Terms and Conditions of Use of Digitised Theses from Trinity College Library Dublin

Copyright statement

All material supplied by Trinity College Library is protected by copyright (under the Copyright and Related Rights Act, 2000 as amended) and other relevant Intellectual Property Rights. By accessing and using a Digitised Thesis from Trinity College Library you acknowledge that all Intellectual Property Rights in any Works supplied are the sole and exclusive property of the copyright and/or other IPR holder. Specific copyright holders may not be explicitly identified. Use of materials from other sources within a thesis should not be construed as a claim over them.

A non-exclusive, non-transferable licence is hereby granted to those using or reproducing, in whole or in part, the material for valid purposes, providing the copyright owners are acknowledged using the normal conventions. Where specific permission to use material is required, this is identified and such permission must be sought from the copyright holder or agency cited.

Liability statement

By using a Digitised Thesis, I accept that Trinity College Dublin bears no legal responsibility for the accuracy, legality or comprehensiveness of materials contained within the thesis, and that Trinity College Dublin accepts no liability for indirect, consequential, or incidental, damages or losses arising from use of the thesis for whatever reason. Information located in a thesis may be subject to specific use constraints, details of which may not be explicitly described. It is the responsibility of potential and actual users to be aware of such constraints and to abide by them. By making use of material from a digitised thesis, you accept these copyright and disclaimer provisions. Where it is brought to the attention of Trinity College Library that there may be a breach of copyright or other restraint, it is the policy to withdraw or take down access to a thesis while the issue is being resolved.

Access Agreement

By using a Digitised Thesis from Trinity College Library you are bound by the following Terms & Conditions. Please read them carefully.

I have read and I understand the following statement: All material supplied via a Digitised Thesis from Trinity College Library is protected by copyright and other intellectual property rights, and duplication or sale of all or part of any of a thesis is not permitted, except that material may be duplicated by you for your research use or for educational purposes in electronic or print form providing the copyright owners are acknowledged using the normal conventions. You must obtain permission for any other use. Electronic or print copies may not be offered, whether for sale or otherwise to anyone. This copy has been supplied on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement.

Diagnosis of temporomandibular disorders and assessment of disclusion time in a chronic daily headache population

A Thesis submitted in partial fulfilment of D.Ch.Dent

2010

Prosthodontics

Rebecca Carville

Declaration

I declare that this thesis has not previously been submitted as an exercise for a degree at this or any other University.

I declare that this consists of entirely my own work, except where references indicate otherwise in the text.

I give the Library permission to lend or copy this thesis on request.

Signed: Rebecca Caile.

Date: 5th October 2010.

Acknowledgements

I would like to acknowledge the contribution of Miss Amina Coffey and the staff of St. Vincent's Neurology Outpatient ward. The statistical direction provided by Dr Alan Kelly and the support and advice provided by my supervisors Prof. Brian O'Connell and Dr Niall Tubridy. I wish to thank my colleague Dr Seamus Sharkey for his helpful advice during the write up. Finally I wish to acknowledge my family for their constant encouragement, particularly my mother.

I would like dedicate this thesis to Mr Simon Mc Cafferty

Summary

Chronic Daily Headache (CDH) is characterised by the presence of headache for more than 15 days/month for a period longer than 3 months. Temporomandibular Disorders (TMD) are a group of conditions involving the masticatory musculature, the temporomandibular joints and/or associated structures. It has been suggested that TMD is a likely under diagnosed cause of CDH. Myofascial pain is a common form of TMD that is often associated with headache. It has been suggested that an increased disclusion time (time taken for posterior teeth to separate during mandibular excursions) may be related to myofascial pain. Disclusion time reduction by tooth adjustment has been suggested as a possible management strategy for myofascial pain conditions. This study aimed to compare the incidence of diagnosed TMD in a CDH population with a non headache suffering control population using a validated diagnostic method. The Research Diagnostic Criteria for Temporomandibular disorders (RDC/TMD) was employed as it is considered the most widely accepted diagnostic criteria for research purposes. The sensitivity and specificity of a simple questionnaire "Fonseca's questionnaire" was evaluated in relation to the diagnostic ability of the RDC/TMD. The relationship between gender, age, depression, chronic pain related disability, occlusal factors and the presence of TMD and CDH was assessed. The study also aimed to investigate if a relationship exists between disclusion time, TMD subtypes and occlusal factors in this population.

A total of 173 participants completed Fonseca's questionnaire, 115 controls and 58 with CDH. A clinical appointment was attended by 36 controls (mean 44 years) and 36 CHD sufferers (mean age 40 years) during which the RDC/TMD was completed. The clinical examiner was blinded to their status. Participants underwent an occlusal evaluation and T.scan analysis for disclusion time in both right and left lateral excursions.

Fonseca's questionnaire suggested the presence of TMD in 23% of controls and 87% of CDH population. The RDC/TMD identified TMD in 16.6% of the control group and 61% of the CDH group. Pearson's Chi square test suggested a highly significant association between CDH and TMD (X_2= 13, DF = 1, p-value < 0.001). Females were over-represented in the CDH group with 32 (89%) compared to the control group with 14 (39%) females. The gender disproportion was accounted for by gender balancing of the two groups. A highly significant association between TMD and CDH remained in

the gender balanced groups (X_2 = 5, DF = 1, p-value = 0.02). Fonseca's questionnaire demonstrated a high sensitivity (0.82) and low specificity (0.58) in identifying TMD. Myofascial pain was the most common TMD identified in the CDH group, disc displacement with reduction was the most common TMD in the control group. The CDH group displayed a significantly increased incidence of chronic pain related disability. Depression was significantly associated with the presence of CDH. In this study no statistically significant relationship was established between incisal relationship, CDH and TMD status. There was no significant association between the presence of TMD and guidance scheme in lateral excursions. The mean disclusion time for all participants was 0.9sec (SD=0.8). The mean disclusion time for TMD positive participants not significantly different to non TMD participants (W = 1773, p-value = 0.47). 70% of excursions in participants with a diagnosis of Myofascial pain with or without limited opening had a disclusion time greater than 0.5seconds. Despite the high proportion of long disclusion time in this group there was no compelling evidence from this study that a disclusion time of greater than 0.5 seconds was associated with any particular subtype of TMD or TMD itself.

In conclusion CDH patients have a significantly higher incidence of TMD than a non-headache control group. Disability due to chronic pain is significantly associated with CDH in both TMD and non-TMD groups. Depression was significantly associated with CDH. It is not clear whether concurrent TMD is contributing to depression due to chronic pain in this group. Myofascial pain is the most commonly occurring TMD in a CDH population. Fonseca's questionnaire demonstrated high sensitivity but limited specificity in diagnosing TMD. It may serve as a useful screening tool in ruling out TMD during a neurological assessment. A positive result in Fonseca's questionnaire should be followed by a comprehensive clinical exam to confirm diagnosis. There is no relationship between incisal relationship and TMD. Mean disclusion time was not significantly longer for TMD positive individuals than TMD negative individuals. Disclusion time was not related to guidance scheme, or incisal relationship. Disclusion time greater than 0.5 seconds was not significantly associated with a diagnosis of myofascial pain.

Contents

Table of Figures

Table of Tables

1 Introduction

1.1 Orofacial pain

Orofacial pain encompasses both acute and chronic pain conditions affecting the hard and soft tissues of the head, face, neck and intraoral structures. This broad range of conditions includes many diagnoses including pain from headache, pain of musculoskeletal origin, neuropathic pain, psychogenic pain and pain secondary to various systemic diseases. The overlap between these, often similar conditions, results in orofacial pain patients requiring a multidisciplinary team being involved in their management. Physicians, dentists, neurologists, psychologists, pain specialists, physiotherapists may all have a role in the management of these complex conditions.

The prevalence of orofacial pain is approximately 17-26% in the general population and studies indicate that between 7-11% of orofacial pain is "chronic" in nature. In 1993 Lipton and co workers reported the prevalence of reported orofacial pain in the United States of America (USA). They estimated that approximately 22% of the general population experienced at least one of the five types of orofacial pain described. The most common form of orofacial pain was dental pain which was reported by 12.2%, followed by temporomandibular pain at 5.3%, and cheek or facial pain at 1.4% (Lipton et al., 1993).

Pain has been defined by Bonica as "*...the unpleasant sensory and emotional experience, triggered by noxious stimulation of sensory nerve endings, usually from tissue damage...*" (Bonica, 1989) . The dense anatomy of the head and neck area, and its complex system of cranial nerves and pain pathways make it a highly sensitive area. Pain may be stimulated by noxious stimuli triggering nociceptors to initiate the classical pain pathways. Modulation of pain in the higher centres may enhance or diminish nociceptive input causing a highly variable pain experience within and between individuals. Heterotrophic pain describes pain remote from its source (referred pain) and although this type of pain is largely unexplained the convergence theory suggests that converging afferent fibres from different nerve pathways may lead to a diffuse pain sensation that is difficult to localize. Referred pain can make diagnosis of orofacial pain more difficult. Clinical studies have suggested that the trigeminal autonomic cephalalgias commonly radiate or refer to the face and teeth (Bahra and Goadsby, 2004, Benoliel et al., 2002, Benoliel and Sharav, 1998) and

orofacial structures may themselves give rise to headache symptoms (Graff-Radford, 2007) Thus cross referral of pain can occur between headache and orofacial pain conditions and this close association has been frequently suggested in the literature.

Central sensitization has an important role to play in the development of chronic pain conditions. An alteration of a neural impulse, referred to as neuroplasticity, may lead to increased intensity and duration of pain. As well as the organic causes of pain the biopsychosocial model of pain proposed by Engel, reminds us of the psychological and social factors influential to the pain experience (Engel, 1997). Pain disorders should thus be diagnosed on two axes, the physical or somatosensory input (axis I) and the psychosocial input (axis II).

When pain is acute in nature it is usually caused by a trigger of rapid onset producing severe symptoms over a short time period. Generally acute pain is considered to be of 6 months or less and usually resolves with healing of the initial cause of the pain, it is usually associated with axis I factors. Chronic pain on the other hand is usually associated with conditions that develop slowly but tend to persist over time. Chronic pain tends to endure and becomes a large component of the sufferer's everyday life. This type of pain can be constant or intermittent and is defined as pain that lasts for six months or more. Chronic pain is often associated with both behavioural and psychological impairment , it is thus often strongly associated with axis II factors (Okeson, 1996). It is important not to mistake chronic pain with psychological factors as psychogenic pain. Psychogenic pain refers to a form of mental suffering for which there is no organic disease substrate and it is associated with emotional stress or psychiatric disorders and thus is exclusively caused by axis II factors.

1.1.1 Chronic orofacial pain conditions

Chronic orofacial pain conditions include a multitude of disorders affecting the orofacial region. Chronic headache conditions such as migraine and tension type headache are considered orofacial pain conditions by some experts. Neck ache, and temporomandibular disorders such as arthralgia, myofascial pain, internal derangements of the temporomandibular joint, generalized joint hypermobility and degenerative joint conditions, all fall into this category when they present in their chronic forms. Atypical odontalgia (phantom tooth pain), oral dysaesthesias (burning mouth syndrome, glossodynia, glossopyrosis) and atypical facial pain are described in

the literature as chronic forms of orofacial pain (Dworkin et al., 1990b, Lipton, 1993, Schiffman, 1990, Pollmann, 1993b, Pollmann, 1993a) . It is important to note that there is no universally accepted consensus as to what conditions fall into chronic orofacial pain categories and various authors use the term in different contexts.

Pain or dysfunction that originates from the musculoskeletal structures of the masticatory system is known as a temporomandibular disorder (TMD). Many TMDs may present as acute and self-limiting, however, chronic TMD, which is defined as persistent TMD related pain present for more than six months, is one of the most common causes of chronic orofacial pain. Chronic headache is also a common form of orofacial pain, it affects a large proportion of the population at some time in their life (Lainez, 2005). Some studies have suggested an overlap or association between chronic pain conditions, the extent of the relationship between chronic headaches and chronic TMD remains to be clarified despite some documentation suggesting an association between various types of headache and TMD.

1.1.2 Gender and orofacial pain

The literature examining gender and pain suggests a disproportionate amount of women receiving treatment for many pain conditions. Women tend to report more severe pain, more frequent pain, and pain of longer duration than do men. Gender differences in pain perception have also been extensively studied using experimentally induced pain. These studies show a sex disparity, with females often reporting lower pain thresholds and tolerance than males (Dao and LeResche, 2000). Most chronic pain conditions, including orofacial pain and headaches, tend to have a significantly higher prevalence in women. Although some researchers suggest a possible hormonal influence in chronic pain conditions the results of studies on orofacial pain and hormones are as yet inconclusive (Meisler, 1999). Dao and Le Resche examined the higher prevalence of chronic orofacial pain in women and found that there is little consensus in the literature as to whether these sex differences reflect the actual female and male responses to pain, a response to social rules for the expression of pain, or physical differences in the way noxious stimuli are processed between male and females (Dao and LeResche, 2000). A cross-sectional population-based survey was performed in the United Kingdom, of 424 participants in the four-year follow-up, 229 reported orofacial pain and 195 did not. The results of this study suggest that persistent orofacial pain was positively associated with the female gender, older age

groups, presence of psychological distress and/or widespread chronic body pain, and the taking of medication (Macfarlane, 2004).

1.1.3 Management of chronic orofacial pain conditions

Depending on the diagnosis and in some cases the clinician, orofacial pain conditions are managed in a variety of ways. Chronic pain is often managed by pharmacological methods. In the case of chronic headache conditions this is usually through careful management of any analgesic use and overuse. Pharmacological management depends on the headache type. Low dose antidepressants, anticonvulsants and non steroidal anti-inflammatory drugs are utilised under the guidance of the appropriate physician (Goadsby and Boes, 2002). Psychological techniques including behavioural therapy and counselling can be applied to a number of chronic orofacial pain conditions. It is common for more cause specific therapies to be applied to conditions such as TMD where treatments such as physiotherapy, use of oral appliance, physical medicine and other reversible therapies may be utilised. These treatments are usually carried out under the guidance of a dentist or orofacial pain specialist. Some authorities recommend occlusal therapies involving adjustment of the dentition with the aim of reducing muscle hyperactivity (Fricton, 2006). Some highly dysfunctional TMD cases warrant surgical interventions, such as arthrocentesis, arthroscopy, open arthrotomy, and combined joint and reconstructive procedures (Scrivani et al., 2008). All management techniques, particularly invasive methods, should be preceded by thorough diagnostics and should only be recommended in specific circumstances. It is due to the contrasting ways of treating these complex conditions that accurate diagnosis is so crucial to successful management.

1.1.4 Diagnosis of orofacial pain conditions

Diagnosis of orofacial pain is made very difficult by the fact that these conditions present with non specific and often atypical features. It is further complicated by the close proximity of many highly sensitive anatomical structures, such as eyes, nose, sinuses, muscles, ears, teeth, oral structures and the temporomandibular joints. All of these structures may be the source of orofacial pain. Many of the commonly utilized diagnostic classifications fail to integrate head pain and orofacial pain despite their obvious intimate relationship. As a result many conditions are often diagnosed independently of each other despite a possible overlap. Many of the more highly

esteemed orofacial pain clinics routinely employ a number of the following diagnostic systems:

1. **International Headache Society (IHS) Diagnostic Criteria**: This criteria was developed and amended by the International Headache society in 2004.It is known as the **International classification of headache disorders** (ICHD II) It is a widely accepted criteria for the diagnosis of headache conditions (Olesen et al., 2004).
2. **American Academy of Orofacial Pain (AAOP) -** This system was developed by Jeffrey Okeson in 1996 and was adopted by the American Academy of Orofacial Pain as a comprehensive guideline in the assessment and management of orofacial pain conditions (Okeson, 1996).
3. **Research Diagnostic Criteria of Temporomandibular Disorders (RDC/TMD)** This widely accepted diagnostic tool used in the diagnosis of common TMDs utilized for research purposes. It consists of operationally defined measurement criteria to generate computer-derived diagnostic algorithms. It accounts for both axis I and II factors and will be discussed in more detail later (Dworkin, 1992).
4. **Criteria for Neurovascular Orofacial Pain (NVOP).** This is a non standardized list of features characteristic of neurovascular pain in the facial region such as facial migraine (Benoliel and Sharav, 2008)

Benoliel and co workers discussed the limitations of using a single diagnostic criterion and that even using multiple criteria may leave certain conditions under diagnosed. For example accurate diagnosis of neurovascular pain is not adequately accounted for in the current IHS or AAOP classification systems (Benoliel et al., 2008b).

As the accepted diagnostic criteria for chronic orofacial pain and headache conditions fall short of recognizing similar orofacial pain conditions there may be an unrecognized diagnostic overlap between chronic headache conditions and chronic orofacial pain conditions. The most commonly encountered chronic orofacial pain condition in the dental setting is TMD. The primary aim of this study was to compare a population diagnosed with a recognized chronic headache condition "chronic daily headache" with a non headache suffering control group, and to test both groups for TMD using an accepted diagnostic criterion. In doing so, the prevalence and forms of TMD in the CDH group could be compared to that of the control group.

1.2 Chronic daily headache

According to the classification committee of the International Headache Society in 2004, the headache terminology "chronic" denotes persistence over a period longer than 3 months for secondary headache disorders. In the case of primary headache disorders, which are usually more episodic in nature, "chronic" is used whenever attacks occur on more days than not over a period longer than 3 months. Chronic daily headache (CDH) is therefore characterized by the presence a headache for more than 15 days/month for longer than 3 months. Studies indicate that CDH affects females predominantly and it is present in approximately 4-5% of the general population worldwide (Nappi et al., 2008, Lipton RB, 2001, Scher A, 1998, Castillo J, 1999)

Like many chronic conditions, CDH may be secondary to an underlying medical condition such as a space occupying lesion or systemic disorder (Table 1.2-1). It is important to recognise secondary CDH as a diagnosis, as the predisposing conditions are either completely treatable or life threatening. Some warning signs for secondary CDH are fever, neck stiffness, personality change or abnormal neurological signs. Giant cell (temporal) arteritis must be considered in the over 50s with CDH. CDH can present secondary to substance abuse or indeed analgesic overuse; this is more common in individuals with a history of an acute or chronic pain condition or a history of drug abuse.

CDH is much more common in its primary form (primary CDH) and unlike secondary CDH is more difficult to diagnose and manage (Goadsby and Boes, 2002). Primary CDH encompasses a heterogeneous group of headache disorders which can be sub classified into disorders of short duration (<4 h/attack) including chronic cluster and disorders of long duration (> or =4 h/attack) (Table 1.2-2). Primary chronic daily headache disorders of long duration include chronic tension-type headache, chronic daily migraine, new daily persistent headache, and hemicrania continua (Table 1.2-2). The International Headache Society (IHS 2004) attempted to phenomenologically classify primary CDH present greater than 4 hours daily, into four main categories; 1.chronic migraine, 2. chronic tension type headache, 3. new daily persistent headache and 4. hemicrania continua. This particular classification has been widely accepted for research purposes *(Headache Classification Committee of*

the International Headache Society, 2004). Clinically however it still has limitations with suggestions by some authors that it does not provide adequately for a frequent form of migraine, "transformed migraine"(Goadsby and Boes, 2002).

Table 1.2-1 Classification of secondary Chronic Daily Headache
(Adapted from IHS 2004 classification and diagnostic criteria for headache disorders)

Secondary Chronic Daily Headache
Post traumatic (head injury, post infectious, iatrogenic)
Inflammatory (Giant cell arteritis, sarcoidosis, behçet's syndrome)
Chronic CNS infection
Substance abuse headache*

*Complicated by medication overuse / substance abuse

Table 1.2-2 Classification of primary chronic daily headache
(Adapted from IHS 2004 classification and diagnostic criteria for headache disorders)

Primary Chronic Daily Headache	
>4 hours daily	**< 4 hours daily**
Chronic Migraine*	Chronic cluster headache
Chronic tension type headache*	Chronic paroxysmal hemicranias
New daily persistent headache*	SUNCT (short lasting unilateral neuralgiform headache attacks with conjuntival injection and tearing)
Hemicrania continua*	Hypnic headache

*Complicated by medication overuse / substance abuse

1.2.1 Analgesic overuse

Primary CDH is often associated with analgesic medication overuse. The role of analgesic overuse is debated but it is thought that the cycle begins with acute headaches treated with large quantities of analgesics. Taking analgesics more than twice a week is considered overuse. The pattern of use of analgesics over time is considered extremely important in the development of CDH. (Bigal ME, 2004, Goadsby and Boes, 2002). CDH patients may have headaches that are initially improved by the analgesics, but they experience rebound headaches as the analgesic wears off (Olesen, 1995). A recent paper suggested that the majority of primary chronic daily headache patients overuse analgesics (Silberstein and Lipton, 2000). By far the most common analgesics considered responsible are over the counter compound analgesics such as combinations of paracetamol or aspirin, with caffeine or codeine phosphate or both. Obviously regulation of such drugs is difficult. Goadsby and Boes in a review article explained how the detoxification of patients from codeine based analgesics is required and can prove a very difficult task. However once successful withdrawal of analgesics is achieved in some cases an improvement in daily headache may occur, however in their experience only in about one third to one half of patients will withdraw with a successful outcome. In some cases withdrawal may cause the headache to revert to a more episodic form. In some patients chronic daily headaches continues as bad as ever after analgesic withdrawal (Goadsby and Boes, 2002).

1.2.2 Epidemiology of primary chronic daily headache

Chronic daily headache is considered a significant public health issue due to its prolonged nature and difficult management (Linde et al., 2007, Gladstone et al., 2003). An estimated 4-5% of the general population suffer from primary chronic daily headache. Scher in 1998 presented the first USA population based study describing the prevalence and characteristics of frequent headache. 13,343 individuals from Maryland, between 18 and 65 years of age were randomly selected and interviewed by telephone about headaches. The prevalence of frequent headache was 4.1% (1.8:1 female to male ratio). Frequent headache was 33% more common in Caucasians (4.4%) than in African Americans (3.3%). In both males and females, prevalence was highest in the lowest educational category. Among frequent headache sufferers, more

than half (52% female, 56% male) met criteria for chronic tension-type headache, almost one third (33% female, 25% male) met criteria for frequent headache with migraines features, and the remainder (15% female, 19% male) were unclassified. Overall, 30% of female and 25% of male frequent headache sufferers met International Headache Society (IHS) criteria for migraine (with or without aura). This study suggested that frequent headache is common in the general population. Although CDH is more common in females than males, the female preponderance of frequent headache is less marked than in migraine (Scher, 1998). CDH is common in referral neurology clinics since it is usually accompanied by considerable disability. The most common types of primary CDH seen in neurology clinics are chronic tension type headache (15%) and chronic migraine (78%) (Silberstein, 1996). In general medical practice these figures are reversed with chronic tension type headache (55%) being more common than chronic migraine (33%). The patients with chronic migraine seem to have greater disability associated with the chronic pain and this may result in their high representation in neurology clinic based populations (Goadsby and Boes, 2002, Silberstein, 1996).

1.2.3 Diagnosis of chronic daily headache

The clinical diagnosis of CDH is dependent on a number of clinical factors and the methods of diagnosis are usually based on patient history, self reporting of pain history and medication use. The most widely accepted basis for clinical and particularly research based diagnosis and classification of primary chronic daily headaches (CDH) is the International Headache Society system for the classification of headache disorders. This system was developed in 1988 and updated in 2004. However it remains controversial in its ability to differentiate and definitively diagnose CDH conditions. A number of studies had reported difficulties using the 1988 edition of the International Headache Society (IHS) system for classification of subjects with CDH (Solomon, 1992, Solomon S, 1992, Sanin, 1994, Manzoni and Zanferrari, 1995). The main limitation described was that it did not take into account the natural history of CDH, as it transforms into a chronic daily condition. Sanin and colleagues carried out a study with 400 patients using the 1988 IHS criteria and concluded that most of the patients had more than one IHS diagnosis, that chronic tension type headache (CTTH) rarely occurred alone, and that the IHS criteria were not adequate to classify CDH patients per se (Sanin, 1994). Several recommendations for the classification of CDH patients have been proposed to help account for these limitations (Manzoni and Zanferrari, 1995). The Silberstein-Lipton (S-L) criterion has

been the most frequently used proposal. It divides the primary CDH of long duration into four main diagnoses: (1) transformed migraine (TM); (2) chronic tension type headache (CTTH) (3) new daily persistent headache (NDPH); and (4) hemicranias continua (HC). It then sub classifies these diagnoses into those "with medication overuse" and "without medication overuse." Unlike the 1988 version the 2004 IHS classification includes criteria for all four of these headaches (Silberstein et al., 1994, Silberstein and Lipton, 2001). Bigal and co-workers argued that the 2004 revision of the IHS classification system should include chronic migraine (CM), TM, NDPH, and HC diagnoses. Having tried all three systems on the same group of patient's pain diaries they concluded that the 2004 IHS criteria was an improvement on the previous one but that in the 3rd edition of the IHS classification, the diagnosis of NDPH should be revised so as not to exclude migraine features.

1.3 Temporomandibular disorders

Historically conditions involving the temporomandibular joints and associated structures have been ill defined and there are a myriad of studies and theories into the aetiology, pathophysiology, diagnosis, and management of what are now referred to as TMDs. More recent research has aimed to approach this field from a biopsychosocial point of view. According to Okeson "*TMD is a collective term referring to a number of problems that involve the masticatory muscles, the temporomandibular joint and any associated structures*" (Okeson, 1996). TMD's are a cluster of related disorders in the masticatory system that have a number of common symptoms such as pain, limitation of mandibular movement and joint sounds. They have been classified as a subtype of secondary headache disorders according to the IHS international Classification of Headache disorders (Headache Classification Committee of the International Headache Society, 2004). The American Academy of Orofacial Pain (AAOP) place TMDs into two major categories; (i) Articular disorders and (ii) Muscular disorders as outlined in Table 1.3-1 (de Leeuw, 2008, Okeson, 1996). As explained previously the onset of TMD may be acute or chronic in nature. Acute TMD may follow a traumatic event and although very painful, symptoms are considered relatively mild and self-limiting. In chronic temporomandibular disorders pain is more persistent with physical, behavioural, psychological, and psychosocial factors influencing the pain experience (Fordyce, 1988, Fordyce, 1994, Parker et al., 1993, Scrivani et al., 2008).

Table 1.3-1 Temporomandibular Disorders (classification scheme adapted from the guidelines of the American Acadamy of Orofacial Pain (de Leeuw, 2008).

Articular disorders
Congenital or developmental • First and second branchial arch disorders: hemifacial microsomia, • Treacher Collins syndrome, bilateral facial microsomia • Condylar hyperplasia • Idiopathic condylar resorption (condylysis)
Disk-derangement disorders • Displacement with reduction • Displacement without reduction (closed lock) • Perforation
Degenerative joint disorders • Inflammatory: capsulitis, synovitis, polyarthritides (rheumatoid arthritis, • psoriatic arthritis, ankylosing spondylitis, Reiter's syndrome, gout) • Noninflammatory: osteoarthritis
Trauma • Contusion • Intracapsular haemorrhage • Fracture
TMJ hypermobility • Joint laxity • Subluxation • Dislocation
TMJ hypomobility • Trismus • Post radiation therapy fibrosis • Ankylosis: true ankylosis (bony or fibro-osseous), • pseudoankylosis
Infection
Neoplasia
Masticatory muscle disorders
Myofascial pain disorder
Local myalgia
Myositis
Myospasm
Myofibrotic contracture
Neoplasia

*TMJ refers to Temporomandibular joint.

1.3.1 Epidemiology of temporomandibular disorders

TMD has been established as a condition of public health importance due to a significant prevalence in the general population. In the past there had been considerable difficulty in establishing the prevalence of TMD in a given population as there was no agreed upon definition. La Resche in 1997 conducted a review of the available literature regarding TMD and found that population-based studies were highly variable but they suggest TMD affects between 8-15% of females and 3-10% of males, approximately 10% of the adult population experienced pain in the TMJ region (LeResche, 1997). Lipton et al found that more than 8% of the general population reported TMD or facial pain in the previous 6 months (Lipton, 1993). A more recent survey was carried out by Isong and colleagues in 2008; its aim was to compare the prevalence of self-reported temporomandibular joint and muscle disorders TMJ/TMD pain in the 2002 U.S. National Health Interview Survey (NHIS) by age and gender and race (Schiller and Bernadel, 2004, Lethbridge-Cejku et al., 2004). Data from this survey included information on gender, age, race, ethnicity, education, and TMJ/TMD-type pain was evaluated. The overall prevalence of TMJ/TMD-type pain was 4.6%, with 6.3% for women and 2.8% for men. However, based on age, a modest but significant racial / ethnic difference emerged after adjusting for socioeconomic status. For non-Hispanic white women up to age 50, the prevalence was approximately 7% to 8%, but it decreased after age 55. Non-Hispanic black women had much lower prevalence at younger ages (approximately 4% at 25 to 34 years), which increased thereafter up to 55 to 64 years of age.

A similar racial pattern seemed to emerge for non-Hispanic black men, with the lowest prevalence at ages 25 to 34 years, while non-Hispanic white men had a higher prevalence. Overall, age seemed to play more of a role in women than men. (Isong et al., 2008). Prevalence studies have shown symptoms of TMD to rise and fall with age such that a peak incidence is recorded at middle-age. Females, particularly in the third and fourth decades, may have TMD associated with more severe constitutional distress, including headaches, joint and muscle tenderness, and joint clicking (Wahlund, 2003). From the available data, pain in the temporomandibular region appears to occur twice as frequently in females as males. The male: female ratio is equal until puberty. Females are more likely to present for treatment with a female to male ratio in adults seeking care from 3:1 to as high as 9:1 (Dworkin et al., 1990b, Huber and Hall, 1990). It has been well documented that females seem more aware of

the symptoms of TMD and as a result out number males in many studies (List, 1999,). Huber and Hall attempted to compare the signs and symptoms of TMD and occlusal discrepancies in a symptom free population of men and women. In their sample they found no significant difference and therefore concluded that factors other than the presence of these signs of TMD and occlusal discrepancy must be responsible for the high predominance of female patients with TMD. While occurring in children and adolescents the majority of the data suggests that it is less frequent than in adults. TMD is most prevalent in young and middle aged adults and although the elderly population demonstrate an increased prevalence of clinical and radiological signs, they show a lesser prevalence of symptoms and of treatment demands than seen in younger adults (Poveda Roda et al., 2007).

Signs and symptoms of TMD are found commonly in the population. In adults in the United States the prevalence of at least one sign of temporomandibular disorders is reported as 40 to 75% (Scrivani et al., 2008, de Leeuw, 2008). It should be noted that the presence of particular signs and symptoms alone is not diagnostic, some signs are very common such as TMJ sounds and deviation on opening the jaw which occurs in approximately 50% of asymptomatic people (Dworkin et al., 1990b). Studies have found signs like decreased mouth opening and occlusal changes to be less common, occurring in less than 5% of the general population (Huber and Hall, 1990). The majority of epidemiological studies show rates of clicking of 17-21% for men and 26-28% for women. It may be argued whether joint clicking represents a pathologic condition or a normal variation but it appears that the prevalence is slightly higher amongst women. It has been estimated that between 40-75% have at least one sign of joint dysfunction (movement abnormalities, joint noise, tenderness to palpation etc) and approx 33% have one symptom (face pain, joint pain etc).

TMD is a collective disorder, however the most common feature of all TMDs is chronic pain, common signs and symptoms include tenderness of the muscles of mastication, and of the TMJ. The variety of subtypes is illustrated in table 1.3-1. Clinical findings include restricted movement of the mandible and joint sounds. It is important to note that the most common subtypes found in previous studies of TMD in clinical populations appear to be myofascial pain and arthralgia, followed by disc displacements with reduction (Dworkin et al., 1990b) . In 2001 a retrospective Italian study by Vollaro and co-workers used the RDC/TMD to assess and classify 825 individuals with symptoms of TMD. The study found that 59% of the patients with

TMD experienced muscular pain, 13% had articular pain, 16% had articular pain coexisting with muscular pain, and 4% were diagnosed as having fibromyalgia (Vollaro et al., 2001). Despite the relatively high prevalence of temporomandibular disorders, signs, and symptoms, only 5 to 10% of those with symptoms actually require treatment. The natural history of this disorder suggests that in up to 40% of patients the symptoms will resolve spontaneously (Scrivani et al., 2008).

1.3.2 Aetiology of temporomandibular disorders

The cause of TMD is unknown. Current thinking suggests an interplay between structural factors such as anatomy of TMJ, skeleton and occlusion, psychological factors and functional (neuromuscular) factors (Scrivani et al., 2008, Okeson, 1996). Obviously TMD being a collective disorder contains various conditions with different aetiological mechanisms. Most of the factors described in the literature as aetiological in TMD have not had a proven cause effect relationship. The majority of studies simply suggest an association between the supposed aetiologic factor and the presence of signs and symptoms of TMD. According to Okeson the factors that increase the risk of TMD are described as *predisposing factors*, those that cause its onset are *initiating factors*, and those that interfere with healing or enhance progression are *perpetuating factors,* he explains how individual factors may play any of these roles depending on the individual case. Parker described the equilibrium between the various components of the masticatory system, and how many factors may interfere with the balance such as loss of structural integrity, altered function, biomechanical strains or stresses in the system. He felt that the development of dysfunction depended on the individuals adaptive capacity to these insults (Parker, 1990). The following factors have been considered in the literature as possible initiating, predisposing or perpetuating factors in the complex aetiopathogenesis of TMD.

1.3.2.1 Trauma and TMD

Acute traumatic events such as a direct or indirect trauma to the area have been shown to cause damage to the TMJ and/or related muscles of mastication. Traumatic injuries from eating, wide jaw opening and dental management have also been suggested as possible aetiological factors, but there is very little objective evidence to prove this. Okeson described trauma as "*...any force applied to the mastication structures that exceeds that of normal functional loading* ". He divided trauma into; direct trauma,

indirect trauma and microtrauma. Direct trauma refers to macrotrauma due to an impact. Multiple studies have shown that TMD patients report direct trauma more frequently than non TMD sufferers (Pullinger and Seligman, 1991, Burgess, 1991, Braun and Schiffman, 1991, Locker and Slade, 1989, Pullinger and Monteiro, 1988). Indirect trauma such as that sustained during an indirect impact refers to "Whiplash" injury to the head and neck area. Burgess in 1991 presented descriptive data for 100 patients reporting facial pain and temporomandibular dysfunction precipitated by overt facial/head trauma, and "whiplash" injury with and without overt trauma. A prospective controlled trial by Kasch and co workers was carried out on 19 acute whiplash patients exposed to a motor vehicle accidents involving a rear collision, they suggested that whiplash injury is not a key risk factor for the development of TMD (Kasch, 2002). The aetiological impact of this form of trauma on TMD is very controversial despite numerous case reports, a recent review of the literature suggests conflicting evidence and a lack of homogeneity in studies (Fernandez et al., 2009).

1.3.2.2 Parafunction and TMD

Parafunction has been suggested as a cause of "microtrauma" to the masticatory system by Okeson (Okeson, 1996). Microtrauma describes repeated adverse loading of the masticatory system. Causes suggested are postural imbalance, from oral or parafunctional habits. Postural habits include phone bracing, or forward head positioning, oral habits include biting foreign objects, pressing the tongue against the teeth, lip biting and bruxism. These parafunctional habits have been suggested to lead to musculoskeletal strain. Bruxism refers to the non-functional grinding and clenching of teeth. Individuals usually brux their teeth when they are sleeping, but it can occur at any time in the day. The role of parafunctional habits such as bruxism in the development of TMD have been widely suggested in the literature. The problem with all these studies is that parafunctional habits are difficult to record, measure and thus diagnose. In most studies they are assessed by indirect methods such as patient self report, questionnaires, bed partner report or by the presence of tooth wear (attrition). Seligman and co workers evaluated the relationship between occlusal relationships, degree of attrition and signs and symptoms of TMD in both males and females. There was no significant association between attrition scores and the presence of muscle tenderness to palpation, TMJ clicking, TMJ tenderness, with the single exception that females with TMJ tenderness had higher incisor wear scores. Symptomatic men (n = 71) and women (n = 89), defined by the presence of one or more TMJ-related

symptoms or signs, were compared with 49 men and 13 women who were totally asymptomatic and there were no significant differences in attrition scores between asymptomatic and symptomatic men or women (Seligman and Pullinger, 1991b). Attrition measures as an indicator of parafunction have limited validity and should be considered with caution. Various studies suggested that bruxism and parafunction may act as perpetuating factors in certain TMD subgroups. Bruxism is thought to be a common practice (not necessarily pathological) but varying in severity. Bruxism , lip biting and forward posturing of the mandible are not commonly associated with TMD (Okeson, 1996). Pergamalian and co workers carried out a study on 84 diagnosed TMD patients to determine whether there was a significant association between tooth wear, the parafunctional oral habit of bruxism, temporomandibular joint (TMJ) pain, and muscle pain severity in a TMD population. Bruxism was assessed in a standardized pre-treatment questionnaire and in the dental history and interview (RDC/TMD) to indicate how frequently (0-never to 3-very often) subjects performed a list of oral habits, which included bruxism. Subjects were also compared for muscle and joint pain. Bruxism activity was not correlated with muscle pain on palpation and was inversely associated with TMJ pain on palpation. Tooth wear was not significantly correlated with bruxism, TMJ pain, or muscle pain. The author concluded that, tooth wear factors did not differentiate patients with bruxism from those without (Pergamalian et al., 2003). Glaros and colleagues induced TMD-like symptoms (myalgia and arthralgia) in 3 of a group of 10 previously asymptomatic individuals, by encouraging bruxism via increasing EMG-biofeedback. These participants were compared with a control group. The relevance of this model to the clinical condition of TMDs is questionable due to methods used (Glaros, 2000). A recent study by Manfredini and co-workers found that bruxism had a closer relationship with muscle disorders than with disc displacement and joint pathologies. Bruxism was prevalent in 68.9% of individuals with myofascial pain (Manfredini, 2003). A comprehensive review of the literature failed to find a causal relationship between bruxism and TMD (De Meyer and De Boever, 1997).

1.3.2.3 Orthodontic treatment and TMD

The speculations regarding traditional orthodontic treatment and its possible association with TMD were heavily investigated in the literature. Prevalence studies have documented that there is no increase in the prevalence of the TMDs following orthodontic treatment (How, 2004).

1.3.2.4 Anatomic factors and TMD

Anatomic skeletal relationships have been proposed as possible structural factors predisposing to TMD. Multiple studies have investigated the role of severe skeletal malformations, interarch and intra arch discrepancies. Retrognathia was considered in a study by Schellhas et al (1993) examining childhood internal derangements. They found that although internal derangements were common in children with retrognathia, this could not be considered definitively causative. The steepness of the articular eminence has been proposed as a possible cause of TMDs such as internal derangements. This is due to observed associations in patients with osteoarthritis (Nickel and McLachlan, 1994, Panmekiate et al., 1991b, Panmekiate et al., 1991a). A definitive relationship has yet to be established.

1.3.2.5 Occlusal relationships and TMD

In 1934 an otolaryngologiat, Coston, evaluated a group of patients who presented with pain, dizziness, ear problems and swallowing difficulties, he observed that these people had experienced loss of occlusal vertical dimension due to multiple missing teeth. He described how their symptoms resolved on replacement of teeth; thus malocclusion and poor occlusal relationship were highlighted as a possible cause of TMD (Costen, 1997). Since then the contribution of dental occlusion in the aetiology of TMD has been debated. Some authors have suggested that the presence of a large overjet, minimal overbite, anterior open bite, unilateral posterior crossbite, occlusal slides greater that 2mm, lack of posterior support are more common in TMD patients (Vanderas, 1994, McNamara et al., 1995, Juniper, 1994)

A clinical study on painful internal derangement patients revealed no significant associations with respect to Angle's classification of malocclusion, vertical and horizontal overlap, tooth wear, missing posterior teeth, canine guided occlusion, balancing-side contacts, deflective occlusion, and clenching of the teeth. Interestingly tilted teeth on the contra-lateral side of the pain were more common in cases of reducing disc displacement than in cases without reduction (Roberts et al., 1987) . In a retrospective study of 211 symptomatic TMD sufferers they found that signs of dysfunction were not associated with dental / occlusal status or with the presence of malocclusions (Pedersen and Hansen, 1987b). A systematic review of population-based studies was conducted to determine whether or not a link was present between

different types of malocclusions, as well as grounds of functional occlusion (i.e. occlusal interferences, nonworking-side occlusal contacts) and TMDs in adults 20 years or older. The quality of methodology of the selected studies was established with a quality assessment list. Very few associations were reported between malocclusion and occlusal factors and signs and symptoms of TMD. A positive correlation was only described in two cases between the number of rotated teeth and subjective symptoms of dysfunction, and between excessive abrasion and clinical dysfunction. The strength of the correlation however was not described in either case (Gesch et al., 2004).

Increased overjet, as seen in angles class II division 1 malocclusion, has been found positively associated with osteoarthritic changes in the TMJ of children and adolescents (Pullinger and Seligman, 1993). Significant increases in TMD risk occurred with overjets > 6-7 mm in studies of children and young adults (Riolo, 1987, Heloe et al., 1980). A controlled clinical, electromyographic, and kinesiographic assessment of craniomandibular disorders in women found the TMD group had a higher incidence of increased overjet and excessive anterior mandibular movement than the control group (Tsolka et al., 1994). However the majority of population based studies suggested no notable association between the degree of overjet and the presence of diagnosed TMD (Gunn et al., 1988, Butler et al., 1975, Pullinger and Seligman, 1993, Runge et al., 1989, Roberts et al., 1987, Riolo, 1987, Shiau et al., 1989, Cachiotti, 1991, Heloe and Heiberg, 1980b, Heloe, 1975, Pedersen and Hansen, 1987a, Lieberman, 1985, Castaneda, 1988). Unilateral maxillary posterior reverse horizontal overlap "crossbite" was suggested to be more common in TMD populations than controls (Pullinger et al., 1993). However multiple studies have failed to show a significant association between the presence of cross bite per se and TMD , most studies reported no predominance of crossbite adults with TMDs when compared with control subjects (Seligman and Pullinger, 1991a) . Many authors however found that the more severe forms of crossbite with mandibular displacement caused functional problems (Seligman and Pullinger, 1989, Seligman and Pullinger, 1991b, Runge et al., 1989, Seligman et al., 1988, Cachiotti, 1991, Heloe et al., 1980, de Boever and van den Berghe, 1987, Mohlin and Kopp, 1978). A study by Roberts and co workers on diagnosed internal derangements found a positive association between contralateral crossbite and reducing disc displacement (Roberts et al., 1987).

Several, but not all, studies of TMD patients have suggested an association between molar loss and pain, clicking and progression to locking. However, there is little

correlation between loss of molar support and TMD symptoms in randomly selected individuals (Seligman and Pullinger, 1991b). Incidentally, some studies have suggested that an asymmetric retruded contact position can cause uncharacteristic joint sounds and masticatory muscle tenderness, but there is no significant increase in frequency of asymmetric retruded contact position in TMD groups (Seligman, 1988).

Reduced posterior or molar support can lead to reduced occlusal support, and indeed a reduced vertical dimension of occlusion (Rivera-Morales and Mohl, 1991b, Weinberg, 1979). Skull studies have correlated reduced molar support with osteoarthritic changes in the TMJs, this association however may have been attributed with age as the effect was less common in younger subjects (Granados, 1979, Whittaker et al., 1985). Clinical studies on the other hand involving non patient populations show no evidence of a link between reduced molar support and TMD (Pekkarinen and Yli-Urpo, 1987, Helkimo, 1974a, Kirveskari and Alanen, 1985, Muir and Goss, 1990, Pullinger et al., 1990, Swanljung and Rantanen, 1979, Lundeen et al., 1990, Leake et al., 1994, De Boever and Adriaens, 1983, Witter et al., 1994b, Witter et al., 1994a). Reduced vertical dimension of occlusion and its impact on the health of the masticatory system was examined by Rivera-Morales and Mohl in 1991, an extensive literature review did not reveal evidence that a moderate change in OVD of 4-6mm can cause masticatory muscle hyperactivity or TMD (Rivera-Morales and Mohl, 1991a)

Recent studies have attempted to estimate the contribution of occlusal relationships through logistic regression analysis (De Laat et al., 1986, de Laat and van Steenberghe, 1985, Pullinger et al., 1993). These studies address the complex multifactorial problem of TMDs using a multiple stepwise logistic regression analysis to assess and quantify relationships between TMD and various occlusal factors. Throughout these studies occlusal factors such as RCP-ICP slide length, unilateral posterior crossbite, overjet, anterior open bite, minimal overbite, missing posterior teeth, and right and left first molar asymmetry displayed some association with various TMDs, however it is important to note that the weak level of significance often presented may suggest a possible random association. The more extreme cases of certain occlusal features were positively associated with TMD patients. Normal subjects without TMD tended to show less severe occlusal problems. Only anterior open bites in the osteoarthrosis groups (> 17.8:1 to > 24.4:1 odds ratios) and unilateral posterior crossbite in the disk displacement groups (> 7.6:1 to 13.9:1 odds ratios) showed significant predictive risk for identification of disease. Pullinger stated that

"the *literature does not contain compelling evidence for an occlusal contribution to TMDs but an absence of any relationship should not be inferred because this would imply an absence of any relationship between form and function."* They concluded that "*the association of occlusion should not be overstated because only 4.8% to 27.1% of the log likelihood for TMD is accounted for by the occlusal factors studied in the logistic regression sets, this does not mean that 4.8% to 27.1% of the cases were caused by occlusal factors.*

Many controversial occlusal therapies aimed at treating TMD propose removing occlusal interferences and restoring so called occlusal harmony and thereby reducing or eliminating TMD. An occlusal interference is defined by the eighth edition of the glossary of prosthodontic terms as "*any tooth contact that inhibits the remaining occluding surfaces from achieving stable and harmonious contacts*" (GPT, 2005). Occlusal interferences have been suggested as perpetuating factors in myogenic TMD by numerous authors , Geering in 1974 discussed functional disturbances of the TMJ and masticatory muscles induced by occlusal interferences (Geering, 1974). Riise and Sheikholeslam through the 1980's and 90's investigated the effect of occlusal interferences on masticatory muscles through quantitative electromyography (EMG). Their studies showed that a small occlusal interference of 0.5 mm in the intercuspal position can affect the co-ordination of muscular activity during mastication. In general, they showed a prolonged contraction time as well as a reduction of the activity in all the elevator muscles, especially on the side of the interference. Once the occlusal interference was removed the pattern of co-ordination of muscular activity returned to a similar pre-experimental pattern within 2 weeks. When occlusal splints were introduced the authors found that an occlusal splint diminished signs and symptoms of functional disorders and re-established symmetric and reduced postural activity in the temporal and masseter muscles (Riise and Sheikholeslam, 1984, Sheikholeslam and Riise, 1983, Riise and Sheikholeslam, 1982, Holmgren et al., 1985, Sheikholeslam et al., 1986, Holmgren et al., 1990, Holmgren et al., 1993, Sheikholeslam et al., 1993). Glenn T Clark published a review article concerning experimental occlusal interference studies which included animal studies in which restorations were placed intentionally with occlusal interferences. These iatrogenically placed high crowns have a local deleterious effect on the investing alveolar and pulpal tissues however these effects appear to be transient lasting from several days to several weeks. The traumatized teeth tend to move away from the adverse occlusal forces. Clark further reviewed the literature where experimental occlusal

interferences were placed and their effects on jaw function were investigated. Studies of note include those by Randow and Funakoshi who monitored EMG activity before and after the introduction of an occlusal interference. They observed an asymmetric elevated muscle activity which was not present before the interference was placed. The effects observed had no clear links with the development of TMD symptoms and furthermore there is no conclusive evidence that occlusal interferences can cause nocturnal bruxism or stop it if the naturally occurring interferences are removed (Clark et al., 1999).

Occlusal guidance has been mentioned as influential for TMD signs and symptoms (Ingervall et al., 1980). In a mutually protected occlusal scheme the posterior teeth prevent excessive contact of the anterior teeth in maximum intercuspation, and the anterior teeth disengage the posterior teeth in all mandibular excursive movements (GPT, 2005). Numerous studies where mutually protected occlusions are compared to malocclusion on both patient and non patient populations they failed to prove a direct association between occlusal guidance and the signs and symptoms of TMD (Bush, 1985, Runge et al., 1989, Solberg et al., 1972, Butler et al., 1975, Roberts et al., 1987, Seligman et al., 1988, Shiau et al., 1989, Gunn et al., 1988, Heloe and Heiberg, 1980a, Pedersen and Hansen, 1987a).

Treatment modalities in the management of TMD involving occlusal adjustment have been advocated by numerous authors. Traditionally an occlusal equilibration was recommended in the prosthodontic literature with the intent of equalizing occlusal stress, producing simultaneous occlusal or harmonizing cuspal relations. Most of the literature on occlusal rehabilitation in treating TMD is aimed at management of muscular disorders. Only one study which investigated TMDs and their association with abnormal condyle-disc relationship, reported significant reduction in painful symptoms and locking for up to three years after occlusal correction by prosthodontic methods (Lundh and Westesson, 1989). A number of controlled occlusal adjustment studies were carried out where interferences such as premature contacts in centric relation and non working side interferences were removed to achieve bilateral stability in the centric maxillomandibular relation (CMMR) position and bilateral equal contacts in lateral excursions with no balancing side contacts. Canine guidance was considered the ideal goal of the equilibration but was not achieved in all cases. These studies had a control group were a placebo treatment (no occlusal adjustment) was carried out. There was a similar degree of improvement in symptoms with both the

treated and placebo groups in the majority of these studies (Tsolka and Preiskel, 1993, Tsolka et al., 1992, Forssell et al., 1987, Forssell et al., 1986, Forssell et al., 1985, Goodman et al., 1976, Kardachi et al., 1978, Wenneberg et al., 1988). Tsukiyama and colleagues summarised the published experimental studies on occlusal adjustments and temporomandibular disorders after a panel at the 1996 National Institute of Health technology assessment conference on TMD indicated that no clinical trials demonstrated that occlusal adjustment is superior to non-invasive therapies.

Eleven research experiments involving 413 subjects with either bruxism (n = 59), temporomandibular disorders (n = 219), headaches and temporomandibular disorders (n = 91), or chronic cervical pain (n = 40) were selected for critical review from the English dental literature. Three experiments evaluated the relationship between occlusal adjustment and bruxism. Six experiments evaluated occlusal adjustment therapy as a treatment for patients with primary temporomandibular disorders. One experiment looked at occlusal adjustment effect on headache/temporomandibular disorder symptoms; another looked at its effect on chronic neck pain. Most of these experiments used a mock adjustment or a comparison treatment as the control condition in adults who had an existing non acute general temporomandibular disorder. Overall, the data from these experiments did not demonstrate elevated therapeutic efficacy for occlusal adjustment over the control or the contrasting therapy. They concluded that the experimental evidence reviewed was not powerful enough to support the use of occlusal therapy as a method for treating Chronic TMD, headache or bruxism (Tsukiyama et al., 2001).

Forssell carried out a systematic review of randomized controlled trials (RCTs) of occlusal treatment studies from 1966 to 1999. Eighteen studies were accepted for review. The trials were scored using a quality scale developed by Antczak in 1986 (Antczak, 1986). Forssell concluded that the overall quality of the trials was fairly low, with a mean quality score of only 0.43/1.00 (range 0.12-0.78). The most obvious methodological limitations were inadequate blinding of examiners, short follow-up periods, small sample sizes, wide variety of outcome measures and numerous control treatments, some of unknown effectiveness. They suggested that compared to control methods the evidence for the use of occlusal adjustment was lacking. Forssell stated that "*There is an obvious need for well designed controlled studies to analyse the current clinical practices*" (Forssell and Kalso, 2004).

Koh and Robinson reviewed the effectiveness of occlusal adjustment for treating and preventing TMDs in adults by evaluating all randomised controlled trials (RCTs) comparing occlusal adjustment to placebo treatments, reassurance or no treatment in TMD suffering adults. Data on incidence of symptoms and symptom-based outcomes were extracted from included studies. Neither showed any difference between occlusal adjustment and control group. The authors concluded that "*there is insufficient evidence, from RCTs, that occlusal adjustment treats or prevents TMDs.*" (Koh and Robinson, 2003, Koh and Robinson, 2004).

1.3.2.6 Disclusion time and TMD

Robert Kerstein has proposed the association between increased disclusion time and myofascial pain. The author subsequently recommends disclusion time reduction therapy in its management. Disclusion time is defined as the duration of time working and non working molars and premolars are in contact during mandibular excursive movements. This time commences from the habitual closure position through to the contact of anterior guiding tooth surfaces. Disclusion time measures the time with which posterior teeth separate from each other during guided mandibular motion. It was first described by Kerstein and Wright for "T-scan" Force movie occlusal analysis (Tekscan®, Inc., Boston, Mass). The T-Scan system was developed in 1987 with the start of the company Tekscan® . It utilises a 100 micron thick sensor, that records digitally, occlusal force distribution, over time.

Previous studies by Kerstein and Farrell suggested that a lengthy disclusion time increased contractile muscle activity in the masseter and temporalis muscles of patients with chronic myofascial pain (Kerstein, 1995, Kerstein, 1994, Kerstein and Farrell, 1990) . Kerstein described how traditional occlusal equilibration therapies were usually limited to the elimination of interferences to achieving coincident maximum intercuspating position and centric maxillomandibular relation. The authour suggests complete elimination of both working and nonworking side interferences as well as reduction of disclusion time and achievement of canine guidance by immediate complete anterior guidance development (ICAGD) as an alternative method of equilibration (Kerstein, 1992). Kerstein has published a series of studies suggesting this form of treatment to be therapeutic for chronic myofacial pain dysfunction syndrome (MPDS)" (Kerstein, 1994, Kerstein and Wright, 1991a, Kerstein, 1992). ICAGD refers to the occlusal adjustment process that focuses primarily on establishing immediate posterior disclusion in right and left lateral excursions.

The driving force behind this method was an observsation by Robert Kerstein of asimilar pattern of balancing and working side interferences in a group of 53 myofascial pain sufferers. After CAGD he claimed 51 of the 53 underwent a reduction in symptoms. An additional seven female patients with diagnosed myofascial pain symptoms underwent an EMG study, they too were observed to have a lengthy disclusion time with working and balancing posterior contacts during excursions. EMG showed elevated contractile muscle activity was proportional to disclusion time. Kerstein suggested that lengthy disclusion time (>0.5seconds) creates elevated muscle activity in the masseter and temporalis muscle, suggesting that overuse of muscles leads to an atypical spastic state. After CAGD all seven subjects had a significant reduction in contractile activity in both the masseter and temporalis, with subsequent resolution of almost all MPDS symptoms in one month (Kerstein and Wright, 1991b). The suggested mechanism behind this treatments apparent effectiveness is that by reducing stress on posterior periodontal ligaments during extended tooth contact, there is a reduction in relaying contractile muscle impulse via the proprioceptive mechanism of the CNS (Kerstein, 1993) A duration of <0.4 seconds is considered short enough to reduce long periods of tooth contact and thus reduce masticatory muscle hyperactivity (Kerstein and Wright, 1991a).

One study compared ICAGD to a mock ICAGD to test for a placebo effect on subject remissions (Kerstein et al., 1997). This study involved Twenty-five dental students, who exhibited symptoms of myofascial pain, they were divided into treatment, control, and untreated groups. They participated in an occlusal adjustment study which measured changes in disclusion time, as well as muscular symptom remissions resultant from treatment. The treated group of ten subjects received ICAGD occlusal adjustments to shorten their disclusion time to less than 0.5 seconds per mandibular excursion. The goal of this therapy was to totally disclude the posterior teeth in a measurable time frame of 0.5 seconds or less. The control group of eight subjects received mock ICAGD with tooth polishing as a placebo. The untreated group had their disclusion times measured but received no treatment to adjust, or to simulate adjustment to their occlusion. The goal of analyzing an untreated group was to attempt to show that mock treatment (performed on the control subjects), or no treatment (performed on the untreated subjects), resulted in no measurable change in the disclusion time in either of these two subject groups. Each subject was recalled for disclusion time measurement four to five times that year, at which time, they reported

their symptoms by answering an ordinal scale questionnaire. The results suggest that shortening disclusion time to less than 0.5 seconds per mandibular excursion can induce remissions of many muscular myofascial pains symptoms, whilst the mock treatment and no treatment did not. Myofacial pain is a relatively common form of TMD which may also be associated with headache. To date no independent researcher has published any study on the relationship between disclusion time and TMD and CDH.

1.3.2.7 Pathophysiologic factors and TMD

An increased occurrence of generalized joint hypermobility (GJH) in some TMD patients has been suggested in certain groups (Buckingham, 1991). Children with joint hypermobility may have an increased likelihood of TMJ related pain. Dijkstra and co workers conducted a study to question the conflicting evidence in the literature for the association between TMDs and generalized joint hypermobility (GJH). The quality of methodology of the 14 papers reviewed was assessed, however the association between GJH and TMDs still remained unclear; consequently the authors recommended the need for more rigorous studies (Dijkstra, 2002,).

1.3.2.8 Psychological factors and TMD

As suggested earlier, according to the biopsychosocial model, chronic pain conditions are often partly influenced by psychological factors. Stressful experiences and traumatic life events have been more frequently reported in a group of TMD patients than in a non-affected control group (Fearon, 1983). The psychologically influenced patients exclusively presented with muscle-related TMDs according to Pergamalian (Pergamalian et al., 2003). In an experimental study Katz and Rugh (1989), investigated the effects of an experimentally induced stress on the muscle activity of a sample of TMD patients and compared these to a sample of asymptomatic patients. There was a significant difference observed between the groups with regard to EMG activity after being exposed to a stressor and this has been claimed to lend some support to the psychophysiological theory (Katz et al., 1989). It is worthy of note that myofascial pain and TMDs themselves may adversely affect the quality of life of patients (Bush, 1995, Kafas, 2008). An increased prevalence of post traumatic stress disorder in TMD patients has been suggested but remains unconfirmed (Aghabeigi et al., 1992). Psychiatric illness has been connected with TMD in some studies, notably anxiety and other affective disorders, such as depression, somatoform disorders, and

personality disorders may be more frequent in groups of TMD patients than in control groups.(Aghabeigi et al., 1992, Speculand et al., 1983) Forty percent of one US study group satisfied the diagnostic criteria for at least one personality disorder, the most common being obsessive compulsive disorder (Kinney et al., 1992).

Some investigators have attempted to explore the possible link between psychological variables and the predisposition to, initiation and progression of TMD. Psychological therapies have been found to be beneficial to some TMD patients. The Research Diagnostic Criteria for TMD highlights this association in that it is divided into axes. Axis 1 involves the clinical TMD symptoms while axis 2 involves the pain-related disability and psychological status. A recent study by Yap showed that in a sample of patients with diagnosed TMDs those diagnosed with myofascial pain and other joint conditions had significantly higher levels of depression and somatization than those diagnosed with only disk displacements (Yap et al., 2002). While many studies have linked TMD with anxiety states and depression it is still unclear as to the nature of this relationship and a cause and effect link has yet to be clearly demonstrated.

1.3.3 Diagnosis of TMD

As previously described the aetiology of TMD is as yet still unclear, this makes definitive diagnosis more difficult. It is important to note that one set of diagnostic criteria may not satisfy all clinical or experimental situations and the validity, sensitivity, specificity and limitations of a given criteria should be known prior to drawing definitive conclusions. When researching TMD there should be a known inclusion criteria, and the researcher should be aware of the risk of false positives and negatives so as to avoid over diagnosis or failure to detect disease.

Numerous diagnostic systems have been proposed for TMD for both research and clinical diagnosis (Talley et al., 1990, Eversole and Machado, 1985). Some screening tools have been developed. They generally allow patient reporting of single signs or a combination of signs and symptoms into indices, examples include Helkimo-Index (Helkimo, 1974a, Helkimo, 1974b), The Craniomandibular Index (Fricton and Schiffman, 1987) TMJ scale (Levitt, 1991, Levitt et al., 1988) and Fonseca's questionnaire (Fonseca., 1992). The advantage of these screening tools is their ease and simplicity of use and their ability to quickly determine a tentative diagnosis. Unfortunately their value, validity, sensitivity and specificity have rarely been examined against more accurate diagnostic methods. Only two diagnostic classifications are currently in wide use, the clinically-oriented American Academy of

Orofacial Pain system (Okeson, 1996) and the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) (Dworkin, 1992). These two systems have many areas of overlap and agreement. Okeson developed a diagnostic classification in order to allow comparisons of patient population in different studies and to provide a conceptual framework for diagnosis on the clinic. This classification was adopted by the American Academy of Orofacial pain and the temporomandibular disorder diagnostic criteria as an addendum to the Classification and Diagnostic Criteria for headache disorders, Cranial Neuralgias and Facial pain of the International Headache Society (HIS). Temporomandibular disorders are listed by the IHS under the 11th major classification: headache or facial pain associated with disorders of the cranium, neck, eyes, ears, nose, sinuses, teeth mouth and other facial or cranial structures. TMDs are divided into articular disorders and masticatory muscle disorders . Articular disorders are conditions affecting the TMJ specifically and include disc displacements, arthritic and arthralgiac conditions, conversely muscular disorders are those conditions affecting the muscles of mastication such as myofascial pain conditions (Headache Classification Committee of the International Headache Society, 2004).

The RDC/TMD diagnostic system is the only available TMD diagnostic system that is empirically-based. It utilises an operationally defined measurement criteria to generate computer-derived diagnostic algorithms for the most common types of TMD. Specifications for conducting a standardized clinical physical examination are provided for by the RDC/TMD. It has been translated/back-translated into 18 languages and is the common diagnostic method used by the 45 member consortium of RDC/TMD-based international researchers (International Consortium for RDC/TMD-based Research, 2004).

Reliability and validity of a given diagnostic tool are the most important measures of its ability to diagnose. The use of expert groups to develop the RDC/TMD can be taken as an indication of its face validity. Its reliability and validity has been tested both prior and after its use. Reliability was established initially for individual clinical signs in single clinical centre studies that were mostly designed for establishing examiner calibration prior to initiation of a subsequent research study (Dworkin et al., 1990a, John and Zwijnenburg, 2001, Wahlund, 2003, Wahlund et al., 1998) However it must be noted that the reliability of the RDC/TMD diagnosis cannot exceed the reliability of the component signs/symptoms used to derive the diagnosis. Since its

development multiple studies testing the reliability of clinical detection of signs and symptoms of TMD and of RDC TMD itself have been carried out, taking each diagnosis and testing it against more definitive tests such as MRI imaging and EMG tests combined with clinical investigation, (John and Zwijnenburg, 2001, Dworkin et al., 1990c, Goulet et al., 1998;, Lobbezoo et al., 2010, Anderson et al., 2010, Schiffman et al., 2010b, Ohrbach et al., 2010, Schiffman et al., 2010c, Ahmad et al., 2009, Hasanain et al., 2009, Steenks and de Wijer, 2009, Schmitter et al., 2006, Klasser and Okeson, 2006, Brandlmaier et al., 2003, Emshoff et al., 2002) These studies have shown that the majority of components of the diagnoses have excellent reliability. The reliability of clinical TMD diagnosis using standardized methods and operational definitions contained in the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) was assessed by John and co workers. Data came from reliability assessment trials conducted at 10 international clinical centres, involving 30 clinical examiners assessing 230 subjects. Intraclass correlation coefficients (ICC) were calculated to typify the reliability. The research group concluded that the RDC/TMD demonstrates adequately high reliability for the most common TMDs diagnosis, supporting its use in clinical investigations and decision making (John et al., 2005b). Thus the RDC/TMD provides evidence that it is superior to other systems. Its dual-axis system proved to be finer than other instruments, since it can be used to grade and measure both physical and psychosocial components.

The RDC for TMDs comprises a complete temporomandibular system examination to be carried out by a trained examiner. Patients are asked to complete a self-reported 31-item questionnaire. The patient has to provide demographic information, information about general and oral health, facial pain related history/problem (i.e. nature, distribution, pain affecting life style), jaw and chewing problems; also other medical conditions that could affect the TMJ, history of injury and relevant family history.

As part of this questionnaire, patients are also required to supply information about distressing conditions and other causes that can potentially provoke TMD symptoms. The physical examination information and the 31-item questionnaire is used to build up the first axis of the diagnostic criteria (physical factor). The axis I diagnosis should falls three subgroups: muscle disorders (group I); disc displacement (group II); and arthralgia, arthritis and arthrosis (group III).

A possible limitation of the current RDC/TMD is the palpation of the lower head of the lateral pterygoid muscle. Turp and Minagi, 2001 searched the literature to uncover evidence with regard to the validity and reliability of this diagnostic procedure. They found a lack of evidence supporting palpation of the lateral pterygoid area and subsequently suggested that this diagnostic procedure be discontinued (Turp and Minagi, 2001). Diagnostic measures with regard to problems involving the TMJ and related structures remain a controversial subject. Although radiographs, CTs (computed tomography) and MRI (magnetic resonance imaging) were established as being of immense diagnostic value in diagnosis of group II and III of RDC/TMD; they were unsuccessful in patients diagnosed with (group I) muscle disorders (Schmitter et al., 2008, Brandlmaier et al., 2003, Emshoff et al., 2002, Koh et al., 2009, Liedberg et al., 1996, Ahmad et al., 2009). Other diagnostic procedures including electronic registration (myomonitor), neuromuscular junction testing, somatosensory testing and thermography were recommended by some authorities; but it is accepted universally that diagnosis of group I (RDC/TMD) patients is primarily based on clinical examination and patient account of pain. An RDC/TMD validation project has been carried out and following the Workshop discussion in Toronto-2008 a number of suggested amendments will be carried out to further improve a proposed, amended version of the RCD/TMD. However for now the RDC/TMD with its high degree of reliability and reproducibility has been tested and validated and this has ensured its international acceptance(de Lucena et al., 2006, Brandlmaier et al., 2003, Emshoff et al., 2002, John et al., 2005a, List et al., 2006).

Identifying TMD in a neurology clinic dealing with headache patients is often difficult. TMD diagnosis requires a time consuming and technically demanding clinical examination including a thorough pain history, assessment of mandibular function, muscle palpation and even joint imaging required to definitively diagnose various TMDs. It has been suggested that a simple self-administered questionnaire would offer the advantage of a less time consuming and less technically demanding application (de Oliveira et al., 2006). Being self applied may reduce examiner variability and provide a simple severity index based on patient experience. Simplified questionnaires have been produced aiming to quickly highlight signs and symptoms of TMD such as Fonseca's questionnaire (Fonseca., 1992). Fonseca's anamnestic questionnaire became popular in the 1990's and classifies subjects as having none, mild, moderate or severe TMD. The author claimed a reliability of 95% and a strong correlation with Helkimo's index ($r = 0.6169$, $p < 0.05$). In this study we

attempted to test the reliability of Fonseca's questionnaire against the widely accepted RDC/TMD.

1.4 The relationship between CDH and TMD

Like many chronic pain conditions the aetiology of both chronic TMD and primary CDH are multifactorial with physical, psychological, social and neurobiological factors involved in their aetiology (Suvinen et al., 2005). Magnusson and Carlsson suggested as many as 70 -85% of TMD patients suffer from headaches, compared to only 20 % of the general population (Magnusson and Carlsson, 1978a, Magnusson and Carlsson, 1978b, Magnusson and Carlsson, 1983). TMD may be caused by structural, functional and morphopathalogical abnormalities in the TMJ and/or masticatory musculature, which may or may not be aggravated by occlusal or parafunctional problems. However the role of psychological, social and behavioural factors particularly in chronic forms of TMD are extremely significant, with stress, psychiatric conditions, somatoform disorders, personality disorders, hypochondriasis, paranoia and schizophrenia all contributing to the severity of the problem (Jerjes W, 2007) Approximately 50% of acute TMD sufferers exhibit some form of anxiety disorder compared to 10% CDH sufferers (Jerjes W, 2007, Puca F, 1999). The cause of primary CDH is still largely unknown, diagnosis is based on patient self report and unlike TMD a physical or functional problem cannot be identified, instead CDH is indirectly disabling leading to a highly subjective diagnosis.

As primary CDH and chronic TMD are concentrated in similar anatomical regions, with similar clinical presentations such as pain, psychological distress, interference with daily activities and a lack of well defined correspondence with physical pathology the possibility of a relationship between these conditions is worthy of investigation. It has been widely accepted that a common symptom of TMD is headache. The International Headache Society suggests TMD as a distinct cause of recurrent headaches and has outlined general criteria for its diagnosis as illustrated in Table 1.4-1. Some authors differentiate headaches associated with TMD as being a specific type of chronic headache. Siccoli and collegues described the "*TMD headache*" as being "*temporal, peri-orbital, or frontal*" (Siccoli et al., 2006).

In 2001 Ciancaglini and Radaelli published an epidemiologic study to investigate the relationship between headache and symptoms of temporomandibular disorder (TMD) in a general population. They used a personal interview to survey adult subjects from the metropolitan community of Segrate, in northern Italy. The questions were designed to elicit a yes or no answer. In particular, questions focused on TMD were adapted from "Helkimo index" (Helkimo, 1974b) and thus included a list of TMD symptoms. The overall prevalence of headache in the past year was 21.2%. The prevalence of temporomandibular symptoms was 54.3%. Headaches occurred significantly more in females than males (26.5 vs. 15.4%), and in subjects with, rather than without, symptoms of TMD (27.4 vs. 15.2%). Using a univariate analysis they determined that symptoms such as temporomandibular pain, temporomandibular joint sounds, and pain on movements of the jaw were positively associated with headache. After adjustment for confounding variables, a multiple logistic regression confirmed a significant relationship between headache and temporomandibular pain (Ciancaglini and Radaelli, 2001).

Table 1.4-1 International Headache Society Criteria for Headache or Facial Pain Attributed to TMD (Headache Classification Committee of the International Headache Society, 2004)

	International Headache Society Criteria for Headache or Facial Pain Attributed to TMD
A	Recurrent pain one or more regions of the head or face fulfilling criteria C and D
B	Radiographs, MRIs, or bone scintigraphy demonstrating a TMJ disorder
C	Evidence that the pain can be attributed to the TMJ disorder based on one or more of the following: • Pain is precipitated by jaw movements or by chewing tough or hard food • Reduced range of motion • Noise from one or both TMJs during movement. • Tenderness of the joint capsule(s) of one or both TMJs
D	Headache resolves at or before 3 months and does not recur after successful treatment of the TMD

Abbreviations: MRI, magnetic resonance image; TMD, temporomandibular disorder; TMJ, temporomandibular join

In 2007 Lupoli and Lockey suggested that TMD may be an "*overlooked cause of CDH*". A review of the literature was conducted and a table was developed based on the IHS classification, presenting the differential diagnosis of CDH, where TMD found was highlighted as a potential cause of CDH based on the character, duration and features of the pain (**Table 1.4-2**). They stated that "*the percentage of individuals with recurrent headaches fulfilling the diagnostic criteria for TMD is uncertain*", however they illustrated that early studies pre RDC/TMD such as Reik and Hale estimate that TMD is the cause of headaches in 14% to 26% of patients with chronic headaches (Reik and Hale, 1981). They recommended that "*further research is needed to elucidate the prevalence of TMD among individuals with chronic headaches based on the current standardized RDC/TMD criteria.*"

A diagnostic and behavioural overlap between headaches and TMD was suggested by Glaros et al 2007 (Glaros et al., 2007). Individuals were recruited from the general population with self-described headaches being compared with non-headache controls. The examination and diagnostic procedures in the Research Diagnostic Criteria (RDC) for TMD were applied to both sets of subjects by a blinded examiner. Following their examination pain, tooth contact, masticatory muscle tension, emotional states and stress were assessed. They found that a significantly higher proportion of the headache patients received an RDC/TMD diagnosis of myofascial pain than non-headache controls. Headache patients also reported significantly more frequent and intense tooth contact, more masticatory muscle tension, more stress and more pain in the face/head and other parts of the body than non-headache. They also found the headache suffering populations were significantly more likely to have myofascial pain than the control group. A more recent blinded study of a headache population, consisting of 76 females and 23 males ranging from 18-88 years, was conducted (Ballegaard et al., 2008). All 99 patients were referred to a specialized headache centre where they were diagnosed by a blinded examiner, according to the RDC/TMD and classified into headache groups according to the International Classification of Headache Disorders (second edition) for headache diagnoses. The prevalence of TMD in the headache population was 56.1%. Psychosocial dysfunction caused by TMD pain was observed in 40.4%. No significant differences in TMD prevalence were revealed between headache groups, although TMD prevalence tended to be higher in patients with combined migraine and tension-type headache. Moderate to severe depression was experienced by 54.5% of patients.

Table 1.4-2 Differential Diagnosis of the More Common Causes of Chronic Daily Headaches (Lupoli and Lockey, 2007)

Type	Duration	Quality	Exacerbated by	Clinical features
Migraine headache	4–72 h	Moderate-to-severe intensity pulsatile pain. Associated with nausea, photophobia, or phonophobia	Light, noise, walking, and climbing stairs.	Photophobia, phonophobia
Tension headache	30 min to 7 d	Mild-to-moderate intensity. Bilateral, nonpulsatile pressing or squeezing pain. May be associated with phonophobia.	Noise	Increased pericranial tenderness to palpation
Cluster headache	15–180 min	Severe, unilateral, sharp Peri-orbital pain.	Alcohol, histamine, and nitroglycerine associated with provoking attacks	Ipsilateral hyper-parasympathetic activity, ie, lacrimation, or rhinorrhea.
TMD induced	variable	Deep, dull, or burning pain Worse in morning when caused by involuntary nocturnal teeth grinding; worse in afternoon or evening when caused by stress-induced jaw clenching or excessive chewing	Jaw movements, excessive talking, chewing gum or tough-textured foods, and stress.	Tender TMJ capsules, reduced mandibular opening capacity, noise or crepitus with mandibular movements
Neoplasm induced	Continuous	Deep non pulsatile pain, worse in morning.	Coughing, leaning forward, or bearing down	Valsalva maneuver exacerbates pain, CT or MRI demonstrates intracranial neoplasm, neurologic deficit(s).
Analgesic overuse	Variable Mild-to-moderate, bilateral,	Non pulsatile, squeezing pain	Markedly worse during analgesic use	Analgesic use 15 d/mo for 3 months.Headache frequency and intensity improves within 2 months of discontinuing the analgesic medication.
Headache due to refractive errors	Variable	Mild-to-moderate pain, absent on waking.	Prolonged visual tasks	Ophthalmologic examination reveals refractive error. Headache resolves with refractive correction.

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; TMD, temporomandibular dysfunction; TMJ, temporomandibular joint

Patients with coexistent TMD had a significantly higher prevalence of depression. This was most notable in patients with combined migraine and tension type headache. These results indicated that a high proportion of headache patients have significant depression potentiated by ongoing chronic TMD pain. The trend to a higher prevalence of TMD in patients with combined migraine and tension-type headache suggests that this could be a risk factor for TMD development. Ballegaard suggested a need for screening procedures and treatment strategies concerning depression in headache patients with coexistent TMD (Ballegaard et al., 2008).

Following Ballegaard's study Di Paulo investigated the prevalence of migraine and related disability in craniofacial pain patients (CFP) They used the RDC/TMD to identify TMD, and for migraine diagnosis used the "ID Migraine" and the "Migraine Disability Assessment Scale" (MIDAS). The ID Migraine is a validated three-item self-assessed screening tool used to identify key migraine features such as disabling headache, photophobia and vomiting which indicate a positive migraine diagnosis with a positive predictive value of 93% according to the IHS (Headache Classification Committee of the International Headache Society, 2004) . MIDAs is a validated five item questionnaire used to quantify headache-related disability. Out of 45 patients, 69% were diagnosed with migraine as well as chronic tension-type headache (CTTH); 9% presented with CTTH and 20% had migraine. Out of 39 migraine sufferers who completed MIDAS, 56% presented the highest possible disability grade (grade IV). Out of 37 patients who completed the ID migraine questionnaire, 32 were affected by probable migraine with a diagnostic sensibility and specificity of 94% and 100%, respectively. The authors concluded that their findings indicated a definite clinical association between migraine and TMD they stated " *We support a clinical role of ID migraine and MIDAS in TMDs patients with CFP and we underline the importance of multidisciplinary evaluation in this group of migraineurs.." (Di Paolo et al., 2009).*

In 2009, Gonglaves and co workers carried out an epidemiological study to examine the prevalence of migraine, episodic tension-type headaches (ETTH), and chronic daily headaches (CDH), as well as symptoms of temporomandibular disorders (TMD) in an adult population. 1230 participants were interviewed using a validated phone survey based on the index proposed by the AAOP. TMD symptoms were assessed via 5 questions. Primary headaches were diagnosed by the International Classification of

Headache Disorders. They found that when one symptom of TMD symptom was reported, headache occurred in 56.5% of cases. For two TMD symptoms 65.1% had headaches ($P < .0001$); and when 3 or more symptoms were present, 72.8% had headaches. Specifically relating to CDH, which include chronic migraine and chronic tension type headache, a strong association was illustrated with 1 symptom of TMD found in 67%, 2 in 27% and 3 in 9% (Goncalves et al., 2009). Recently da Silva and co-workers conducted a population based cross-sectional study to investigate the co-morbidities associated with CDH. They evaluated the presence of associated psychiatric and temporomandibular disorder (TMD) co-morbidities, on the population of a city representative of a rural area in Brazil. Participants older than 10 years were interviewed locally. All individuals who reported headaches on 4 or more days per week were subsequently evaluated by a multidisciplinary team. CDH and medication overuse headache were classified according to the second edition of the International Classification of Headache Disorders (ICHD-2). Psychiatric co-morbidities and TMD were diagnosed based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) and the RDC/TMD, respectively. TMD was diagnosed in 58.1 % of those with CDH. A significant proportion of CDH sufferers had psychiatric co-morbidities and/or TMD.

Orofacial pain conditions such as TMD and CDH show considerable overlap of symptoms and associated chronic pain co-factors. This study aims to identify the extent of this relationship in an Irish CDH population compared to a control population. Additionally the T. Scan will be used to calculate the disclusion time and investigate the extent of its relationship with occlusal factors, CDH, and TMD.

2 Aims and Objectives

1) To compare the incidence of TMD in a CDH population with a non headache suffering control population.
2) To evaluate the sensitivity, specificity, positive and negative predictive value of Fonseca's Questionnaire in identifying TMD, in relation to the diagnostic ability of the RDC/TMD.
3) To assess the relationship between sex, age, depression, chronic pain related disability, occlusal factors and the presence of TMD and CDH.
4) To compare the various sub-types of TMD in a CDH population with a control population
5) To assess disclusion time in right and left lateral excursions and to investigate if a relationship exists between disclusion time and various types of TMD and occlusal factors

3 Methodology

3.1 Ethical Approval

Ethical approval was sought and obtained for this study from the Faculty Research Ethics Group, Faculty of Health Sciences, Trinity College Dublin (Appendix 8.1) and St Vincent's Healthcare Group, Ethics and Medical Research Committee, St Vincent's Hospital Dublin (Appendix 8.2).

3.2 Participants

3.2.1 Chronic Daily Headache Population

The CDH patients were sourced from the neurology out-patients clinic in St Vincent's University Hospital Elm Park, Dublin. Patients diagnosed with primary chronic daily headache were approached by a receptionist in the clinic with an information leaflet describing the purpose and nature of the study (Appendix 8.3). Those who were interested in participating were given a detailed consent form, and a week to consider the study and think of any questions, queries or concerns that they may have had (Appendix 8.5). They were given the contact details of the researcher to address any queries. Only those who fulfilled the inclusion criteria, read the information leaflet and provided signed informed consent were invited to participate in the study.

3.2.1.1 Inclusion Criteria for CDH group

- CDH group diagnosed as having a headache for more than 15 days/month for longer than 3 months
- Primary CDH patients only
- Participants were aged 18-70

3.2.1.2 Exclusion Criteria for CDH group

- CDH secondary to trauma, Giant cell arteritis, Sarcoidosis, Behçet's syndrome, Chronic CNS infection
- Abnormal neurological signs
- A significant history of psychiatric illness
- A history of illegal drug abuse
- History of space occupying lesion
- Unable to provide informed consent

- A history of head and neck surgery

3.2.2 The Control Population

The control group consisted of randomly selected non headache suffering individuals. They were randomly approached by the receptionist of orthopaedic out-patients ward in St. Vincent's Hospital. Patients were provided with an information leaflet explaining the purpose and nature of the study (Appendix 8.4). The information leaflet described who would and would not be suitable. Patients who were interested in participating were given a consent form for their consideration. Similarly to the CDH group any queries were addressed and those who were interested completed a signed consent form (Appendix 8.5). The first question asked was, Do you suffer from headaches? Only those who answered no were considered suitable.

3.2.2.1 Inclusion Criteria for control population

- Male and female
- Age 18-70
- Non headache sufferers

3.2.2.2 Exclusion Criteria for control population

- History of head or neck injury
- History of frequent Headaches
- Abnormal neurological signs
- Unable to provide informed consent
- A history of psychiatric illness
- History of drug misuse
- History of space occupying lesion
- A history of head and neck surgery

Appointments for the RDC/TMD examinations were not made until orthopaedic treatment was completed and patients had discontinued any pain medication i.e. patients were healthy, not taking analgesics and not in pain at the time of examination.

3.3 Headache Diagnosis for CDH population

The International Headache Society (IHS) provides a phenomenologically based classification system of primary headache and dispersing daily headache with its episodic variants (Appendix 8.6). The volunteers for the CDH group were each assessed and diagnosed by a consultant neurologist as being primary CDH sufferers. This was constructed by Dr Niall Tubridy, consultant Neurologist. The diagnosis was based on clinical evaluation, standardised questionnaire, clinical history, pain diaries over at least 8 weeks. The neurologists was blinded as to who would participate in the study at this stage. The diagnosis was based on the International Classification of Headache Disorders, second edition (ICHD-II) as illustrated in appendix 8.6.

3.4 Fonseca's Questionnaire

All willing and suitable participants from both the CDH and Control group completed Fonseca's screening questionnaire (Table 3.4-1). This self administered questionnaire consists of ten questions about the presence of symptoms of TMD such as pain in the temporomandibular joint, head, back and while chewing, parafunctional behaviour, limited mandibular movement, joint sounds, perception of malocclusion and feelings of emotional stress. Questions were answered with "yes", "no" or "sometimes". The questionnaire contains an anamnestic index and as such each supplied answer had a value attributed to it. For analysis, the answers "yes", "no" and "sometimes" from each questionnaire were tallied and the total was multiplied by the value attributed to each answer: ten, five, and zero, respectively (Table 3.4-2). Positive answers ('yes' and 'sometimes') were summed, the final value was compared to the clinical index and the volunteers were classified per TMD degree. This index classified participants as having mild TMD, moderate TMD, severe TMD or no TMD. No time limit was given for completion and participants were advised to answer honestly and all answers would remain confidential.

Table 3.4-1 Fonseca's Questionnaire (Fonseca., 1992)

Fonseca's Questionnaire
Answer all 10 questions with "yes" (10 points), sometimes" (5 points) or "no"(0 points)
1. Is it hard for you to open your mouth?
2. Is it hard for you to move your mandible/jaw from side to side?
3. Do you get tired/muscular pain when chewing?
4. Do you have frequent headaches?
5. Do you have pain in the nape of your neck or a stiff neck?
6. Do you have ear aches or pains in the Craniomandibular/jaw joints?
7. Have you noticed any TMJ/jaw joint clicking while chewing or opening your mouth?
8. Do you clench or grind your teeth?
9. Do you feel your teeth do not articulate well?
10. Do you consider yourself a tense (nervous) person?

Table 3.4-2 Scoring system for Fonseca's questionnaire (Fonseca., 1992)

Clinical index classification
Total between 0 and 15 points No TMD
Total between 20 and 40 points Mild TMD
Total between 45 and 65 points Moderate TMD
Total between 70 and 100 points Severe TMD

3.5 Clinical Appointment

After completing Fonseca's Questionnaire all suitable participants, who consented to do so, were invited to attend a clinical appointment in St Vincent's Neurology out-patient clinic. Two clinical examiners were involved in the clinical appointment:

3.5.1 Examiner 1

Examiner 1 was a medical student with a special interest in Neurology (Miss Amina Coffey). This examiner underwent supervised training with consultant Neurologist Dr Tubridy in medical history taking. This examiner also carried out online training in the axis II biobehavioural questionnaire of the RDC/TMD Details of the questionnaire can be found at http://www.rdctmdinternational.org (Appendix 8.7)

3.5.2 Examiner 2

Examiner 2 was a qualified Dentist undergoing full time postgraduate training in Prosthodontics (Dr Rebecca Carville). Examiner 2 was the lead researcher in this study. This examiner underwent training in the axis I and II clinical examination of the RDC/TMD. This examiner was trained in the standardized examination procedure at the Dublin Dental School and Hospital, Trinity College Dublin. Intra- and inter-observer reliability was validated in this setting. This examiner was also trained by Prof Brian O'Connell and via the user's manual in use of the T-scan Force movie occlusal analysis (Tekscan®, Inc, Boston) for the purpose of measuring disclusion time. Examiner 2 was a blinded examiner and subsequently was unaware of the CDH or control status of the subjects being examined.

3.5.3 Schedule of clinical appointment

On arrival the receptionist meets the participant, and checks that they have completed and understood the consent form. She then allocates them with a number. The participant meets examiner 1 who explains the format of the appointment and answers any queries. They then complete the biobehavioural questionnaire with examiner one following the protocol outlined in the RDC/TMD guidelines. Examiner one checks

that all questions have been correctly completed and confirms demographic details with the participant.

Blinded examiner 2 is unaware of the CDH v Control status of the participant. The patient's number is recorded and the RDC/TMD physical examination is completed according to the standardised procedure. A brief occlusal assessment is carried out and the appropriate form is completed. The T.scan is shown to the participant and examiner 2 demonstrates how it works and carries out two test measurements to ensure reproducibility. Examiner 2 then records the T.scan movie for each participant in both right and left lateral excursions. After the clinical appointment examiner 2 advises participants that a letter detailing any findings will be sent to them (see appendix 8.8). The biobehavioural questionnaire took approximately 30-45 minutes to complete and the clinical examination took approximately 15-20 minutes.

3.6 Armamentarium

The following items were utilised during the clinical appointment

- RDC/TMD forms guidelines and specifications
- Individual folder for each participant; numbered and containing, consent form, completed Fonseca's questionnaire, completed headache questionnaire, biobehavioural questionnaire, physical exam form, occlusal analysis form, T.scan disclusion time form (See appendix 8.7 and 8.9)
- Laptop computer for data input and to conduct and save T.scan movie
- Assigned memory storage device to save data on confidentially
- Secure filing cabinet in neurology outpatient clinic
- Secure passwords to protect research data and confidentiality.
- Force measure for calibrating palpation force
- T-scan sensor one per participant (Small or large)
- T-scan handle and software

- Examination kit consisting of mouth mirror, probe, tweezers, callipers to measure width of central incisor, mm ruler for measuring range of mandibular movement.

Figure 3.6-1 Armamentarium

3.7 Research Diagnostic Criteria for Temporomandibular Disorders

3.7.1 RDC/TMD Bio-behavioural questionnaire (axis II)

The bio-behavioural questionnaire (axis II) of the RDC/TMD consists of 31 questions. It aims to detect and classify the severity of the pain condition in terms of intensity of pain and pain-related disability. It also assesses the presence or absence of depression and non-specific physical symptoms via the "symptom check list - 90" (SCL-90) depression scale (Derogatis, 1983). Socio-demographic information is also obtained from the bio-behavioural questionnaire which took 30-45 minutes to complete (Appendix 8.7).

3.7.2 RDC/TMD Physical Examination (axis I)

The clinical examination follows a standardized procedure as outlined in the RDC/TMD specifications. The examination includes measurement of the range of mandibular motion, assessment of restricted movement, assessment of pain in joints and muscles in movement, and palpation of clicks or crepitus on movement of the

mandible. The following areas were palpated bilaterally (tenderness was graded as 'no pain', 'mild', 'moderate' or 'severe' pain): posterior/middle/anterior temporal muscle, superior/middle/inferior masseter muscle, posterior mandibular region, submandibular region, lateral/posterior pole of the temporomandibular joint, lateral pterygoid area and tendon of temporal muscle. The clinical examination took approximately 10-15 minutes to complete. Details of procedures, specifications, examination and the questionnaire can be found at http://www.rdctmdinternational.org (Appendix 8.7). The RDC/TMD identifies when there is no specific diagnosis i.e. no TMD identified. It identifies eight of the more common subtypes of TMD (Table 3.7-1)

Table 3.7-1 TMD subtypes identified by RDC/TMD

Classification of temporomandibular disorders (TMD) according to Research Diagnostic Criteria (RDC/TMD)
Axis I classifies TMDs into the following three diagnostic groups:
Group I. Muscle diagnoses
a. Myofascial pain
b. Myofascial pain with limited opening
Group II. Disk displacements
a. Disk displacement with reduction
b. Disk displacement without reduction, with limited opening
c. Disk displacement without reduction, without limited opening
Group III. Arthralgia, osteoarthritis, osteoarthrosis
a. Arthralgia
b. Osteoarthritis of the temporomandibular joint
c. Osteoarthrosis of the temporomandibular joint

3.8 Occlusal Assessment

The occlusal assessments consisted of the following measurements, recorded by examiner 2 before and after the T.scan movie creation (Appendix 8.9). A section for comments was included to detail any relevant information such as; missing teeth, wearing a denture, in orthodontic appliances or simply unable to co-operate with the occlusal analysis.

1) **Incisor Relationship** - This was assessed by examiner 2 according to the British Standards Institute Classification based on incisor relationship. The classifications were defined as follows:

- **Class I** – Lower incisor edges occlude with or lie immediately below the cingulum plateau (middle third of the palatal surface) of the upper incisors.
- **Class II** – Lower incisal edges lie posterior to the cingulum plateau of the upper incisors.
- **Class II Division 1-** There is thus an increased overjet and the incisors are proclined or of average inclination.
- **Class II Division 2-** Upper central incisors are retroclined, overjet is usually minimum but may be increased
- **Class III** – Lower incisal edges lie anterior to the cingulum plateau of the upper incisors; overjet is reduced or reversed

Additionally the following two relationships were recorded if present:

- **Cross bite**: reverse horizontal overlap, buccolingual mal-relationship of upper and lower teeth that may be categorized as anterior, posterior, bilateral and unilateral. This information was included in the comments section of the form.
- **Anterior Open Bite**: Incisors do not overlap vertically when posterior teeth are in occlusion.

2) **Lateral Guidance**

The teeth in contact during right and left lateral excursions were visually assessed and also evaluated on the T-scan occlusal analysis movie. The type of guidance was recorded for both right and left excursions as follows:

- **Canine Guidance**: was defined as the presence of a mutually protected articulation in which the vertical and horizontal overlap of the canine teeth disengage the posterior teeth in the excursive movements of the mandible,

therefore it was recorded as canine guidance when there was contact on only the working side canine during right or left lateral excursions

- **Incisal Guidance**: contact only occurred on the central or lateral incisors during lateral excursions

- **First premolar guidance**: contact on only the working side first premolar during excursions

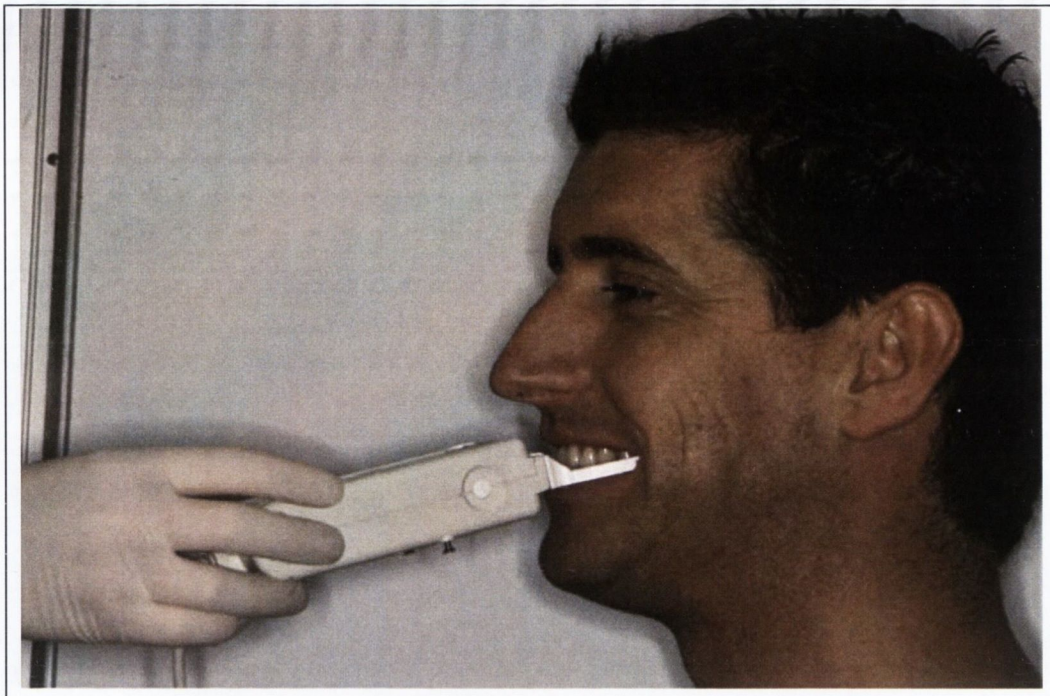
- **Group Function** was defined as multiple contact relations between the maxillary and mandibular teeth in lateral movements on the working side whereby simultaneous contact on several teeth acts as a group to distribute occlusal force. It was recorded as present when there was mutual contact on multiple teeth on the working side during excursions

- **Other**: this referred to situations when there was no contact or additional tooth contacts (i.e.) interferences during lateral excursions. An interferences is defined as any tooth contacts that interferes with or hinder harmonious mandibular movement (GPT 8)

3.9 Disclusion Time Measurement

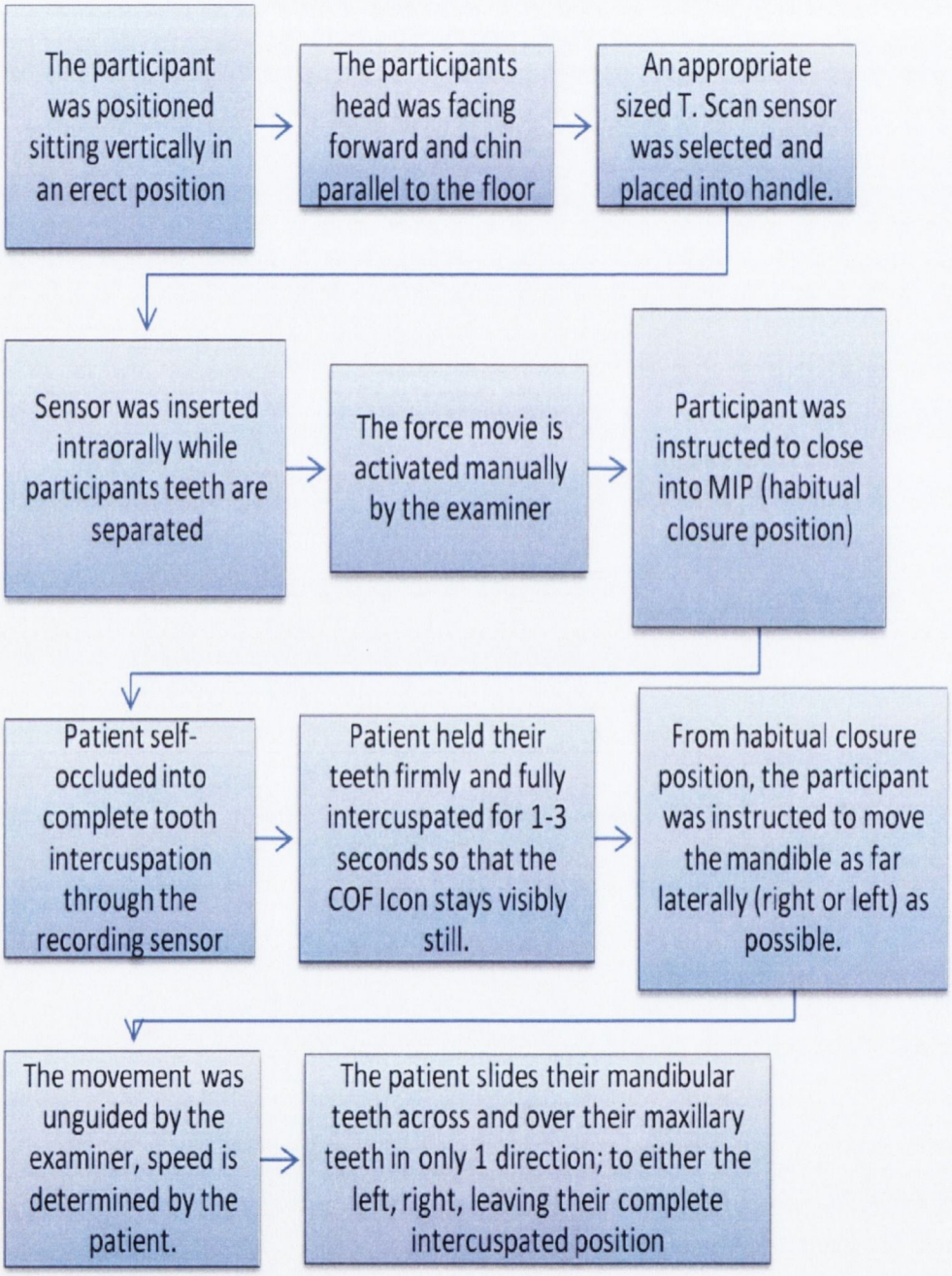
Disclusion Time is defined as the elapsed time required for a patient to exit their complete maximum intercuspation position, and move their mandible either right, left, or forward, so as to disclude (completely separate) all posterior teeth, including and behind the 1st premolar tooth, so that only the canines and/or Incisors are making tooth contact. The disclusion time measurement in this study was carried out using the T-scan® III (Tekscan, Boston) which is a computerised occlusal analysis system. This system senses, records and analyzes occlusal contact forces using disposable sensors. It also measures and records in real time the contacts occurring during excursive movements. The percentage contact force is plotted against time on a graph which illustrates contact from all 4 quadrants. Individual tooth contacts are illustrated in real time on the occlusal force movie. The photographs in Figure 3.9-1 shows a patient undergoing disclusion time measurement

Figure 3.9-1 Disclusion time measurement



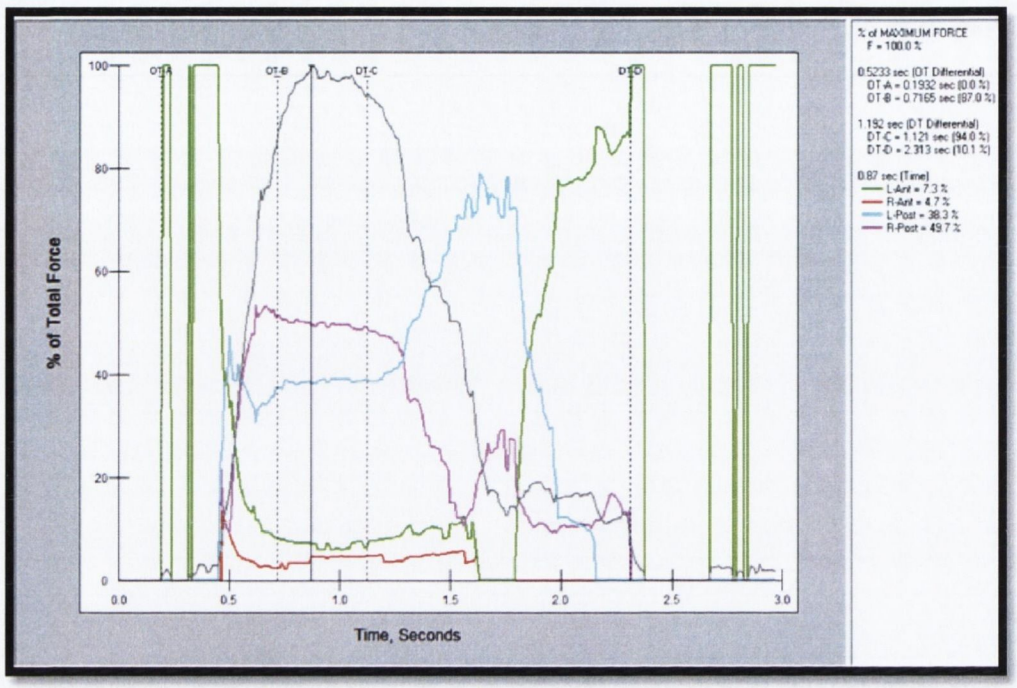
Each patient depending on maxillary arch size was allocated an appropriate T-scan sensor. The central incisor width was measured using a millimetre gauge and entered into the T-scan program to calibrate the sensor for recording. An MIP record was made to ensure that the sensor was reading the occlusal contacts and the force was standardized according to the T-scan user guide instructions. Each patient had up to three test lateral excursion movies made to ensure that they understood the instructions and were comfortable with the procedure. Both right and left lateral excursions were then recorded. The T-scan computer documents and times the occlusal contacts while the patient closes into MIP (habitual closure) and then makes unguided excursive movements (right and left). An assessment of the disclusion time was recorded for all patients for each excursion

Figure 3.9-2 Procedure for recording disclusion time



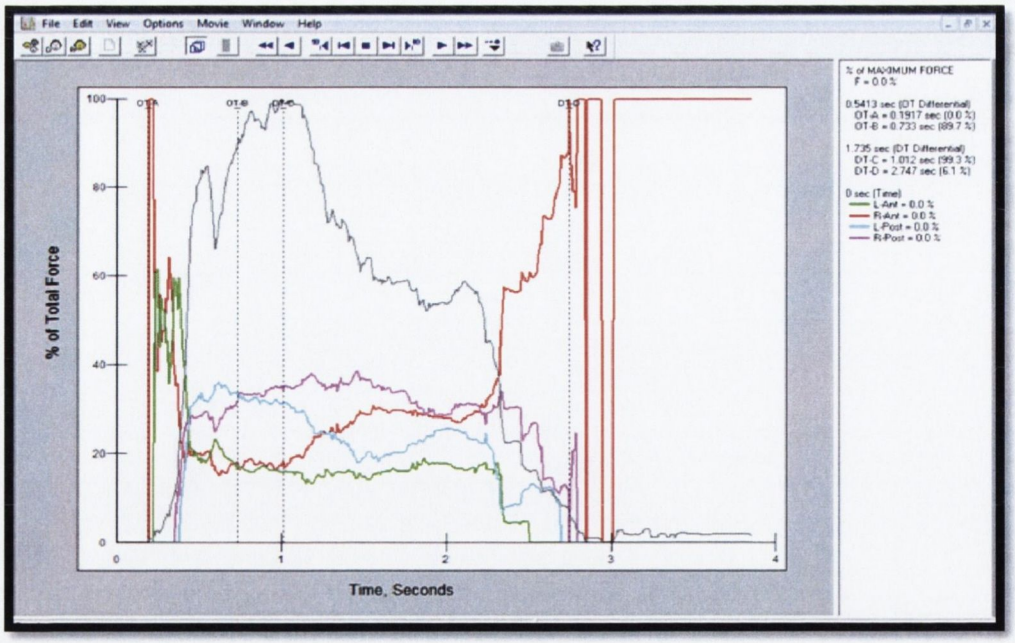
Each lateral excursion results in the production of a graph (Figure 3.9-3 & Figure 3.9-4). The graph is marked by "A" at the point of habitual closure. The "A-B" Increment / Differential lines are used to denote the start (A) and end (B) of the Occlusion time (OT-A and OT-B). The C-D Increment / Differential lines are used to denote the start and end of the disclusion time (C-start and D-end). To the right of the graph, the elapsed times are noted. These lines are used to mark two separate sets of positions (frames) of the movie. Disclusion Time is defined as "*The elapsed time required for a patient to exit their complete intercuspated position, and move their mandible either right or left, so as to disclude (completely separate) all posterior teeth, including and behind the 1st premolar*" (Kerstein, 1992). In a properly recorded excursive movement, the graph at the bottom of the playback windows has a horizontal force period during static intercuspation between B and C that results from having the centre of force icon (COF) stays still because the patient stays firmly and completely intercuspated before the excursion commences. The B-C period is over 1 second long, and that the patients Total Force line and each coloured quadrant line is horizontal for that whole time. Then at C there is a clear change in all lines that indicates true excursive commencement. When measurable disclusion is achieved, it is marked by the D line. The disclusion is calculated between C and D within the graph, and it is noted in the graph data box for examiner two to record and calculate.

Figure 3.9-3 Left disclusion time graph



Disclusion Time = (DT-D) – (DT-C) = (2.313)-(1.121) = 1.192seconds

Figure 3.9-4 Right disclusion time graph



Disclusion time = (DT-D) – (DT-C) = (2.747) – (1.012) = 1.735 seconds

4 Analysis

4.1 Fonseca's Questionnaire

The results of Fonseca's questionnaire were analyzed by evaluating each participants score and recording an absence or presence of TMD. When present, TMD was categorized as mild, moderate and severe. The frequency of each diagnosis was calculated for each group, as was the occurrence of TMD versus no TMD. The frequency of TMD was compared between the CDH and control groups using the chi-square test. Significance level was set at 5%. The sensitivity and specificity of Fonseca's questionnaire in finding a presence or absence of TMD was tested against the result of the RDC/TMD. Sensitivity (Sn) and specificity (Sp) as well as the positive predictive value (PPV) and negative predictive value (NPV) was calculated as illustrated in table 4.1-1 (Altman and Bland, 1994).

Table 4.1-1 Calculation of diagnostic value of Fonseca's questionnaire

		RDC/TMD Diagnosis of TMD		
		+	–	
Fonseca's Questionnaire (mild, moderate, severe TMD)	+	True Positives	False Positives	Positive predictive value = TP / (TP + FP)
	-	False Negatives	True Negatives	Negative Predictive value = TN / (FN +TN)
		Sensitivity = TP / (TP+FN)	Specificity = TN / (FP + TN)	

4.2 Analysis of RDC/TMD Biobehavioural Questionnaire (axis II)

4.2.1 Chronic pain related disability grade

If the participant reported any pain in the previous six month the results from the questionnaire were recorded according to the axis II scoring protocol for graded chronic pain (Dworkin, 1992). A chronic pain grade and a depression and non-specific symptom check list, was calculated for each participant as specified in the scoring system (Appendix 8.7).

Chronic Pain grade classification:

- Grade 0 No TMD pain in prior 6 months

Low Disability

- Grade I Low Intensity Characteristic Pain Intensity < 50, and less than 3 Disability Points
- Grade II High Intensity Characteristic Pain Intensity > 50, and less than 3 Disability Points.

High Disability.

- Grade III Moderately Limiting 3 to 4 Disability Points, regardless of Characteristic Pain Intensity.
- Grade IV Severely Limiting 5 to 6 Disability Points regardless of Characteristic Pain Intensity

The chronic pain related disability scores obtained by CDH participants was compared to that of the control group, taking into account the presence or absence of TMD. Significance was tested for with Pearson's Chi square test. The level of statistical significance was set at $P<0.05$.

4.2.2 Depression and Non-Specific Physical Symptoms Scale

A list of 49 questions are answered, 20 of which refer to depression the rest of which relate to non specific symptoms. Answers to those relating to depression are are scored as follows: Not at all=0; A little bit=1; moderately=2; Quite a bit=3; extremely=4. Enter "Total Score" below. The total for the 20 items related to depression are calculated and divided by 20 providing a score between 0 and 4 (Appendix 8.7)

<1 = not depressed

1-4 = depressed (mild - severe)

The incidence of depression amongst the CDH and control groups were compared as was the incidence of depression between the TMD positive and TMD negative individuals. Significance was tested for with Pearson's Chi square test. The level of statistical significance was set at $P<0.05$.

4.3 RDC/TMD Clinical Examination (axis I)

Observed signs and symptoms were recorded by standardized procedures outlined in the RDC/TMD specifications. The RDC/TMD uses specific algorithms that define 3 diagnostic groups (group 1-3) of TMD (Appendix 8.7). This is further subdivided into 8 subgroups dealing with only the more common forms of TMD for research purposes (Table 3.7-1). Each participant found 'positive' for TMD fell into to one or more of these categories. Participants who did not fall into any of these categories were considered 'negative' for TMD. Comparison of the incidence of positive TMD diagnoses between CDH and control groups was performed. Descriptive statistics were used to compare incidence of various TMD subgroups. Significance was tested for with Pearson's Chi square test. The level of statistical significance was set at $P<0.05$.

4.4 T-scan Analysis

The incisal relationship, lateral guidance scheme and disclusion time (seconds) for both right and left lateral excursion is recorded and mean disclusion time and standard deviations were calculated for CDH, control, TMD positive and TMD negative groups. Results for each excursion are divided into two groups for analysis: Short disclusion time i.e. disclusion time less than 0.5 seconds (<0.5 sec) and long disclusion time i.e. disclusion time of greater than 0.5seconds (>0.5secs). Those unable to carry out disclusion due to being edentulous or an inability to perform the desired movements were excluded from analysis. The proportion of all excursions, with a disclusion time above or below 0.5seconds, in each group, was compared according to the following factors:

- TMD status (positive, negative, axis 1, axis 2, axis 3 diagnosis)
- CDH status
- Incisal relationship (class I, class II div1, class II div 2, class III)

- Guidance scheme (canine guidance, first premolar guidance, group function, incisal guidance)

The difference between the proportion of excursions above and below 0.5seconds in each group were compared to each other and significance was tested for with Pearson's Chi square test. The level of statistical significance was set at $P<0.05$, trends were illustrated using descriptive statistics.

5 Results

5.1 Participant information

A total of 173 participants completed Fonseca's questionnaire: 115 controls and 58 with CDH. Of the 115 controls, 46 were willing to attend a clinical appointment. Four of these were later excluded due to a history of head/neck injury and 6 were over 75 years of age. 45 from the CDH group were willing to attend for RDC/TMD. Four were excluded due to the presence of abnormal neurological signs and 3 because they were less than 18 years of age. Thus, 36 controls and 36 CHD sufferers attended the clinical appointment and completed the RDC/TMD (Table 5.1-1). The CDH group was aged 18-65 (mean 40 years) and the control group was aged 18-73 (mean 44 years). Females were over-represented in the CDH group with 32 (89%) compared to only 4 (11%) males. The control group consisted of 24 (61%) males and 14 (39%) females.

Table 5.1-1 Clinical examination participant information

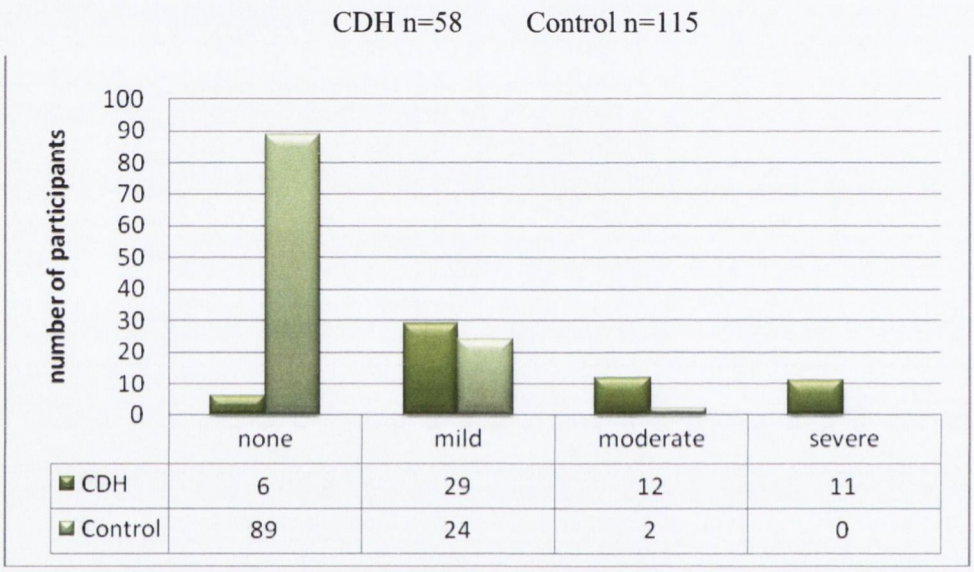
	CDH	Control
number	36	36
female	32	14
male	4	22
mean age	40.03	44.43

The T-scan Disclusion time analysis was attempted on all 72 individuals who attended the clinical appointment. Three were completely edentulous and were subsequently excluded, 4 were excluded as they were unable to follow the desired instructions to obtain an accurate reading despite numerous test attempts. Two individuals were only capable of carrying out one excursion in one direction due to an inability to carry out the desired excursion in the opposite direction as instructed. In total 128 lateral excursions were recorded on 65 participants.

5.2 Fonseca's Questionnaire Results

Fonseca's Questionnaire was completed by 115 non headache sufferers and 58 frequent headache sufferers. Each participant was scored and attributed as having no, mild, moderate or severe TMD according to the anamnestic index. The percentage of each group attributed to each category are illustrated in Figure 5.2-1.

Figure 5.2-1 Results of Fonseca's screening Questionnaire



Of the 72 participants who attended the clinical exam the following table illustrates the results of Fonseca's questionnaire for those individuals (Figure 5.2-1)

Table 5.2-1 Fonseca's questionnaire results of participants attending the clinical examination (n=72)

	CDH	Control
No TMD	10	25
Mild TMD	14	9
Moderate TMD	6	2
Severe TMD	7	0

5.3 Research Diagnostic Criteria for Temporomandibular Disorders Results

The RDC/TMD was completed by 36 controls and 36 CHD sufferers. It identified TMD in 22 (61%) of the CDH group (mean age 41.5 years of which only 2 were male). Six (16.6%) of the control group had an identifiable TMD (mean age 55.5 years; 2 male and 4 female). This is illustrated in Table 5.3-1

Table 5.3-1 TMD prevalence according to RDC/TMD

	CDH	CONTROL	Total
TMD	22	6	28
NO TMD	14	30	44
Total	36	36	
Pearson X^2	X_2= 13, DF = 1, p-value < 0.001		

Pearsons Chi-squared test found a highly significant association between TMD and CDH (X_2= 13, DF = 1, p-value < 0.001). There was no significant association between age group and CDH (X_2= 0.6, DF = 2, p-value = 0.7), nor age group and TMD status (X_2= 0.3, DF = 2, p-value = 0.9).

5.4 Gender and TMD

There was a highly significant association between CDH and the female gender (X_2 = 17, DF = 1, p-value > 0.0001) as shown in table 5.4-1. A less significant association was observed between TMD and female gender as illustrated in table 5.4-2

Table 5.4-1 Gender and CDH

	CDH	Control	total
female	32	14	46
male	4	22	26
total	36	36	
Pearsons X^2	(X_2 = 17, DF = 1, p-value=3.031e-05)		

Table 5.4-2 Gender and TMD

	TMD	NO TMD	total
female	24	22	46
male	4	22	26
total	28	44	
Pearsons X^2	(X^2= 7.9754, df = 1, p-value = 0.004742)		

As the over representation of females in the CDH group may have skewed the association between CDH and TMD, the data was subsequently corrected to gender-balance the two groups. This was done by equalising the proportion of male to female in each group by randomly eliminating some males from the control group and females from the CDH group. On testing the difference in TMD incidence between the CDH and control group after gender balancing, a Chi-squared test still revealed a significant association between CDH and TMD (Table 5.4-3)

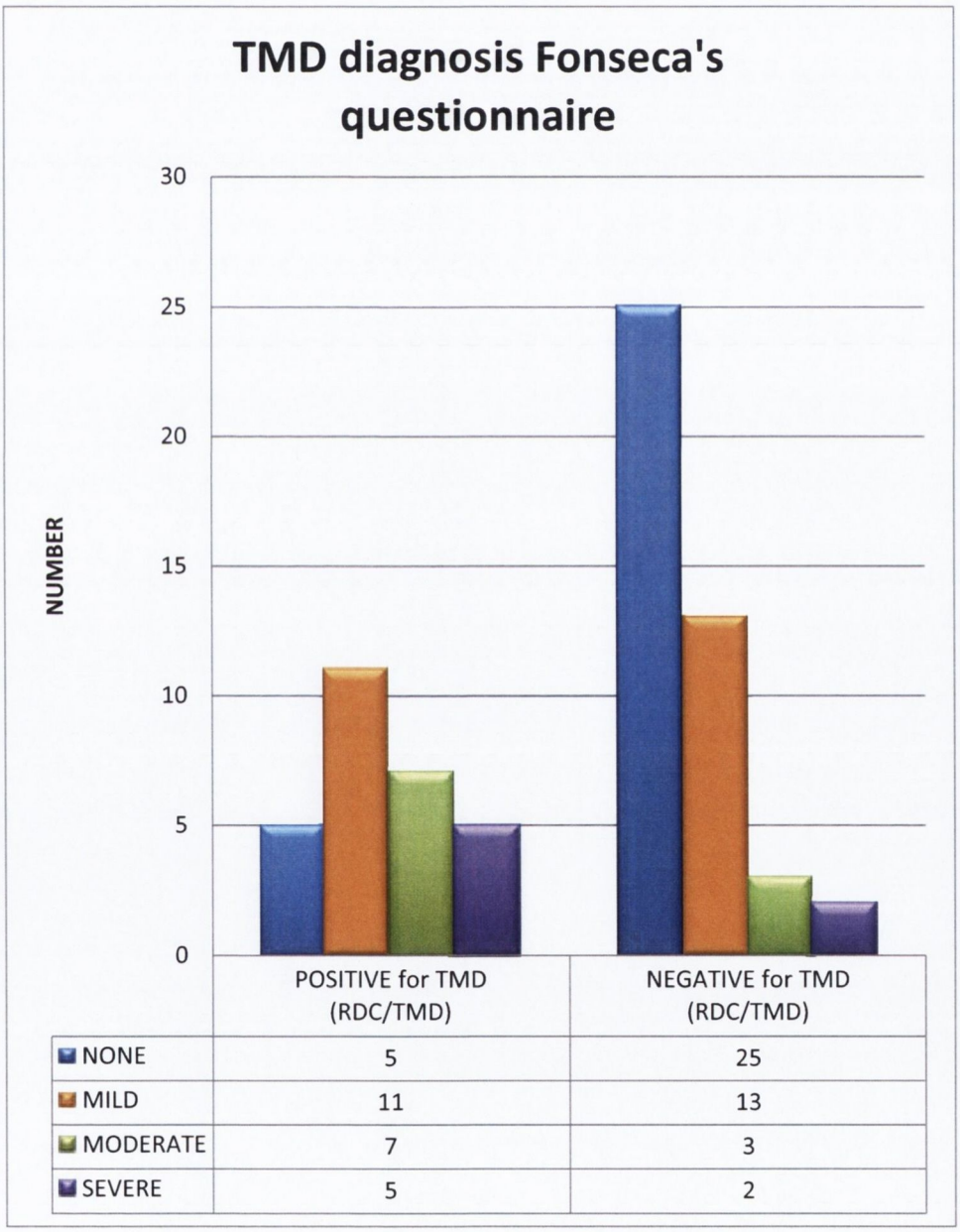
Table 5.4-3 CDH and TMD in gender balanced groups
(cdh n=24 and control n=27)

	TMD	No TMD	total
Control	5	15	20
CDH	19	12	31
total	24	27	
Pearson X^2	X^2= 5.0523, df = 1, p-value = 0.02459		

5.5 Concordance between Fonseca's questionnaire and RDC/TMD

The results from Fonseca's questionnaire obtained by the participants who completed the RDC/TMD were compared. Table 5.5-1 illustrates the relationship between the results of Fonseca's questionnaire with findings of the RDC/TMD.

Table 5.5-1 Concordance of Fonseca's Questionnaire and RDC/TMD in TMD diagnosis



5.6 Sensitivity and Specificity of Fonseca's Questionnaire

Table 5.6-1 outlines the calculation of sensitivity (Sn), specificity (Sp), positive predictive value (PPV), and negative predictive value (NPV) of Fonseca's questionnaire finding mild, moderate or severe TMD in participants who were diagnosed with a form of TMD. The sensitivity of Fonseca's questionnaire was high at 0.82 (82%) with slightly poorer specificity of 0.58 (58%). The PPV of Fonseca's questionnaire was 0.56 (56%); The NPV was 0.83 (83%). Most false positives fell into the mild TMD category (12 out of 18 FP). When Fonseca's questionnaire results suggested moderate or severe TMD, the PPV increased to 0.70 (70%). Similarly, those found with none or mild TMD had a negative predictive value of 0.70 (70%).

Table 5.6-1 Diagnostic value of Fonseca's Questionnaire, calculation of sensitivity (Sn), specificity (Sp), positive & negative predictive value (PPV & NPV)

		RDC/TMD Diagnosis of TMD		
		+	–	
Fonseca's Questionnaire (mild, moderate, severe TMD)	+	TP =23	FP=18	PPV = TP / (TP + FP) = 0.56
	-	FN=5	TN=25	NPV = TN / (FN +TN) = 0.83
		Sn = TP / (TP+FN) = 0.82	Sp = TN / (FP + TN) = 0.58	

5.7 Types of TMD

There was a marked difference in the distribution of TMD subgroups between the CDH and control group as illustrated in figure 5.7-1. Group I diagnosis represented muscular disorders, Group II represented disc related disorders, Group III represented degenerative, arthritic or inflammatory changes in the TMJ. The 6 individuals within the control group who were diagnosed as positive for TMD displayed only 2 types of TMD; 3 had disc displacement with reduction and co-existent osteoarthrosis; 2 had disc displacement with reduction alone; and 1 had osteoarthrosis. The 22 individuals from the CDH group found 'positive' for TMD displayed a much wider variety of conditions. The most prevalent TMD in the CDH group was myofascial pain (29% of cases), followed by arthralgia and disc displacement with reduction (see table 5.7-1). Some individuals were diagnosed with more than one TMD as illustrated in table 5.7-2.

Figure 5.7-1 TMD subtypes in CDH and control groups

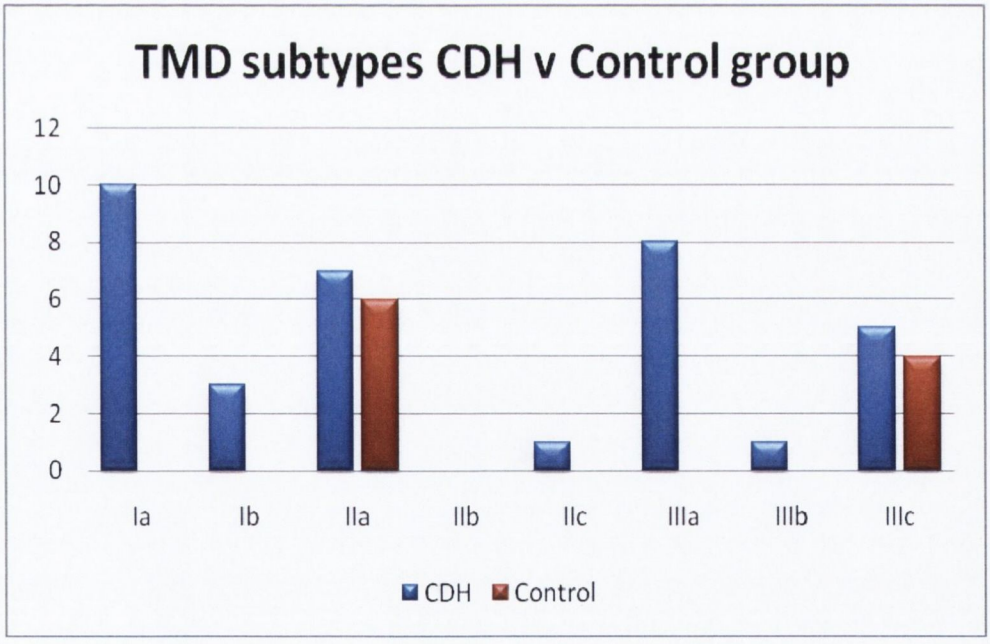


Table 5.7-1 TMD subtypes in the CDH and control group

RDC/TMD Diagnosis	CDH	CONTROL
Group Ia = Myofascial pain	10	0
Group Ib = Myofascial pain with limited opening	3	0
Group IIa = DD with reduction	7	6
Group IIb = DD without red and limited opening	0	0
Group IIc = DD without reduction without limited opening	1	0
Group IIIa = Arthralgia	8	0
Group IIIb = Osteoarthritis	1	0
Group IIIc = Osteoarthrosis	5	4

Table 5.7-2 TMD subtypes combinations within individuals

TMD Sub-groups	CDH	Control
Ia	5	
Ia,IIIa	2	
Ia, IIa, IIIa	2	
Ib,IIIa	1	
Ib,IIIa	2	
Ib, IIc, IIIc, IIIb	1	
IIa	3	2
IIa,IIIa	2	
IIIc	4	1
IIa,IIIc		3

5.8 Chronic pain grade classification (axis II)

Thirty-two of the CDH group reported facial pain according to the RDC/TMD axis II chronic pain grade classification (3 male, 29 female). Only 2 of the control group reported chronic facial pain (both female). Chronic pain is graded by RDC/TMD by severity from grade I-V. Table 5.8-1 illustrates the distribution of chronic pain grades 0-IV between the Control and CDH group. Pearson's Chi square test suggested a very significant association between an absence of CDH and no chronic pain related disability, and a strong relationship between grade II disability in patients with CDH (X_2= 50, DF = 4, p-value < 0.0001), A significant association was also found between grade I disability in TMD patients (X_2= 19, DF = 4, p-value > 0.001). In the gender balanced group a highly significant association between no chronic pain related disability and the absence of CDH was found by Fishers exact test (X^2= 30 df = 4, p-value =<0.005), however numbers were too small to test for a significant relationship between the various disability grades and CDH or TMD status.

Table 5.8-1 Chronic pain related disability score

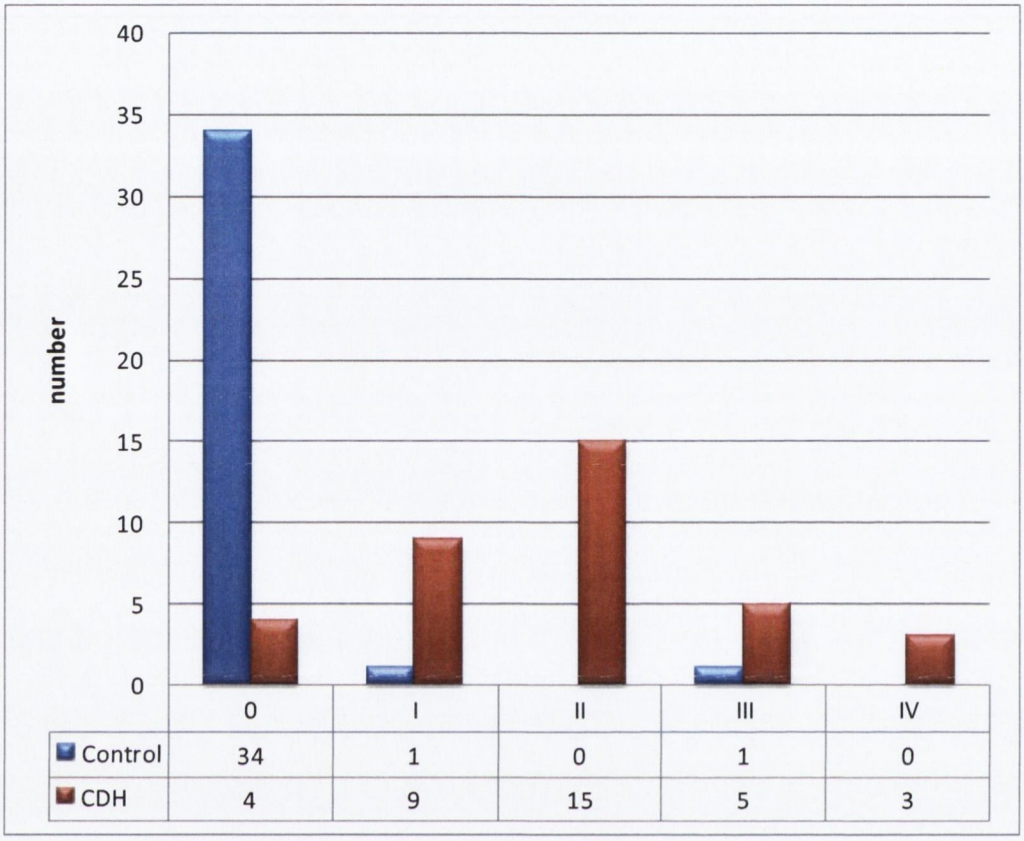
DISABILITY SCORE	DEFINITION
0	no TMD pain (6 months prior)
I	low disability /low intensity
II	low disability/ high intensity
III	high disability/moderately limiting
IV	high disability severely limiting

Table 5.8-2 Chronic pain related disability in CDH and control groups

Disability grade	Control	CDH	total
0	34	4	43
I	1	9	9
II	0	15	13
III	1	5	5
IV	0	3	2
Total	36	36	72
Pearson X^2	X^2 = 50.7509, df = 4, p-value = 2.516e-10		

Figure 5.8-1 Chronic pain related disability in CDH and control group

from 0=none to grade IV = most severe

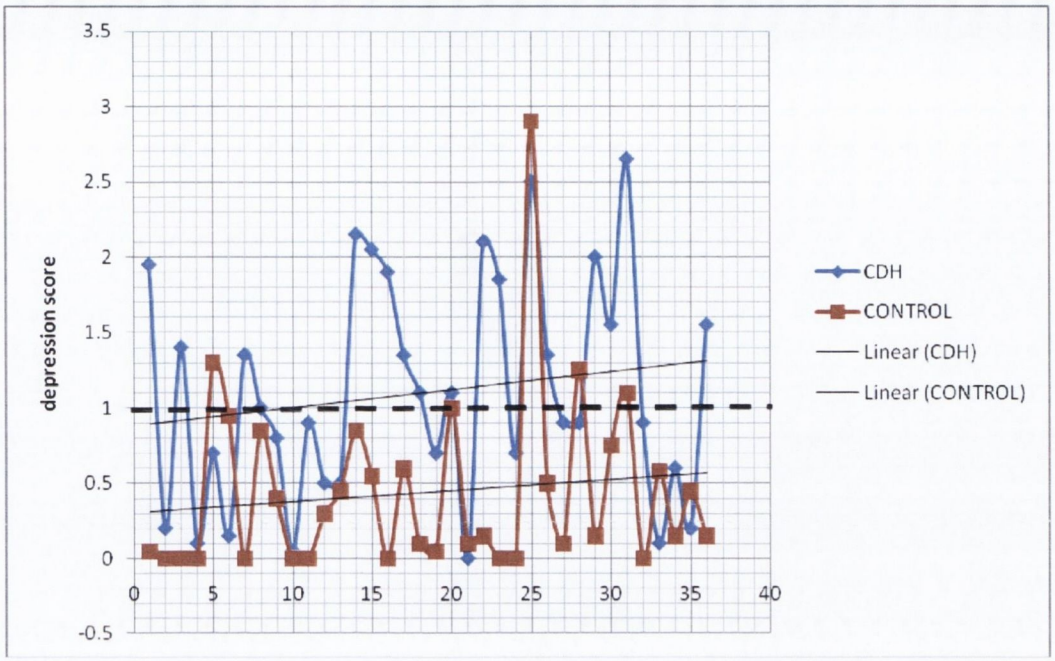


	0	I	II	III	IV
Control	34	1	0	1	0
CDH	4	9	15	5	3

5.9 Depression Score (axis II)

All participants completed the scale for depression and non-specific symptoms. The mean depression score obtained by the CDH group was 1.1 +/- 0.7, compared to 0.4 +/- 0.5 for the control group. The following graph illustrates the distribution of depression scores obtained by individuals from each group. It shows that the majority of the control group fall below 1 compared to the CDH group where the line of best fit exceeds 1 (**Figure 5.9-1**)

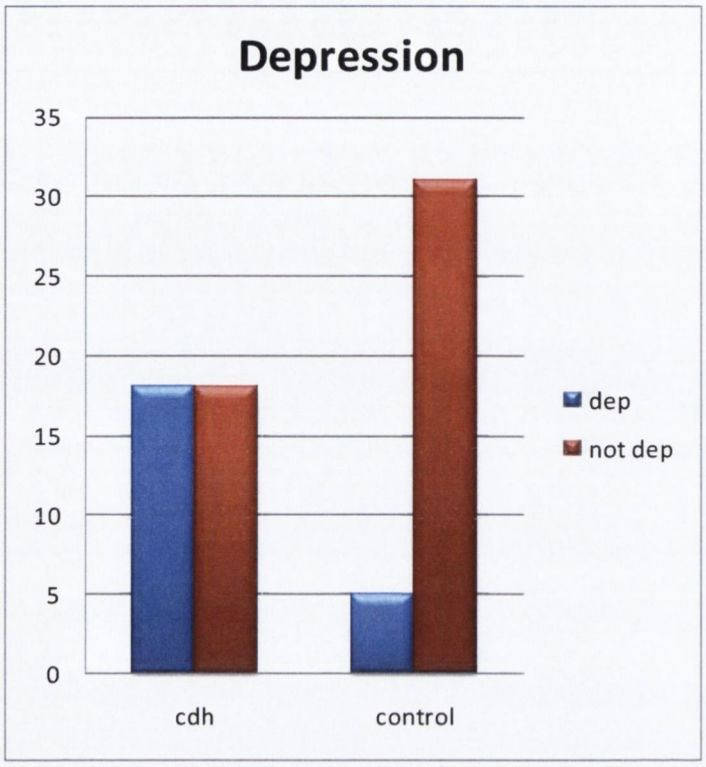
Figure 5.9-1 Depression scores CDH compared to Control group



Those who scored 1 or greater were considered depressed those less than 1 not depressed and results are illustrated in figure 5.9-2. In the control group, 5 (13.8%) individuals showed a significant depression score, only one of whom was positive for TMD. The TMD status of those positive and negative for depression is illustrated in table 5.9-1 for the CDH group and table 5.9-2 for the control group.

A significant association was observed between CDH and depression (X_2 = 9, df = 1, p-value = 0.002). In the CDH group, 18 individuals (50%) scored 1 or greater suggestive of the presence of significant depression. Ten of these had no TMD and 8 were diagnosed with TMD by RDC/TMD. There was no significant association between TMD and depression in the CDH group (Table 5.9-1). The absence of TMD in the control group was significantly associated with "no depression" (Table 5.9-2). In the gender balanced group there was no significant association between CDH status and depression (X^2= 3.0 df = 1, p-value = 0.08) or TMD status and depression (X^2 = 0.1, df = 1, p-value = 0.7).

Figure 5.9-2 Depression presence and absence Control v CDH



	CDH	Control	
Depression	18	5	23
No depression	18	31	49
	36	36	
Pearsons X^2	$X^2 = 9$, df = 1, p-value = 0.002		

Table 5.9-1 TMD and depression status in the CDH group

	CDH		Total
	TMD	**NO TMD**	
Depression >1	10	8	**18**
No depression	11	7	**18**
Total	21	15	
Pearsons X^2	$X^2 = 0$, df = 1, p-value = 1		

Table 5.9-2 TMD and depression status in the Control Group

	Control		Total
	TMD	**No TMD**	
Depression >1	1	4	5
No Depression	6	24	30
Total	7	28	
Pearsons X^2	$X^2 = 0.3307$, df = 1, p-value = 0.5653		

5.10 Logistic regression analysis

A logistic regression analysis was carried out with CDH as the dependant variable. The following independent binary variables were tested for, age, sex, the presence of TMD, depression, chronic pain related disability. Significant variables were carried forward to the final model. In the final model (table 5.10-1) Only the presence of chronic pain related disability was definitively predictive of CDH. It is note worthy that the very wide confidence interval suggest uncertainty in this finding.

Table 5.10-1 Logistic regression analysis CDH dependant variable

Initial model

CDH	Estimate	Standard Error	Z value	P value
Age	-0.01028	0.03196	-0.322	0.747707
Sex	-0.98084	1.03047	-0.952	0.341182
TMD	1.00418	1.01283	0.991	0.321458
Depression	-0.36258	1.27831	-0.284	0.776685
Disability	4.46206	1.17027	3.813	0.000137*
Significance level = 0.001*				

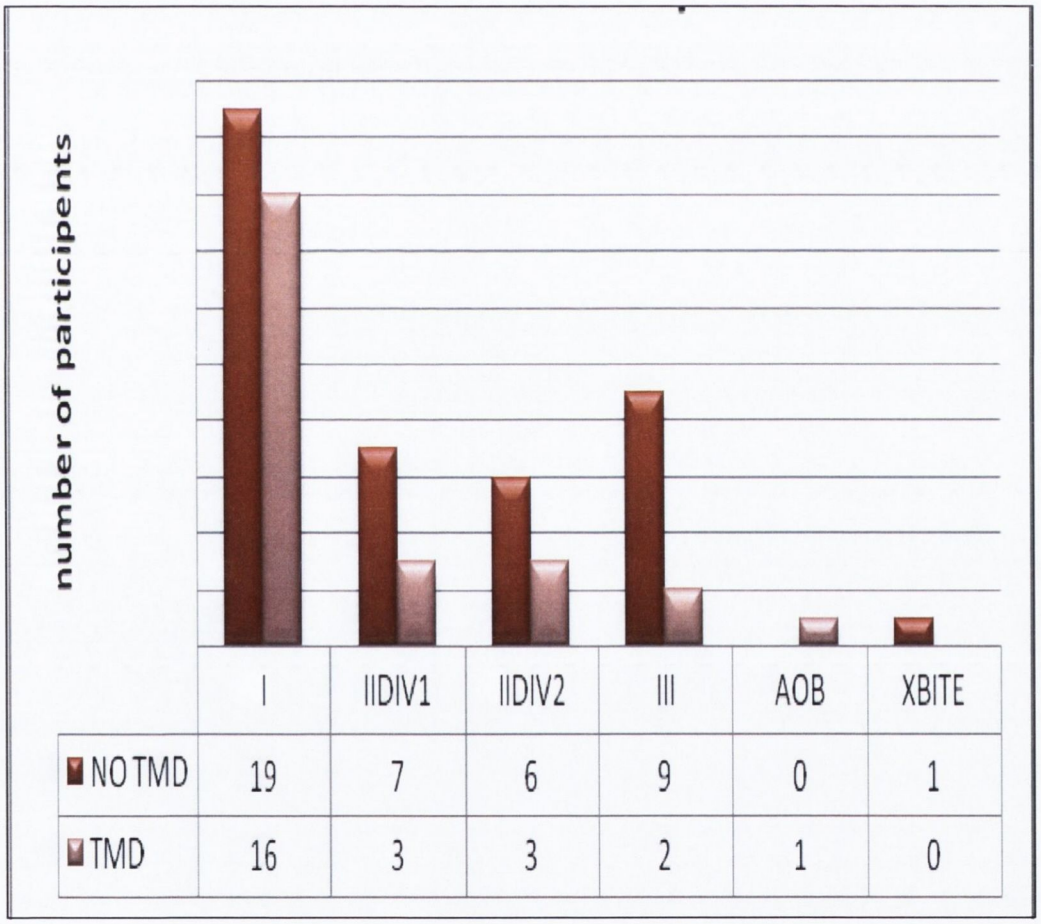
Final model

CDH	estimate	Std error	P value	Odds Ratio	Confidence interval
Disability	4.9	0.9	0.0005	136	23.29-794.19

5.11 Occlusal analysis

Thirty five participants had a class I incisal relationship, ten were class II division 1, nine were class II division 2, eleven were class III. One participant was class II with an anterior open bite, another was class III with an anterior unilateral cross bite. The relationship between TMD status and dental incisal relationship is illustrated in Figure 5.11-1.

Figure 5.11-1 Incisal relationship and TMD status

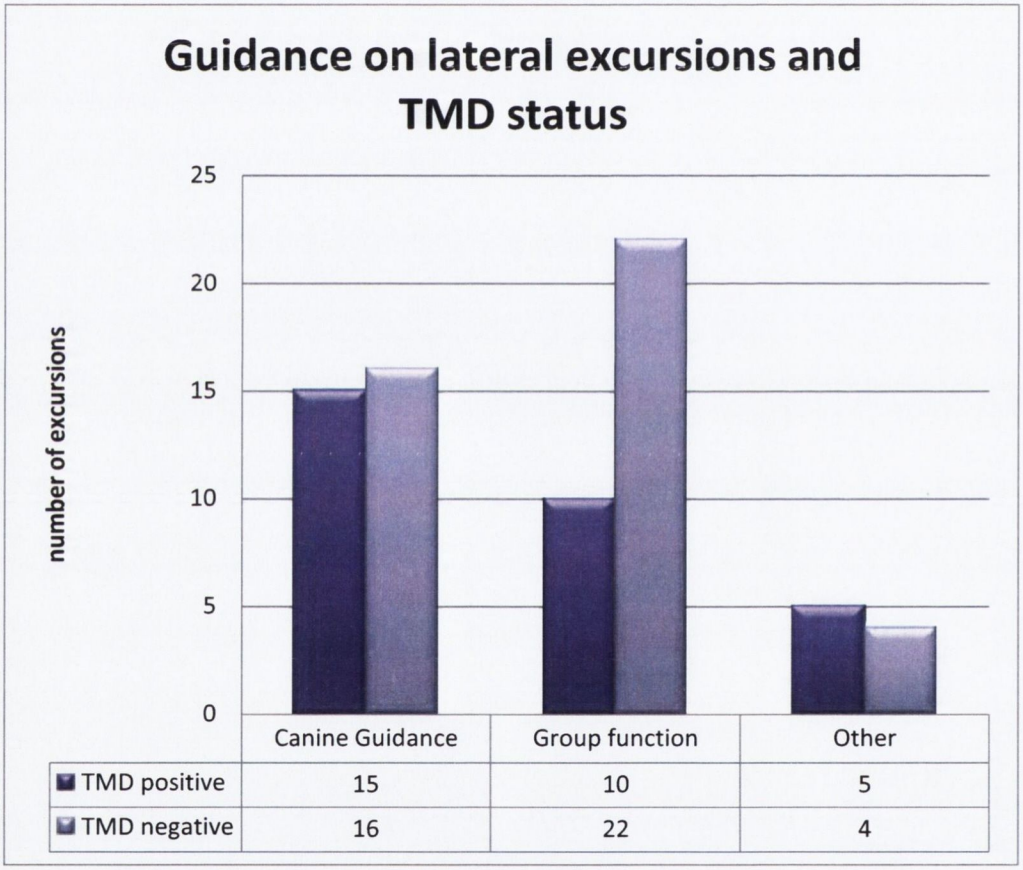


	I	IIDIV1	IIDIV2	III	AOB	XBITE
NO TMD	19	7	6	9	0	1
TMD	16	3	3	2	1	0

5.12 Guidance Scheme

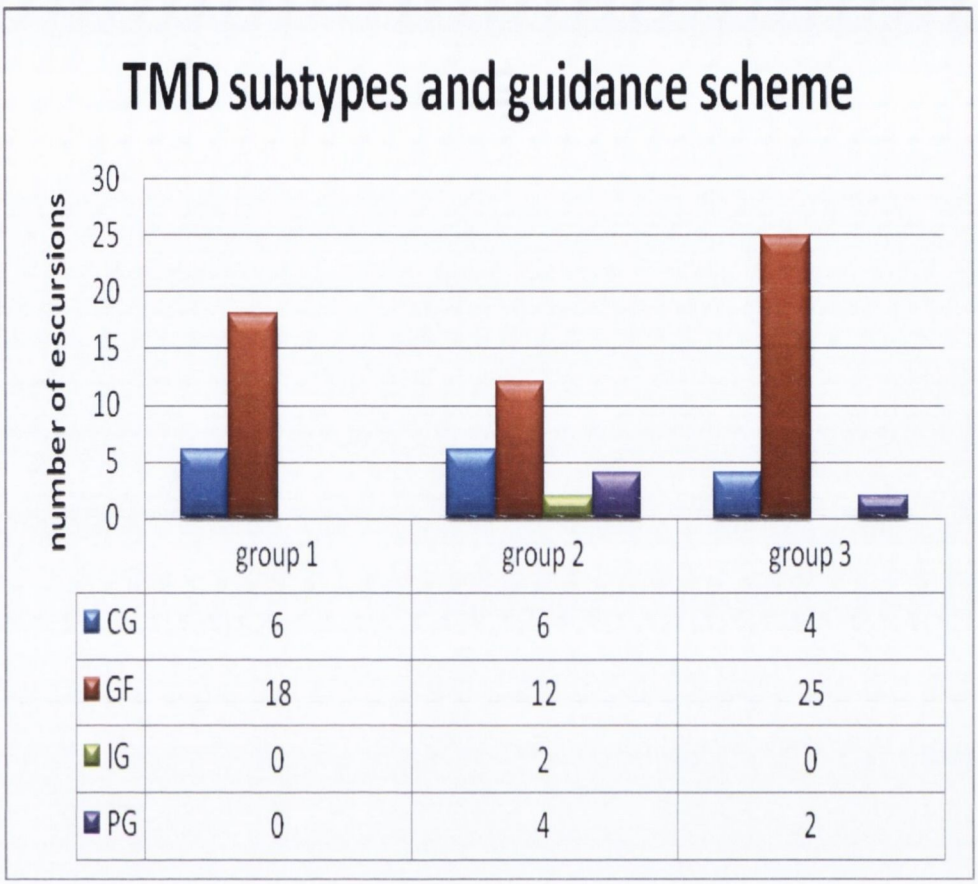
43% of participants had canine guidance in one or both of their lateral excursions (n=31), group function was found in 43.5% of individuals (n=32), Guidance on the first premolar was present bilaterally in three individuals, incisal contact during lateral excursions was evident in two individuals. The relationship between TMD status and the form of guidance on lateral excursions is represented in Figure 5.12-1 where the guidance scheme seen in TMD positive and negative individuals is presented as canine guidance group function and other (1st premolar guidance, incisal guidance etc)

Figure 5.12-1 Guidance scheme and TMD status



Of those individuals diagnosed as TMD positive they were assigned a group 1, 2 or 3 diagnoses. Group 1 being myofascial pain with or without limited opening, group two being disc displacement with or without reduction and group three being, arthralgia, osteoarthrosis or osteoarthritis. The following graph figure 5.12-2 illustrates the lateral guidance schemes found in these TMD positive individuals.

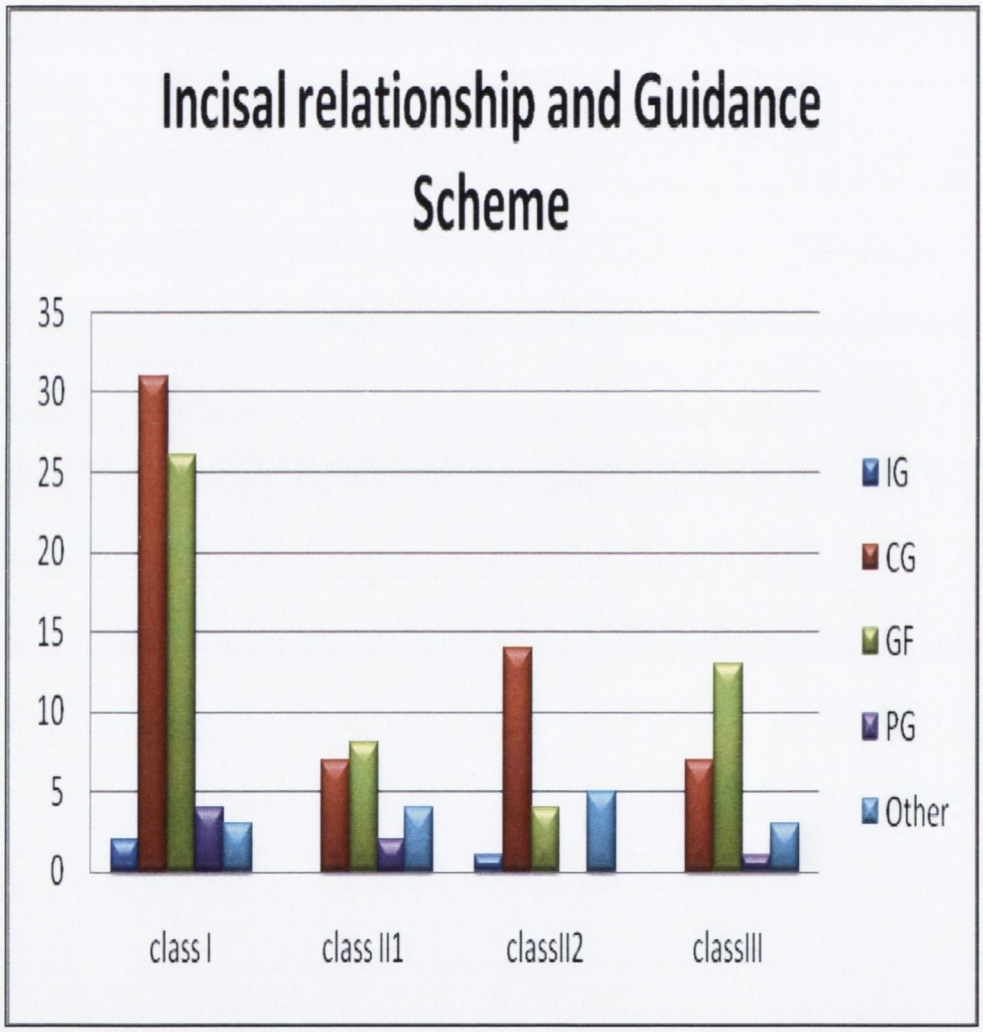
Figure 5.12-2 Guidance scheme found in TMD positive Subgroups (group 1,2,3)



The incisal relationship may have an impact on the lateral guidance scheme, the relationship between lateral guidance scheme and incisal relationship is illustrated over leaf in figure 5.12-3.

Figure 5.12-3 Incisal relationship and guidance scheme in lateral excursions.

	Class I	Class II1	Class II2	Class III
Incisal guidance (IG)	2	0	1	0
Canine guidance (CG)	31	7	14	7
Group Function (GF)	26	8	4	13
Premolar guidance (PG)	4	2	0	1
Other	3	4	5	3

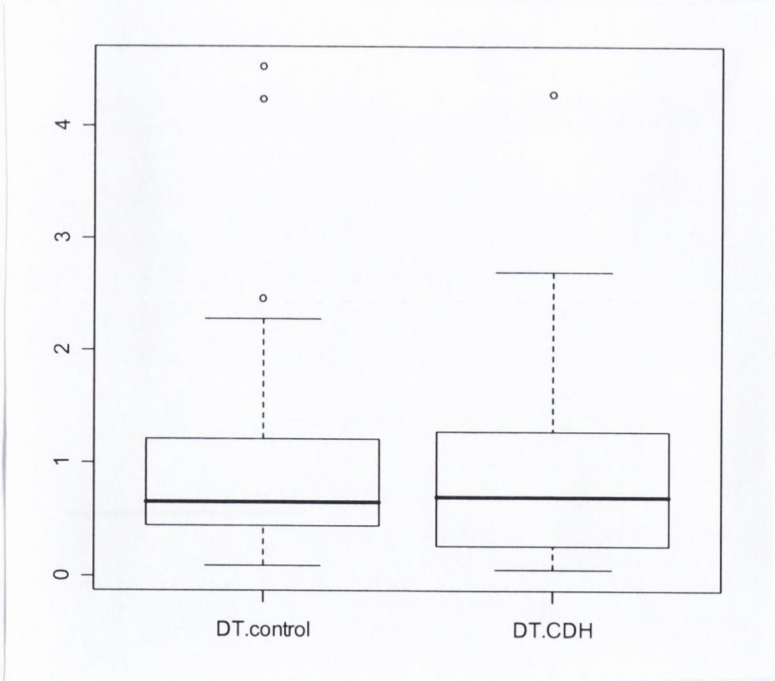


5.13 T-scan Results

The T-scan disclusion time analysis was attempted on all 72 individuals, 3 were completely edentulous and were subsequently excluded, four were excluded as they were unable to follow the desired instructions to obtain an accurate reading despite numerous test attempts. Two individuals were only capable of carrying out one excursion in one direction (when excursions in both directions were requested due to an inability to carry out the desired excursion in the opposite direction as instructed. In total 128 lateral excursions were recorded on 65 participants.

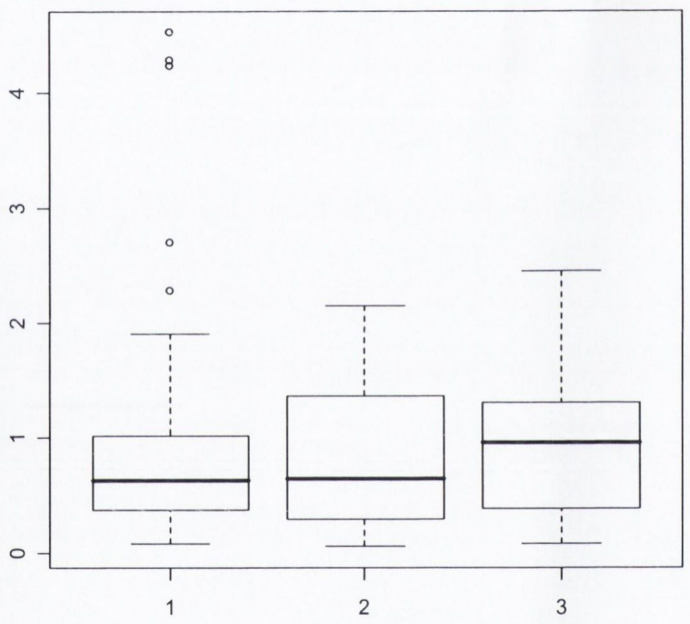
The mean disclusion time for all participants was 0.9 seconds (SD=0.8). The mean disclusion time for TMD positive participants was 0.90 seconds (SD=0.63), and it was similar for non TMD participants at 0.89 seconds (SD=0.87). Disclusion times are recorded in the box plot below figure 5.12-1

Figure 5.13-1 box plot of disclusion times for control group compared to CDH



there was no significant difference in the mean disclusion time for TMD positive and non TMD groups (W = 1773, p-value = 0.47). Figure 5.12-2 is a box plot of the mean disclusion time for TMD negative participants, those with a positive group I diagnosis i.e. muscular TMD (i.e. Myofascial pain with or without limited opening), group II & III diagnosis (disc displacements and degenerative TMDs).

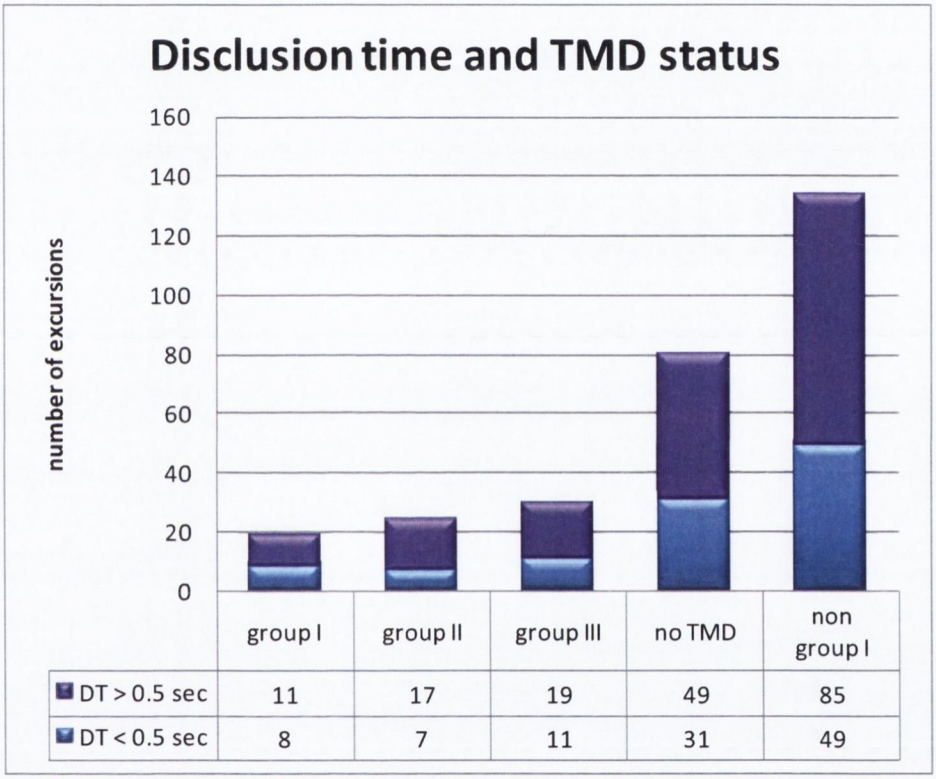
Figure 5.13-2 Box plot of mean disclusion time for muscular TMD (group I), articular TMD (group II,III), and non TMD groups



1	No TMD
2	Group I positive (Muscular TMD)
3	Group II & III positive (Articular TMD)

positive group 1 diagnosis mean disclusion time and that of other forms of TMD (W = 302.5, p-value = 0.6454). A disclusion time of less than 0.5 seconds is suggested to be associated with remission of symptoms of myofacial pain dysfunction. Disclusion times were examined for each group according to whether or not they were greater than or less than 0.5 seconds. The proportion of total excursions greater than, or less than 0.5 seconds according to TMD diagnosis are illustrated below in figure 5.13-3.

Figure 5.13-3 Disclusion time and TMD status



6 Discussion

6.1 Outline of the study

Chronic daily headache and temporomandibular disorders are relatively common Sufferers of either condition often present with persistent pain that may be difficult to manage. The aetiology of these complex conditions is still misunderstood, with multiple theories and recommended treatment approaches. A misdiagnosis of either condition may result in poor management and as such validated diagnostic techniques are crucial to management. The relationship between headache conditions and TMD had been addressed in the literature with attempts made to identify a relationship if any, between the two conditions. In this study an attempt to definitively identify TMD in a CDH population was completed using the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) which is widely accepted internationally for diagnosis of TMD in research.

A group of diagnosed chronic daily headache patients were compared to a non headache control group. Firstly all participants completed a self administered simple questionnaire "Fonseca's questionnaire" which using an index and scoring system classified respondents as having "no TMD", "mild TMD", "moderate TMD" or "severe TMD" (Table 3.4-1). Thirty six consenting individuals from each group participated in a clinical appointment were the RDC/TMD was carried out (see appendix 8.7). The RDC/TMD generated a TMD diagnosis based on axis 1 and axis 2 factors. The axis I element revealed any underlying dysfunction due to TMD, diagnosing the eight most common TMD sub-types, these were divided into three groups: group 1 (muscular), group 2 (disc displacements), group 3 (degenerative. arthritic) conditions. Axis 2 findings highlighted any underlying chronic pain related disability due to the temporomandibular disorders, and generated a depression score via the SLC-90 (symptom check list -90). At the clinical appointment a simple occlusal analysis was conducted and each patient's incisal relationship according to the British Standards Institute classification was recorded. The teeth contacting in lateral guidance were recorded and guidance was classified into incisal guidance (IG), canine guidance (CG), first premolar guidance (PG), Group function (GF) or other. A T-scan movie was generated for each participant where possible in both right and left lateral excursions. The disclusion time was measured and recorded in both.

6.2 Diagnosis of TMD

6.2.1 Fonseca's qustionnaire

Fonseca developed his questionnaire in 1992 (Fonseca, 1992). It identifies signs and symptoms of TMD and classifies participants as having none, mild, moderate or severe TMD. Previous authors utilising this questionnaire claimed a reliability of 95% and a strong correlation with Helkimo's index ($r = 0.6169$, $p < 0.05$)(de Oliveira et al., 2006, Bevilaqua Grossi et al., 2006). However its concordance with the RDC/TMD, had not been tested prior to this study. Fonseca's questionnaire is a much simpler, more user friendly and time efficient method of identifying TMD. It does not require a clinical examination and although it does not attempt to reveal specific forms of TMD it gives an indication of severity. It is not influenced by the examiner, as it is completely self administered. This form of simple questionnaire may have value in flagging a possible TMD during the early stages of orofacial pain diagnosis. This may be particularly useful in a medical, or neurology setting.

Fonseca's questionnaire was completed by 58 CDH sufferers and 115 controls. According to Fonseca's questionnaire the majority of controls (77%) had no TMD. Of the 23% of controls with TMD the majority fell into the "mild TMD" category. Conversely according to Fonseca's questionnaire 87% of the CDH group were positive for TMD with 50% of them scoring "mild TMD" with a further 37% falling into the "moderate or severe TMD" categories. This result suggests that according to Fonseca's questionnaire the CDH group had a higher frequency of "mild, moderate and severe TMD" than the non headache suffering control group.

According to previous studies, chronic daily headache like many chronic pain conditions are often associated with a number of co-morbidities (Puca F, 1999, Meisler, 1999). This corresponds with our finding of an increased incidence of TMD in the CDH population. It is important to note that some of the questions in Fonseca's questionnaire may relate to headache type pain such as *"Do you get frequent headaches?"* and *" Do you consider yourself a tense (nervous) person?"* Answering yes to both of these questions generates a score of 20 which automatically produces a diagnosis of mild TMD without having answered positively to any other TMD related questions. This may generate a degree of false positives at least in the "mild TMD" category. Despite this these results still suggest a significantly greater presence of the

signs and symptoms of TMD in the CDH group compared to the control group, with an increased severity of TMD experienced by the CDH group.

6.2.2 The Research Diagnostic Criteria for Temporomandibular Disorders

36 CDH and 36 controls fulfilled the inclusion criteria and attended the clinical appointment. The RDC/TMD is currently the most widely accepted standard in TMD diagnosis for research purposes. Generating a validated clinical diagnosis, of high sensitivity. It was completed by a blinded examiner for all 72 of these participants. Their age groups were fairly well matched for both groups with a mean age of 41.5 and 45.5 respectively for CDH and control. A gender imbalance was evident between the groups, with the majority of the CDH group being female (94%). Chronic daily headache is a condition affecting females predominantly. This female dominance of the CDH population is characteristic of other studies in the literature where with the exception of chronic tension type headache, CDH is considerably more common in females. Dao and LeResche described the disproportionate number of women receiving treatment for chronic pain conditions (Dao and LeResche, 2000).

6.3 Prevalence of TMD

The RDC/TMD found a TMD prevalence of 16.6% within the control group. This was slightly higher than would be expected for a normal population according to estimations derived from population-based studies were it is suggested that TMD affects between 8-15% of females and 3-10% of males (LeResche, 1997). It is possible that individuals were more likely to volunteer as control participants for the clinical aspect of the study, if they had responded positively to Fonseca's questionnaire initially thus driving up the proportion of TMD positives.

There was a much higher prevalence of TMD in the CDH group (61%), and a statistically significant association was found between TMD and CDH (X_2= 13, DF = 1, p-value < 0.001) in the original study group. The high proportion of females in the original study group may have had an impact on the results, as females are more likely to present for treatment for TMD than men with a female to male ratio in adults seeking care from 3:1 to as high as 9:1 (Dworkin et al., 1990b, Huber and Hall, 1990). As expected there was a statistically significant association between the female gender and CDH (X_2 = 17, DF = 1, p-value > 0.0001). To account for this the study groups

were gender balanced and retested. The gender balanced group still produced a highly significant association between CDH and TMD ($X_2 = 5$, DF = 1, p-value = 0.02). This confirms the suggestion of Magnusson and Carlsson in their studies from the late 1970's early 1980's where they found a close relationship between chronic headaches and chronic TMD. It also reinforces the more recent findings of Glaros et al 2007, Ballegaard et al 2008 and Gonglaves et al 2009 that suggest a diagnostic overlap between chronic headache and TMD.

6.4 Diagnostic Methods

The similarity between orofacial pain conditions such as CDH and TMD makes independent diagnosis difficult. Orofacial pain clinics and researchers often implement a number of diagnostic tools to ensure the most accurate diagnosis possible. The validity of many of these systems is constantly under review. The RDC/TMD has been critically reviewed, updated and re-validated in diagnostic capabilities for the various TMD subgroups (Schiffman et al., 2010a). It is crucial for accurate diagnosis, to validate and reassess the evidence to support the use of various diagnostic tools. The RDC/TMD although considered by some, the gold standard for research purposes, still requires improvement and cannot be considered 100% diagnostic of TMD. However the use of RDC/TMD in this study can be considered the most reliable of TMD research tools available. It has been used to estimate prevalence of TMD in the general population studies internationally and has been adopted by many highly esteemed orofacial pain authorities. Its use in a headache population has been demonstrated in many studies such as Glaros et al (2007), Bellgaard et al (2008), Di Paulo et al (2009). Importantly its recognition of the influence of both axis I and II factors and consideration of the biopsychosocial aspects of chronic pain makes it an appropriate test for this cohort of patients.

In this study Fonseca's questionnaire, when tested for concordance with the RDC/TMD, demonstrated a relatively high sensitivity of 0.82. This suggests that it is highly effective at correctly identifying people with RDC/TMD diagnosed TMD. Its specificity was 0.58 which suggests that it is less able to identify people who do not have TMD due to a high proportion of false positives, those without TMD according to RDC/TMD. The PPV suggests that 56% of positive results achieved by Fonseca's

will result in a true diagnosis. The NPV suggests that 83% of those diagnosed as having no TMD will score a true negative in the RDC/TMD. Interestingly when Fonseca's questionnaire diagnosed 'moderate or severe TMD', the PPV increased to 70%. Similarly, when 'no TMD, or mild TMD were diagnosed by Fonseca's questionnaire, the NPV is also 70%. These results suggest that Fonseca's questionnaires can serve as a useful screening tool to rule out TMD at the early stage of headache diagnosis. This confirms its value in a medical or neurology setting were thourogh evaluation of temporomandibular function may not be feasible. If a patient is found to have no TMD through Fonseca's it can be ruled out in 83% likelihood. If Fonseca's suggests moderate or severe TMD it is quite possible that they have some form of TMD, however when mild TMD is suggested false positives are more likely. A positive diagnosis of TMD by Fonseca's should warrant further clinical examination to confirm a TMD diagnosis.

6.5 TMD subtypes (axis I)

The RDC/TMD generates an axis I diagnosis that falls into three subgroups: muscle disorders (group I); disc displacement (group II); and arthralgia, arthritis and arthrosis (Group III). Controls found positive for TMD fell into group II or III via the RDC/TMD, they had disc displacement with reduction and/or osteoarthrosis. These conditions are generally diagnosed based on limitation or movement, deviation and joint sounds during various mandibular excursions. In the general population such conditions are fairly common. Population studies have found a prevalence of 15% with disc displacement with reduction. Such conditions tend to be painless in nature (Rantala et al., 2003). In this study those presenting with osteoarthrosis were all over 60 years old which may explain the degenerative nature of their TMD.

Previous studies including a multicenter study based on the RDC/TMD found Myofacial pain to be the most common painful TMD (John et al., 2005a). The CDH group in this study showed a wide variation of TMD's but the most prevalent were myofascial pain conditions, with a group 1 diagnosis found in 13 (36%) of CDH group. It consisted of 59% of all TMDs in this group. This result corresponds to findings in studies examining headache populations, where muscular disorders were more prevalent in headache sufferers (Glaros et al., 2007, Benoliel et al., 2008a). Similarly to CDH, myofascial pain has previously been found to have a preponderance in female patients (Okeson, 1996, Dworkin, 1992). In general the CDH group had

more of the classically painful TMD conditions and showed a wider variety of TMD subtypes than the control group. It was noted that subtypes of TMD co-existed within one individual, this was much more common in the CDH group with 10 individuals having more than one TMD diagnosis compared to only 3 in the control group. One individual in the CDH group had four separate TMD conditions identified by the RDC/TMD.

6.6 Chronic pain related disability (axis II)

Chronic pain can be constant or intermittent and is defined as pain that lasts for six months or more. By nature chronic pain becomes a large component of the sufferer's everyday life. It is often associated with both behavioural and psychological impairment, it is thus is often strongly associated with axis II factors. Most of the CDH group reported facial pain according to the RDC/TMD axis II chronic pain grade classification, this contrasted dramatically with the control group in which only two individuals reported chronic pain related disability. Grade II disability, was found to be significantly associated with the presence of CDH. It represents pain of a high intensity with a low level of pain related disability. One can speculate that this chronic pain described may be due to the presence of CDH independently or indeed combined with orofacial pain from co-existent TMD. TMD was significantly associated with grade I disability (low disability of a low intensity), this suggests a lower level of debilitating effects than CDH. Both conditions are considered debilitating but CDH was associated with a higher grade of chronic pain related disability and thus seems to have a more negative effect on everyday life. This corresponds to the findings of Jerjes and co workers in 2007, where they found CDH patients had greater pain intensity and pain related disability than TMD patients. The significant association between an absence of CDH and no chronic pain related disability was strong in the original study group and remained significant in the gender balanced group.

6.7 Depression (axis II)

All participants completed the scale for depression and non specific symptoms. A significant association was observed between CDH and depression with 50% of the CDH group scoring higher than 1. However this significant association was not established in the gender matched group suggesting the influence of the female weighting in the CDH group may have influenced the higher rate of depression. In Ballegaard's study, they found significant depression present in almost 55% of the headache population, it was particularly apparent in the chronic headache sufferers

with TMD. Depression has been repeatedly associated with chronic TMD in the literature, however in this study there was no significant association between a diagnosis of TMD and depression in the either group, including the gender matched population. This refutes previous suggestions that co-existent TMD in headache populations potentiates depression. CDH alone seemed to be the major contributor to depression in this population.

6.8 Occlusal Analysis

The occlusal analysis highlighted a range of incisal relationships, of those classified, 35 participants had a class I relationship, class II was present in 20 and class III in 12 participants one of which had a reverse horizontal overlap "cross-bite". It is important to note that due to small numbers in each group limited conclusions can be drawn. With regard to TMD status, there were no statistically significant relationships between any incisal relationship and the presence or absence of TMD. However most notably the vast majority of class III individuals (9 out of 12) had no TMD. Class I individuals had the highest proportion of TMD positive individuals (45%) accounting for 16 out of 35. The single individual with an anterior open bite had TMD also. The proportion positive for TMD in Class II div 1 individuals was comparable to class II div 2 (3 out of 10, and 3 out of 9 respectively). These results do not correlate with suggestions by Vanderas 1994, Juniper 1994 and Mc Namara 1995 that malocclusion is related to TMD status. As this study consists of a headache population and relatively small numbers it is not directly comparable to studies of occlusion and TMD status in the general population. This study did not make an attempt to record the stability of the occlusion, missing teeth, presence of occlusal interferences or evidence of tooth surface loss or parafunction. So these results cannot be compared to studies where detailed occlusal evaluations were carried out. Studies such as Gesch et al 2004, and Pullinger et al found no convincing link between occlusal factors and the signs and symptoms of TMD, as was the case in this study.

6.9 Guidance Scheme

The teeth contacting during lateral guidance was observed and recorded by the examiner clinically. This was an observational record only and a standardized validated method was not utilized. The reason guidance scheme was recorded was because in Robert Kerstein's technique of "immediate complete anterior guidance development (ICAGD)", it is suggested that posterior tooth contact during excursions,

increases disclusion time, and may elevate muscular activity and thus increases the likelihood of myofascial pain and related conditions.

43% of our participants had canine guidance and, 43.5% had group function in one or both of their excursions. Guidance on the first premolar only was present in four individuals during seven excursions. Canine guidance was the most common scheme during excursions in class I, and class II division 2 individuals. Group function was most common in class II division1 and class III individuals.

In this study there was no significant association between the presence or absence of TMD and guidance scheme. According to Kerstein's observation balancing and working side interferences in a group of 53 myofascial pain sufferers was related to a seemingly long disclusion time (greater than 0.5 seconds), once disclusion time was reduced it resulted in remission of symptoms. In this study when guidance scheme was evaluated in relation to TMD type 18 out of 23 recorded (i.e. 78%) excursions in those diagnosed with a group I TMD were group function. In this form of guidance posterior tooth contacts are observed during lateral excursions. Interestingly the presence of group function in participants diagnosed with a group 1 (muscular) disorder was not accompanied by a significantly longer disclusion time than that of other guidance schemes.

6.10 TMD Diagnosis and Disclusion Time

The T.scan produced a graph for each lateral excursion, recording the disclusion time, this is the time in which posterior teeth separate from each other during guided mandibular motion, during which working and non working molars and premolars are in contact during mandibular lateral excursive movements. This time commences from the habitual closure position through to the contact of anterior guiding tooth surfaces.

The mean disclusion time for all participants was 0.9sec (SD=0.8). The mean disclusion time for TMD positive participants not significantly different to non TMD participants (W = 1773, p-value = 0.47). Nor was there a significant difference between CDH and controls in terms of disclusion time (W = 1907.5, p-value = 0.51). There was no significant difference in mean disclusion time between the various TMD subtypes (group I,II,III diagnosis). All groups had a mean disclusion time greater than 0.5 seconds. Disclusion time was greater than 0.5 seconds in the majority of lateral excursions regardless of TMD diagnosis.

A disclusion time of less than 0.5 seconds is suggested to be associated with remission of symptoms of myofascial pain dysfunction. Disclusion times were examined for each group according to whether or not they were greater than or less than 0.5 seconds. All TMD positive groups had a larger proportion of excursions greater than 0.5 seconds except for the group III conditions where 55% of excursions disclusion times were actually less than 0.5seconds.

70% of excursions in participants with an group I diagnosis of Myofacial pain with or without limited opening had a disclusion time greater than 0.5seconds. Kerstein's study focused on the management of "myofascial pain dysfunction syndrome", i.e. muscular TMDs. Such conditions would fall into a group I positive diagnosis according to the RDC/TMD. In this study of those who were diagnosed with group I TMDs such as myofacial pain with or without limited opening (n= 22), 11 had a disclusion time greater than 0.5 seconds, 8 has a disclusion time shorter than 0.5 seconds. Although the majority had a long disclusion time, this difference was not statistically significant.

Despite the high proportion of long disclusion time in the myofascial pain group there was no compelling evidence from this study that a disclusion time of greater than 0.5 seconds was associated with any particular subtype of TMD or TMD itself. Koh and Robinson reviewed 660 randomized/quasi-randomized studies that addressed the role of occlusal therapy as a means of treating TMD. They found a lack of well controlled standardised techniques utilised in the majority of studies and a lack of evidence to prove that occlusal adjustment treats or prevents TMD. Although occlusal adjustment was not carried out in this study we found a lack of evidence to link specific occlusal traits with TMD.

6.11 Strengths of this study

In contrast to previous studies investigating the prevalence of TMD in a chronic daily headache population, we compared the CDH group to a non headache control group. The groups were matched in number and closely matched in age group. Unlike previous studies the examiner was blinded to the CDH / control status of the participant on examination. A standardized procedure was carried out for each

individual regardless of whether they were from the CDH group or control group thus ensuring a fair and unbiased diagnosis. The use of a control group ensures that the effect observed i.e. TMD diagnosis is influenced by CDH status and not by some other confounding variable.

The CDH population were diagnosed according to the most widely accepted tool in headache diagnosis proposed by the international headache society, the International Classification of Headache Disorders second edition (ICHDII), this is the most widely accepted criteria for headache diagnosis and as such is currently the most capable of generating a CDH diagnosis comparable to other studies.

The Research Diagnostic Criteria for Temporomandibular disorders is the most widely utilized, standardized and validated research tool for identifying TMD in both the general and a headache population. . The use of these standardized, diagnostic, tools maximizes the validity of the findings of this study and allows comparison of this study with others in its field internationally.

This study compared the concordance of Fonseca's questionnaire to that of the Research Diagnostic Criteria for TMD. It is the first study, to the author's knowledge, that has presented the diagnostic limitations of Fonseca's questionnaire.

To date very few studies have examined disclusion time in relation to TMD status as diagnosed by the RDC/TMD. The vast majority of studies evaluating disclusion time have been carried out by advocates of disclusion time reduction therapy such as ICAGD. In this study the author was completely unbiased.

6.12 Limitations of this study

Unfortunately despite the random assignment of participants there was a gender imbalance in the CDH versus control group. Unfortunately due to random selection there was no way to prospectively predict this. It is probably due to the fact that CDH is predominantly a condition affecting females. Females may have been more inclined to participate in the study as it has been shown that women with chronic pain conditions are more inclined to seek treatment. An attempt was made however in the analysis to gender balance the groups to eliminate it as a possible confounding variable. Interestingly the gender balanced group still demonstrated a significant

association between CDH and TMD. Analysis revealed that the control group were slightly older demographic than CDH population but only by 4 years which should not confound the results.

Despite a relatively good response rate to Fonseca's questionnaire relatively few individuals agreed to or were suitable to attend for the clinical examination resulting in a fairly small sample particularly where certain variable such as the occlusal analysis were concerned. A larger sample may have allowed more definitive conclusions to be drawn in some areas. A larger sample may have reduced the gender disparity between the two groups. Unfortunately when dealing with a CDH population a limited number of individuals were available thus accounting for the small sample.

In a hospital setting sourcing a control group is a difficult task, the orthopaedic group without a history of head or neck injury or arthritis were selected as they are generally systemically healthy within the same age demographic as CDH sufferer. We initially expected a balanced male to female response rate. It is important to note that although randomly selected, and not taking pain medication at the time of examination, they were derived from a patient population.

Fonseca's questionnaire was found to lack specificity in our study population, the fact that one of the questions was "Do you suffer from frequent headaches?" may have accounted for the high incidence of false positives in the CDH groups driving this result.

The use of the RDC/TMD in a CDH population group has been tried and tested by various authors in the past, however it is important to note that the questionnaire aims to indicate the extent, nature and impact of TMD related 'facial pain'. It was difficult for patients to differentiate the effect of facial pain from their headache pain in the CDH group.

Due to the limitations of this study the occlusal assessment utilized was fairly simple and non-standardised. Although a recognized British standards criteria was used to assess incisal relationship, the assessment of guidance scheme was based on observation of the teeth in lateral excursions and cannot be considered a truly definitive diagnosis of guidance scheme.

6.13 Future Direction

Having found an increased incidence of TMD in a chronic daily headache population, it would be beneficial to apply this model to a larger population of CDH patients across a number of centres to evaluate whether this pattern is reproduced. It certainly appears to be a recurring theme throughout similar studies.

It remains to be seen whether the increased incidence of TMD in a CDH population can be attributed to a link between these conditions or a diagnostic overlap. It would be interesting to assess if the increased level of depression in the CDH group was purely due to their headache condition or if it was potentiated by the co-morbidity of TMD. The treatment of CDH is predominantly through pharmacological, behavioural and management of pain with control of analgesic use. TMD on the other hand is often managed by the dentist by resting of the temporomandibular joint, anti-inflammatory drugs, splint therapy or indeed in some cases by surgical management. In order to shed some light on the extent of morbidity due to co-existing TMD, an attempt at managing TMD specifically within this CDH population and assessing the impact of TMD treatment on quality of life, depression scores and chronic pain related disability would be a useful follow up study.

Both CDH and chronic TMD are affected by axis II factors such as psychological, behavioural issues. These issues are likely to be the factors that lead to so called co-morbidities where chronic pain conditions tend to be more common in patients with an existing chronic pain condition. The patients presenting with a combination of diagnoses such as CDH and TMD would benefit from psychological assessment and management perhaps focusing on axis II factors particularly for those who respond poorly to more traditional therapies. An assessment of the efficacy of behavioural therapy, counselling and management of depression on patients suffering from co-existent TMD and CDH may illustrate the influence of axis II factors in these patients.

In this study CDH was diagnosed but not differentiated into its various subgroups as illustrated in Table 1.2-2. A future direction worth consideration would be to examine a larger CDH population classified according to CDH type to examine if TMD is more associated with particular subgroups.

7 Conclusions

- CDH patients have a significantly higher incidence of TMD than a non-headache control group.
- Low disability of a high intensity due to chronic pain of is significantly associated with CDH in both TMD and non-TMD groups.
- Depression was significantly associated with CDH. It is not clear whether concurrent TMD is contributing to depression due to chronic pain in this group.
- Although a wide variety of TMD's were diagnosed, myofascial pain is the most commonly occurring TMD in a CDH population.
- Fonseca's questionnaire demonstrated high sensitivity but limited specificity in diagnosing TMD. It may serve as a useful screening tool in ruling out TMD during a neurological assessment.
- A positive result in Fonseca's questionnaire should be followed by a comprehensive clinical exam to confirm diagnosis.
- There is no relationship between incisal relationship and TMD
- Group I diagnosis of myofascial pain was more common in those with group function guided lateral excursions
- Disclusion time was no greater for TMD positive individuals than TMD negative individuals.
- Disclusion time was not related to guidance scheme, or incisal relationship
- Disclusion time greater than 0.5 seconds was not significantly associated with a diagnosis of myofascial pain.

8 Appendices

8.1 Appendix 8.1 Ethical approval St Vincent's Health Care Group

St. Vincent's Healthcare GROUP LIMITED

UCD DUBLIN

Ethics and Medical Research Committee
ELM PARK, DUBLIN 4
Tel. (01) 2774117 Fax (01) 2838123 email: joan.mcdonnell@ucd.ie

4th June, 2008

Dr. N. Tubridy,
Consultant Neurologist,
St. Vincent's University Hospital,
Elm Park,
D. 4.

Re: The prevalence of Temporomandibular Disorders (TMD) in patients with chronic daily headache (CDH).
PIL/Consent vs 3: February 2007. Questionnaires

Dear Dr. Tubridy,

Thank you for the revisions and clarifications that were requested prior to approval at the Ethics and Medical Research Committee meeting held on Wednesday 7th May 2008 at which the above study was reviewed.

This study is now approved..

Yours sincerely,

Dr. B. Kirby,
Chairman,
Ethics and Medical Research Committee

cc. Ms A Coffey, Medical Student, UCD School of Medicine,
dd. Dr. R. Carville, Dept of Restorative Dentistry, Dublin Dental Hospital & School, Lincoln Place, D. 2.

8.2 Appendix 8.2 Ethical approval Faculty of Health Sciences, Trinity College

THE UNIVERSITY OF DUBLIN
TRINITY COLLEGE

SCHOOL OF MEDICINE
FACULTY OF HEALTH SCIENCES

Trinity College, Dublin 2, Ireland
Tel: +353 1 896 1476
Fax: +353 1 671 3956
Email: medicine@tcd.ie

Professor Dermot Kelleher, MD, FRCPI, FRCP, F Med Sci
Head of School of Medicine
Vice Provost for Medical Affairs

Ms. Fedelma McNamara
School Administrator
Email: fmcnamar@tcd.ie

Ms Rebecca Carville,
Department of Dental Science,
Dublin Dental Hospital,
Trinity College Dublin,
Dublin 2.

Tuesday 24th June 2008

Study Title:
The Prevalence of Temporomandibular Disorders (TMD) in Patients with Chronic Daily Headache (CDH). The Relationship between TMD and Occlusal Factors in CDH Patients

Dear Ms Carville,

Further to the meeting of the Faculty of Health Sciences Research Ethics Committee on 29th April 2008, I am pleased to inform you that the above project has been approved without further audit.

Yours sincerely,

PP Susan Cree

Dr. Orla Sheils
Chairperson
Faculty of Health Sciences Ethics Committee

cc. Professor Brian O'Connell, Dental Science, Dublin Dental School.

8.3 Appendix 8.3 Information leaflet CDH group

St. Vincent's Healthcare GROUP LIMITED

Department of Neurology and Neurophysiology,
St Vincent's University Hospital,
Elm Park, Dublin 4.

TELEPHONE +353 1 269 4179 –FAX+353 1 2773506

PARTICIPANT INFORMATION AND CONSENT FORM

STUDY TITLE: The prevalence of Temporomandibular Disorders (TMD) in patients with Chronic daily headache (CDH).

NAME OF PRINCIPAL INVESTIGATOR: Dr Niall Turbidy (Consultant Neurologist).

You are being invited to participate in a research study. Thank you for taking time to read this.

WHAT IS THE PURPOSE OF THIS STUDY?

Chronic daily headache affects 1-2% of the population. There are often a number of underlying reasons for the headaches including tension headache, medication overuse and chronic migraine. One aspect that has been suggested as having a role in chronic headache is Temporomandibular disorders (TMD). These are disorders affecting the jaw joints and muscles that open and close your mouth. This project aims to assess people with chronic headaches by way of a questionnaire initially. If you fulfil the criteria you will be invited to attend the Department of Neurology at St' Vincent's Hospital in July 2008 for a further questionnaire and brief clinical assessment of your jaw joints, facial muscles and bite. This will involve measuring your range of mouth opening, and examining the way your teeth come together.

WHY HAVE I BEEN CHOSEN?

The project calls for volunteers with chronic headaches of any type. The neurologist will review your medical condition and will let you know if you are suitable for the study.

The study will help us to identify any un-diagnosed TMD in participants and may aid in the assessment of these conditions in headache patients in general. As our examination is simple and non invasive we do not anticipate any risks associated.

WHAT WILL HAPPEN IF I VOLUNTEER?

Your participation is entirely voluntary. If you initially decide to take part you can subsequently change your mind without difficulty. This will not affect your future treatment in any way. Furthermore your doctor may decide to withdraw you from this study if he/she feels it is in your best interest.

If you agree to participate, you will be requested to attend the Department of Neurology for a once off appointment in July - August 2008. At that meeting, you will be asked some details about your headaches, and jaw function. You

will then be assessed by a qualified dentist with simple measures of TMD. The muscles, jaw joints and bite will be examined and range of movement of the joints will be measured. In total the visit will last 30 minutes.

ARE THERE ANY BENEFITS FROM MY PARTICIPATION?

The study will help us to identify any un-diagnosed TMD in participants and may aid in the assessment of these conditions in headache patients in general. The information we will obtain will provide further knowledge of this condition (TMD) and its future diagnosis in chronic daily headache patients.

ARE THERE ANY RISKS INVOLVED IN PARTICIPATING?

We do not anticipate any risks associated with this study as our examination is simple and non invasive.

WHAT HAPPENS IF I DO NOT AGREE TO PARTICIPATE?

If you decide not to participate in this study your treatment will not be affected in any way.

CONFIDENTIALITY

Full confidentiality is guaranteed for all persons with or without headaches helping with this important research. No personal identity or family information given by volunteers to the study will be released, published or made public for any reason. This study is covered by standard institutional indemnity insurance. Nothing in this document restricts or curtails your rights. The information gathered from the study will be kept in a secure site in St Vincent's Hospital. If you are diagnosed with TMD you and your neurologist will be informed ,with your consent. You will also be advised to attend your dentist if necessary.

COMPENSATION

Your doctors are adequately insured by virtue of their participation in the clinical indemnity scheme.

WHO IS ORGANISING AND FUNDING THIS RESEARCH?

The research is being carried out by the doctors in the department of neurology St Vincent's Hospital in association with the dentists from the department of restorative Dentistry from Trinity College Dublin.

Will I be paid for taking part in this study? No
Will my expenses be covered for taking part in this study? No

IS THIS STUDY SAFE AND BENEFICIAL?

The St. Vincent's Healthcare Group, Ethics and Medical Research Committee have reviewed and approved this study.

CONTACT DETAILS

You can get more information or answers to your questions about the study, your participation in the study, and your rights, from Dr Rebecca Carville ,who can be telephoned at (01) 6127312 If the study team learns of important new information that might affect your desire to remain in the study, you will be informed at once

PLEASE TICK YOUR RESPONSE IN THE APPROPRIATE BOX

- I have read and understood the Participant Information YES ☐ NO ☐
- I consent to being informed if I am diagnosed with TMD. YES ☐ NO ☐
- I consent to informing my neurologist if I am diagnosed with TMD YES ☐ NO ☐
- I have had the opportunity to ask questions and discuss the study YES ☐ NO ☐
- I have received satisfactory answers to all my questions YES ☐ NO ☐
- I have received enough information about this study and that attending the Department of Neurology at St. Vincent's Hospital in July or August 2008 for assessment of temporomandibular function. This will involve assessment of the 'jaw joint', "facial muscles", digital analysis of the bite, and further questionnaires about headaches, this in a non-invasive examination. YES ☐ NO ☐
- I understand that I am free to withdraw from the study at any time without giving a reason and without this affecting my future medical care YES ☐ NO ☐
- I agree to take part in the study YES ☐ NO ☐

Participant's Signature: _____ Date: _____

Participant's Name in print: _____

Witness Signature: _____ Date: _____

Witness Name in print: _____

Investigator's Signature: _____ Date: _____

Investigator's Name in print: _____

8.4 Appendix 8.4 information leaflet control group

St. Vincent's Healthcare GROUP LIMITED

Department of Neurology and Neurophysiology,
St Vincent's University Hospital,
Elm Park, Dublin 4.

TELEPHONE +353 1 269 4179 –FAX +353 1 2773506

obtained for this study from the Faculty Research Ethics Group, Faculty of Health Sciences, Trinity College Dublin and St Vincent's Healthcare Group, Ethics and medical research committee, St Vincent's Hospital Dublin.

PARTICIPANT INFORMATION

STUDY TITLE: The prevalence of Temporomandibular Disorders (TMD) in patients with Chronic daily headache (CDH).

NAME OF PRINCIPAL INVESTIGATOR: Dr Niall Turbidy (Consultant Neurologist).

You are being invited to participate in a research study. Thank you for taking time to read this.

WHAT IS THE PURPOSE OF THIS STUDY?

Chronic daily headache affects 1-2% of the population. There are often a number of underlying reasons for the headaches including tension headache, medication overuse and chronic migraine. One aspect that has been suggested as having a role in chronic headache is Temporomandibular disorders (TMD). These are disorders affecting the jaw joints and muscles that open and close your mouth. This project aims to compare non headache sufferers to people with chronic headaches by way of a questionnaire initially. If you fulfil the criteria you will be invited to attend the Department of Neurology at St Vincent's Hospital in July 2008 for a further questionnaire and brief clinical assessment of your jaw joints, facial muscles and bite. This will involve measuring your range of mouth opening, and examining the way your teeth come together.

WHY HAVE I BEEN CHOSEN?

The project calls for healthy volunteers without headaches.

The study will help us to identify any un-diagnosed TMD in participants and may aid in the assessment of these conditions in headache patients in general. As our examination is simple and non invasive we do not anticipate any risks associated.

WHAT WILL HAPPEN IF I VOLUNTEER?

Your participation is entirely voluntary. If you initially decide to take part you can subsequently change your mind without difficulty. This will not affect your future treatment in any way. Furthermore your doctor may decide to withdraw you from this study if he/she feels it is in your best interest.

If you agree to participate, you will be requested to attend the Department of Neurology for a once off appointment in July - August 2008. At that meeting, you will be asked some details about your headaches, and jaw function. You will then be assessed by a qualified dentist with simple measures of TMD. The muscles, jaw joints and bite will be examined and range of movement of the joints will be measured. In total the visit will last 30 minutes.

ARE THERE ANY BENEFITS FROM MY PARTICIPATION?

The study will help us to identify any un-diagnosed TMD in participants and may aid in the assessment of these conditions in headache patients in general. The information we will obtain will provide further knowledge of this condition (TMD) and its future diagnosis in chronic daily headache patients.

ARE THERE ANY RISKS INVOLVED IN PARTICIPATING?

We do not anticipate any risks associated with this study as our examination is simple and non invasive.

WHAT HAPPENS IF I DO NOT AGREE TO PARTICIPATE?

If you decide not to participate in this study your treatment will not be affected in any way.

CONFIDENTIALITY

Full confidentiality is guaranteed for all persons with or without headaches helping with this important research. No personal identity or family information given by volunteers to the study will be released, published or made public for any reason. This study is covered by standard institutional indemnity insurance. Nothing in this document restricts or curtails your rights. The information gathered from the study will be kept in a secure site in St Vincent's Hospital. If you are diagnosed with TMD you will be informed ,with your consent.

COMPENSATION

Your doctors are adequately insured by virtue of their participation in the clinical indemnity scheme.

WHO IS ORGANISING AND FUNDING THIS RESEARCH?

The research is being carried out by the doctors in the department of neurology St Vincent's Hospital in association with the dentists from the department of restorative Dentistry from Trinity College Dublin.

Will I be paid for taking part in this study? No
Will my expenses be covered for taking part in this study? No

IS THIS STUDY SAFE AND BENEFICIAL?

The Faculty Research Ethics Group, Faculty of Health Sciences, Trinity College Dublin and St Vincent's Healthcare Group, Ethics and medical research committee, St Vincent's Hospital Dublin have approved this study.

CONTACT DETAILS

You can get more information or answers to your questions about the study, your participation in the study, and your rights, from Dr Rebecca Carville .who can be telephoned at (01) 6127312 If the study team learns of important new information that might affect your desire to remain in the study, you will be informed at once

PLEASE TICK YOUR RESPONSE IN THE APPROPRIATE BOX

- I have read and understood the Participant Information YES ☐ NO ☐
- I consent to being informed if I am diagnosed with TMD. YES ☐ NO ☐
- I consent to informing my neurologist if I am diagnosed with TMD YES ☐ NO ☐
- I have had the opportunity to ask questions and discuss the study YES ☐ NO ☐
- I have received satisfactory answers to all my questions YES ☐ NO ☐
- I have received enough information about this study and that attending the Department of Neurology at St. Vincent's Hospital in July or August 2008 for assessment of temporomandibular function. This will involve assessment of the 'jaw joint', "facial muscles", digital analysis of the bite, and further questionnaires about headaches, this in a non-invasive examination. YES ☐ NO ☐
- I understand that I am free to withdraw from the study at any time without giving a reason and without this affecting my future medical care YES ☐ NO ☐
- I agree to take part in the study YES ☐ NO ☐

Participant's Signature: _____ Date: _____

Participant's Name in print: _____

Witness Signature: _____ Date: _____

Witness Name in print: _____

Investigator's Signature: _____ Date: _____

Investigator's Name in print: _____

8.5 Appendix 8.5 Consent form

Department of Neurology and Neurophysiology,
St Vincent's University Hospital,
Elm Park, Dublin 4.

Telephone +353 1 2694179 ~Fax +353 1 2773506

Dublin Dental School

The prevalence of Temporomandibular Disorders (TMD) in patients with Chronic daily headache (CDH).

STATEMENT OF INFORMED CONSENT

1. I have read and understood the 'Information Sheet' for this research study, and I understand that I am under no obligation to participate in this study.
2. The nature and possible effects of the study have been explained to me.
3. I understand that the study involves attending the Department of Neurology at St. Vincent's Hospital in July or August 2008 for assessment of temporomandibular function. This will involve assessment of the 'jaw joint', "facial muscles", analysis of the bite and further questionnaires about headaches, this in a non-invasive examination.
4. I understand that all information given by me will be treated as confidential.
5. Any questions that I have asked have been answered to my satisfaction.
6. I agree to participate in this investigation and understand that I may withdraw at any time without explanation and without compromising my relationship with my doctor.
7. I agree to the study investigators reviewing my medical records if necessary.
8. I agree that research data gathered for the study may be published provided that neither I nor any of my relatives can be identified as a participant.
9. I agree that the data gathered may be retained after the study is completed, the material will not be used in future unrelated studies without specific permission being obtained.

Name of subject .....TELEPHONE No.....

Signature of subject ..... Date .....

I have explained this project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

Name of investigator .....

Signature of investigator ..... Date .....

8.6 Appendix 8.6 International Classification of Headaches

Classification and WHO ICD-10NA Codes

IHS ICHD-II code	WHO ICD-10NA code	Diagnosis [and aetiological ICD-10 code for secondary headache disorders]
1.	**[G43]**	**Migraine**
1.1	[G43.0]	Migraine without aura
1.2	[G43.1]	Migraine with aura
1.2.1	[G43.10]	Typical aura with migraine headache
1.2.2	[G43.10]	Typical aura with non-migraine headache
1.2.3	[G43.104]	Typical aura without headache
1.2.4	[G43.105]	Familial hemiplegic migraine (FHM)
1.2.5	[G43.105]	Sporadic hemiplegic migraine
1.2.6	[G43.103]	Basilar-type migraine
1.3	[G43.82]	Childhood periodic syndromes that are commonly precursors of migraine
1.3.1	[G43.82]	Cyclical vomiting
1.3.2	[G43.820]	Abdominal migraine
1.3.3	[G43.821]	Benign paroxysmal vertigo of childhood
1.4	[G43.81]	Retinal migraine
1.5	[G43.3]	Complications of migraine
1.5.1	[G43.3]	Chronic migraine
1.5.2	[G43.2]	Status migrainosus
1.5.3	[G43.3]	Persistent aura without infarction
1.5.4	[G43.3]	Migrainous infarction
1.5.5	[G43.3] + [G40.x or G41.x][1]	Migraine-triggered seizure
1.6	[G43.83]	Probable migraine
1.6.1	[G43.83]	Probable migraine without aura
1.6.2	[G43.83]	Probable migraine with aura
1.6.5	[G43.83]	Probable chronic migraine
2.	**[G44.2]**	**Tension-type headache (TTH)**
2.1	[G44.2]	Infrequent episodic tension-type headache
2.1.1	[G44.20]	Infrequent episodic tension-type headache associated with pericranial tenderness
2.1.2	[G44.21]	Infrequent episodic tension-type headache not associated with pericranial tenderness
2.2	[G44.2]	Frequent episodic tension-type headache
2.2.1	[G44.20]	Frequent episodic tension-type headache associated with pericranial tenderness
2.2.2	[G44.21]	Frequent episodic tension-type headache not associated with pericranial tenderness
2.3	[G44.2]	Chronic tension-type headache
2.3.1	[G44.22]	Chronic tension-type headache associated with pericranial tenderness
2.3.2	[G44.23]	Chronic tension-type headache not associated with pericranial tenderness
2.4	[G44.28]	Probable tension-type headache
2.4.1	[G44.28]	Probable infrequent episodic tension-type headache

[1] The additional code specifies the type of seizure.

2.4.2	[G44.28]	Probable frequent episodic tension-type headache
2.4.3	[G44.28]	Probable chronic tension-type headache
3.	**[G44.0]**	**Cluster headache and other trigeminal autonomic cephalalgias**
3.1	[G44.0]	Cluster headache
3.1.1	[G44.01]	Episodic cluster headache
3.1.2	[G44.02]	Chronic cluster headache
3.2	[G44.03]	Paroxysmal hemicrania
3.2.1	[G44.03]	Episodic paroxysmal hemicrania
3.2.2	[G44.03]	Chronic paroxysmal hemicrania (CPH)
3.3	[G44.08]	Short-lasting Unilateral Neuralgiform headache attacks with Conjunctival injection and Tearing (SUNCT)
3.4	[G44.08]	Probable trigeminal autonomic cephalalgia
3.4.1	[G44.08]	Probable cluster headache
3.4.2	[G44.08]	Probable paroxysmal hemicrania
3.4.3	[G44.08]	Probable SUNCT
4.	**[G44.80]**	**Other primary headaches**
4.1	[G44.800]	Primary stabbing headache
4.2	[G44.803]	Primary cough headache
4.3	[G44.804]	Primary exertional headache
4.4	[G44.805]	Primary headache associated with sexual activity
4.4.1	[G44.805]	Preorgasmic headache
4.4.2	[G44.805]	Orgasmic headache
4.5	[G44.80]	Hypnic headache
4.6	[G44.80]	Primary thunderclap headache
4.7	[G44.80]	Hemicrania continua
4.8	[G44.2]	New daily-persistent headache (NDPH)
5.	**[G44.88]**	**Headache attributed to head and/or neck trauma**
5.1	[G44.880]	Acute post-traumatic headache
5.1.1	[G44.880]	Acute post-traumatic headache attributed to moderate or severe head injury [S06]
5.1.2	[G44.880]	Acute post-traumatic headache attributed to mild head injury [S09.9]
5.2	[G44.3]	Chronic post-traumatic headache
5.2.1	[G44.30]	Chronic post-traumatic headache attributed to moderate or severe head injury [S06]
5.2.2	[G44.31]	Chronic post-traumatic headache attributed to mild head injury [S09.9]
5.3	[G44.841]	Acute headache attributed to whiplash injury [S13.4]
5.4	[G44.841]	Chronic headache attributed to whiplash injury [S13.4]
5.5	[G44.88]	Headache attributed to traumatic intracranial haematoma
5.5.1	[G44.88]	Headache attributed to epidural haematoma [S06.4]
5.5.2	[G44.88]	Headache attributed to subdural haematoma [S06.5]
5.6	[G44.88]	Headache attributed to other head and/or neck trauma [S06]
5.6.1	[G44.88]	Acute headache attributed to other head and/or neck trauma [S06]
5.6.2	[G44.88]	Chronic headache attributed to other head and/or neck trauma [S06]
5.7	[G44.88]	Post-craniotomy headache
5.7.1	[G44.880]	Acute post-craniotomy headache
5.7.2	[G44.30]	Chronic post-craniotomy headache
6.	**[G44.81]**	**Headache attributed to cranial or cervical vascular disorder**
6.1	[G44.810]	Headache attributed to ischaemic stroke or transient ischaemic attack
6.1.1	[G44.810]	Headache attributed to ischaemic stroke (cerebral infarction) [I63]
6.1.2	[G44.810]	Headache attributed to transient ischaemic attack (TIA) [G45]

6.2	[G44.810]	Headache attributed to non-traumatic intracranial haemorrhage [I62]
6.2.1	[G44.810]	Headache attributed to intracerebral haemorrhage [I61]
6.2.2	[G44.810]	Headache attributed to subarachnoid haemorrhage (SAH) [I60]
6.3	[G44.811]	Headache attributed to unruptured vascular malformation [Q28]
6.3.1	[G44.811]	Headache attributed to saccular aneurysm [Q28.3]
6.3.2	[G44.811]	Headache attributed to arteriovenous malformation (AVM) [Q28.2]
6.3.3	[G44.811]	Headache attributed to dural arteriovenous fistula [I67.1]
6.3.4	[G44.811]	Headache attributed to cavernous angioma [D18.0]
6.3.5	[G44.811]	Headache attributed to encephalotrigeminal or leptomeningeal angiomatosis (Sturge Weber syndrome) [Q85.8]
6.4	[G44.812]	Headache attributed to arteritis [M31]
6.4.1	[G44.812]	Headache attributed to giant cell arteritis (GCA) [M31.6]
6.4.2	[G44.812]	Headache attributed to primary central nervous system (CNS) angiitis [I67.7]
6.4.3	[G44.812]	Headache attributed to secondary central nervous system (CNS) angiitis [I68.2]
6.5	[G44.810]	Carotid or vertebral artery pain [I63.0, I63.2, I65.0, I65.2 or I67.0]
6.5.1	[G44.810]	Headache or facial or neck pain attributed to arterial dissection [I67.0]
6.5.2	[G44.814]	Post-endarterectomy headache [I97.8]
6.5.3	[G44.810]	Carotid angioplasty headache
6.5.4	[G44.810]	Headache attributed to intracranial endovascular procedures
6.5.5	[G44.810]	Angiography headache
6.6	[G44.810]	Headache attributed to cerebral venous thrombosis (CVT) [I63.6]
6.7	[G44.81]	Headache attributed to other intracranial vascular disorder
6.7.1	[G44.81]	Cerebral Autosomal Dominant Arteriopathy with Subcortical Infarcts and Leukoencephalopathy (CADASIL) [I67.8]
6.7.2	[G44.81]	Mitochondrial Encephalopathy, Lactic Acidosis and Stroke-like episodes (MELAS) [G31.81]
6.7.3	[G44.81]	Headache attributed to benign angiopathy of the central nervous system [I99]
6.7.4	[G44.81]	Headache attributed to pituitary apoplexy [E23.6]
7.	**[G44.82]**	**Headache attributed to non-vascular intracranial disorder**
7.1	[G44.820]	Headache attributed to high cerebrospinal fluid pressure
7.1.1	[G44.820]	Headache attributed to idiopathic intracranial hypertension (IIH) [G93.2]
7.1.2	[G44.820]	Headache attributed to intracranial hypertension secondary to metabolic, toxic or hormonal causes
7.1.3	[G44.820]	Headache attributed to intracranial hypertension secondary to hydrocephalus [G91.8]
7.2	[G44.820]	Headache attributed to low cerebrospinal fluid pressure
7.2.1	[G44.820]	Post-dural puncture headache [G97.0]
7.2.2	[G44.820]	CSF fistula headache [G96.0]
7.2.3	[G44.820]	Headache attributed to spontaneous (or idiopathic) low CSF pressure
7.3	[G44.82]	Headache attributed to non-infectious inflammatory disease
7.3.1	[G44.823]	Headache attributed to neurosarcoidosis [D86.8]
7.3.2	[G44.823]	Headache attributed to aseptic (non-infectious) meningitis [code to specify aetiology]
7.3.3	[G44.823]	Headache attributed to other non-infectious inflammatory disease [code to specify aetiology]
7.3.4	[G44.82]	Headache attributed to lymphocytic hypophysitis [E23.6]
7.4	[G44.822]	Headache attributed to intracranial neoplasm [C00-D48]
7.4.1	[G44.822]	Headache attributed to increased intracranial pressure or hydrocephalus caused by neoplasm [code to specify neoplasm]

7.4.2	[G44.822]	Headache attributed directly to neoplasm [code to specify neoplasm]
7.4.3	[G44.822]	Headache attributed to carcinomatous meningitis [C79.3]
7.4.4	[G44.822]	Headache attributed to hypothalamic or pituitary hyper- or hyposecretion [E23.0]
7.5	[G44.824]	Headache attributed to intrathecal injection [G97.8]
7.6	[G44.82]	Headache attributed to epileptic seizure [G40.x or G41.x to specify seizure type]
7.6.1	[G44.82]	Hemicrania epileptica [G40.x or G41.x to specify seizure type]
7.6.2	[G44.82]	Post-seizure headache [G40.x or G41.x to specify seizure type]
7.7	[G44.82]	Headache attributed to Chiari malformation type I (CM1) [Q07.0]
7.8	[G44.82]	Syndrome of transient Headache and Neurological Deficits with cerebrospinal fluid Lymphocytosis (HaNDL)
7.9	[G44.82]	Headache attributed to other non-vascular intracranial disorder
8.	**[G44.4 or G44.83]**	**Headache attributed to a substance[2] or its withdrawal**
8.1	[G44.40]	Headache induced by acute substance use or exposure
8.1.1	[G44.400]	Nitric oxide (NO) donor-induced headache [X44]
8.1.1.1	[G44.400]	Immediate NO donor-induced headache [X44]
8.1.1.2	[G44.400]	Delayed NO donor-headache [X44]
8.1.2	[G44.40]	Phosphodiesterase (PDE) inhibitor-induced headache [X44]
8.1.3	[G44.402]	Carbon monoxide-induced headache [X47]
8.1.4	[G44.83]	Alcohol-induced headache [F10]
8.1.4.1	[G44.83]	Immediate alcohol-induced headache [F10]
8.1.4.2	[G44.83]	Delayed alcohol-induced headache [F10]
8.1.5	[G44.4]	Headache induced by food components and additives
8.1.5.1	[G44.401]	Monosodium glutamate-induced headache [X44]
8.1.6	[G44.83]	Cocaine-induced headache [F14]
8.1.7	[G44.83]	Cannabis-induced headache [F12]
8.1.8	[G44.40]	Histamine-induced headache [X44]
8.1.8.1	[G44.40]	Immediate histamine-induced headache [X44]
8.1.8.2	[G44.40]	Delayed histamine-induced headache [X44]
8.1.9	[G44.40]	Calcitonin gene-related peptide (CGRP)-induced headache [X44]
8.1.9.1	[G44.40]	Immediate CGRP-induced headache [X44]
8.1.9.2	[G44.40]	Delayed CGRP-induced headache [X44]
8.1.10	[G44.41]	Headache as an acute adverse event attributed to medication used for other indications [code to specify substance]
8.1.11	[G44.4 or G44.83]	Headache induced by other acute substance use or exposure [code to specify substance]
8.2	[G44.41 or G44.83]	Medication-overuse headache (MOH)
8.2.1	[G44.411]	Ergotamine-overuse headache [Y52.5]
8.2.2	[G44.41]	Triptan-overuse headache
8.2.3	[G44.410]	Analgesic-overuse headache [F55.2]
8.2.4	[G44.83]	Opioid-overuse headache [F11.2]
8.2.5	[G44.410]	Combination medication-overuse headache [F55.2]
8.2.6	[G44.410]	Headache attributed to other medication overuse [code to specify substance]
8.2.7	[G44.41 or G44.83]	Probable medication-overuse headache [code to specify substance]

[2] In ICD-10 substances are classified according to the presence or absence of a dependence-producing property. Headaches associated with psychoactive substances (dependence-producing) are classified in G44.83 with an additional code to indicate the nature of the disorder related to the substance use: *eg*, intoxication (F1x.0), dependence (F1x.2), withdrawal (F1x.3), *etc*. The 3rd character can be used to indicate the specific substance involved: *eg*, F10 for alcohol, F15 for caffeine, *etc*. Abuse of non-dependence-producing substances is classified in F55, with a 4th character to indicate the substance: *eg*, F55.2 abuse of analgesics. Headaches related to non-dependence-producing substances are classified in G44.4.

8.3	[G44.4]	Headache as an adverse event attributed to chronic medication [code to specify substance]
8.3.1	[G44.418]	Exogenous hormone-induced headache [Y42.4]
8.4	[G44.83]	Headache attributed to substance withdrawal
8.4.1	[G44.83]	Caffeine-withdrawal headache [F15.3]
8.4.2	[G44.83]	Opioid-withdrawal headache [F11.3]
8.4.3	[G44.83]	Oestrogen-withdrawal headache [Y42.4]
8.4.4	[G44.83]	Headache attributed to withdrawal from chronic use of other substances [code to specify substance]
9.		**Headache attributed to infection**
9.1	[G44.821]	Headache attributed to intracranial infection [G00-G09]
9.1.1	[G44.821]	Headache attributed to bacterial meningitis [G00.9]
9.1.2	[G44.821]	Headache attributed to lymphocytic meningitis [G03.9]
9.1.3	[G44.821]	Headache attributed to encephalitis [G04.9]
9.1.4	[G44.821]	Headache attributed to brain abscess [G06.0]
9.1.5	[G44.821]	Headache attributed to subdural empyema [G06.2]
9.2	[G44.881]	Headache attributed to systemic infection [A00-B97]
9.2.1	[G44.881]	Headache attributed to systemic bacterial infection [code to specify aetiology]
9.2.2	[G44.881]	Headache attributed to systemic viral infection [code to specify aetiology]
9.2.3	[G44.881]	Headache attributed to other systemic infection [code to specify aetiology]
9.3	[G44.821]	Headache attributed to HIV/AIDS [B22]
9.4	[G44.821 or G44.881]	Chronic post-infection headache [code to specify aetiology]
9.4.1	[G44.821]	Chronic post-bacterial meningitis headache [G00.9]
10.	**[G44.882]**	**Headache attributed to disorder of homoeostasis**
10.1	[G44.882]	Headache attributed to hypoxia and/or hypercapnia
10.1.1	[G44.882]	High-altitude headache [W94]
10.1.2	[G44.882]	Diving headache
10.1.3	[G44.882]	Sleep apnoea headache [G47.3]
10.2	[G44.882]	Dialysis headache [Y84.1]
10.3	[G44.813]	Headache attributed to arterial hypertension [I10]
10.3.1	[G44.813]	Headache attributed to phaeochromocytoma [D35.0 (benign) or C74.1 (malignant)]
10.3.2	[G44.813]	Headache attributed to hypertensive crisis without hypertensive encephalopathy [I10]
10.3.3	[G44.813]	Headache attributed to hypertensive encephalopathy [I67.4]
10.3.4	[G44.813]	Headache attributed to pre-eclampsia [O13-O14]
10.3.5	[G44.813]	Headache attributed to eclampsia [O15]
10.3.6	[G44.813]	Headache attributed to acute pressor response to an exogenous agent [code to specify aetiology]
10.4	[G44.882]	Headache attributed to hypothyroidism [E03.9]
10.5	[G44.882]	Headache attributed to fasting [T73.0]
10.6	[G44.882]	Cardiac cephalalgia [code to specify aetiology]
10.7	[G44.882]	Headache attributed to other disorder of homoeostasis [code to specify aetiology]
11.	**[G44.84]**	**Headache or facial pain attributed to disorder of cranium, neck, eyes, ears, nose, sinuses, teeth, mouth or other facial or cranial structures**
11.1	[G44.840]	Headache attributed to disorder of cranial bone [M80-M89.8]

11.2	[G44.841]	Headache attributed to disorder of neck [M99]
11.2.1	[G44.841]	Cervicogenic headache [M99]
11.2.2	[G44.842]	Headache attributed to retropharyngeal tendonitis [M79.8]
11.2.3	[G44.841]	Headache attributed to craniocervical dystonia [G24]
11.3	[G44.843]	Headache attributed to disorder of eyes
11.3.1	[G44.843]	Headache attributed to acute glaucoma [H40]
11.3.2	[G44.843]	Headache attributed to refractive errors [H52]
11.3.3	[G44.843]	Headache attributed to heterophoria or heterotropia (latent or manifest squint) [H50.3-H50.5]
11.3.4	[G44.843]	Headache attributed to ocular inflammatory disorder [code to specify aetiology]
11.4	[G44.844]	Headache attributed to disorder of ears [H60-H95]
11.5	[G44.845]	Headache attributed to rhinosinusitis [J01]
11.6	[G44.846]	Headache attributed to disorder of teeth, jaws or related structures [K00-K14]
11.7	[G44.846]	Headache or facial pain attributed to temporomandibular joint (TMJ) disorder [K07.6]
11.8	[G44.84]	Headache attributed to other disorder of cranium, neck, eyes, ears, nose, sinuses, teeth, mouth or other facial or cervical structures [code to specify aetiology]
12.	**[R51]**	**Headache attributed to psychiatric disorder**
12.1	[R51]	Headache attributed to somatisation disorder [F45.0]
12.2	[R51]	Headache attributed to psychotic disorder [code to specify aetiology]
13.	**[G44.847, G44.848 or G44.85]**	**Cranial neuralgias and central causes of facial pain**
13.1	[G44.847]	Trigeminal neuralgia
13.1.1	[G44.847]	Classical trigeminal neuralgia [G50.00]
13.1.2	[G44.847]	Symptomatic trigeminal neuralgia [G53.80] + [code to specify aetiology]
13.2	[G44.847]	Glossopharyngeal neuralgia
13.2.1	[G44.847]	Classical glossopharyngeal neuralgia [G52.10]
13.2.2	[G44.847]	Symptomatic glossopharyngeal neuralgia [G53.830] + [code to specify aetiology]
13.3	[G44.847]	Nervus intermedius neuralgia [G51.80]
13.4	[G44.847]	Superior laryngeal neuralgia [G52.20]
13.5	[G44.847]	Nasociliary neuralgia [G52.80]
13.6	[G44.847]	Supraorbital neuralgia [G52.80]
13.7	[G44.847]	Other terminal branch neuralgias [G52.80]
13.8	[G44.847]	Occipital neuralgia [G52.80]
13.9	[G44.851]	Neck-tongue syndrome
13.10	[G44.801]	External compression headache
13.11	[G44.802]	Cold-stimulus headache
13.11.1	[G44.8020]	Headache attributed to external application of a cold stimulus
13.11.2	[G44.8021]	Headache attributed to ingestion or inhalation of a cold stimulus
13.12	[G44.848]	Constant pain caused by compression, irritation or distortion of cranial nerves or upper cervical roots by structural lesions [G53.8] + [code to specify aetiology]
13.13	[G44.848]	Optic neuritis [H46]
13.14	[G44.848]	Ocular diabetic neuropathy [E10-E14]
13.15	[G44.881 or G44.847]	Head or facial pain attributed to herpes zoster
13.15.1	[G44.881]	Head or facial pain attributed to acute herpes zoster [B02.2]
13.15.2	[G44.847]	Post-herpetic neuralgia [B02.2]

13.16	[G44.850]	Tolosa-Hunt syndrome
13.17	[G43.80]	Ophthalmoplegic 'migraine'
13.18	[G44.810 or G44.847]	Central causes of facial pain
13.18.1	[G44.847]	Anaesthesia dolorosa [G52.800] + [code to specify aetiology]
13.18.2	[G44.810]	Central post-stroke pain [G46.21]
13.18.3	[G44.847]	Facial pain attributed to multiple sclerosis [G35]
13.18.4	[G44.847]	Persistent idiopathic facial pain [G50.1]
13.18.5	[G44.847]	Burning mouth syndrome [code to specify aetiology]
13.19	[G44.847]	Other cranial neuralgia or other centrally mediated facial pain [code to specify aetiology]
14.	**[R51]**	**Other headache, cranial neuralgia, central or primary facial pain**
14.1	[R51]	Headache not elsewhere classified
14.2	[R51]	Headache unspecified

8.7 Appendix 8.7 Research Diagnostic Criteria for Temporomandibular Disorders

DEPARTMENT OF ORAL MEDICINE

OROFACIAL PAIN RESEARCH GROUP

RESEARCH DIAGNOSTIC CRITERIA FOR TEMPOROMANDIBULAR DISORDERS

AXIS I: CLINICAL PHYSICAL EXAMINATION FORMS AND SPECIFICATIONS

INSTRUCTIONS FOR SCORING AND ASSESSMENT

AXIS II: BIOBEHAVIORAL QUESTIONNAIRES INSTRUCTIONS FOR SCORING AND ASSESSMENT

Seattle, WA 98195-6370
Phone (206) 543-5912 • Fax (206) 685-8412

TABLE OF CONTENTS

INTRODUCTION

The RDC/TMD booklet is an updated version of the original publication of the RDC/TMD and been prepared to allow clinical researchers to have access to the most current version of the RDC/TMD.

The RDC/TMD booklet contains all the information needed to:

1. administer, score and obtain an RDC/TMD Axis I algorithm clinical diagnosis
2. administer, score and derive an RDC/TMD Axis II assessment of mandibular function, psychological status and level of TMD-related psychosocial disability*

The RDC/TMD is understood to represent a "work-in-progress" with significant research effort continuously devoted to improving its reliability, validity and clinical utility.

Note: The RDC/TMD Axis II portion of this Booklet incorporates corrections from the original publication for scoring the Depression and Non-Specific Physical Symptoms Scales. Part 3 includes a Summary page (Axis II: Scoring the Scale Items), containing items comprising each scale and empirically-derived guidelines for interpreting those scales based on U.S. population data.

RESEARCH DIAGNOSTIC CRITERIA
FOR TEMPOROMANDIBULAR DISORDERS

Part 1

ADMINISTERING THE RDC

HISTORY QUESTIONNAIRE

ID# _____

Date: ___ ___ / ___ ___ / ____ ___

Please read each question and respond accordingly. For each of the questions below circle only one response.

1. Would you say your health in general is excellent, very good, good, fair or poor?

Excellent	1
Very good	2
Good	3
Fair	4
Poor	5

2. Would you say your oral health in general is excellent, very good, good, fair or poor?

Excellent	1
Very good	2
Good	3
Fair	4
Poor	5

3. Have you had pain in the face, jaw, temple, in front of the ear or in the ear in the past month?

No	0
Yes	1

[If no pain in the past month, SKIP to question 14]

If Yes,

4.a. How many years ago did your facial pain begin for the first time?

___ ___ years

[If one year ago or more SKIP to question 5] **[If less than one year ago, code 00]**

4.b. How many months ago did your facial pain begin for the first time?

____ ____ months

5. Is your facial pain persistent, recurrent or was it only a one-time problem?

Persistent	1
Recurrent	2
One-Time	3

6. Have you ever gone to a physician, dentist, chiropractor or other health professional for facial ache or pain?

No	1
Yes, in the last six months	2
Yes, more than six months ago	3

7. How would you rate your facial pain on a 0 to 10 scale at the present time, that is right now, where 0 is "no pain" and 10 is "pain as bad as could be"?

No pain **Pain as bad as could be**

0 1 2 3 4 5 6 7 8 9 10

8. In the past six months, how intense was your worst pain rated on a 0 to 10 scale where 0 is "no pain" and 10 is "pain as bad as could be"?

No pain **Pain as bad as could be**

0 1 2 3 4 5 6 7 8 9 10

9. In the past six months, on the average, how intense was your pain rated on a 0 to 10 scale where 0 is "no pain" and 10 is "pain as bad as could be"? [That is, your usual pain at times you were experiencing pain].

No pain **Pain as bad as could be**

0 1 2 3 4 5 6 7 8 9 10

10. About how many days in the last six months have you been kept from your usual activities (work, school or housework) because of facial pain?

_____ _____ _____

DAYS

11. In the past six months, how much has facial pain interfered with your daily activities rated on a 0 to 10 scale where 0 is "no interference" and 10 is "unable to carry on any activities"?

No Interference **Unable To Carry On Any Activities**

0 1 2 3 4 5 6 7 8 9 10

12. In the past six months, how much has facial pain changed your ability to take part in recreational, social and family activities where 0 is "no change" and 10 is "extreme change"?

No **Change** **Unable To Carry On Any Activities**

0 1 2 3 4 5 6 7 8 9 10

13. In the past six months, how much has facial pain changed your ability to work including housework) where 0 is "no change" and 10 is "extreme change"?

No Change **Unable To Carry On Any Activities**

0 1 2 3 4 5 6 7 8 9 10

14.a. Have you ever had your jaw lock or catch so that it won't open all the way? No 0 Yes 1

[If no problem opening all the way, SKIP to question 15]

If Yes,

14.b. Was this limitation in jaw opening severe enough to interfere with your ability to eat? No 0 Yes 1

15.

a. Does your jaw click or pop when you open or close your mouth or when chewing? No 0 Yes 1

b. Does your jaw make a grating or grinding noise when it opens and closes or when chewing? No 0 Yes 1

c. Have you been told, or do you notice that you grind your teeth or clench your jaw while sleeping at night? No 0 Yes 1

d. During the day, do you grind your teeth or clench your jaw? No 0 Yes 1

e. Does your jaw ache or feel stiff when you wake up in the morning? No 0 Yes 1

f. Do you have noises or ringing in your ears? No 0 Yes 1

g. Does your bite feel uncomfortable or unusual? No 0 Yes 1

16.a. Do you have rheumatoid arthritis, lupus, or other systemic arthritic disease? No 0 Yes 1

16.b. Do you know of anyone in your family who has had any of these diseases? No 0 Yes 1

16.c. Have you had or do you have any swollen or painful joint(s) other than the joints close to your ears (TMJ)? No 0 Yes 1

[If no swollen or painful joints, SKIP to question 17.a.]

If Yes,

16.d. Is this a persistent pain which you have had for at least one year? No 0 Yes 1

17.a. Have you had a recent injury to your face or jaw? No 0 Yes 1

[If no recent injuries, SKIP to question 18]

If Yes,

17.b. Did you have jaw pain before the injury? No 0 Yes 1

18. During the last six months have you had a problem with headaches or migraines? No 0 Yes 1

19. What activities does your present jaw problem prevent or limit you from doing?

a.	Chewing	No	0	g.	Sexual activity	No	0
		Yes	1			Yes	1
b.	Drinking	No	0	h.	Cleaning teeth or face	No	0
		Yes	1			Yes	1
c.	Exercising	No	0	i.	Yawning	No	0
		Yes	1			Yes	1
d.	Eating hard foods	No	0	j.	Swallowing	No	0
		Yes	1			Yes	1
e.	Eating soft foods	No	0	k.	Talking	No	0
		Yes	1			Yes	1
f.	Smiling/laughing	No	0	l.	Having your usual facial appearance	No	0
		Yes	1			Yes	1

20. In the last month, how much have you been distressed by. . .

		Not At All	A Little Bit	Moder-ately	Quite A Bit	Ex-tremely
a.	Headaches	0	1	2	3	4
b.	Loss of sexual interest or pleasure	0	1	2	3	4
c.	Faintness or dizziness	0	1	2	3	4
d.	Pains in the heart or chest	0	1	2	3	4
e.	Feeling low in energy or slowed down	0	1	2	3	4
f.	Thoughts of death or dying	0	1	2	3	4
g.	Poor appetite	0	1	2	3	4
h.	Crying easily	0	1	2	3	4
i.	Blaming yourself for things	0	1	2	3	4
j.	Pains in the lower back	0	1	2	3	4
k.	Feeling lonely	0	1	2	3	4
l.	Feeling blue	0	1	2	3	4
m.	Worrying too much about things	0	1	2	3	4
n.	Feeling no interest in things	0	1	2	3	4
o.	Nausea or upset stomach	0	1	2	3	4
p.	Soreness of your muscles	0	1	2	3	4
q.	Trouble falling asleep	0	1	2	3	4
r.	Trouble getting your breath	0	1	2	3	4
s.	Hot or cold spells	0	1	2	3	4
t.	Numbness or tingling in parts of your body	0	1	2	3	4
u.	A lump in your throat	0	1	2	3	4
v.	Feeling hopeless about the future	0	1	2	3	4
w.	Feeling weak in parts of your body	0	1	2	3	4
x.	Heavy feelings in your arms or legs	0	1	2	3	4
y.	Thoughts of ending your life	0	1	2	3	4
z.	Overeating	0	1	2	3	4
aa.	Awakening in the early morning	0	1	2	3	4

		Not At All	A Little Bit	Moder-ately	Quite A Bit	Ex-tremely
bb.	Sleep that is restless or disturbed	0	1	2	3	4
cc.	Feeling everything is an effort	0	1	2	3	4
dd.	Feelings of worthlessness	0	1	2	3	4
ee.	Feeling of being caught or trapped	0	1	2	3	4
ff.	Feelings of guilt	0	1	2	3	4

21. How good a job do you feel you are doing in taking care of your health overall?

Excellent	1
Very good	2
Good	3
Fair	4
Poor	5

22. How good a job do you feel you are doing in taking care of your oral health?

Excellent	1
Very good	2
Good	3
Fair	4
Poor	5

23. When were you born? Month __ __ Day __ __ Year __ __

24. Are you male or female?

Male	1
Female	2

25. Which of the following groups best represent your race?

Aleut, Eskimo or American Indian	1
Asian or Pacific Islander	2
Black	3
White	4
Other	5
(please specify) _____	

26. Are any of these groups your national origin or ancestry?

Puerto Rican	1	Chicano	5
Cuban	2	Other Latin American	6
Mexican/Mexicano	3	Other Spanish	7
Mexican American	4	None of the above	8

27. What is the highest grade or year of regular school that you have completed?

Never attended or Kindergarten:	00							
Elementary School:	1	2	3	4	5	6	7	8
High School:	9	10	11	12				
College:	13	14	15	16	17	18+		

28. During the past 2 weeks, did you work at a job or business not counting work around the house (include unpaid work in the family farm/business)?

Yes	1
No	2

29. Are you married, widowed, divorced, separated or never been married?

Married-spouse in household	1
Married-spouse not in household	2
Widowed	3
Divorced	4
Separated	5
Never Married	6

30. Which of the following best represents your total combined household income during the past 12 months

___ $0-$14,999
___ $15,000-$24,999
___ $25,000-$34,999
___ $35,000-$49,999
___ $50,000 or more

31. What is your USA 5 digit zip code or your national postal code? _ _ _ _ _

RESEARCH DIAGNOSTIC CRITERIA
TMD CLINICAL EXAMINATION FORM

ID# _____

Date: ___ ___ / ___ ___ / ____ ___

1. Do you have pain on the right side of your face, the left side or both sides?

None	0
Right	1
Left	2
Both	3

2. Could you point to the areas where you feel pain?

Right		Left	
None	0	None	0
Jaw Joint	1	Jaw Joint	1
Muscles	2	Muscles	2
Both	3	Both	3

[Examiner feels area subject points to, if it is unclear whether it is joint or muscle pain]

3. Opening Pattern

Straight	0
Right Lateral Deviation (uncorrected)	1
Right Corrected ("S") Deviation	2
Left Lateral Deviation (uncorrected)	3
Left Corrected ("S") Deviation	4
Other	5

Type_____
(specify)

4. Vertical Range of Motion

Maxillary incisor used	8
	9

		MUSCLE PAIN				JOINT PAIN			
		None	Right	Left	Both	None	Right	Left	Both
a. Unassisted opening without pain	___ ___mm								
b. Maximum unassisted opening	___ ___mm	0	1	2	3	0	1	2	3
c. Maximum assisted opening	___ ___mm	0	1	2	3	0	1	2	3
d. Vertical incisal overlap	___ ___mm								

5. Joint Sounds (palpation)

			RIGHT	LEFT
a.	Opening	None	0	0
		Click	1	1
		Coarse Crepitus	2	2
		Fine Crepitus	3	3
	Measurement of Opening Click		___ __mm	___ __mm
b.	Closing	None	0	0
		Click	1	1
		Coarse Crepitus	2	2
		Fine Crepitus	3	3
	Measurement of Closing Click		___ __mm	___ __mm
c.	Reciprocal click eliminated on protrusive opening	No	0	0
		Yes	1	1
		NA	8	8

6. Excursions

		MUSCLE PAIN				JOINT PAIN			
		None	Right	Left	Both	None	Right	Left	Both
a. Right Lateral Excursion	___ __mm	0	1	2	3	0	1	2	3
b. Left Lateral Excursion	___ __mm	0	1	2	3	0	1	2	3
c. Protrusion	___ __mm	0	1	2	3	0	1	2	3

		RIGHT	LEFT	NA
d. Midline Deviation	___ __mm	1	2	8

7. Joint Sounds on Excursions

Right Sounds:

	None	Click	Coarse Crepitus	Fine Crepitus
Excursion Right	0	1	2	3
Excursion Left	0	1	2	3
Protrusion	0	1	2	3

Left Sounds:

	None	Coarse Click	Fine Crepitus	Crepitus
Excursion Right	0	1	2	3
Excursion Left	0	1	2	3
Protrusion	0	1	2	3

DIRECTIONS, ITEMS 8-10

The examiner will be palpating (touching) different areas of your face, head and neck. We would like you to indicate if you do not feel pain or just feel pressure (0), or pain (1-3). Please rate how much pain you feel for each of the palpations according to the scale below. Circle the number that corresponds to the amount of pain you feel. We would like you to make a separate rating for both the right and left palpations.

0 = No Pain/Pressure Only

1 = Mild Pain

2 = Moderate Pain

3 = Severe Pain

8. Extraoral muscle pain with palpation:

		RIGHT	LEFT
a.	Temporalis (posterior) "Back of temple"	0 1 2 3	0 1 2 3
b.	Temporalis (middle) "Middle of temple"	0 1 2 3	0 1 2 3
c.	Temporalis (anterior) "Front of temple"	0 1 2 3	0 1 2 3
d.	Masseter (superior) "Cheek/under cheekbone"	0 1 2 3	0 1 2 3
e.	Masseter (middle) "Cheek/side of face"	0 1 2 3	0 1 2 3
f.	Masseter (inferior) "Cheek/jawline"	0 1 2 3	0 1 2 3
g.	Posterior mandibular region (Stylohyoid/posterior digastric region) "Jaw/throat region"	0 1 2 3	0 1 2 3
h.	Submandibular region (Medial pterygoid/Suprahyoid/anterior digastric region) "Under chin"	0 1 2 3	0 1 2 3

9. Joint pain with palpation:

		RIGHT	LEFT
a.	Lateral pole "outside"	0 1 2 3	0 1 2 3
b.	Posterior attachment "inside ear"	0 1 2 3	0 1 2 3

10. Intraoral muscle pain with palpation:

		RIGHT	LEFT
a.	Lateral pterygoid area "Behind upper molars"	0 1 2 3	0 1 2 3
b.	Tendon of temporalis "Tendon"	0 1 2 3	0 1 2 3

Part 2

CLINICAL EXAMINATION SPECIFICATIONS

RESEARCH DIAGNOSTIC CRITERIA FOR TMD
Specifications for Clinical Examination

A. GENERAL DIRECTIONS FOR EXAMINATION

1. All questionnaire and examination items need to be completed unless the subject refuses or is unable to cooperate. In this case, write "SR" (subject refuses) in large block letters adjacent to the examination item and note why the subject refuses or cannot do item.
2. All measurements will be conducted with the jaw muscles in a passive state, unless the examination specifies otherwise. The joints and muscles should not receive additional weight or pressure at any time.
3. All millimeter recordings will be done as single or double digits. If a double-digit reading is only one digit, precede with a lead zero. If a measurement is between two millimeter markings, record the lesser value.
4. Subjects will sit in chairs at approximately a 90-degree angle to the examiner.
5. Examiners will wear gloves at all times.
6. Subjects with replacement prostheses will be examined with the prostheses in their mouth except if it is necessary to remove these for observing the mucosa and gingiva and performing intraoral palpations. Bite plates and other appliances that do not replace teeth are to be removed for the examination.
7. If the subject has a beard, a neck brace or any other potential physical barrier that may interfere with muscle or TMJ palpation, indicate this.
8. Conduct the examination procedures in the order on the form and record all measurements in the appropriate places on the specified form.
9. Items 4.d, Vertical incisal overlap, and 6.d, Midline deviation, are included so corrections to measurements in items 4 and 6, respectively, can be done to determine actual values of openings and excursions. For items 4.a through 4.c, the amount of vertical incisor overlap (4.d) should be added to each of these measurements to determine the actual amount of opening. For items 6.a and 6.b, if midline deviation (6.d) is greater than 0, this measurement should be added to one side of the lateral excursion and subtracted from the other side.

   For example: If a subject has a 2-mm deviation to the right, then subtract 2 mm from the value given to the right lateral excursion and add 2 mm to the value given to the left lateral excursion.

Note: Because the research diagnostic criteria require self-report of pain location (examination items 1 and 2), verified by the examiner, these items have been moved from the questionnaire to the examination. This will allow the examiner the opportunity to reliably confirm the type and location of pain.

B. EXAMINATION

1. Circle the appropriate answer. If the subject indicates midline pain score as "Both."
2. Circle the appropriate answer. If it is unclear to the examiner whether the subject is indicating a joint or muscle, press on the area as lightly as possible to correctly identify the anatomic site. For example, if the subject indicates pain in the joint, but the examiner identifies the location as muscle, the examiner's findings are those which are recorded.
3. *Opening Pattern.* General Instruction: Ask the subject to position the mandible in a comfortable position. ("Place your mouth in a comfortable position with your teeth lightly touching.") Place your thumb under the subject's lower lip so that the lip reveals the lower teeth. This will facilitate observing midline deviation. Ask the subject to open the mouth as wide as possible, even if he/she feels pain. ("I'd like you to open your mouth as wide as you can, even if it's a little painful.") If the degree of deviation is unclear, then use a millimeter ruler held vertically between the maxillary and mandibular incisor embrasures (or mark mandibular incisor if midlines do not match) as a guide. Ask the subject to open three times. If the subject exhibits more than one opening pattern then ask the subject to repeat the three openings and score according to the following criteria (*note:* only opening pattern is assessed).

a. *Straight.* If there is no perceptible deviation upon opening.

b. *Laterial Deviation to Right or Left.* For deviations that are visually perceptible to one side at maximum opening, determine which side of the subject's face the deviation goes towards and record accordingly.

c. *Corrected Deviation ("S" Deviation).* The subject exhibits a perceptible deviation to the right or left but corrects to the midline before or upon reaching the maximum unassisted mandibular opening.

d. *Other.* The subject exhibits jerky opening (not smooth or continuous) or has an opening other than those provided; indicate this and the type of deviation. If the subject has more than one opening pattern, use this category and write "more than one."

4. *Vertical Range of Motion of Mandible.* If the subject is wearing a denture or partial and it is loose, compress it against the ridge for all opening measurements.

a. *Unassisted (Mandibular) Opening Without Pain*

i. *Obtaining Measurement.* Ask the subject to place the mandible in a comfortable position. ("Place your mouth in a comfortable position.") Ask the subject to open the mouth as far as possible (unassisted), without feeling any pain. ("I would like for you to open as wide as you can without feeling any pain.") Place the edge of the millimeter ruler at the incisal edge of the maxillary central incisor that is the most vertically oriented and measure vertically to the labioincisal edge of the opposing mandibular incisor; record this measurement. Indicate on the form which maxillary incisor was chosen. If the subject did not open at least 30 mm, to insure understanding, repeat the opening. If the second opening still does not produce more than a 30-mm opening, record the measurement.

b. *Maximum Unassisted (Mandibular) Opening*

i. *Obtaining Measurement.* Ask the subject to place the mandible in a comfortable position. ("Place your mouth in a comfortable position.") Then ask the subject to open the mouth as wide as possible, even if he/she feels pain. ("I would like for you to open your mouth as wide as you can, even if it's a little uncomfortable.") Place the edge of the millimeter ruler at the incisal edge of the maxillary central incisor that is the most vertically oriented and measure vertically to the labioincisal edge of the opposing mandibular incisor; record this measurement.

ii. *Pain.* Ask the subject if he/she felt pain on maximum unassisted opening. ("When you opened this time, did you have any pain?") Record whether or not they had pain, and the location. The location is scored in two ways: by left and/or right side and specifically whether or not the pain is in the joint. Two entries are required for items 4.b and 4.c to assess pain: record side of pain as "None" (0), "Right" (1), "Left" (2) or "Both" (3). Also record if pain in the joint is "Present" (1) or "Absent" (0). If the subject had no pain, circle "NA" (9) for location. If he/she indicates pressure or tightness, score as "None."

c. *Maximum Assisted (Mandibular) Opening*

i. *Obtaining Measurement.* Ask the subject to position the mandible in a comfortable position. ("Place your mouth in a comfortable position.") Ask the subject to open the mouth as wide as possible, even if he/she feels pain. ("I would like for you to open your mouth as wide as you can, even if it's a little uncomfortable.") After the subject has opened this wide, place your thumb on the subject's maxillary central incisors, and cross your index finger over to the subject's mandibular central incisors. From this position you will gain the leverage necessary to force the subject's mouth open wider. Use moderate pressure, but do not forcefully open the mouth wider. ("I am checking to see if I can push your mouth open a little further and I will stop if you raise your hand.") Measure from labioincisal edge of the same maxillary central incisor as before to the labioincisal edge of the mandibular incisor with the millimeter ruler; record the measurement.

ii. *Pain.* Record whether or not the subject felt pain and the location. ("Did you feel any pain when I tried to open your mouth wider with my fingers?") Score pain locations as in maximum unassisted opening. If they indicated feeling pressure or tightness, score as "None."

d. *Vertical Incisal Overlap.* Ask the patient to close the teeth completely together. With a pen or fingernail, mark the line where the incisal edge of the same maxillary central incisor used before

for measurements overlaps the mandibular incisor. Measure the distance from the mandibular incisal edge to the marked line and record the measurement.

5. *Temporomandibular Joint Sounds on Palpation for Vertical Range of Motion.*

General Instructions: Subjects will indicate the presence or absence of sounds; if present, the examiners will score the *type* of sound observed.

Place left index finger over the subject's right TMJ and the right index finger over the subject's left TMJ (preauricular area). The pad of the right finger is placed anterior to the tragus of the ear. Ask the subject to slowly open as wide as possible, even if it causes pain. Each closure should bring the teeth completely together in maximum intercuspation. Ask the subject: "While I have my fingers over your joint, I would like you to slowly open as wide as you can and then slowly close until your teeth are completely together." Ask the subject to open and close 3 times. Record the action/sound that the joint produces, on opening or closing as detected by palpation and as defined below.

a. *Definition of sounds*

0 = *None.*

1 = *Click.* A distinct sound, of brief and very limited duration, with a clear beginning and end, which usually sounds like a "click." Circle this item only if the click is reproducible on two of three openings/closings.

2 = *Coarse Crepitus.* A sound that is continuous, over a longer period of jaw movement. It is not brief like a click or pop; the sound may make overlapping continuous noises. This sound is not muffled; it is the noise of bone grinding against bone, or like a stone grinding against another stone.

3 = *Fine Crepitus.* Fine crepitus is a fine grating sound that is continuous over a longer period of jaw movement on opening or closing. It is not brief like a click; the sound may make overlapping continuous sounds. It may be described as a rubbing or crackling sound on a rough surface.

b. *Scoring of clicking sounds.* While many of the following types of sounds are not pertinent to specific diagnostic criteria, this exhaustive list of definitions is provided in order to better delineate how the sound types required to meet RDC may differ from other sounds.

i. *Reproducible Opening Click.* If upon opening and closing from maximum intercuspation, a click is noted on two of three opening movements, record as positive for opening click.

ii. *Reproducible Closing Click.* A click present on two of three closing mandibular movements.

iii. *Reproducible Reciprocal Click.* This sound is determined by the millimeter measurement of opening and closing clicks and the elimination of both clicks when the subject opens and closes from a protruded position. With the millimeter ruler, measure the interincisal distance at which the first opening and closing clicks are heard. Measure from labioincisal embrasure of the maxillary central identified in 4 to the labioincisal embrasure of the opposing mandibular incisor. If the clicking ceases and therefore is not measurable, leave the ___ ___'s unfilled. (Computer analyses will then indicate this is not a reciprocal click; even though a click *had* been present, it did not *continue* to be present.) Assess elimination of clicks on protrusive opening by asking the subject first to maximally protrude. Next ask the subject to open and close from this protruded jaw position. The opening and closing click will normally be eliminated. Circle "Yes" (1) if the click can be eliminated if the jaw is opened and closed in a protruded or more anterior jaw position. If the click is not eliminated, circle "No" (0). If the subject lacks either a reproducible opening click or a reproducible closing click, circle "NA" (9).

iv. *Non-Reproducible Click* (Do Not Score). A nonreproducible click is present if the sound is only demonstrated periodically during opening or closing; it cannot be reproduced on at least two of three full mandibular movements. More than one sound can be circled overall for Opening (a) and Closing (b). If none (0) is circled, no other responses can be circled.

6. *Mandibular Excursive Movements*

a. *Right Lateral Excursion*

i. *Obtaining Measurement.* Ask subject to open slightly and move the mandible as far as possible to the right, even if it is uncomfortable. If necessary, repeat the movement. (*Example:* "Move

your jaw as far as possible towards the right, even if it is uncomfortable, and move your jaw back to its normal position. Move your jaw back towards the right again.") With the teeth slightly separated, use a millimeter ruler to measure from the labioincisal embrasure between the maxillary centrals to the labioincisal embrasure of the mandibular incisors; record this measurement.

ii. *Pain.* Ask the subject if he/she had pain. Record whether or not the subject felt pain and the location. The location is scored in two ways: by left and/or right side and specifically whether or not the pain is in the joint. Two entries are required for items 6.a through 6.c to assess pain: record side of pain as "None" (0), "Right" (1), "Left" (2), or "Both" (3). Also record if pain in the joint is "Present" (1) or "Absent" (0). If the subject indicated feeling pressure or tightness, score as "None."

b. *Left Lateral Excursion*

i. *Obtaining Measurement.* Ask the subject to move the mandible as far as possible to the other side (left). ("I would like you to now move your jaw as far as possible towards the other side and back to its normal position.") Record this measurement in the same manner as right excursion.

ii. *Pain.* Ask the subject if he/she had pain. Record whether or not the subject felt pain and the location. ("Did you feel any pain when you moved to the side?") Score pain locations as in right lateral excursion. If the subject indicated feeling pressure or tightness, score as "None."

c. *Protrusion*

i. *Obtaining Measurement.* Ask the subject to open slightly and protrude the mandible. ("Slide your jaw straight out in front of you as far as you can, even if it is uncomfortable.") If the subject has a deep overbite, ask him/her to open wider so he/she can protrude without getting interference from the maxillary incisors.

ii. *Pain.* Ask the subject if he/she had pain. Record whether or not the subject felt pain and the location. ("Did you feel any pain when you moved your jaw forward?") Score pain locations as in right lateral excursion. If the subject indicated feeling pressure or tightness, score as "None."

d. *Midline Deviation.* If the incisal embrasures of the maxillary and mandibular incisors do not line up vertically, determine the horizontal difference between the two while the subject is biting together. Measure in millimeters how far the mandibular embrasure is from the maxillary embrasure and on which side of the subject the mandibular embrasure is located. If the midline deviation is less than 1 mm, or there is no deviation, enter "00."

7. *Temporomandibular Joint Sounds on Palpation for Lateral Excursions and Protrusion*

Ask the subject to move to the right, to the left, and protrude (see 6).

a. *Definition of Sounds.* Refer to item 5.

b. *Scoring of Clicking Sounds.*

i. *Reproducible Laterotrusive and Protrusive Click.* Occurs when the TMJ displays a click with two of three lateral movements or protrusion of the mandible respectively.

ii. *Nonreproducible Laterotrusive and Protrusive Clicks.* A nonreproducible click is present if the click is only demonstrated periodically during laterotrusion movements or protrusion but cannot be reproduced on at least two of three movements. Do not score.

C. GENERAL INSTRUCTION FOR MUSCLE AND JOINT PALPATION FOR TENDERNESS

1. Examining the muscles and joint capsules for tenderness requires that you press on a specific site using the fingertips of the index and third fingers or the spade-like pad of the distal phalanx of the index finger only with standardized pressure, as follows: palpations will be done with 2 lbs of pressure for extraoral muscles (1 lb of pressure in the Posterior Mandibular Region and Submandibular Region), 1 lb of pressure on the joints and intraoral muscles. Palpate the muscles while using the opposite hand to brace the head to provide stability. The subject's mandible should be in a resting position, without the teeth touching. Palpate while muscles are in a passive state. As needed, have the subject lightly

clench and relax to identify and to insure palpation of the correct muscle site. ("I'm going to press on some muscles. I would like for you to clench your teeth together gently and then relax and have your teeth slightly apart from each other.") First locate the site of palpation using the landmarks described and then press. Because the site of maximum tenderness may vary from subject to subject and is localized, it is important to press in multiple areas in the region specified to determine if tenderness exists. Before beginning the palpations, say: "In the next part of the exam, we'd like you to record whether you feel pain or pressure when I palpate or press on certain parts of your head and face." Ask the subject to determine if the palpation hurts (painful) or if he/she just feels pressure. If it hurts, ask the subject to indicate if the pain is mild, moderate, or severe. Record any equivocal response or the report of pressure only as "No Pain."

2. *Description of Specific Extraoral Muscle Sites (2 lbs digital pressure) *(1 lb of digital pressure)*

   a. *Temporalis (Posterior).* Palpate posterior fibers behind the ears to directly above the ears. Ask the subject to clench and then relax to help identify muscle. Walk fingers towards the subject's face (medially) to the anterior border of the ear.

   b. *Temporalis (Middle).* Palpate fibers in the depression about 4-5 cm lateral to the lateral border of the eyebrow.

   c. *Temporalis (Anterior).* Palpate fibers over the infratemporal fossa, immediately above the zygomatic process. Ask the subject to clench and relax to help identify muscle.

   d. *Origin of Masseter.* Ask the subject to first clench then relax and observe masseter for location. Palpate the origin of the muscle beginning in the area 1 cm immediately in front of the TMJ and immediately below the zygomatic arch, and palpate anteriorly to the border of the muscle.

   e. *Body of the Masseter.* Start just below the zygomatic process at the anterior border of the muscle. Palpate from here down and back to the angle of the mandible across a surface area about two fingers wide.

   f. *Insertion of the Masseter.* Palpate the area 1 cm superior and anterior to the angle of the mandible.

   *g. *Posterior Mandibular Region (Stylohyoid / Posterior Digastric).* Ask the subject to tip the head back a little. Locate the area between the insertion of the SCM and the posterior border of the mandible. Place finger so it is going medially and upwards (and not on the mandible). Palpate the area immediately medial and posterior to the angle of the mandible.

   *h. *Submandibular Region (Medial Pterygoid, Suprahyoid, Anterior Digastric).* Locate the site under the mandible at a point 2 cm anterior to the angle of the mandible. Palpate superiorly, pulling toward the mandible. If a subject has a lot of pain in this area, try to determine if the subject is reporting muscle or nodular pain. If it is nodes, indicate on the exam form.

3. *Description of Specific Joint Palpation Sites (1 lb digital pressure)*

   a. *Lateral Pole.* Place index finger just anterior to the tragus of the ear and over the subject's TMJ. Ask the subject to open slightly until the examiner feels the lateral pole of the condyle translated forward. Use 1 lb pressure on the side that is being palpated, supporting the head with the opposite hand.

   b. *Posterior Attachment.* This site can be palpated intrameatally. Place tips of the right little finger into the subject's left external meatus and the tip of the left little finger into the subject's right external meatus. Point the fingertips towards the examiner and ask subject to slightly open the mouth (or wide open if necessary) to make sure the joint movement is felt with the fingertips. Place firm pressure on the right side and then the left side while the subject's teeth are completely together.

   (Change examination gloves.)

4. *Description of Specific Intraoral Palpation Sites (1 lb digital pressure)*

   Explain to the subject that you will now be palpating the inside of the mouth: ("Now I am going to palpate around the inside of your mouth. While I do these palpations I would like you to keep your jaw in a relaxed position.")

a. *Lateral Pterygoid Area.* Before palpating, make sure the fingernail of the index finger is trimmed to avoid false positives. Ask the subject to open the mouth and move the jaw to the side that is being examined. ("Move your jaw towards this hand.") Place the index finger on lateral side of alveolar ridge above the right maxillary molars. Move finger distally, upward, and medial to palpate. If the index finger is too large, use the little finger (5th digit).

b. *Tendon of Temporalis.* After completing the lateral pterygoid, rotate your index finger laterally near the coronoid process, ask the subject to open slightly, and move your index finger up the anterior ridge of the coronoid process. Palpate on the most superior aspect of the process. *Note:* If it is difficult to determine in some subjects if they are feeling pain in the lateral pterygoid or the tendon of the temporalis, rotate and palpate with the index finger medially then laterally. If there is still difficulty, the lateral pterygoid is usually the more tender of the two

Part 3

SCORING THE RD

AXIS II: SCORING PROTOCOL FOR GRADED CHRONIC PAIN

ID# _____

Date: ___ ___ / ___ ___ / ___ ___

ANY TMD PAIN REPORTED IN THE PRIOR MONTH? (*History Questionnaire, Question 3*)

If NO, Graded Chronic Pain (GCP)= 0
If YES, Continue

CHARACTERISTIC PAIN INTENSITY (CPI): (*GCP Scale, Questions 7, 8, and 9*) Calculate as follows:

CPI = _____ (*Question #7.*) + _____ (*Question #8.*) + _____ (*Question #9.*) = _____ divided by 3 = _____ x 10 = ☐

DISABILITY POINTS:

Disability Days: (*GCP Scale, Question 10*)

Number of Disability Days = _____ (*Question #10.*).

0-6 days = **0** Disability Points
7-14 days = **1** Disability Point
15-30 days = **2** Disability Points
31+ days = **3** Disability Points

Disability Score: (*GCP Scale, Questions 11,12,and 13*)

_____ (*Question #11.*) + _____ (*Question #12.*) + _____ (*Question #13.*) = _____

divided by 3 = _____

x 10 = _____.

Score of **0-29** = **0** Disability Points
Score of **30-49** = **1** Disability Point
Score of **50-69** = **2** Disability Points
Score of **70+** = **3** Disability Points

_____ (Points for Disability Days) + _____ (Points for Disability Score) = ☐ **(DISABILITY POINTS)**

CHRONIC PAIN GRADE CLASSIFICATION:

Grade 0 No TMD pain in prior 6 months

Low Disability

Grade I *Low Intensity* Characteristic Pain Intensity < 50, and less than 3 Disability Points

Grade II *High Intensity* Characteristic Pain Intensity ≥ 50, and less than 3 Disability Points

High Disability

Grade III *Moderately Limiting* 3 to 4 Disability Points, regardless of Characteristic Pain Intensity

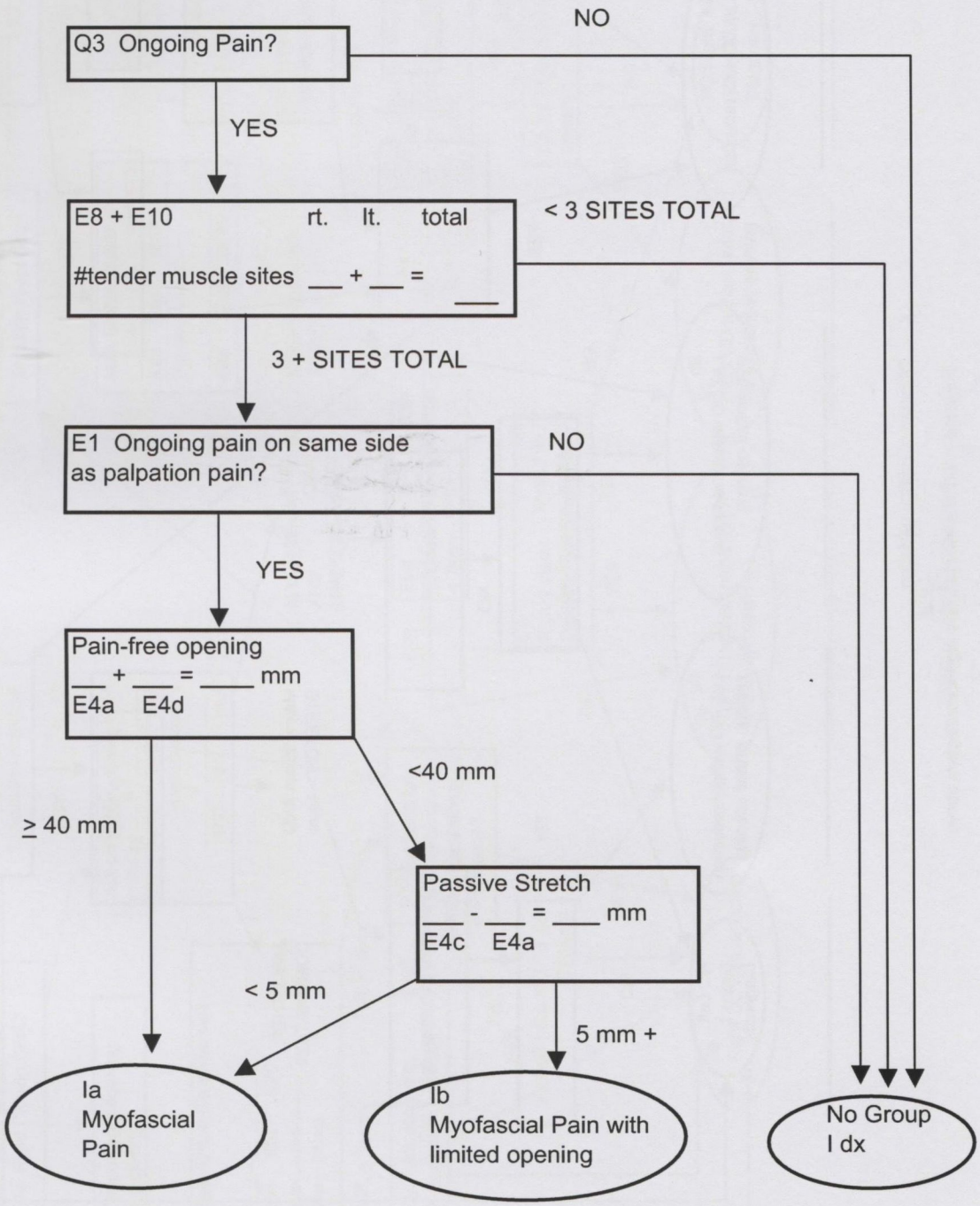
Grade IV *Severely Limiting* 5 to 6 Disability Points regardless of Characteristic Pain Intensity

AXIS II: SCORING THE SCALE ITEMS

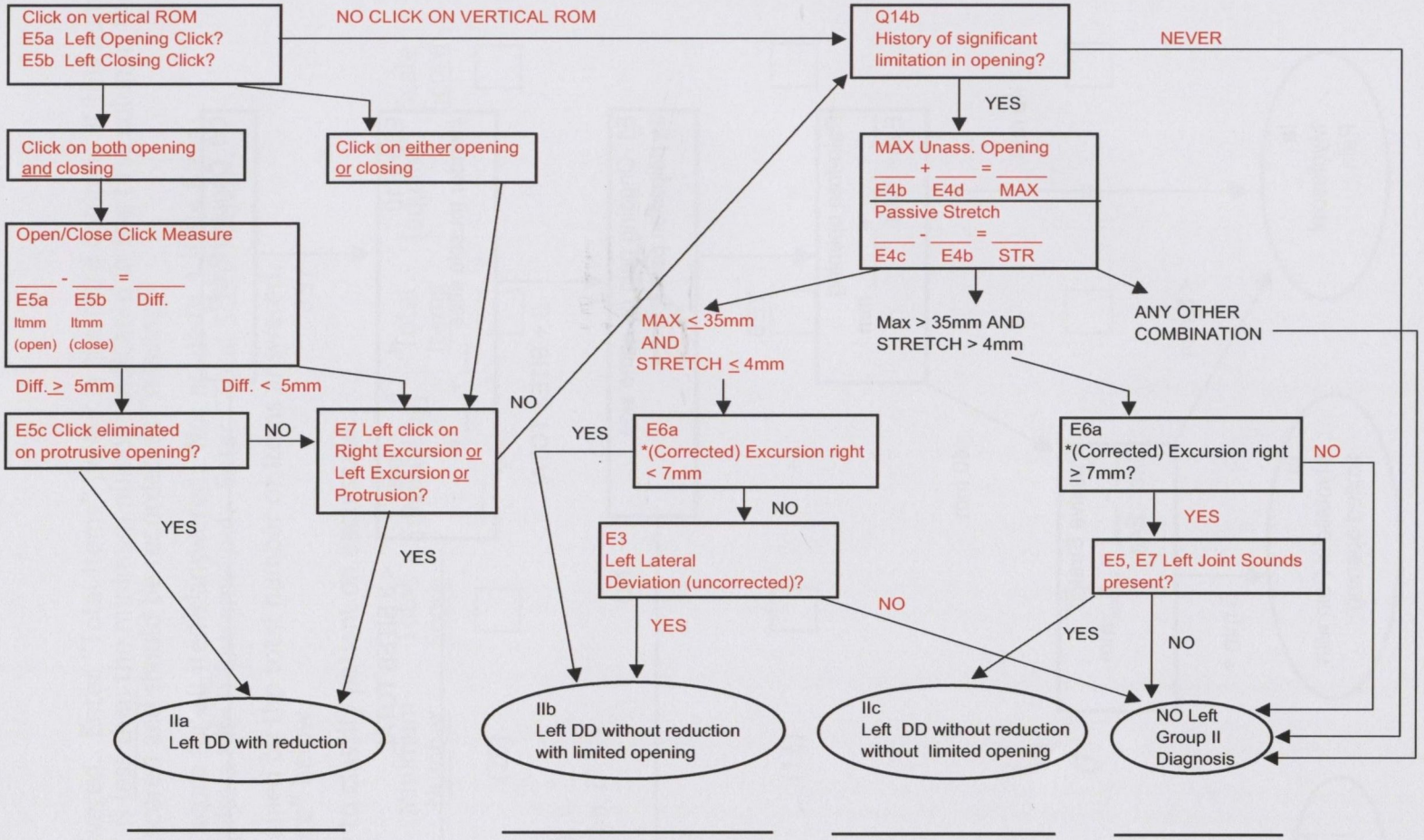
1. Count items answered. Enter "Total Items" below in the third column. If this number of "Total Items" is less than the minimum number indicated in the first column, the scale cannot be scored and should be recorded as "missing."
2. Add up the item score for all items answered: Not at all=0; A little bit=1; Moderately=2; Quite a bit=3; Extremely=4. Enter "Total Score" below.
3. Divide score obtained by the total number of items answered. Enter "Scale Score" below.
4. Use guide below to classify patient on each scale.

	Minimum Number	Total Score	[divided by]	Total Items	[equals]	Scale Score
Depression:	(20)	☐	÷	☐	=	☐
Items: b, e, h, i, k, l, m, n, v, y, cc, dd, ee, f, g, q, z, aa, bb, ff						
Nonspecific physical symptoms (pain items included):	(12)	☐	÷	☐	=	☐
Items: a, c, d, j, o, p, r, s, t, u, w, x						
Nonspecific physical symptoms (pain items excluded):	(7)	☐	÷	☐	=	☐
Items: c, r, s, t, u, w,x						

Group I


Q3 Ongoing Pain?
NO
YES
E8 + E10 rt. lt. total
#tender muscle sites ___ + ___ = ___
< 3 SITES TOTAL
3 + SITES TOTAL
E1 Ongoing pain on same side as palpation pain?
NO
YES
Pain-free opening
___ + ___ = ____ mm
E4a E4d
<40 mm
≥ 40 mm
Passive Stretch
___ - ___ = ____ mm
E4c E4a
< 5 mm
5 mm +
Ia Myofascial Pain
Ib Myofascial Pain with limited opening
No Group I dx

Group II - Left Joint



*Amount of midline deviation __ __
6 d

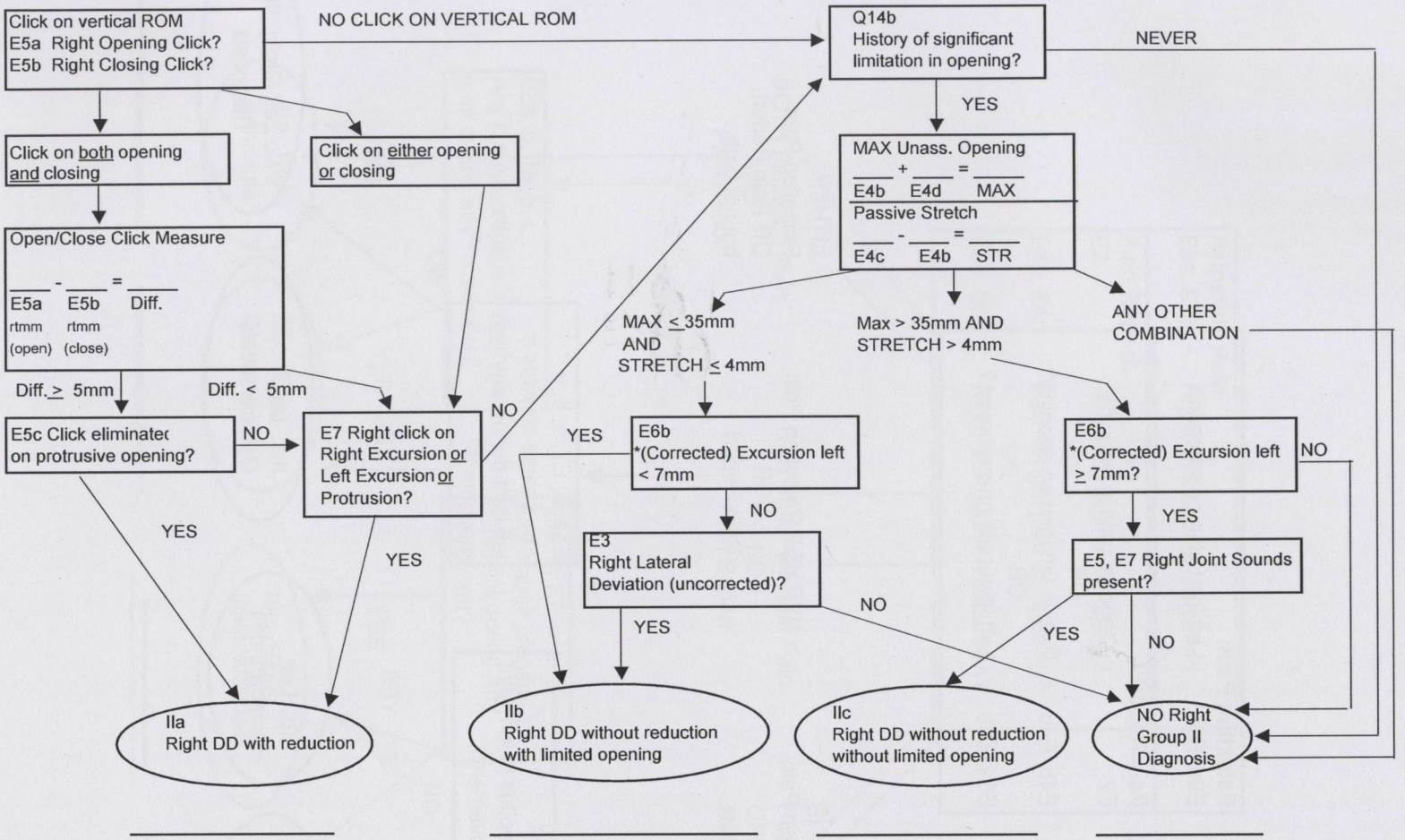
If midline = "00" continue to follow algorithm/diagram above

If midline = "01" or greater:

For Midline Deviation to the Right
Right excursion =
__ __ - __ __ = corrected right excursion
6 a 6 d

For Midline Deviation to the Left
Right excursion =
__ __ + __ __ = corrected right excursion
6 a 6 d

Group II - Right Joint



*Amount of midline deviation __ __
6 a

If midline = "00" continue to follow algorithm/diagram above

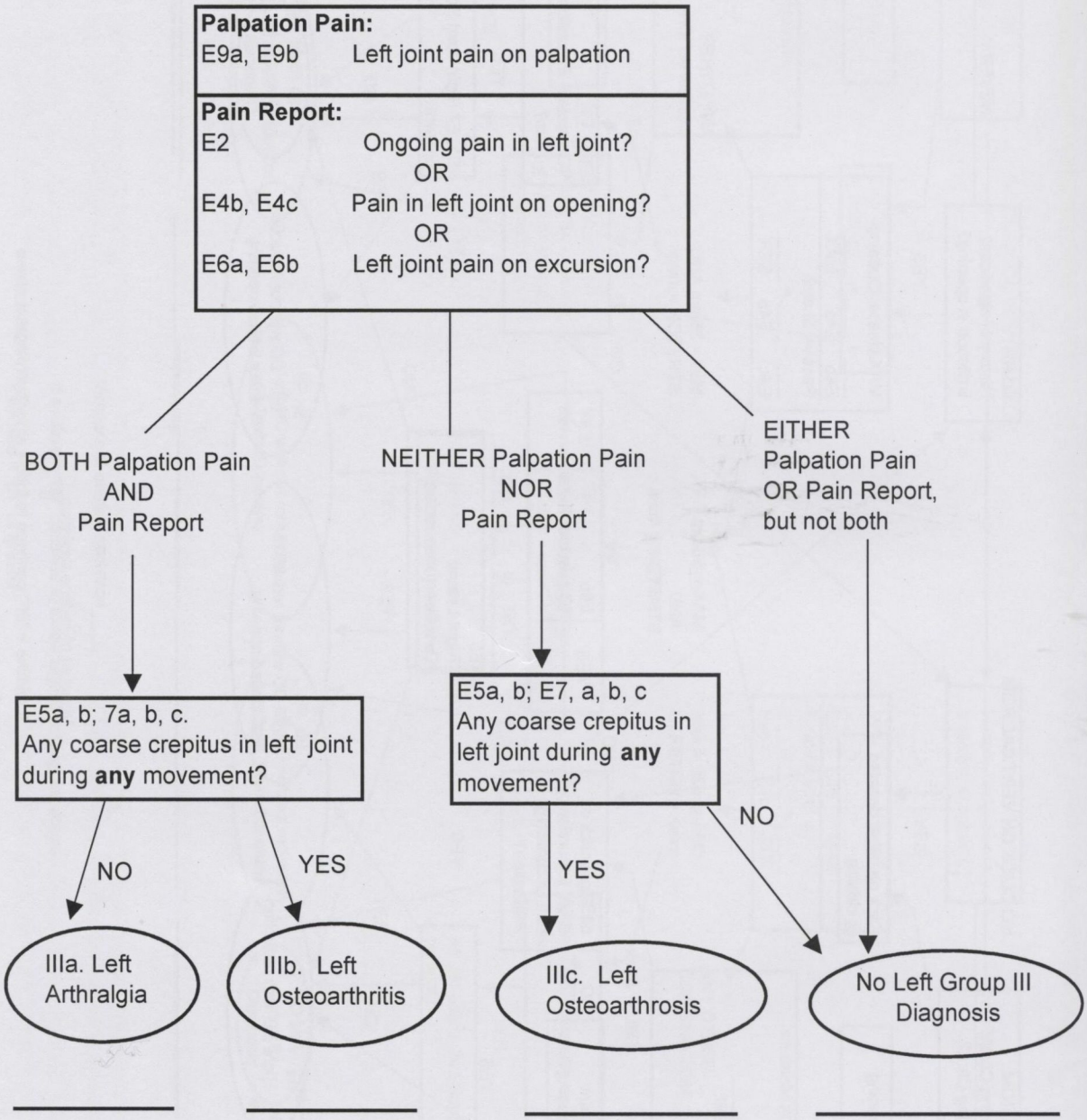
If midline = "01" or greater:

For Midline Deviation to the Right
Left excursion =
__ __ + __ __ = corrected left excursion
6 b 6 d

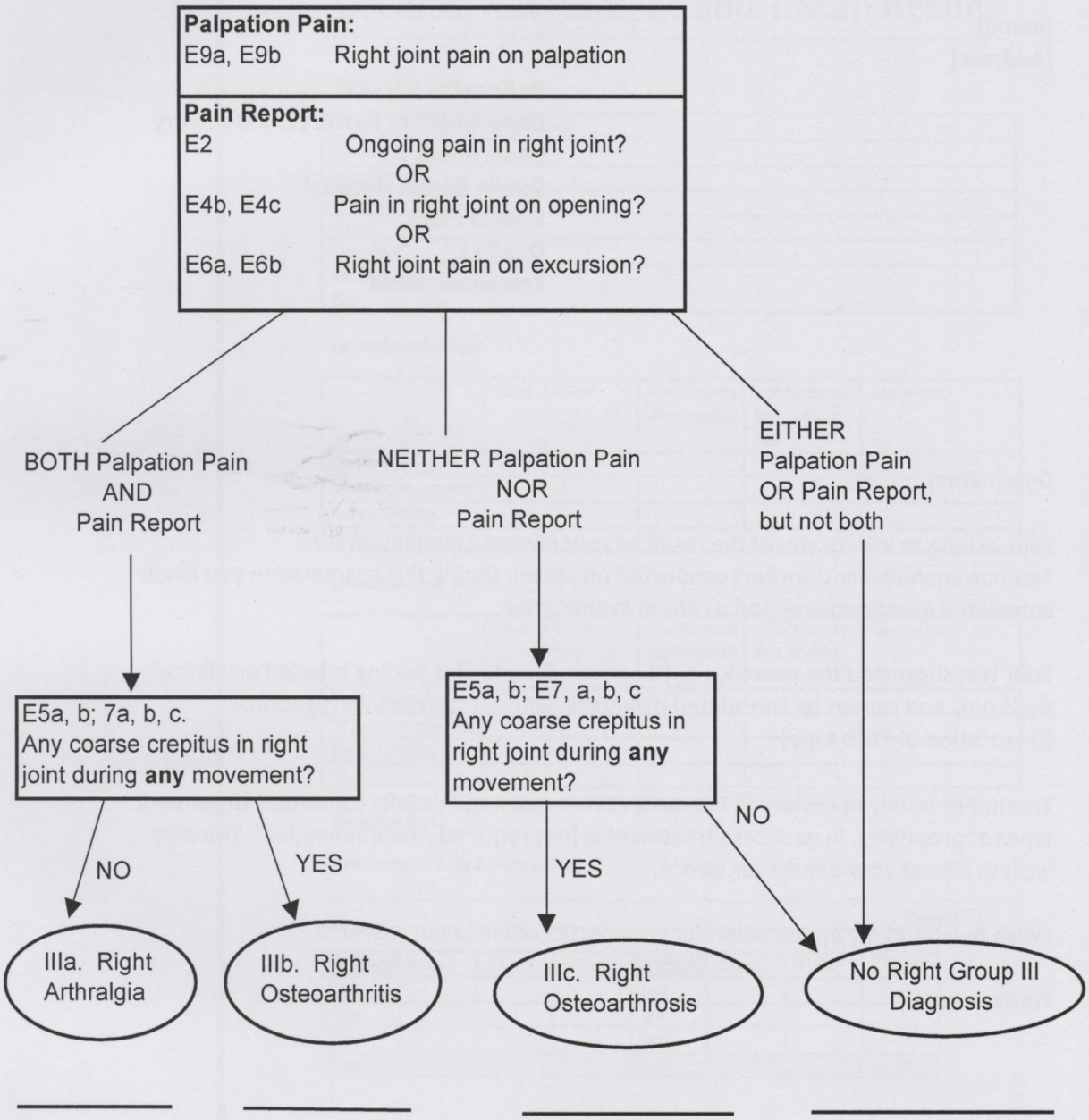
For Midline Deviation to the Left
Left excursion =
__ __ - __ __ = corrected left excursion
6 b 6 d

algogrp2RRDCBook

Group III - Left Joint



Group III - Right Joint



8.8 Appendix 8.8: Template Letters to participants post examination

[name]
[Address]

Dr Rebecca Carville
Department of Restorative Dentistry
Department 2
Dublin Dental Hospital
Lincoln Place
Dublin 2
Telephone: 0161

Dear[name],

I am writing to inform you of the result of your clinical examination for Temporomandibular disorders conducted on [date]. During this examination you kindly completed questionnaires and a clinical examination.

Your test suggested the presence of [diagnosis if any]. This finding is based on clinical signs only and cannot be considered diagnostic without further investigation.
[Description of TMD type]

Treatment is only necessary in the most severe cases and usually consists of [treatment types appropriate]. In your case treatment is [not required / recommended]. You may wish to attend your dentist for advice.

I wish to extend my appreciation for your participation in our research

Yours sincerely

_____

Rebecca Carville
Postgraduate Student in Prosthodontics
MFDRCSI B Dent Sc (TCD)

8.9 Appendix 8.9. Occlusal evaluation and disclusion time recording form

Patient No date:

Occlusal Assessment and T.Scan Results

Incisal Relationship

	tick	Comments
Class I		
Class IIdiv1		
ClassIIdiv2		
ClassIII		
Cross Bite		
Anterior Open Bite		

Lateral Excursion Right

	Visual	T.Scan	Interferences Working side	Interferences Non working side	Comments
Canine Guidance					
1st premolar guidance					
Group Function					
Other					

Lateral Excursion Left

	Visual	T.Scan	Interferences Working side	Interferences Non working side	Comments
Canine Guidance					
1st premolar guidance					
Group Function					
Other					

Disclusion Time :

Comments: **Fully dentate patient**

_____

_____ Unable ☐

RIGHT	A (sec)	B (sec)	DT (sec)	LEFT	A (sec)	B (sec)	DT (sec)
Test				Test			
Test				Test			
Test				Test			
Final				Final			

9 REFERENCES

AGHABEIGI, B., FEINMANN, C. & HARRIS, M. (1992) Prevalence of post-traumatic stress disorder in patients with chronic idiopathic facial pain. *Br J Oral Maxillofac Surg,* 30, 360-4.

AHMAD, M., HOLLENDER, L., ANDERSON, Q., KARTHA, K., OHRBACH, R., TRUELOVE, E. L., JOHN, M. T. & SCHIFFMAN, E. L. (2009) Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod,* 107, 844-60.

ALTMAN, D. G. & BLAND, J. M. (1994) Statistics Notes: Diagnostic tests 2: predictive values. *BMJ,* 309, 102-.

ANDERSON, G. C., GONZALEZ, Y. M., OHRBACH, R., TRUELOVE, E. L., SOMMERS, E., LOOK, J. O. & SCHIFFMAN, E. L. (2010) The Research Diagnostic Criteria for Temporomandibular Disorders. VI: future directions. *J Orofac Pain,* 24, 79-88.

ANTCZAK, A. A. T., J. CHALMERS,T.C. (1986) Quality assessment of randomized control trials in dental research Methods. *J. Periodontal Res.,* 21, 305-314.

BAHRA, A. & GOADSBY, P. J. (2004) Diagnostic delays and mis-management in cluster headache. *Acta Neurol Scand,* 109, 175-9.

BALLEGAARD, V., THEDE-SCHMIDT-HANSEN, P., SVENSSON, P. & JENSEN, R. (2008) Are headache and temporomandibular disorders related? A blinded study. *Cephalalgia,* 28, 832-841.

BENOLIEL, R., BIRMAN, N., ELIAV, E. & SHARAV, Y. (2008a) The International Classification of Headache Disorders: accurate diagnosis of orofacial pain? *Cephalalgia,* 28, 752-762.

BENOLIEL, R., BIRMAN, N., ELIAV, E. & SHARAV, Y. (2008b) The International Classification of Headache Disorders: accurate diagnosis of orofacial pain? *Cephalalgia,* 28, 752-62.

BENOLIEL, R., ROBINSON, S., ELIAV, E. & SHARAV, Y. (2002) Hemicrania continua. *J Orofac Pain,* 16, 317-25.

BENOLIEL, R. & SHARAV, Y. (1998) Paroxysmal hemicrania. Case studies and review of the literature. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod,* 85, 285-92.

BENOLIEL, R. & SHARAV, Y. (2008) Neurovascular orofacial pain. *Cephalalgia,* 28, 199-200.

BEVILAQUA GROSSI, D., CHAVES, T., DE OLIVEIRA, A. S. & MONTEIRO-PEDRO, V. (2006) Anamnestic index severity and signs ans syptoms of TMD. *Cranio,* 24, 112-118.

BIGAL ME, T. S., SHEFTELL MD, RAPOPORT MD, LIPTON RB (2004) Chronic Daily Headache: Correlation Between the 2004 and 1988 International Headache Society Diagnostic Criteria. *Headache*, 684-691.

BONICA, J. J. (1989) *The Management of Pain* Philadelphia, Lea & Febiger.

BRANDLMAIER, I., GRUNER, S., RUDISCH, A., BERTRAM, S. & EMSHOFF, R. (2003) Validation of the clinical diagnostic criteria for temporomandibular disorders for the diagnostic subgroup of degenerative joint disease. *J Oral Rehabil,* 30, 401-6.

BRAUN, B. & SCHIFFMAN, E. L. (1991) The validity and predictive value of four assessment instruments for evaluation of the cervical and stomatognathic systems. *J Craniomandib Disord,* 5, 239-44.

BUCKINGHAM, R. B. B., T. HARINSTEIN, D.A. ORAL, K. BAUMAN, D. BARTYNSKI,W. KILLIAN, P.J. BIDULA, L.P. (1991) Temporomandibular joint dysfunction syndrome: a close association with systemic joint laxity (the hypermobile joint syndrome). *Oral Surg Oral Med Oral Pathol* 72, 514-519.

BURGESS, J. (1991) Symptom characteristics in TMD patients reporting blunt trauma and/or whiplash injury. *J Craniomandib Disord,* 5, 251-7.

BUSH, F. M. (1985) Malocclusion, masticatory muscle, and temporomandibular joint tenderness. *J Dent Res,* 64, 129-33.

BUSH, F. M. H., S.W (1995) Pain-related limitation in activities of daily living in patients with chronic orofacial pain: psychometric

properties of a disability index. *J Orofac Pain,* 9, 57-63.
BUTLER, J. H., FOLKE, L. E. & BANDT, C. L. (1975) A descriptive survey of signs and symptoms associated with the myofascial pain-dysfunction syndrome. *J Am Dent Assoc,* 90, 635-9.
CACHIOTTI, D. P., O. BIANCHI P. ET AL (1991) Signs and symptoms with and without temporomandibular disorders. *J Craniomandib Disord Facial Oral Pain,* 5, 167-172.
CASTANEDA, R. M., C. NOEL, W. (1988) Biomechanical factors in TMJ osteoarthritis. *J Dent Res,* 67.
CASTILLO J, M. P., GUITERA V, ET AL. (1999) Epidemiology of chronic daily headache in the general population. *Headache,* 39, 190-6.
CIANCAGLINI, R. & RADAELLI, G. (2001) The relationship between headache and symptoms of temporomandibular disorder in the general population. *J Dent,* 29, 93-8.
CLARK, G. T., TSUKIYAMA, Y., BABA, K. & WATANABE, T. (1999) Sixty-eight years of experimental occlusal interference studies: what have we learned? *J Prosthet Dent,* 82, 704-13.
COSTEN, J. B. (1997) A syndrome of ear and sinus symptoms dependent upon disturbed function of the temporomandibular joint. 1934. *Ann Otol Rhinol Laryngol,* 106, 805-19.
DAO, T. T. & LERESCHE, L. (2000) Gender differences in pain. *J Orofac Pain,* 14, 169-84; discussion 184-95.
DE BOEVER, J. A. & ADRIAENS, P. A. (1983) Occlusal relationship in patients with pain-dysfunction symptoms in the temporomandibular joints. *J Oral Rehabil,* 10, 1-7.
DE BOEVER, J. A. & VAN DEN BERGHE, L. (1987) Longitudinal study of functional conditions in the masticatory system in Flemish children. *Community Dent Oral Epidemiol,* 15, 100-3.
DE LAAT, A. & VAN STEENBERGHE, D. (1985) Occlusal relationships and temporomandibular joint dysfunction. Part I: Epidemiologic findings. *J Prosthet Dent,* 54, 835-42.
DE LAAT, A., VAN STEENBERGHE, D. & LESAFFRE, E. (1986) Occlusal relationships and temporomandibular joint dysfunction. Part II: Correlations between occlusal and articular parameters and symptoms of TMJ dysfunction by means of stepwise logistic regression. *J Prosthet Dent,* 55, 116-21.
DE LEEUW, R. (2008) *Orofacial Pain: guidelines for assessment, diagnosis and management,* Chicago, Quintessence Publishing.
DE LUCENA, L. B., KOSMINSKY, M., DA COSTA, L. J. & DE GOES, P. S. (2006) Validation of the Portuguese version of the RDC/TMD Axis II questionnaire. *Braz Oral Res,* 20, 312-7.
DE MEYER, M. D. & DE BOEVER, J. A. (1997) [The role of bruxism in the appearance of temporomandibular joint disorders]. *Rev Belge Med Dent,* 52, 124-38.
DE OLIVEIRA, A. S., DIAS, E. M., CONTATO, R. G. & BERZIN, F. (2006) Prevalence study of signs and symptoms of temporomandibular disorder in Brazilian college students. *Braz Oral Res,* 20, 3-7.
DEROGATIS, L. R. M., N. (1983) The brief symptom inventory: an introductory report. Psychol Med *Psychol Med,* 13, 595-605.
DI PAOLO, C., DI NUNNO, A., VANACORE, N. & BRUTI, G. (2009) ID migraine questionnaire in temporomandibular disorders with craniofacial pain: a study by using a multidisciplinary approach. *Neurol Sci.*
DIJKSTRA, P. U. K., T.J. STEGENGA, B. (2002,) The association between generalized joint hypermobility and temporomandibular joint disorders: a systematic review. *J Dent Res,* 81, 158-163.
DWORKIN, S. F., HUGGINS, K. H., LERESCHE, L., VON KORFF, M., HOWARD, J., TRUELOVE, E. & SOMMERS, E. (1990a) Epidemiology of signs and symptoms in temporomandibular disorders: clinical signs in cases and controls. *J Am Dent Assoc,* 120, 273 - 281.
DWORKIN, S. F., HUGGINS, K. H., LERESCHE, L., VON KORFF, M., HOWARD, J., TRUELOVE, E. & SOMMERS, E. (1990b) Epidemiology of signs and symptoms

in temporomandibular disorders: clinical signs in cases and controls. *J Am Dent Assoc,* 120, 273-81.
DWORKIN, S. F., LE RESCHE L (1992) Research diagnostic criteria for temporomandibular disorders: review, criteria, examination and specifications, critique. . *J Craniomandibular Disorders*, 301-355.
DWORKIN, S. F., LERESCHE, L., DEROUEN, T. & VON KORFF, M. (1990c) Assessing clinical
signs of temporomandibular disorders: reliability of clinical examiners. *J Prosthet Dent* 63, 574-9.
EMSHOFF, R., BRANDLMAIER, I., BOSCH, R., GERHARD, S., RUDISCH, A. & BERTRAM, S. (2002) Validation of the clinical diagnostic criteria for temporomandibular disorders for the diagnostic subgroup - disc derangement with reduction. *J Oral Rehabil,* 29, 1139-45.
ENGEL, G. L. (1997) From biomedical to biopsychosocial. Being scientific in the human domain. *Psychosomatics,* 38, 521-8.
EVERSOLE, L. R. & MACHADO, L. (1985) Temporomandibular joint internal derangements
and associated neuromuscular disorders. *J Am Dent Assoc,* 110, 69-79.
FEARON, C. G. S., W.J. (1983) A common denominator for nonorganic TMJ pain-dysfunction. *J Prosthet Dent,* 49, 805-808.
FERNANDEZ, C. E., AMIRI, A., JAIME, J. & DELANEY, P. (2009) The relationship of whiplash injury and temporomandibular disorders: a narrative literature review. *J Chiropr Med,* 8, 171-86.
FONSECA, D. M. (1992) Bauru: Disfunção Craniomandibular (DCM): diagnóstico
pela anamnese [Dissertação de Mestrado]. *Faculdade de Odontologia de Bauru da USP; 1992.*
FONSECA., D. (1992) Bauru: Disfunção Craniomandibular (DCM): diagnóstico
pela anamnese [Dissertação de Mestrado]. *Faculdade de Odontologia de Bauru da USP; 1992.*
FORDYCE, W. E. (1988) Pain and suffering. A reappraisal. *Am Psychol,* 43, 276-83.
FORDYCE, W. E. (1994) Pain and suffering: what is the unit? *Qual Life Res,* 3 Suppl 1, S51-6.
FORSSELL, H. & KALSO, E. (2004) Application of principles of evidence-based medicine to occlusal treatment for temporomandibular disorders: are there lessons to be learned? *J Orofac Pain,* 18, 9-22; discussion 23-32.
FORSSELL, H., KIRVESKARI, P. & KANGASNIEMI, P. (1985) Changes in headache after treatment of mandibular dysfunction. *Cephalalgia,* 5, 229-36.
FORSSELL, H., KIRVESKARI, P. & KANGASNIEMI, P. (1986) Effect of occlusal adjustment on mandibular dysfunction. A double-blind study. *Acta Odontol Scand,* 44, 63-9.
FORSSELL, H., KIRVESKARI, P. & KANGASNIEMI, P. (1987) Response to occlusal treatment in headache patients previously treated by mock occlusal adjustment. *Acta Odontol Scand,* 45, 77-80.
FRICTON, J. (2006) Current evidence providing clarity in management of temporomandibular disorders: summary of a systematic review of randomized clinical trials for intra-oral appliances and occlusal therapies. *J Evid Based Dent Pract,* 6, 48-52.
FRICTON, J. R. & SCHIFFMAN, E. L. (1987) The craniomandibular index: Validity. *The Journal of Prosthetic Dentistry,* 58, 222-228.
GEERING, A. H. (1974) Occlusal interferences and functional disturbances of the masticatory system. *J Clin Periodontol,* 1, 112-9.
GESCH, D., BERNHARDT, O. & KIRBSCHUS, A. (2004) Association of malocclusion and functional occlusion with temporomandibular disorders (TMD) in adults: a systematic review of population-based studies. *Quintessence Int,* 35, 211-21.
GLADSTONE, J., EROSS, E. & DODICK, D. (2003) Chronic daily headache: a rational approach to a challenging problem. *Semin Neurol,* 23, 265-76.
GLAROS, A. G., URBAN, D. & LOCKE, J. (2007) Headache and temporomandibular disorders: evidence for diagnostic and behavioural overlap. *Cephalalgia,* 27, 542-549.

GLAROS, A. G. F., M. SHANKER, J. GLASS, E.G. (2000) Effect of parafunctional clenching on temporomandibular disorder pain and proprioceptive awareness. *Cranio,* 18, 198-204.

GOADSBY, P. J. & BOES, C. (2002) Chronic daily headache. *J Neurol Neurosurg Psychiatry,* 72 Suppl 2, ii2-ii5.

GONCALVES, D. A., BIGAL, M. E., JALES, L. C., CAMPARIS, C. M. & SPECIALI, J. G. (2009) Headache and Symptoms of Temporomandibular Disorder: An Epidemiological Study. *Headache*.

GOODMAN, P., GREENE, C. S. & LASKIN, D. M. (1976) Response of patients with myofascial pain-dysfunction syndrome to mock equilibration. *J Am Dent Assoc,* 92, 755-8.

GOULET, J., CLARK, G. T., FLACK, V. F. & LIU, C. J. O. P. (1998;) The reproducibility of muscle and joint tenderness detection methods and maximum mandibular movement measurement for the temporomandibular system. 12, 17-26.

GPT (2005) The Glossary of Prosthodontic Terms. *The Journal of Prosthetic Dentistry,* 94, 10-92.

GRAFF-RADFORD, S. B. (2007) Temporomandibular disorders and headache. *Dent Clin North Am,* 51, 129-44, vi-vii.

GRANADOS, J. I. (1979) The influence of the loss of teeth and attrition on the articular eminence. *J Prosthet Dent,* 42, 78-85.

GUNN, S. M., WOOLFOLK, M. W. & FAJA, B. W. (1988) Malocclusion and TMJ symptoms in migrant children. *J Craniomandib Disord,* 2, 196-200.

HASANAIN, F., DURHAM, J., MOUFTI, A., STEEN, I. N. & WASSELL, R. W. (2009) Adapting the diagnostic definitions of the RDC/TMD to routine clinical practice: a feasibility study. *J Dent,* 37, 955-62.

HEADACHE CLASSIFICATION COMMITTEE OF THE INTERNATIONAL HEADACHE SOCIETY (2004) Classification and diagnostic criteria for headache disorders, cranial neuralgia and facial pain. *Cephalalgia.*

HELKIMO (1974a) Studies on function and dysfunction of the masticatory system. 3. Analyses of anamnestic and clinical recordings of dysfunction with the aid of indices. *Sven Tandlak Tidskr.,* (3), 165-81.

HELKIMO, M. (1974b) Studies on function and dysfunction of the masticatory system. II. Index for anamnestic and clinical dysfunction and occlusal state.

. *Sven Tandlak Tidskr.* , (2), 101-21.

HELOE, B. & HEIBERG, A. N. (1980a) A follow-up study of a group of female patients with myofascial pain-dysfunction syndrome. *Acta Odontol Scand,* 38, 129-34.

HELOE, B. & HEIBERG, A. N. (1980b) A multiprofessional study of patients with myofascial pain-dysfunction syndrome. II. *Acta Odontol Scand,* 38, 119-28.

HELOE, B., HEIBERG, A. N. & KROGSTAD, B. S. (1980) A multiprofessional study of patients with myofascial pain-dysfunction syndrome. I. *Acta Odontol Scand,* 38, 109-17.

HELOE, B. H., LA (1975) Characteristics of a group of patients with temporomandibular joint disorders. . *Community Dent Oral Epidemiol,* 3, 72-79.

HOLMGREN, K., SHEIKHOLESLAM, A. & RIISE, C. (1985) An electromyographic study of the immediate effect of an occlusal splint on the postural activity of the anterior temporal and masseter muscles in different body positions with and without visual input. *J Oral Rehabil,* 12, 483-90.

HOLMGREN, K., SHEIKHOLESLAM, A. & RIISE, C. (1993) Effect of a full-arch maxillary occlusal splint on parafunctional activity during sleep in patients with nocturnal bruxism and signs and symptoms of craniomandibular disorders. *J Prosthet Dent,* 69, 293-7.

HOLMGREN, K., SHEIKHOLESLAM, A., RIISE, C. & KOPP, S. (1990) The effects of an occlusal splint on the electromyographic activities of the temporal and masseter muscles during maximal clenching in patients with a habit of nocturnal bruxism and signs and symptoms of craniomandibular disorders. *J Oral Rehabil,* 17, 447-59.

HOW, C. K. (2004) Orthodontic treatment has little to do with temporomandibular disorders. *Evid Based Dent,* 5, 75.

HUBER, M. A. & HALL, E. H. (1990) A comparison of the signs of temporomandibular joint dysfunction and occlusal discrepancies in a symptom-free population of men and women. *Oral Surg Oral Med Oral Pathol,* 70, 180-3.

INGERVALL, B., MOHLIN, B. & THILANDER, B. (1980) Prevalence of symptoms of functional disturbances of the masticatory system in Swedish men. *J Oral Rehabil,* 7, 185-97.

INTERNATIONAL CONSORTIUM FOR RDC/TMD-BASED RESEARCH (2004).

ISONG, U., GANSKY, S. A. & PLESH, O. (2008) Temporomandibular joint and muscle disorder-type pain in U.S. adults: the National Health Interview Survey. *J Orofac Pain,* 22, 317-22.

JERJES W, M. G., FEINMANN, HOPPER C, KUMAR M, UPILE T, NEWMAN S (2007) A psychological comparison of temporomandibular disorder and chronic daily headache: are there targits for therapeutic interventions? *Oral Surg Oral Med Oral Pathol Oral Radiol Endod,* 103, 367-73.

JOHN, M. T., DWORKIN, S. F. & MANCL, L. A. (2005a) Reliability of clinical temporomandibular disorder diagnoses. *Pain,* 118, 61-9.

JOHN, M. T., DWORKIN, S. F. & MANCL, L. A. (2005b) Reliability of clinical temporomandibular disorder diagnoses. *Pain,* 118, 61 - 69.

JOHN, M. T. & ZWIJNENBURG, A. J. (2001) Interobserver variability in assessment of signs of TMD. *Int J Prosthodont,* 14, 265 - 270.

JUNIPER, R. P. (1994) The shape of the condyle and position of the meniscus in temporomandibular joint dysfunction. *Br J Oral Maxillofac Surg,* 32, 71-6.

KAFAS, P. K., G. CHRISTOFIDES, A. CHIOTAKI, N. THEODORIDIS, M. (2008) Chewing ability, mood and sleep are negatively influenced by chronic TMJ pain: preliminary results. *Res J Med Sci,* 2, 5-6.

KARDACHI, B. J., BAILEY, J. O. & ASH, M. M. (1978) A comparison of biofeedback and occlusal adjustment on bruxism. *J Periodontol,* 49, 367-72.

KASCH, H. H., T. SVENSSON, P. NYHUUS, L. JENSEN, T.S. (2002) Temporomandibular disorders after whiplash injury: a controlled, prospective study. *J Orofac Pain,* 16, 118-128.

KATZ, J. O., RUGH, J. D., HATCH, J. P., LANGLAIS, R. P., TEREZHALMY, G. T. & BORCHERDING, S. H. (1989) Effect of experimental stress on masseter and temporalis muscle activity in human subjects with temporomandibular disorders. *Arch Oral Biol,* 34, 393-8.

KERSTEIN, R. B. (1992) Disocclusion time-reduction therapy with immediate complete anterior guidance development to treat chronic myofascial pain-dysfunction syndrome. *Quintessence Int,* 23, 735-47.

KERSTEIN, R. B. (1993) A comparison of traditional occlusal equilibration and immediate complete anterior guidance development. *Cranio,* 11, 126-39; discussion 140.

KERSTEIN, R. B. (1994) Disclusion time measurement studies: A comparison of disclusion time between chronic myofascial pain dyfunction patients and nonpatients: A population analysis. *The Journal of Prosthetic Dentistry,* 72, 473-480.

KERSTEIN, R. B. (1995) Treatment of myofascial pain dysfunction syndrome with occlusal therapy to reduce lengthy disclusion time--a recall evaluation. *Cranio,* 13, 105-15.

KERSTEIN, R. B., CHAPMAN, R. & KLEIN, M. (1997) A comparison of ICAGD (immediate complete anterior guidance development) to mock ICAGD for symptom reductions in chronic myofascial pain dysfunction patients. *Cranio,* 15, 21-37.

KERSTEIN, R. B. & FARRELL, S. (1990) Treatment of myofascial pain-dysfunction syndrome with occlusal equilibration. *The Journal of Prosthetic Dentistry,* 63, 695-700.

KERSTEIN, R. B. & WRIGHT, N. R. (1991a) Electromyographic and computer analyses of patients suffering from chronic myofascial pain-dysfunction syndrome: Before and after treatment with immediate complete anterior guidance development. *The Journal of Prosthetic Dentistry,* 66, 677-686.

KERSTEIN, R. B. & WRIGHT, N. R. (1991b) Electromyographic and computer analyses of patients suffering from chronic myofascial pain-dysfunction syndrome: before

and after treatment with immediate complete anterior guidance development. *J Prosthet Dent,* 66, 677-86.
KINNEY, R. K., GATCHEL, R. J., ELLIS, E. & HOLT, C. (1992) Major psychological disorders in chronic TMD patients: implications for successful management. *J Am Dent Assoc,* 123, 49 - 54.
KIRVESKARI, P. & ALANEN, P. (1985) Association between tooth loss and TMJ dysfunction. *J Oral Rehabil,* 12, 189-94.
KLASSER, G. D. & OKESON, J. P. (2006) The clinical usefulness of surface electromyography in the diagnosis and treatment of temporomandibular disorders. *J Am Dent Assoc,* 137, 763-71.
KOH, H. & ROBINSON, P. G. (2003) Occlusal adjustment for treating and preventing temporomandibular joint disorders. *Cochrane Database Syst Rev*, CD003812.
KOH, H. & ROBINSON, P. G. (2004) Occlusal adjustment for treating and preventing temporomandibular joint disorders. *J Oral Rehabil,* 31, 287-92.
KOH, K. J., LIST, T., PETERSSON, A. & ROHLIN, M. (2009) Relationship between clinical and magnetic resonance imaging diagnoses and findings in degenerative and inflammatory temporomandibular joint diseases: a systematic literature review. *J Orofac Pain,* 23, 123-39.
LAINEZ, M. J. (2005) Chronic headaches: from research to clinical practice. *J Headache Pain,* 6, 175-8.
LEAKE, J. L., HAWKINS, R. & LOCKER, D. (1994) Social and functional impact of reduced posterior dental units in older adults. *J Oral Rehabil,* 21, 1-10.
LERESCHE, L. (1997) Epidemiology of temporomandibular disorders: implications for the investigation of etiologic factors. *Crit Rev Oral Biol Med,* 8, 291-305.
LETHBRIDGE-CEJKU, M., SCHILLER, J. S. & BERNADEL, L. (2004) Summary health statistics for U.S. adults: National Health Interview Survey, 2002. *Vital Health Stat 10*, 1-151.
LEVITT, S. R. (1991) Predictive value: A model for dentists to evaluate the accuracy of diagnostic tests for temporomandibular disorders as applied to a TMJ scale. *The Journal of Prosthetic Dentistry,* 66, 385-390.
LEVITT, S. R., LUNDEEN, T. F. & MCKINNEY, M. W. (1988) Initial studies of a new assessment method for temporomandibular joint disorders. *The Journal of Prosthetic Dentistry,* 59, 490-495.
LIEBERMAN, N. G., E. FUCHS, C. (1985) Mandibular dysfunction in 10-18 year old school children as related to morphological malocclusion *j Oral Rehabil,* 12, 209-214.
LIEDBERG, J., PANMEKIATE, S., PETERSSON, A. & ROHLIN, M. (1996) Evidence-based evaluation of three imaging methods for the temporomandibular disc. *Dentomaxillofac Radiol,* 25, 234-41.
LINDE, M., NORDLANDER, E. & CARLSSON, J. (2007) [Chronic daily headache--a public health problem]. *Lakartidningen,* 104, 1820-4.
LIPTON, J., SHIP JA, LARACH-ROBINSON D, (1993) Estimated prevelence and didtribution of reported orofacial pain in the United States. . *J Am Dent Assoc,* 124, 115-21.
LIPTON, J. A., SHIP, J. A. & LARACH-ROBINSON, D. (1993) Estimated prevalence and distribution of reported orofacial pain in the United States. *J Am Dent Assoc,* 124, 115-21.
LIPTON RB, S. W., DIAMOND S, (2001) Prevalence and burden of migraine in the United States: data from the American migraine study II. *Headache,* 41, 646-57.
LIST, T., JOHN, M. T., DWORKIN, S. F. & SVENSSON, P. (2006) Recalibration improves inter-examiner reliability of TMD examination. *Acta Odontol Scand,* 64, 146-52.
LIST, T. W., K. WENNEBERG, B. DWORKIN, S.F. (1999,) TMD in children and adolescents: prevalence of pain, gender differences, and perceived treatment need. *J Orofac Pain*, 9-20.
LOBBEZOO, F., VISSCHER, C. M. & NAEIJE, M. (2010) Some remarks on the RDC/TMD Validation Project: report of an IADR/Toronto-2008 Workshop discussion. *J Oral Rehabil.*
LOCKER, D. & SLADE, G. (1989) Association of symptoms and signs of TM disorders in an adult population. *Community Dent Oral Epidemiol,* 17, 150-3.

LUNDEEN, T. F., SCRUGGS, R. R., MCKINNEY, M. W., DANIEL, S. J. & LEVITT, S. R. (1990) TMD symptomology among denture patients. *J Craniomandib Disord,* 4, 40-6.

LUNDH, H. & WESTESSON, P. L. (1989) Long-term follow-up after occlusal treatment to correct abnormal temporomandibular joint disc position. *Oral Surg Oral Med Oral Pathol,* 67, 2 - 10.

LUPOLI, T. A. & LOCKEY, R. F. (2007) Temporomandibular dysfunction: an often overlooked cause of chronic headaches. *Ann Allergy Asthma Immunol,* 99, 314-8.

MACFARLANE, T. V. B., A.S. DAVIES, R.M. KINCEY, J. WORTHINGTON, H.V. (2004) Predictors of outcome for orofacial pain in the general population: a four-year follow-up study. *J Dent Res,* 83, 712-717.

MAGNUSSON, T. & CARLSSON, G. E. (1978a) Comparison between two groups of patients in respect of headache and mandibular dysfunction. *Swed Dent J,* 2, 85-92.

MAGNUSSON, T. & CARLSSON, G. E. (1978b) Recurrent headaches in relation to temporomandibular joint pain-dysfunction. *Acta Odontol Scand,* 36, 333-8.

MAGNUSSON, T. & CARLSSON, G. E. (1983) A 21/2-year follow-up of changes in headache and mandibular dysfunction after stomatognathic treatment. *J Prosthet Dent,* 49, 398-402.

MANFREDINI, D. C., E. ROMAGNOLI, M. BOSCO, M. (2003) Prevalence of bruxism in patients with different research diagnostic criteria for temporomandibular disorders (RDC/TMD) diagnoses. *Cranio,* 21, 279-285.

MANZONI, G. C. G., F. SANDRINI, G. CAVALLINI, A. & ZANFERRARI, C. N., G. (1995) Classification of chronic daily headache by International Headache Society criteria: Limits and new proposals. *Cephalalgia,* 37-43.

MCNAMARA, J. A., JR., SELIGMAN, D. A. & OKESON, J. P. (1995) Occlusion, Orthodontic treatment, and temporomandibular disorders: a review. *J Orofac Pain,* 9, 73-90.

MEISLER, J. G. (1999) Chronic pain conditions in women. *J Womens Health,* 8, 313-20.

MOHLIN, B. & KOPP, S. (1978) A clinical study on the relationship between malocclusions, occlusal interferences and mandibular pain and dysfunction. *Swed Dent J,* 2, 105-12.

MUIR, C. B. & GOSS, A. N. (1990) The radiologic morphology of painful temporomandibular joints. *Oral Surg Oral Med Oral Pathol,* 70, 355-9.

NAPPI, G., PERROTTA, A., ROSSI, P. & SANDRINI, G. (2008) Chronic daily headache. *Expert Rev Neurother,* 8, 361-84.

NICKEL, J. C. & MCLACHLAN, K. R. (1994) An analysis of surface congruity in the growing human temporomandibular joint. *Arch Oral Biol,* 39, 315-21.

OHRBACH, R., TURNER, J. A., SHERMAN, J. J., MANCL, L. A., TRUELOVE, E. L., SCHIFFMAN, E. L. & DWORKIN, S. F. (2010) The Research Diagnostic Criteria for Temporomandibular Disorders. IV: evaluation of psychometric properties of the Axis II measures. *J Orofac Pain,* 24, 48-62.

OKESON, J. P. (1996) *Orofacial pain, guidelines for assessment, diagnosis and management,* Illinois, Quintessence Publishing.

OLESEN, J. (1995) Analgesic headache. A common, treatable condition that deserves more attention. *BMJ,* 310, 479-80.

OLESEN, J., BOUSSER, M. G., DIENER, H. C., DODICK, D., FIRST, M. & GOADSBY, P. J. (2004) The International Classification of Headache Disorders, 2nd Edition. *Cephalalgia,* 24, 24-150.

PANMEKIATE, S., PETERSSON, A. & AKERMAN, S. (1991a) Angulation and prominence of the posterior slope of the eminence of the temporomandibular joint in relation to disc position. *Dentomaxillofac Radiol,* 20, 205-8.

PANMEKIATE, S., PETERSSON, A. & AKERMAN, S. (1991b) Some anatomical factors of the upper compartment of the temporomandibular joint related to the disc position. *Int J Oral Maxillofac Surg,* 20, 375-7.

PARKER, M. W. (1990) A dynamic model of etiology in temporomandiular disorders. *J Am Dent Assoc,* 120, 283-289.

PARKER, M. W., HOLMES, E. K. & TEREZHALMY, G. T. (1993) Personality characteristics of patients with temporomandibular disorders: diagnostic and therapeutic implications. *J Orofac Pain,* 7, 337-44.

PEDERSEN, A. & HANSEN, H. J. (1987a) Internal derangement of the temporomandibular joint in 211 patients: symptoms and treatment. *Community Dent Oral Epidemiol,* 15, 339-43.

PEDERSEN, A. & HANSEN, H. J. (1987b) Long-term evaluation of 211 patients with internal derangement of the temporomandibular joint. *Community Dent Oral Epidemiol,* 15, 344-7.

PEKKARINEN, V. & YLI-URPO, A. (1987) Helkimo's indices before and after prosthetic treatment in selected series. *J Oral Rehabil,* 14, 35-42.

PERGAMALIAN, A., RUDY, T. E., ZAKI, H. S. & GRECO, C. M. (2003) The association between wear facets, bruxism, and severity of facial pain in patients with temporomandibular disorders. *The Journal of Prosthetic Dentistry,* 90, 194-200.

POLLMANN, L. (1993a) Sounds produced by the mandibular joint in a sample of healthy workers. *J Orofac Pain,* 7, 359 - 361.

POLLMANN, L. (1993b) Sounds produced by the mandibular joint in a sample of healthy workers. *J Orofac Pain,* 7:, 359-361.

POVEDA RODA, R., BAGAN, J. V., DIAZ FERNANDEZ, J. M., HERNANDEZ BAZAN, S. & JIMENEZ SORIANO, Y. (2007) Review of temporomandibular joint pathology. Part I: classification, epidemiology and risk factors. *Med Oral Patol Oral Cir Bucal,* 12, E292-8.

PUCA F, G. S., PRUDENZANO MP, SAVARESE M, BUSSONE G, D'AMICO ET AL (1999) Psychiatric co-morbidity and psychosocial stress in patients with tension type headache from headache centers in Italy. The Italian Collaborative Group for the Study of Psychopathological Factors in Primary Headaches. *Cephalalgia,* 19, 159-64.

PULLINGER, A. G., BALDIOCEDA, F. & BIBB, C. A. (1990) Relationship of TMJ articular soft tissue to underlying bone in young adult condyles. *J Dent Res,* 69, 1512-8.

PULLINGER, A. G. & MONTEIRO, A. A. (1988) History factors associated with symptoms of temporomandibular disorders. *J Oral Rehabil,* 15, 117-24.

PULLINGER, A. G. & SELIGMAN, D. A. (1991) Trauma history in diagnostic groups of temporomandibular disorders. *Oral Surg Oral Med Oral Pathol,* 71, 529-34.

PULLINGER, A. G. & SELIGMAN, D. A. (1993) The degree to which attrition characterizes differentiated patient groups of temporomandibular disorders. *J Orofac Pain,* 7, 196-208.

PULLINGER, A. G., SELIGMAN, D. A. & GORNBEIN, J. A. (1993) A multiple logistic regression analysis of the risk and relative odds of temporomandibular disorders as a function of common occlusal features. *J Dent Res,* 72, 968-79.

RANTALA, M. A., AHLBERG, J., SUVINEN, T. I., NISSINEN, M., LINDHOLM, H., SAVOLAINEN, A. & KONONEN, M. (2003) Temporomandibular joint related painless symptoms, orofacial pain, neck pain, headache, and psychosocial factors among non-patients. *Acta Odontol Scand,* 61, 217-22.

REIK, L. & HALE, M. (1981) The temporomandibular joint pain-dysfunction syndrome: a frequent cause of headache. *Headache,* 21, 151-156

RIISE, C. & SHEIKHOLESLAM, A. (1982) The influence of experimental interfering occlusal contacts on the postural activity of the anterior temporal and masseter muscles in young adults. *J Oral Rehabil,* 9, 419-25.

RIISE, C. & SHEIKHOLESLAM, A. (1984) Influence of experimental interfering occlusal contacts on the activity of the anterior temporal and masseter muscles during mastication. *J Oral Rehabil,* 11, 325-33.

RIOLO, M. B., D. TEN HAVE, TR. (1987) Associations between occlusal characteristics and signs and symptoms of TMJ dysfunction in children and young adults. *Am J Orthod Dentofacial Orthop,* 92, 467-477.

RIVERA-MORALES, W. C. & MOHL, N. D. (1991a) Relationship of occlusal vertical dimension to the health of the masticatory system. *J Prosthet Dent,* 65, 547-53.

RIVERA-MORALES, W. C. & MOHL, N. D. (1991b) Relationship of occlusal vertical dimension to the health of the masticatory system. *The Journal of Prosthetic Dentistry,* 65, 547-553.

ROBERTS, C. A., TALLENTS, R. H., KATZBERG, R. W., SANCHEZ-WOODWORTH, R. E., ESPELAND, M. A. & HANDELMAN, S. L. (1987) Comparison of internal derangements of the TMJ with occlusal findings. *Oral Surg Oral Med Oral Pathol,* 63, 645-50.

RUNGE, M. E., SADOWSKY, C., SAKOLS, E. I. & BEGOLE, E. A. (1989) The relationship between temporomandibular joint sounds and malocclusion. *Am J Orthod Dentofacial Orthop,* 96, 36-42.

SANIN, L. M., NT. BELLMYER, LR. ALI, S. (1994) The International Headache Society (IHS) headache classification as applied to a headache clinic population. *Cephalalgia,* 14, 443-446.

SCHER A, S. W., LIBERMAN J, ET AL. (1998) Prevalence of frequent headache in a population sample. *Headache,* 38, 497-506.

SCHER, A. S. W., LIBERMAN J, ET AL. (1998) Prevalence of frequent headache in a population sample. *Headache,* 38, 497-506.

SCHIFFMAN, E., L. , TRUELOVE, E. L., OHRBACH, R., ANDERSON, G. C., JOHN, M. T., LIST, T. & JOHN, O. L. (2010a) The Research Diagnostic Criteria for Temporomandibular Disorders.I: Overview and Methodology for Assessment of Validity

Journal of Orofacial Pain, 24.

SCHIFFMAN, E. L., OHRBACH, R., TRUELOVE, E. L., TAI, F., ANDERSON, G. C., PAN, W., GONZALEZ, Y. M., JOHN, M. T., SOMMERS, E., LIST, T., VELLY, A. M., KANG, W. & LOOK, J. O. (2010b) The Research Diagnostic Criteria for Temporomandibular Disorders. V: methods used to establish and validate revised Axis I diagnostic algorithms. *J Orofac Pain,* 24, 63-78.

SCHIFFMAN, E. L., TRUELOVE, E. L., OHRBACH, R., ANDERSON, G. C., JOHN, M. T., LIST, T. & LOOK, J. O. (2010c) The Research Diagnostic Criteria for Temporomandibular Disorders. I: overview and methodology for assessment of validity. *J Orofac Pain,* 24, 7-24.

SCHIFFMAN, E. L. F., J.R. HALEY, D.P. SHAPIRO, B.L. (1990) The prevalence and treatment needs of subjects with temporomandibular disorders. *J Am Dent Assoc,* 120.

SCHILLER, J. S. & BERNADEL, L. (2004) Summary health statistics for the U.S. population: National Health Interview Survey, 2002. *Vital Health Stat 10,* 1-101.

SCHMITTER, M., GABBERT, O., OHLMANN, B., HASSEL, A., WOLFF, D., RAMMELSBERG, P. & KRESS, B. (2006) Assessment of the reliability and validity of panoramic imaging for assessment of mandibular condyle morphology using both MRI and clinical examination as the gold standard. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod,* 102, 220-4.

SCHMITTER, M., KRESS, B., LECKEL, M., HENSCHEL, V., OHLMANN, B. & RAMMELSBERG, P. (2008) Validity of temporomandibular disorder examination procedures for assessment of temporomandibular joint status. *Am J Orthod Dentofacial Orthop,* 133, 796-803.

SCRIVANI, S. J., KEITH, D. A. & KABAN, L. B. (2008) Temporomandibular disorders. *N Engl J Med,* 359, 2693-705.

SELIGMAN, D. A. & PULLINGER, A. G. (1989) Association of occlusal variables among refined TM patient diagnostic groups. *J Craniomandib Disord,* 3, 227-36.

SELIGMAN, D. A. & PULLINGER, A. G. (1991a) The role of functional occlusal relationships in temporomandibular disorders: a review. *J Craniomandib Disord,* 5, 265-79.

SELIGMAN, D. A. & PULLINGER, A. G. (1991b) The role of intercuspal occlusal relationships in temporomandibular disorders: a review. *J Craniomandib Disord,* 5, 96-106.

SELIGMAN, D. A., PULLINGER, A. G. & SOLBERG, W. K. (1988) Temporomandibular disorders. Part III: Occlusal and articular factors associated with muscle tenderness. *J Prosthet Dent,* 59, 483-9.

SELIGMAN, D. A. P., A.G. SOLBERG, W.K. (1988) The prevalence of dental attrition and its association with factors of age, gender, occlusion, and TMJ symptomatology. *J Dent Res,* 67, 1323-1333.

SHEIKHOLESLAM, A., HOLMGREN, K. & RIISE, C. (1986) A clinical and electromyographic study of the long-term effects of an occlusal splint on the temporal and masseter muscles in patients with functional disorders and nocturnal bruxism. *J Oral Rehabil,* 13, 137-45.

SHEIKHOLESLAM, A., HOLMGREN, K. & RIISE, C. (1993) Therapeutic effects of the plane occlusal splint on signs and symptoms of craniomandibular disorders in patients with nocturnal bruxism. *J Oral Rehabil,* 20, 473-82.

SHEIKHOLESLAM, A. & RIISE, C. (1983) Influence of experimental interfering occlusal contacts on the activity of the anterior temporal and masseter muscles during submaximal and maximal bite in the intercuspal position. *J Oral Rehabil,* 10, 207-14.

SHIAU, Y. Y., KWAN, H. W. & CHANG, C. (1989) [Prevalence of temporomandibular disorder syndrome (TMD) in university students--a third year report of the epidemiological study in Taiwan]. *Zhonghua Ya Yi Xue Hui Za Zhi,* 8, 106-16.

SICCOLI, M. M., BASSETTI, C. L. & SANDOR, P. S. (2006) Facial pain: clinical differential diagnosis. *Lancet Neurol,* 5, 257-67.

SILBERSTEIN, S. D. & LIPTON, R. B. (2000) Chronic daily headache. *Curr Opin Neurol,* 13, 277-83.

SILBERSTEIN, S. D. & LIPTON, R. B. (2001) *Chronic daily headache, including transformed migraine, chronic tension-type headache, and medication overuse.,* New York, Oxford University Press.

SILBERSTEIN, S. D., LIPTON, R. B., SOLOMON, S. & MATHEW, N. (1994) *Classification of daily and near-daily headaches in the headache clinic. Proposed revision to the International Headache Society criteria. ,* New York:, Raven Press.

SILBERSTEIN, S. D. L., R.B. SLIWINSKI, M. (1996) Classification of daily and near-daily headaches: a field study of revised IHS criteria. Neurology. 47, 871-5.

SOLBERG, W. K., FLINT, R. T. & BRANTNER, J. P. (1972) Temporomandibular joint pain and dysfunction: a clinical study of emotional and occlusal components. *J Prosthet Dent,* 28, 412-22.

SOLOMON S, L. R., NEWMAN LC. . (1992) Evaluation of chronic daily headache-comparison to criteria for chronic tension-type headache. *Cephalalgia,* 365-368.

SOLOMON, S. L., RB. NEWMAN, LC. (1992) Evaluation of chronic daily headache-comparison to criteria for chronic tension-type headache. *Cephalalgia,* 365-368.

SPECULAND, B., GOSS, A. N., HUGHES, A., SPENCE, N. D. & PILOWSKY, I. (1983) Temporo-mandibular joint dysfunction: pain and illness behaviour. *Pain,* 17, 139 - 150.

STEENKS, M. H. & DE WIJER, A. (2009) Validity of the Research Diagnostic Criteria for Temporomandibular Disorders Axis I in clinical and research settings. *J Orofac Pain,* 23, 9-16; discussion 17-27.

SUVINEN, T. I., READE, P. C., KEMPPAINEN, P., KÖNÖNEN, M. & DWORKIN, S. F. (2005) Review of aetiological concepts of temporomandibular pain disorders: towards a biopsychosocial model for integration of physical disorder factors with psychological and psychosocial illness impact factors. *European Journal of Pain,* 9, 613-633.

SWANLJUNG, O. & RANTANEN, T. (1979) Functional disorders of the masticatory system in southwest Finland. *Community Dent Oral Epidemiol,* 7, 177-82.

TALLEY, R. L., MURPHY, G. J., SMITH, S. D., BAYLIN, M. A. & HADEN, J. L. (1990) Standards for the history, examination, diagnosis, and treatment of temporomandibular disorders (TMD): a position paper: American academy of head, neck and facial pain. *Cranio,* 8, 60-77.

TSOLKA, P., FENLON, M. R., MCCULLOCK, A. J. & PREISKEL, H. W. (1994) A controlled clinical, electromyographic, and kinesiographic assessment of craniomandibular disorders in women. *J Orofac Pain,* 8, 80-9.

TSOLKA, P., MORRIS, R. W. & PREISKEL, H. W. (1992) Occlusal adjustment therapy for craniomandibular disorders: a clinical assessment by a double-blind method. *J Prosthet Dent,* 68, 957-64.

TSOLKA, P. & PREISKEL, H. W. (1993) Kinesiographic and electromyographic assessment of the effects of occlusal adjustment therapy on craniomandibular disorders by a double-blind method. *J Prosthet Dent,* 69, 85-92.

TSUKIYAMA, Y., BABA, K. & CLARK, G. T. (2001) An evidence-based assessment of occlusal adjustment as a treatment for temporomandibular disorders. *J Prosthet Dent,* 86, 57-66.

TURP, J. C. & MINAGI, S. (2001) Palpation of the lateral pterygoid region in TMD - where is the evidence? *J Dent,* 29, 475 - 483.

VANDERAS, A. P. (1994) Relationship between craniomandibular dysfunction and malocclusion in white children with and without unpleasant life events. *J Oral Rehabil,* 21, 177-83.

VOLLARO, S., MICHELOTTI, A., CIMINO, R., FARELLA, M. & MARTINA, R. (2001) [Epidemiologic study of patients with craniomandibular disorders. Report of data and clinical findings]. *Minerva Stomatol,* 50, 9-14.

WAHLUND, K. (2003) Temporomandibular disorders in adolescents. Epidemiological and methodological studies and a randomized controlled trial. *Swed Dent J Suppl.*

WAHLUND, K., LIST, T. & DWORKIN, S. F. (1998) Temporomandibular disorders in children and adolescents: reliability of a questionnaire, clinical examination, and diagnosis. *J Orofac Pain,* 12, 42-51.

WEINBERG, L. A. (1979) An evaluation of occlusal factors in TMJ dysfunction-pain syndrome. *The Journal of Prosthetic Dentistry,* 41, 198-208.

WENNEBERG, B., NYSTROM, T. & CARLSSON, G. E. (1988) Occlusal equilibration and other stomatognathic treatment in patients with mandibular dysfunction and headache. *J Prosthet Dent,* 59, 478-83.

WHITTAKER, D. K., DAVIES, G. & BROWN, M. (1985) Tooth loss, attrition and temporomandibular joint changes in a Romano-British population. *J Oral Rehabil,* 12, 407-19.

WITTER, D. J., DE HAAN, A. F., KAYSER, A. F. & VAN ROSSUM, G. M. (1994a) A 6-year follow-up study of oral function in shortened dental arches. Part I: Occlusal stability. *J Oral Rehabil,* 21, 113-25.

WITTER, D. J., DE HAAN, A. F., KAYSER, A. F. & VAN ROSSUM, G. M. (1994b) A 6-year follow-up study of oral function in shortened dental arches. Part II: Craniomandibular dysfunction and oral comfort. *J Oral Rehabil,* 21, 353-66.

YAP, A. U., TAN, K. B., CHUA, E. K. & TAN, H. H. (2002) Depression and somatization in patients with temporomandibular disorders. *J Prosthet Dent,* 88, 479-84.