analysed based on age groups, it was found that TMD peaked at 18-29 years old and second highest was in the 30-39 age group. There were minor age groups peaks for TMD with a slightly higher prevalence in the youngest age group. Headache disorders peaked in the age 50+ group, however this was only slightly higher than the other age groups for headache. The findings of this study
showed neuropathic pain were higher in the 50+ years of age group. The majority of patients referred to the Orofacial Pain Clinic were female.

The location of the pain as indicated by the patients on a diagram showed that pain arising in the TMJ area was the most frequently selected area of pain. The TMJ area was located as the main source with 127 of the 150 participants (84.6%). Of the patients that indicated pain in the TMJ area, 50% of the patients were accurate in locating the pain as they had a definitive diagnosis of TMD. Of the patients diagnosed with TMD, 94% had pain in the TMJ area. This study demonstrated that the majority of patients that have located pain in the TMJ was related to the diagnosis of TMD. A total of 11% identified their pain to be of odontogenic origin but the actual diagnosis of odontogenic pain was present in only in 3.3% of the patients. Of the patients that located pain in the frontal head zone, the majority of patients were accurate in locating the frontal head as the area of pain relative to the definitive diagnosis of headache.

Pain on mandibular movement, jaw joint noises and restricted mouth opening were common patient reported symptoms. The results of this study showed that there was a statistically significant relationship between TMD symptoms and the diagnosis of TMD.

The relationship between the patients perceived origin of pain and the actual diagnosis was further assessed in this study. From a patient perspective, jaw joint pain was the most frequently self-reported pain with 90 of the 150 participants (60%)
perceiving it as the source of their pain. For the patients diagnosed with TMD, the majority (80.9%) perceived their pain arising from the TMJ and were correct in identifying their area of pain. Of those patients diagnosed with TMD, 13.2% of patients perceived their pain as odontogenic and four (5.9%) thought they had headache disorders. In patients diagnosed with headache disorders, 54.4% of these patients perceived their pain originated from the jaw joint and 39.4% of these headache patients believed their pain was of odontogenic origin.

This study highlighted that patients were unable to differentiate between pain of non-odontogenic origin, confusing it with odontogenic pain. In total, 39.4% of the patients believed their pain was of odontogenic origin while 3.3% of these patients had a definitive diagnosis of odontogenic pain. In this study, 22% of the patients seeking treatment in an Orofacial Pain Clinic had a diagnosis of headaches and perceived their pain to be TMD or odontogenic indicating that nearly one quarter of patients attending the clinic were incorrectly referred to the clinic.

In conclusion, the results of this study demonstrated:

- The majority of patients referred to the Orofacial Pain Clinic were female. The majority of patients were in the 50+ age groups.
- The most common diagnosis amongst the patients attending the clinic was TMD.
- In patients attending the Orofacial Pain Clinic, TMD patients were accurate in locating and identifying the area of pain relative to the definitive diagnosis.
• In patients attending the Orofacial Pain Clinic, patients diagnosed with headache disorders were poor in their ability to differentiate between headache, TMD and pain of odontogenic origin.

• This study proposed the use of a facial diagram for the patient to more accurately illustrate their location of pain, thereby assisting the referring clinician in making a more accurate distinction between the various types of Orofacial pain.
References


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from headache that is comorbid with temporomandibular disorder. *Pain, Publish Ah*, 820–830. doi:10.1097/j.pain.0000000000002770


doi:10.1922/CDH_2578McMillan07


Appendix 1. Ethical Approval Letter

Dear Dr. Tasha Moodley,

Approval Date: 22 April 2021

Submission Number: 29. A Study to Determine the Frequency of Headache Disorders and Temporomandibular Joint Disorders in Patients attending Facial Pain Clinics. Submission Date: 07/03/2021 20:33

Dear Dr. Moodley,

On behalf of the Chair and members of the SB/TUH Joint Research Ethics Committee I wish to inform you that your study has received FULL APPROVAL.

Please update your application per the below comments:

Title
3.2.6 Please provide information on the Study Design
3.2.7 Please provide information on the Rationale for this study
3.18.1 Are all researchers and medical staff covered by the Clinical Indemnity Scheme?
4.1.1.3 Please outline who will be the data controller of the coded study data
4.1.1.4 Who are the processors of the study data?
4.1.1.6 Please outline what data protection training has been undertaken by all researchers listed on the application. Please provide dates of training and the date renewal is due
4.1.1.8 Please select how the data will be

Comment
Process of pseudonymising and then anonymising data (or as applicable) to be aligned with Section 3.2.3. Align use of the term ‘gatekeeper’ with Section 3.2.3.
Please confirm the indemnity in place, and that the Clinical Indemnity Scheme will apply.
As the researcher is an employee of a medical facility, the medical facility will be the Data Controller.
Data Processors are parties who are external to the Data Controller, such as subcontractors. The researchers are correctly listed as Data Handlers (in the applicable section).
Dr. Moodley is collecting the data, but other listed researchers will be Data Handlers. Are applicable training details available for the other researchers? Note that date of GDPR training not provided.
Please confirm the method of pseudonymisation.

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Appendix 2. Consent Form

A study to Determine the Frequency of Headache Disorders in patients with Temporomandibular Joint Disorders.

To be completed by the PARTICIPANT:

<table>
<thead>
<tr>
<th>Statement</th>
<th>YES</th>
<th>NO</th>
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<tbody>
<tr>
<td>I have read and understood the information leaflet.</td>
<td></td>
<td></td>
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<tr>
<td>I have had the opportunity to discuss the study, ask questions about the study and I have received satisfactory answers to all my questions.</td>
<td></td>
<td></td>
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<tr>
<td>I have received enough information about this study.</td>
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<tr>
<td>I understand that I am free to withdraw from the study at any time without giving a reason and this will not affect my future medical care.</td>
<td></td>
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<tr>
<td>I agree to allow the researchers use my information (personal data) as part of this study as outlined in the information leaflet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I agree to allow the researchers access my medical records as part of this study.</td>
<td></td>
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<tr>
<td>I agree to be contacted by researchers as part of this study.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I consent to take part in this research study having been fully informed of the risks, benefits and purpose of the study.</td>
<td></td>
<td></td>
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<tr>
<td>I give my explicit consent to have my data processed as part of this research study.</td>
<td></td>
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</tbody>
</table>

Participant’s Name (Block Capitals):  
Participant’s Signature:  
Date:

To be completed by the RESEARCHER:

<table>
<thead>
<tr>
<th>Statement</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have fully explained the purpose and nature (including benefits and risks) of this study to the participant in a way that he/she could understand. I have invited him/her to ask questions on any aspect of the study.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I confirm that I have given a copy of the information leaflet and consent form to the participant.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Researcher’s Name (Block Capitals):  
Researcher’s Title & Qualifications:  
Researcher’s Signature:  
Date:
Appendix 3. Patient Information Leaflet

A Study to Determine the Frequency of Headache Disorders and Temporomandibular Joint Disorders in Patients attending Facial Pain Clinics.

Patient Information Leaflet

Introduction
My name is Dr. Tashia Moodley and I am a Postgraduate researcher at Dublin Dental University Hospital and Trinity College. I am conducting a research project to identify the correlation between Temporomandibular Joint Disorders (TMD) and Headache Disorders in patients attending either an Orofacial Pain or a Headache specialist clinic.

I would like to invite you to participate in this postgraduate research project as you are attending one of these clinics as a patient. You are being asked to participate as you present with Orofacial Pain.

You should only participate if you wish to; choosing not to take part will not alter your care in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being undertaken and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask us if there is anything that is not clear or if you would like more information.

Background
Pain is a common presentation in dental and medical practice and usually its diagnosis and treatment is normally straightforward. However, patients with non-dental causes of orofacial pain will also present which may be more challenging to diagnose. The first step in managing a patient with orofacial pain is to diagnose the nature of the pain prior to initiating any treatment.

Temporomandibular Disorders (TMDs) describes a number of painful and non-painful disorders affecting the muscles of mastication (facial muscles), the Temporomandibular Joint (TMJ) and adjacent structures. Patients presenting with TMD often suffer from headaches. TMD and headache present with similar overlapping signs and symptoms making the diagnostic process and planning of treatment challenging. As a consequence, many patients with orofacial pain frequently report that they have seen multiple clinicians before a definitive diagnosis of either TMD or headache is made.
Study Details
The study will take part in two clinics: The Orofacial Pain (OFP) Clinic and the Hermitage Medical Clinic. All new patients seeking management of their TMD or Headache will be asked to recruit in this study.

A standardised questionnaire will be given to all participants prior to their examination by a specialist, as a diagnostic tool to aid in the diagnosis of their facial pain. Clinical examinations will be completed in both clinics by specialist practitioners. There are no additional tests required for participation in this study beyond normal clinical procedures.

The aim of the study is to look at the relationship between Headache and TMJ pain in Irish patients presenting with facial pain. Little is known about this link in an Irish population and this important study will be the first to describe the links in Ireland.

Eligibility
1. Patients over 18 years of age who are willing for provide informed consent.
2. Patients who are able to attend for recall appointments.
3. Patients seeking management of their TMD.
4. Patients seeking management of their Headache Disorder.

Patient questionnaire
A questionnaire will be incorporated in this study to evaluate subjective symptoms of Orofacial pain.

Risks and Benefits
No increased risk is foreseen as the study involves routine examination and treatment, whether the participants take part in the study or not.

Confidentiality
Your identity will remain confidential. Your name will not be published and will not be disclosed to anyone outside the research study group. All data will be anonymised in any reports presented and no individual will be identified.

Voluntary Participation
It is up to you to decide whether to take part or not. If you decide to volunteer to participate in this study, you may withdraw at any time without giving a reason. If you decide not to participate, or if you withdraw, it will not affect the standard of care you receive.

Your Rights
You are entitled to:
1. The right to access to your data and receive a copy of it,
2. The right to restrict or object to processing of your data,
3. The right to object to any further processing of the information we hold about you (except where it is de-identified),
4. The right to have inaccurate information about you corrected or deleted,
5. The right to receive your data in a portable format and to have it transferred to another data controller,
6. The right to request deletion of your data

By law you can exercise the following rights in relation to your personal data, unless the request would make it impossible or very difficult to conduct the research. You can exercise these rights by contacting Dr Moodley at Tashia.moodley@dental.tcd.ie or the Trinity College Data Protection Officer, Secretary’s Office, Trinity College Dublin, Dublin 2, Ireland. Email: dataprotection@tcd.ie. Website: www.tcd.ie/privacy.

Further information
If you have any questions or require more information about this study, please contact me or Ms Cathy Dillon using the following contact details:
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