Tufts University

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The Relationship between Mandibular Midline Deviation and Tooth Wear, DMFT and TMD Findings

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Abstract

Aim: The purpose of this study was to determine if there is an association between a deviation of the mandibular frenal dental midline and DMFT, tooth wear and TMD findings.

Introduction: Research has looked at the association between deviation of the dental midline and the impact on esthetics. There also has been some research dealing with the question of discrepancies in growth of the maxilla and mandible and right versus left side of the face.[1,2] Some research has focused on midline deviation and its effect on the Temporomandibular Joint (TMJ) and the muscles associated with this joint as it relates to parafunction.[3,4] There have been no studies which evaluated the effect of midline deviation and its effect on the teeth irrespective of parafunction. This study sought to find any association between these two variables.

Methods: Fifty patients were selected from a general dental practice with varying degrees of mandibular frenal midline deviation. Based on previous research we determined that those with frenal midline deviation of 1mm or less to be within normal limits and those 1.5mm or greater to have excessive deviation. Each patient had clinical photographs, impressions and models of their teeth with bite registration taken in the maximum intercuspal position (MIP), and a clinical exam of teeth and the stomatognathic system based on the research diagnostic criteria for temporomandibular disorders (RDC/TMD).[5]

Results: Eighteen male and 32 female patients were selected with an average age of 48 and 42 respectively. Of these patients 23 had deviation 1mm or less and 27 had deviation

1.5mm or more. It was determined that there was a statistically significant difference in tooth wear between those with deviation 1mm or less and those with deviation 1.5mm or greater ($p<0.0001$), with less tooth wear in those with no deviation. There was also a significant association between tooth wear and side, with more wear on the ipsilateral side when compared to the contralateral side ($p<0.0001$). No significant association was found between midline deviation and TMD findings.

Conclusion: Our research concludes that there is a statistically significant difference in tooth wear and DMFT findings in those with deviation of the frenal midline 1.5mm or more in comparison to those who have deviation 1mm or less.

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Introduction

The concept of symmetry and how it affects the esthetics and functional qualities of both natural and man-made entities has been the subject of studies in many disparate fields. Zee *et al*. stated that "symmetry is a central concept in aesthetics and plays an essential role in art, architecture, design literature, and music"[6] He supported this by describing symmetry in equations within the science of physics, and phenomena that have perfect symmetry in nature. He concluded that "things in nature tend to symmetry and balance." Sefcek *et al.* studied facial symmetry in chimpanzees and if there was a correlation between what they termed fluctuating asymmetry of the face and the chimpanzees' overall physical and mental health. In this study of 21 chimpanzees the researchers determined that facial asymmetry correlates with negative mental and physical health.[7] They also correlated this finding with the chimpanzee's ability to reproduce and produce healthy offspring, concluding that facial asymmetry correlated with a lower reproductive rate and less healthy offspring. This study concluded that there is a functional reason for symmetry in animals, but does not address humans.

In human interactions, the face is a principal source of communication via speech and facial expressions. However, symmetry in the face in humans and its influence on day-to-day activities is not clear. Facial asymmetry in humans was probably first observed by early Greek artists "who recorded what they found in nature – normal facial asymmetry."[8]

Zaidel and colleagues studied the relationship between facial asymmetry and the perception of health in humans.[9] In this study, participants were shown faces of 30 women and 98 men from photographs. The participants were asked to rate the faces on a scale from 1 to 5 on attractiveness, health and symmetry. There was a statistically significant association

between health and symmetry but not with attractiveness and symmetry. Their conclusions were that our perceptions of symmetry may determine our view of the health status of an individual, but that symmetry is not associated with our perception of how attractive an individual appears. In dentistry, the field of orthodontics deals with symmetry of the face and specifically the teeth but only from an esthetic point of view. From this study, it would seem that if symmetry is not a concern in perceiving a person as attractive, we may wonder if there is a point in even looking at symmetry.

It has been shown that human faces are, in general, structurally and functionally asymmetric[10-13] Multiple studies evaluated the relationship between attractiveness and symmetry of the face.[9,14,15] Most of these studies concluded that attractiveness and symmetry are not positively associated. A study by Rhodes *et al.* contradicted these studies concluding that symmetry in the face was more desirable than asymmetry.[14] In this study, the authors looked at the entire face, frontal view, and altered the photographs with varying degrees of symmetry. Teeth were not the focus as all photographs had the subjects with lips closed. Because this study focused on other elements of the face and symmetry the author's findings were that perfect symmetry of the face was preferred to asymmetry. The study was alone in its evaluation as most of the previous studies concluded that attractiveness and the factors associated with determining whether a person is pleasing to the eye are determined by other factors.[16] The other studies focused on the smile and whether the smile was asymmetric or not. Thus, symmetry of the face, specifically the smile, may not be necessary in orthodontics or facial surgery. We must look at other factors, aside from attractiveness, to see if symmetry is important, when looking at the face and smile.

Definition of Asymmetries in the Face

When we look at asymmetries in the face, we first look at facial elements such as the eyes, nose, and chin. From an orthodontic perspective these would include the points sella, anterior nasal spine, menton, and points in the orbit and condyle, on a frontal cephalometric radiograph.[11] These points are considered elements of the skeletal midline. It is also important to look at soft tissue elements, such as the nose and lips in addition to the teeth when considering the midline since this is what the general public will see when looking at a person. Studies have demonstrated a range of prevalence's. In a study by Haraguchi, a population of 1800 Japanese patients was observed to determine whether there was a difference in symmetry between right and left sides; he used as the center point the median between the right and left pupils of the eye and drew a perpendicular line along this point[1]. In this study he determined that for a face to be considered asymmetric, it would need to be at least 3 standard deviations from exactly symmetric. To find the standard deviation for the study, a sample population of 100 patients was selected. It was determined that anything over 1.03mm in the mid-face different from the opposing side was considered asymmetric and any dimension over 1.48mm deviated from center in the mandible was considered asymmetric. Of interest is that in the study population, age ranging from 4 years 2 months to 59 years 11 months, 79.7% of the entire population had right side mid-face asymmetry and 79.3% had the lower jaw deviated to the left of midline. Not only does this study show that asymmetry is common, but it shows that it is far more common to have deviation of the lower jaw to the left.

To further illustrate the prevalence of asymmetries in the face Farkas *et al.* studied a Canadian population of 308 Caucasian children from 6-18 years of age[2]. They attempted to determine the prevalence of asymmetry of the face and selected lateral points of the face

and used standard anthropometric methods[17,18] to get the data. The authors concluded that 64-67% of all patients in this age category had facial asymmetry. Facial asymmetry was defined as any difference in measurement comparing right and left sides greater than 2 mm. The authors concluded that the largest asymmetry occurred in the upper third of the face. The etiology of this facial asymmetry is not known. Once again, this study showed greater growth in the upper right side of the face.

Another study by Sheats *et al.* aimed to determine the prevalence of dental asymmetries in orthodontic patients[19]. In this study of asymmetries of the face in adolescent children in Virginia, prior to orthodontic treatment, it was determined that 62% had mandibular deviation from the facial midline and that 46% of these individuals did not have their maxillary and mandibular midlines coincident. They used the dental midlines to determine asymmetry, but it was not mentioned how they determined the facial midline. Prevalence of asymmetry in the teeth and jaw was also studied by Smith and Bailit[20] with similar data showing asymmetry as a common finding in their population of 763 Melanasian patients. They measured the difference in overjet, overbite and molar relationships. They found in this group of patients that the difference in upper and lower molar relationships, measuring the distance between right and left side in a sagittal direction, was statistically significant.

The etiology of this discrepancy between right and left sides of the face was tested in a study by Rossi *et al*. where they observed 95 skulls of neonates, infants, children and adults. Their definition of asymmetry was based on a direct measurement of the skulls, noting that any difference between the distances measured on the right and left sides was considered asymmetric.[21] In this study they wanted to determine if the asymmetry was linked to

occlusion and chewing forces. They used as their determination of asymmetry what they termed the asymmetry index. They measured the right side of the face and subtracted the same dimension on the left side of the face and divided by the right side. They multiplied the resulting number by 100. The right side of the face was used as a reference so that negative numbers indicated that the left side was larger and positive numbers indicated that the right side was larger. All points were in the upper two thirds of the skull; no measurements of the mandible were taken. In all of the skulls studied, a similar asymmetry was noted at all points at a positive range between 2.8% - 6.5% with the most extreme in the infants. Using ANOVA they established that these differences were statistically significant ($p=0.006$). They concluded that there must be a genetic component to this asymmetry within the face as it was observed even before tooth development. The etiology of asymmetries of the face was also suggested in a study by Inui et al.[22] One of the common etiologies, proposed by Inui and colleagues, which supports the data listed above, is the increased growth of the maxilla on one side as compared to the other. This increased growth would cause the mandible to meet the maxilla unevenly and cause a shift of the mandible. In their study, patients with internal derangement of the TMJ were evaluated skeletally by the use of a frontal cephalogram. They measured the angle connecting menton and anterior nasal spine and the line running through crista galli and anterior nasal spine. This they called the mandibular lateral displacement or MLD. They also measured the frontal occlusal plane (FOP) by drawing a line through the right and left molars. The frontal mandibular plane (FMP) was also measured by drawing a line through the point gonion on both right and left side. It was determined in this study that there was a statistically significant association between the dimension MLD and both FOP and FMP($p<0.0001$). They determined that this was a result of the cant of the frontal occlusal plane and the

frontal mandibular plane. The authors hypothesized the cant was associated with the internal derangement of the TMJ. They surmised that the mandible would naturally meet the maxillary teeth and if the growth was less on one side, the lower teeth still tried to meet the maxillary teeth, which caused a vertical as well as a lateral shift in the mandible. This also caused a shift of the condyle within the TMJ, which resulted in internal derangement by their estimation. Occlusal interferences were not studied.

Esthetics and the Midline

As mentioned previously, there is not a significant association between symmetry and esthetics. Several studies have tried to determine what is esthetic and how far from symmetry a face must be before it is noticed among the general public[23-27]. The study by Ker and colleagues,[28] laypersons were asked what they considered esthetically acceptable in a smile. They evaluated many characteristics of the teeth including the facial midline and maxillary teeth and whether the maxillary teeth and mandibular teeth midlines were coincident. There could be up to 4.4mm of shift in the maxillary midline relative to the center of the face (as determined by the nadir of the cupids bow in the lip and the center of the philtrum of the lip), before an esthetic difference was noticed. There could be a shift of 2.9mm between the maxillary central incisors midline and the mandibular central incisors midline before it became noticeable to the observers. Kokich's[26] results were similar. Their study had a similar design but compared general dentists, orthodontists and lay people and their perception of what was considered esthetically pleasing. They found that a 4mm shift of the midline had to occur before it was noticeable to the eye of the observer and considered less pleasing. This addresses the significance of maxillary and mandibular teeth

asymmetry. There is no clinically significant difference, when considering esthetics, until the shift is greater than 4mm. The layperson is mainly concerned with how teeth look when considering a smile, not necessarily how they fit in the face.

Functional Sequelae for midline deviation

This study addressed the functional effects of asymmetry in the jaw. These effects include temporomandibular joint disorder, commonly referred to as TMJD, breakdown of the teeth through breakage, decay, periodontal concerns, and tooth wear as measured by decayed, missing and filled teeth (DMFT) index, and a tooth wear index (TWI).

Temporomandibular Joint Disorder (TMJD)

The most obvious adverse outcome from having a midline deviation is having a TMJ malpositioned on one side. Goto and colleagues probed this question.[3] They designed a study with 28 patients to determine what significance midline deviation had on the TMJ. They also used 12 controls age and sex matched to the study patients. They acquired MRI imaging on each patient and examined them clinically to determine if there was a significant difference between deviated side and the non-deviated side. They determined that the TMJ on the deviated side showed a smaller condyle and a higher incidence of disc displacement than the non-deviated side and also smaller than the controls. They did not find a statistically significant difference in clinical symptoms between the deviated or non-deviated sides and the controls. In this study, there was not enough statistical evidence to associate disc displacement and condylar size discrepancy with pain.

There was no statistically significant association between displacement of the condyle off of the disc and pain. Goto and colleagues examined this lack of association and tried to correlate occlusal force and mandibular deviation to see if there was a decrease in occlusal force on the deviated versus the non-deviated side.[29] In this study, 23 patients were selected with skeletal mandibular asymmetry, and 23 age and sex matched adults used as controls. The researchers found that there was a decrease in occlusal force compared with controls. They found that about half of the force was evident in the deviated patients versus the controls, but no other significant difference was noted between the deviated and non-deviated sides.

Are there parafunctions which make one person more susceptible to pain and dysfunction than another? Miyake and colleagues[4] studied 3557 Japanese university students, aged between 18 and 26, to determine what parafunctions were associated with TMJD. The variables of TMJD they were looking for were joint noise, joint pain and limitation in opening. The parafunctions most often associated with pain and limited opening, TMJD symptoms that can limit quality of life, were chewing on one side and clenching of the teeth. In both of these variables of parafunction, increased force was the underlying factor with TMJD.

In the studies above, occlusal interferences were not considered. Shiau *et al.* introduced occlusal interferences to see if this had an effect on those who grind their teeth, or bruxers.[30] Their study included 13 bruxers and 14 non-bruxers, where a metallic overlay was applied to the buccal cusps on the upper second premolar and first molar on the habitual chewing side. They found that bruxing events did decrease, and the closing path was narrower and

more guarded with a decreased closing velocity. This study supports the idea that there is less force applied if there is an interference in the closing path, causing the jaw to shift to one side or the other. This may explain why there is not necessarily pain and symptoms associated with deviation of the mandible in the TMJ, even though there is evidence of disc displacement.

A study by Landi *et al.* [31] probed this question further. They wanted to determine the risk of TMJD related problems given different occlusal variables. Using the research diagnostic criteria (RDC), they studied 81 women who had been diagnosed with myofascial pain with or without limited opening and 48 healthy women as a control. They determined in this study that a slide of greater than 2 mm from maximum intercuspal position (MIP) and the retruded position as well as mediotrusive interferences were the only two occlusal variables associated with myofascial pain. They did not find a correlation between myofascial pain and midline deviation without mediotrusive contacts. A study by Fushima[32] concluded that the deviation of the mandible and subsequent pain associated with the asymmetry were a result of the maxillary teeth in an improper position, which then correlates with a mandible forced to fit this deviated position, either dentally or skeletally. The result he found was pain and dysfunction of the stomatognathic system. In his study, 34 subjects with internal derangement of the temporomandibular joint were studied to determine factors associated with this dysfunction. Researchers measured skeletal midline deviation from a posterior/anterior (PA) cephalogram using the points crista galli (CG), a midpoint in the anterior center of the skull, anterior nasal spine (ANS), a bony projection just beneath the nose, and menton (ME), the most inferior point on the chin. They wanted to correlate midline deviation with molar occlusal relationships in the mouth and on a model. They

found that there was a correlation between a distal mandibular molar relationship when comparing it with its opposing molar and midline deviation 76.5% of the time. This also correlated with symptoms on the side of deviation. In this study 61.8% of the participants had an Angles class 2 molar relationship. Other studies have corroborated the correlation between mediotrusive contacts and myofascial pain[30,33,34].

The studies above correlated mediotrusive contacts with pain and dysfunction of the TMJ when there was parafunction evident. In a study examining the question of whether removal of such contacts would allow the mandible to shift towards a more midline position were removed, Fu and coworkers[35] demonstrated an association between mediotrusive contacts and deviation of the mandibular midline. In this study of 17 female and 3 male patients, a flat plane night guard was fitted to help in treating the subjects' TMJD symptoms. All subjects in this study had deviation of the skeletal midline, comparing maxillary and mandibular frenums. Of interest in this study, after treatment with a flat plane night guard, all subjects' mandibular positions shifted toward the frenum midline position. Their results indicated that if the mediotrusive contacts were eliminated, the mandible would drift to a balanced midline position.

Clark *et al.*[36] performed a literature review that included 18 human and 10 animal studies conducted over the last 68 years. They concluded that artificially introduced tooth interferences were not correlated with TMJ pain but some muscle pain resulted from these interferences. This would indicate that a foreign interference, one introduced after development, is less likely to cause problems in the TMJ, than one where the jaw has grown into an asymmetric position with a resultant shift in the condyle, joint, disc relationship.

Tooth Wear

In the past, some have hypothesized that bruxing is caused from occlusal interferences associated with midline deviation.[37] Assuming the relationship between occlusal interferences and bruxing, the person who had the interferences would eventually eliminate those interferences to create a more stable mandibular relationship. This is assuming the clenching and bruxing events would generate enough force to eliminate the interferences. Recent studies indicate that bruxism is multifactorial with a strong correlation between bruxing and sleep disorders. A study by Holley and colleagues determined that 63% of those with obstructive sleep apnea had a retruded jaw position. This jaw position, labeled a class II malocclusion, is often caused from the mandible hitting the maxillary teeth, which are lingually inclined, and this lingual inclination forces the jaw to the retruded position. The bruxing events eventually wear the lower anterior teeth, allowing greater freedom of the mandible to move, unrestricted in space. This would suggest that premature contacts can be ground down through bruxism, and there may be greater evidence of occlusal wear in someone with mediotrusive contacts. Another study showed there is little evidence to support the theory that bruxism is caused from occlusal interferences[38].

There is currently no literature that explores the relationship between facial asymmetry, maxillary and mandibular asymmetry, and the effects that they may have on the teeth and gingival tissue.

Epidemiology

Prevalence

Midline deviation

Facial asymmetry is strongly associated with genetics and to a lesser degree associated with function. This statement is supported by studies of prevalence of facial asymmetry and midline deviation in different countries. A Japanese study has the prevalence at 79%[1], a Canadian study at 64-67%[2], a study in Virginia showed 46%[19], and Melanasian patients had a prevalence of 60% for deviation of the midline.[20] This suggests prevalence dependent on the gene pool of the subjects.

Tooth wear

Tooth wear can be caused by several factors including attrition, erosion and abrasion. Prevalence studies do not always divide tooth wear into these categories but instead lump them all together. It can also be age dependent, as one would not expect the same prevalence of tooth wear when comparing teenagers with octogenarians. A systematic review of the literature from 1980 to 2007 sought to identify the prevalence of tooth wear in the adult population.[39] The authors excluded all literature where subjects were under 18 years of age. They determined using the tooth wear index, which was relatively standard across all studies, tooth wear increased from age 20, where 3% of the population had tooth wear in what is considered the severe category, to 17% in the 70 or older age group. Severe tooth wear was defined as wear into the dentin or greater. They determined that for all causes, tooth wear was age dependent.

Decayed, Missing and Filled Teeth

Nearly all studies associated with calculating DMFT were concerned with fluoride and its effect on caries incidence. These studies gave a general idea of the prevalence of DMFT in the population. One study searched the literature for caries prevalence in European

countries and the United States.[40] In the United States the decayed, missing and filled teeth was age dependent. The average DMFT for 18-24 year old age group was 8.2, the 25-34 group was 10.5, 35-44 year olds average was 14.3 and the 45-54 age group had an average DMFT of 16.9. This paper looked at studies between the years 1990-1995.

TMD Symptoms

Prevalence of TMD symptoms is also age dependent. A study by Locker *et al*.[41] attempted, through telephone interviews using a standard questionnaire, to determine the prevalence of TMD symptoms in a Canadian population. They determined that for those aged 44 and under, the range of those with symptoms was between 6.9 and 9.7% when using pain as a criterion. For those over age 44 the range was 2.6-5.9%. If the criteria were expanded to include popping or clicking of the joint, the prevalence increased to 29.2% in the under 44 group and 15.1% in the over 44 group. Women are twice as likely to have a problem as men. Another study in Seattle, Washington surveyed 1016 subjects, by questionnaire, concerning their pain experience as it relates to the TMJ. They reported results a bit higher in the 25-44 age group.[42] The prevalence of pain in the joint or muscles in front of the ear was 10% for men and 18% for women. When subjects over 65 were asked, 0% of men and 2% of women reported symptoms

Specific Aims and Hypothesis

The aim of this study was to determine if there is an association between the amount of dental breakdown, as determined by a decayed, missing or filled teeth (DMFT) score and the amount of deviation in the midlines of the teeth. It also looked at tooth wear and scored the wear using a tooth wear index (TWI). In addition midline deviation and any effects this had

on the temporomandibular joint and surrounding muscles was evaluated using the RDC/TMD. The hypothesis was that there would be more hard and soft tissue findings in patients with a deviation of the midline.

Research Design and Methods

A power calculation was performed using nQuery Advisor (version 7.0). Assuming a correlation of 0.5 between deviation and DMFT score in the population, a sample size of n=50 was adequate to obtain a Type I error rate of 5% and a power of 97%.

This was a cross sectional study of a patient population in a general dental practice in Nampa, Idaho. Patients who were not edentulous were asked when they came in for their routine cleaning and restorative appointments if they wanted to participate in a study. Thirty patients were enrolled in this manner. After the initial 30 were enrolled, the final 20 were identified by inviting patients who had a deviation 1.5mm or more to participate in the study. They were then asked to have photographs taken, fill out a questionnaire, have impressions taken of their teeth and undergo a routine dental exam as described below.

Photographs

If the patient elected to participate in the study they were seated in a firm chair with a straight back, both feet flat on the ground. The subjects were given a heat sterilizable cheek retractor to retract the lips away from the teeth. They were then asked to close the jaw into the maximum intercuspal position (MIP). A photograph was taken 5 feet from the patient, with a Nikon Digital SLR D80 on a tripod, to capture the teeth in MIP along with the maxillary and mandibular frenum and the soft tissue point between the pupils of the eyes. This view was used to determine midline deviation. One photo was also taken of the

maxillary teeth, full arch using a reflecting mirror, and one of the mandibular teeth full arch, with a reflecting mirror. Two additional photos were taken of the right and left buccal surfaces of the teeth using a reflecting mirror. These photos were used to capture dental breakdown of the teeth and periodontal tissues.

RDC/TMD Questionnaire

Subjects were given the RDC/TMD questionnaire[5,43-47] to answer questions regarding their TMD symptoms. They then underwent an exam using the format of the RDC/TMD booklet to determine signs and symptoms associated with myofacial pain or TMD.

Impressions

Upper jaw and lower jaw alginate impressions were taken by the dental assistant with the patient seated, torso and head vertical, in an A-dec dental chair. Impressions were taken using Alginot and a bite registration was taken with Blue Bite, having the subject bring their teeth together in MIP after the Blue bite had been placed on the lower teeth. Dental models were created from the impressions using buff yellow stone poured into the impressions.

Dental Exam

The subject underwent a routine dental exam. This exam consisted of charting existing decayed, missing and filled teeth and then scoring this using the DMFT[48] scoring method.

Using the dental models, tooth wear was evaluated and scored using a tooth wear index as described by Ekfeldt *et al.*[49] The tooth wear index was calculated based on the following definitions:

T_0= no tooth wear

T_1= tooth wear in enamel

T_2= tooth wear into dentin and up to one third of coronal tooth structure missing

T_3= tooth wear more than one third of coronal tooth structure missing

The teeth for each patient were then multiplied by a number depending on their degree of tooth wear as follows: T_1 was multiplied by 10, T_2 was multiplied by 30, and T_3 was multiplied by 100. The total tooth wear index for each subject was then calculated using the formula:

$$\frac{10xT_1+30xT_2+100xT_3}{T_0+T_1+T_2+T_3}$$

All missing teeth and teeth with full coverage restorations were removed from the data when calculating the tooth wear formula.

Third molars were not included in the DMFT and TWI score. Radiographs were only taken if they were needed as per current protocol, which are a panoramic radiograph every 5 years and four standard bite-wing radiographs every year. If bite-wing radiographs were needed per the subject's routine dental exam they were taken using the #2 Schick digital sensors. If it had been over 5 years since the patient had a panoramic radiograph taken, one was taken using Planmeca digital panoramic machine. Subjects were asked which hand they brushed their teeth with and whether they use a soft, medium, or hard manual toothbrush or an electric toothbrush. They were also asked if they used toothpaste and what kind of toothpaste they use when they brush their teeth. The selection of subjects of this study included those with no deviation and those with varying levels of deviation either to the

right or left of the midline. The study sample excluded all patients under the age of 18. Patients with a history of radiation therapy to the face or jaw, those currently undergoing orthodontic treatment and those who had a smokeless tobacco habit were also excluded from the study. Patients unable to understand the English language well enough to consent were excluded from the study.

Models and Photograph analysis

After the subject was dismissed, buff dental stone was poured into the impressions. The models were analyzed with the patient in MIP. A line was drawn between the maxillary midline frenum and the mandibular midline frenum and the measurement was taken using a millimeter ruler and rounded to the nearest 0.5mm (see figure 3). Photographs were also analyzed for midline deviation to correlate with the model mounting. Tooth wear was analyzed from the models (see figure 4 for an example) utilizing the tooth wear categories previously mentioned.

Statistical Analysis

The association of DMFT difference between left and right and midline deviation was analyzed using Kruskal-Wallis test and the Mann-Whitney U test with Bonferroni correction. DMFT score was compared between two groups, midline deviation 1.5mm and greater in either direction and midline deviation 1.0mm or less using the Kruskal-Wallis test and the Mann-Whitney U test. The association between tooth wear and midline deviation was analyzed using generalized estimating equations. Gender differences in TWI were analyzed using the independent samples t-test. The association between joint click and midline deviation was analyzed using McNemar's test. The association between joint pain and midline deviation was analyzed using McNemar's test. The association between

midline deviation 1.5mm and over and joint pain was analyzed using Fisher's exact test. The association between tooth wear and joint pain was analyzed using the Mann-Whitney U test. The association between tooth wear and brushing frequency was analyzed using the Mann-Whitney U test. The association between tooth wear and type of tooth brush used was analyzed using the Mann-Whitney U test. The association between DMFT and tooth brushing frequency was analyzed using the Mann-Whitney U test.

Results

Table 1 shows the descriptive statistics of the sample. The sample consisted of 50 subjects. The gender distribution consisted of 18 male and 32 female subjects. Average age of the subjects was 44 with a standard deviation of 15 years. Average age of the male subjects was 48 with a standard deviation of 14.4 and the mean age of the female subjects was 42.3 with a standard deviation of 16.1. Minimum age of the subjects was 19 and the maximum age was 76. Of those selected for the study 23 subjects, or 46%, had a midline deviation 1mm or less and 27, or 54%, had deviation 1.5mm or greater. The mean midline deviation for all subjects was -0.310 with the negative number signifying that the deviation was to the right. Standard deviation of the midline deviation was 1.9 with the minimum deviation being -4.0 and the maximum being 4.0. When looking at tooth wear the mean number of teeth with tooth wear was 7.6 with a standard deviation of 7.2. Minimum number of teeth with tooth wear was 0 and maximum number of teeth with tooth wear was 28. Average DMFT on the left side was 6.0, with a standard deviation of 3.4. Minimum DMFT on the left side was 0 and maximum was 14. Mean DMFT on the right side was 5.8 with a standard deviation of 3.5. Minimum DMFT for the right side was 0 and the maximum was 14. When looking at the difference between the left and right side the mean difference, looking at left side minus

right side was 0.2 with a standard deviation of 1.9. The minimum difference was -5 and the maximum difference was 7. Looking at the entire mouth, mean DMFT was 11.8 with a standard deviation of 6.7. Maximum DMFT for the entire mouth was 28 with the minimum being 0.

Looking at the results of midline deviation and DMFT difference, subtracting the DMFT score on the right side from the left side, the results of the Kruskal-Wallis test were statistically significant (p=0.007). Based on the Mann-Whitney U test with Bonferroni correction, the DMFT difference was significantly higher for the group with 1mm or less deviation than for the group with 1.5mm or greater deviation to the left (p=0.002). When analyzing the patient deviated to the right, the DMFT difference on the opposite side of the deviation was not statistically significant (p=0.07). When comparing three groups, midline deviation 1.5mm or greater on the right side, midline deviation 1.5mm or greater on the left side and subjects with deviation 1mm or less and their DMFT scores, there was no statistically significant difference (p=0.634). There was also no significance when comparing DMFT scores of those groups with deviation 1.5mm and greater on either side and those with deviation 1mm or less (p=0.915).

Tooth wear and midline deviation results are found in Table 2. Based on the analysis from the generalized estimating equations, there was a statistically significant association between tooth wear and deviation. Teeth of subjects with deviation 1mm or less had significantly less wear than teeth of subjects opposite the deviation 1.5mm or more ($p < 0.0001$). When comparing deviation on the same side 1.5mm or greater to those with deviation 1mm or less,

there was significantly less wear in the teeth of subjects with deviation 1mm or less ($p<0.0001$). Finally, when comparing the teeth of subjects with deviation 1.5mm or greater, the teeth on the side opposite the deviation had significantly less wear than teeth on the side toward the deviation ($p=0.018$). Examining the association between TWI and gender, males had a TWI mean of 12.65(St. 9.45) and females had a mean TWI of 4.82(St. 3.25)($p<0.0001$). See Table 3 for results.

Temporomandibular disorder symptoms were analyzed separately between joint pain when palpating the joint, muscle pain when the muscles of mastication were palpated and joint clicks when noise was heard in either joint upon opening or closing, using a stethoscope. When examining the association between deviation and the presence of joint click, there was no significant difference between those with deviation 1.5mm or more and those with deviation 1mm or less ($p=0.261$). Comparing same side of deviation with opposite side of deviation there was also no significance in joint clicks or joint pain between the two sides ($p=1.00$ for both tests). The association between midline deviation 1.5mm and over and joint pain was not statistically significant ($p=0.515$).

We examined the association between subjects' total TWI and the presence or absence of joint pain on the right and left side. There was no statistically significant difference between subjects with joint pain on the right side and those without joint pain on the right side and their TWI($p=0.582$). We compared those subjects with joint pain on the left side and those without pain on the left side and their TWI and there was no statistical significance

(p=0.552). When examining the association between TWI and having at least one joint pain (right or left) there was no statistical significance (p=0.460).

We examined the association between brushing frequency and TWI. There was no statistically significant association between brushing frequency and TWI (p=0.548). Looking at the association between type of toothbrush and TWI, there was no statistically significant difference between electric toothbrush users and soft tooth brush users (p=0.430).

Regarding the association between toothbrush frequency and DMFT, those who brushed twice a day or more had a mean DMFT score of 13.42(St. 6.68) and those who brushed once a day or less had a mean DMFT score of 8.33(St. 5.73) (p-value = 0.019).

Discussion

This study looked for a correlation between deviation of the midline and DMFT scores. A statistically significant difference in DMFT scores was found when looking at the difference between left and right sides and correlating that with the side toward the deviation. The difference between left and right DMFT scores was computed by subtracting the right from the left side and then compared that score with those subjects who deviated to the left, right or had no deviation. The finding was that there was no statistically significant difference when looking at those subjects who deviated to the right and those with no deviation(p=0.07), but those who deviated to the left showed greater breakdown, as measured by the DMFT score, in the teeth on the right side of the face(p=0.002).

Most authors have explored deviation of the midline as it pertains to the esthetics of the face[23,24,26,27], while a few have correlated deviation with functional problems with the TMJ[3,22,50-52]. This study sought to find correlation between midline deviation and structural breakdown of the teeth, jaw joint and muscles. Breakdown of the teeth can be recorded in many ways, with one of the common being DMFT. Studies in the past using DMFT looked at caries rate and related that to sugar intake[53], fluoride[40,54], sealant placement[55] and other factors[56].

A theory which would explain these results is that when a patient has a premature contact keeping all of the teeth from maximum intercuspation, that patient will first hit on that premature contact and then slide toward the side of chewing dominance. This premature contact, after being repeatedly hit, and then the jaw forced to slide, would create a stress on that tooth or teeth of first contact, which would cause breakage or breakdown at some point. According to the theory, the side opposite the first contact should then show more wear on the teeth, due to the slide. This would then create a midline deviation to the side opposite first contact. One of the limitations of this study is that we did not record first contact. We cannot, with any degree of confidence, say that our data support this theory without having recorded first contact, however greater breakdown was noticed on the teeth opposite the side of deviation when deviated to the left. Previous studies have explored the lateralization of chewing[57,58] and pain[59]. One possible reason for the left side deviation showing greater breakdown on the right side would be the lateralization of chewing forces. The initial chewing stroke hits premature contact, slides to reach maximum intercuspation towards the dominant side which creates wear on the side opposite the first contact and deviation to the side of the tooth wear. In theory, this would produce greater wear on the teeth towards the

deviation and greater breakdown, as measured by DMFT, on the side opposite the deviation. Our findings support this theory, in both DMFT being greater on the side opposite deviation, and, as will be discussed later, greater tooth wear towards the side of deviation. According to this theory, we should see that same breakdown being greater regardless of the side of deviation, which we did not see. The finding of greater DMFT on the opposite side of deviation when deviated to the left may be supportive of the theory mentioned above or it may be a finding due to chance. The current study did not analyze tooth wear and DMFT to find an association between the two. Future studies could look at the data to see if there is an association on both the right and left side between DMFT and tooth wear.

Because there are many factors that may contribute to a DMFT score, it is hard to predict which factor is most contributory. Studies listed above suggest strong association between the factors of fluoride use, sealant placement and sugar intake. Other factors that may seem contributory, because of their effect on oral hygiene, such as heavy alcohol use, did not demonstrate an association in previous studies attempting to find an association.[60,61] In this study tooth brushing frequency was also analyzed with DMFT. This study found a statistically significant association between frequency of brushing and DMFT but the lower DMFT was associated with less frequent brushing. This result seems counter-intuitive as previous studies have concluded that there is an association between lower DMFT and brushing frequency.[62,63] One systematic review of the literature[64] analyzing socioeconomic status and caries rate concluded that there is a weak association between tooth brushing frequency and caries rate. The more important factor is fluoride contact and ingestion. In our study, we did not differentiate those who used fluoride toothpaste with those who did

not. It is also difficult to evaluate brushing efficiency as compared to frequency. Some may report that they brush twice a day but if they are only brushing the chewing surfaces of the teeth, other areas of the teeth may be prone to decay. Comparing a person who efficiently brushes all surfaces of the teeth once a day to one who brushes less efficiently twice a day, the outcome could very easily be in favor of the more efficient brusher as opposed to the brusher who is more frequent. As DMFT is multi-factorial, without taking all variables into account, it would be hard to determine an association with any degree of accuracy. The current study results show how difficult it is to use DMFT when evaluating tooth breakdown.

In the present study, tooth wear was a more predictable outcome of midline deviation in regard to dental findings (See figure 1). There was a strong association between deviation of the midline and tooth wear, and additionally a finding of greater tooth wear to the side of deviation. One possible theory for these findings was presented by Kanavakis[65] in his paper describing occlusal relationships and associated TMD symptoms. The occlusal fencing theory, first described by Mehta *et al*.[66], describes how the maxilla can dictate and influence what will happen to the form and function of the mandible. If the maxilla is aligned with one side having more vertical growth than another, then the mandible will follow the form of the maxilla and the result will be: 1) a point of first contact; 2) a slide to the dominant side; 3) tooth wear on the dominant side and finally; 4) a result of a midline discrepancy. The diagram by Inui *et al*.[22], figure 2, illustrates the growth discrepancy and the resultant midline deviation. Our findings support the basis of this theory. In our study we found that those with a noticeable deviation, 1.5mm or greater, showed more wear on their teeth than

those with 1mm or less deviation. Furthermore, there was more wear on the side of deviation than the side opposite the deviation in those subjects with deviation 1.5mm or greater.

An interesting finding in the current study was the association between tooth wear and gender; females exhibited significantly less wear than males. One possible reason for this is a recently developed theory of the link between obstructive sleep apnea (OSA) and bruxism[67]. The theory is that bruxism is a result of obstructive apnea events. Research shows that there are gender differences in OSA,[68,69] males having a higher incidence of OSA than females. Putting these two facts together, one could theorize that males may have a higher incidence of bruxism than females. This would result in a higher incidence of tooth wear in males versus females. Another theory, "the weak link theory," was introduced by Mehta *et al.*[70], and studied by his group. They found that patients that are moderate or heavy bruxers will show breakdown in one of three areas and rarely two or three of three. The three areas they studied were periodontal breakdown, tooth wear and TMD symptoms. Using the results they found, and applying them to our results, we could theorize that females have a greater tendency to break down in the TMJ and males have a greater tendency to tooth wear. This theory is supported by the fact that TMJ related injuries are more common in females as compared to males[41]. In our study we did not analyze the association between gender differences and TMD findings. In the future, we will look at the data to see if there is any association to support this theory.

This study found no correlation between midline deviation and either joint click or joint pain. The study by Landi *et al*. [31]concluded that occlusal relationships were of "low predictive value" in TMD findings. Our findings suggest the same thing. The studies by Locker *et al*.[41] and LeResche *et al*.[42] conclude that there are age specific differences in TMD symptoms. In the current study the average age of the patient was 44. In examining the studies just mentioned, it would appear that the vast majority of symptoms occur before age 44 and very few occur after that. If, in the future, we looked at a younger population and restricted our inclusion criteria to a younger population with deviation, it is possible we may see a greater correlation between midline deviation and TMD findings. Another possible reason for our finding no association is that we did not separate or identify any parafunctional habits. In a study by Miyake *et al*. [4]they found a strong correlation between oral parafunction and the presence of TMD symptoms. In our population, we did not differentiate parafunction in our subjects and so this may be a limitation in our study. Another limitation of our study was the selective manner in which we collected our patients. We selected our patients using deviation of the midline as the criteria for inclusion and not random selection. A larger subject pool and random selection of the subject pool would further strengthen our findings. Future studies would include parafunction, gender differences between tooth wear and TMD findings, and age differences in TMD findings to see if an association exists.

Conclusion

In the current study, we determined that there is an association between midline deviation of 1.5mm or greater and tooth wear. We also determined an association between DMFT score and midline deviation. Because the DMFT score and deviation was specific to the left side, further study is indicated in the future to determine if this finding is repeatable. Given our results, one of the things we should look at in our initial exam is midline deviation, and cite the reasons for or against correcting a deviation of the midline 1.5mm or greater.

We also found an association between gender and tooth wear. We did not find an association between midline deviation and TMD findings.

Appendix A: Tables

Table 1. Descriptive Statistics of the Patient Population

	Mean	SD	Min	Max
Age	44.38	15.58	19	76
Total TWI	7.64	7.22	0	32.14
DMFT Left	6.02	3.43	0	14
DMFT Right	5.80	3.48	0	14
Total DMFT	11.82	6.65	0	28
Midline Deviation(in mm) (Left = [+] and Right =[-])	-0.310	1.89	-4.0	4.0
DMFT Left minus Right	0.22	1.89	-5	7

TWI=Tooth wear index; DMFT= Decayed, Missing and Filled Teeth; Left and right refer to the side of the mouth divided sagittally.

Table 2. Tooth Wear Comparing Same side and Opposite side with Deviation 1.5mm or greater with Deviation 1mm or less

	Frequency #of Teeth	Percent of Teeth
Midline Deviation 1.5mm or greater on side opposite side of deviation		
Tooth wear 0	115	34.4
Tooth wear 1	182	54.5

Tooth wear 2	37	11.1
Total	334	100
Midline Deviation <=1 mm		
Tooth wear 0	373	63
Tooth wear 1	215	36.3
Tooth wear 2	4	0.7
Total	592	100
Midline Deviation 1.5mm or greater on the side of deviation		
Tooth wear 0	106	30.8
Tooth wear 1	184	53.5
Tooth wear 2	49	14.2
Tooth wear 3	5	1.5
Total	344	100

Tooth wear 0 = No tooth wear. Tooth wear 1= Tooth wear in enamel Tooth wear 2= Tooth wear into dentin up to 1/3 of coronal tooth structure missing. Tooth wear 3= More than 1/3 of coronal tooth structure missing.

Table 3. Gender differences and TWI

Gender	N	Mean Age	Mean TWI	SD	Min	Max
Male	18	48	12.64	9.45	3.21	32.14

Female	32	42	4.82	3.25	0	12.86

TWI= Tooth Wear Index

Appendix B: Figures

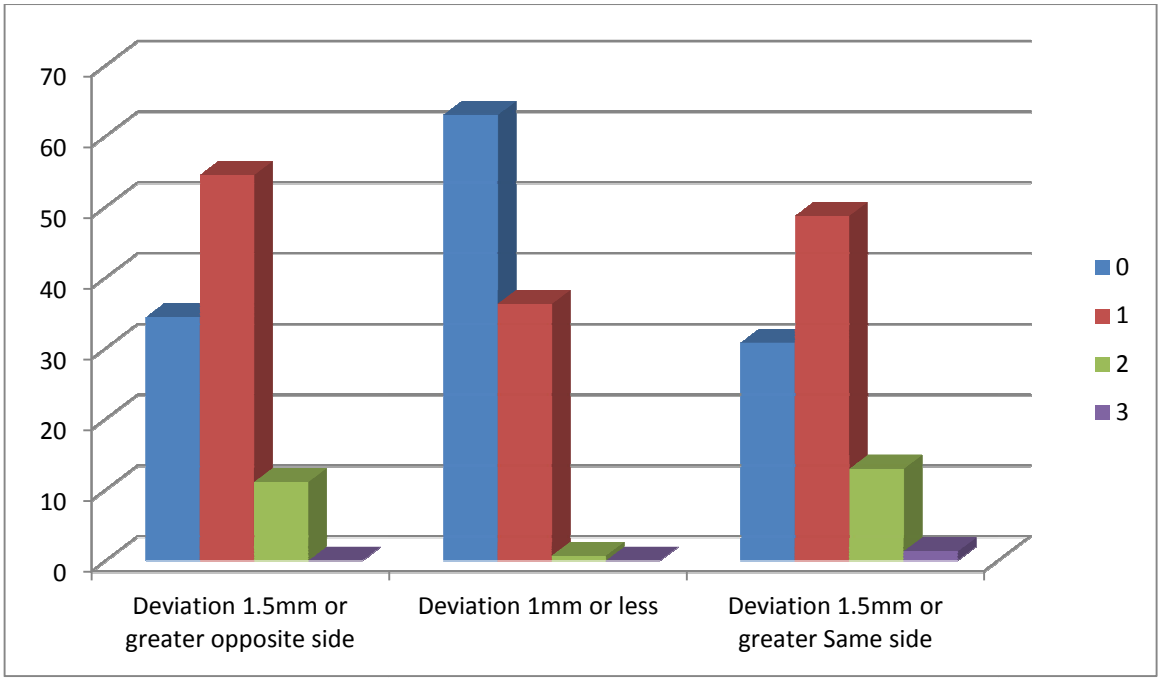

Figure 1. Tooth Wear by deviation. 0= no tooth wear, 1= tooth wear into enamel, 2 = tooth wear into dentin up to 1/3 of coronal tooth structure missing, 3 = more than 1/3 of coronal tooth structure missing

Figure 2 Depiction of Mandibular Midline Shift

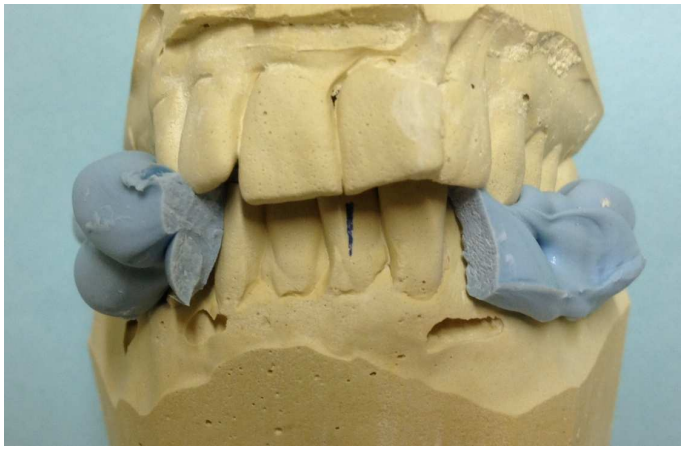

Figure 3. Dental midline deviation calculations

Figure 4. Tooth wear calculation photo (examples)

Tooth #19 – tooth wear category 1

Tooth #27 – tooth wear category 2

Appendix C: Copy of survey instrument

RDC 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
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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 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 contains modest corrections/clarifications from the original publication for scoring templates and for methods of scoring the Depression and Non-Specific Physical Symptoms Scales as well as guides for assessing depression and a summarization based on these scales of the SCL-90.*

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 interference " and 10 is "extreme change"?

Unable To

No **Interference** **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 interference " and 10 is "extreme change"?

No Interference **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

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

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

31. What is your USA 5 digit zip code or your International Area 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

FOR TEMPOROMANDIBULAR DISORDERS

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.")

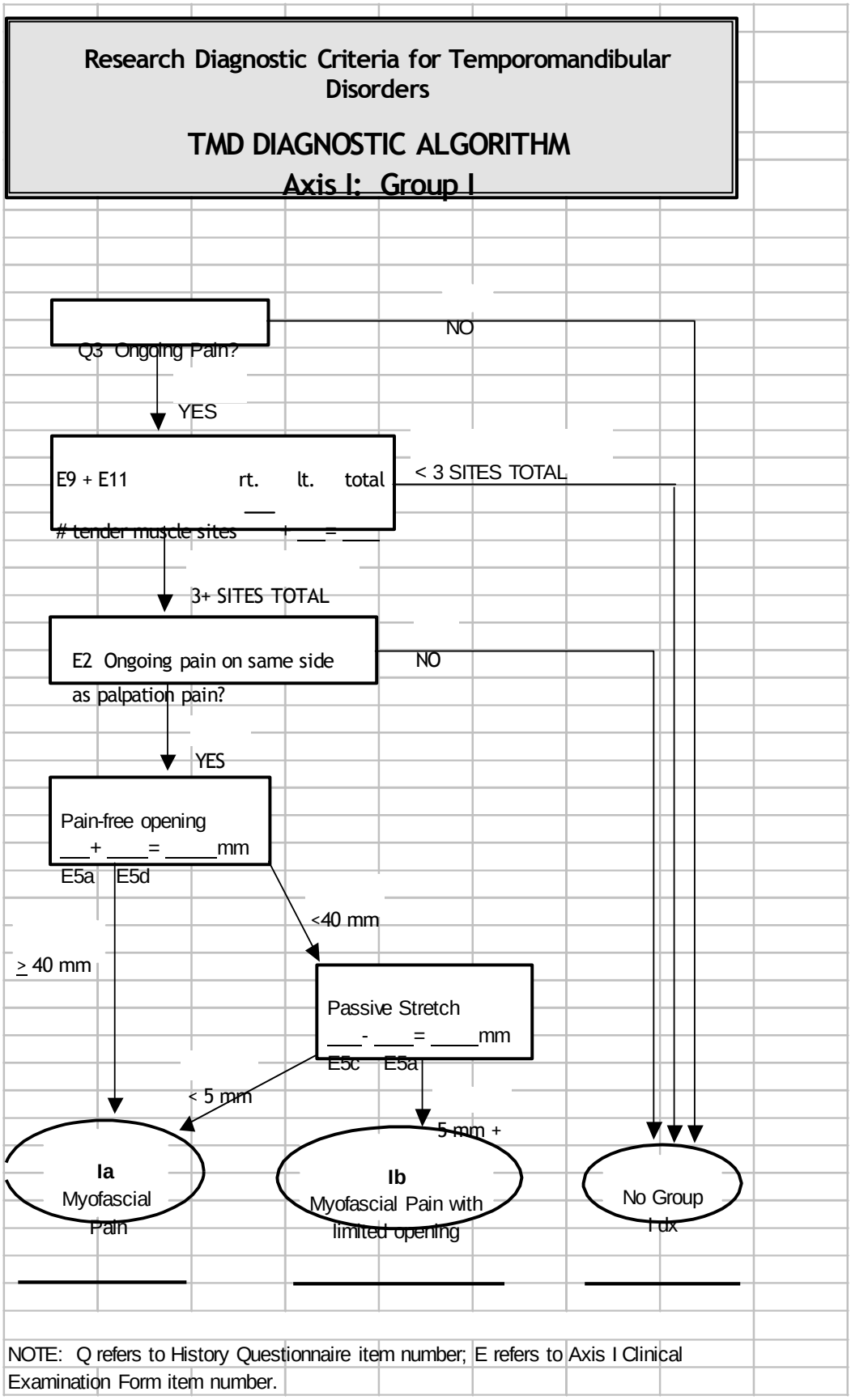
a. *Lateral Pterygoid Area.* Before palpating, make sure the fingernail of the index finger is trimmed to avoid false positives. Ask the subject to open the mouth and move the jaw to the side that is being examined. ("Move your jaw towards this hand.") Place the index finger on lateral side of

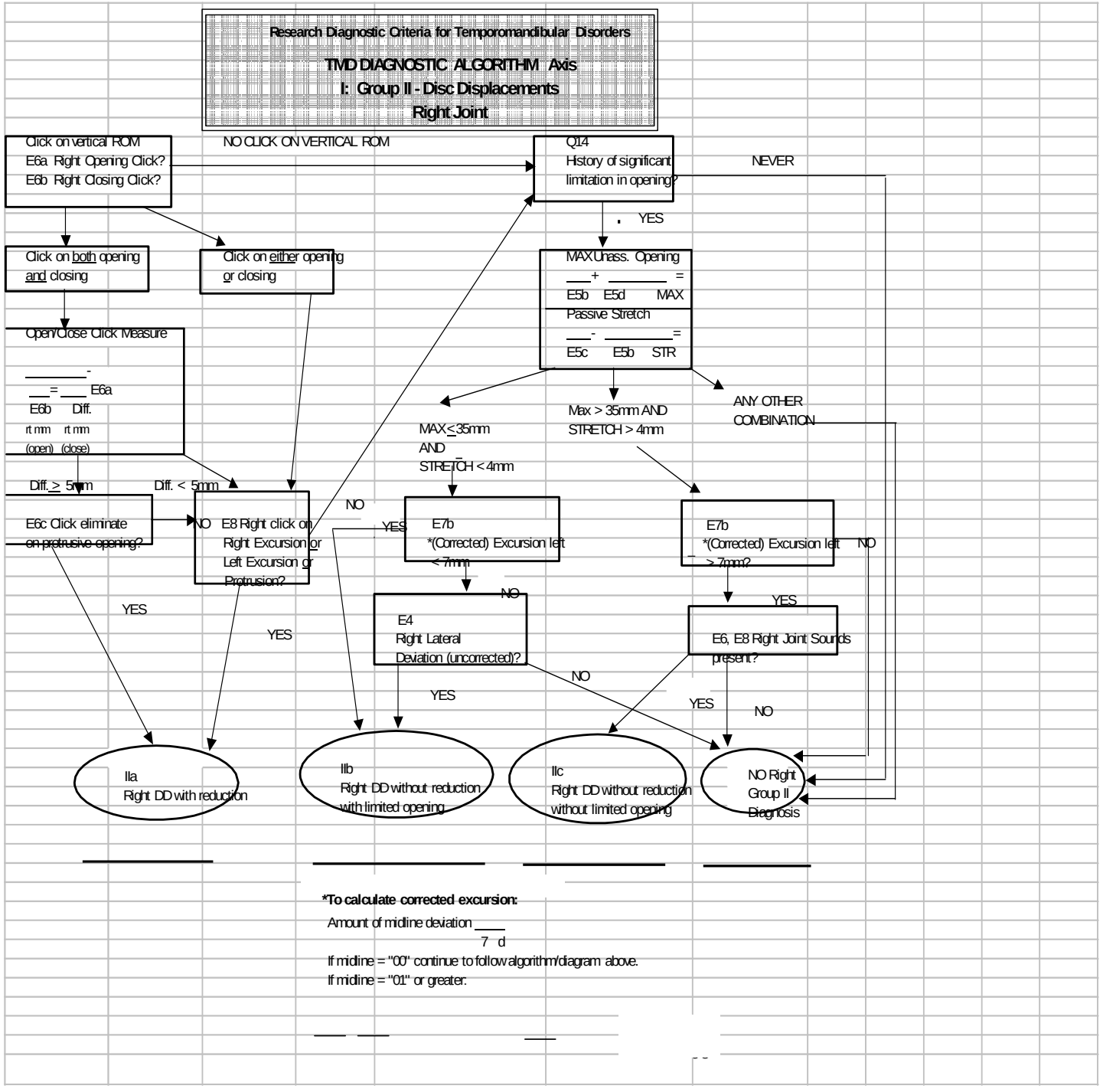
alveolar ridge above the right maxillary molars. Move finger distally, upward, and medial to palpate. If the index finger is too large, use the little finger (5th digit).

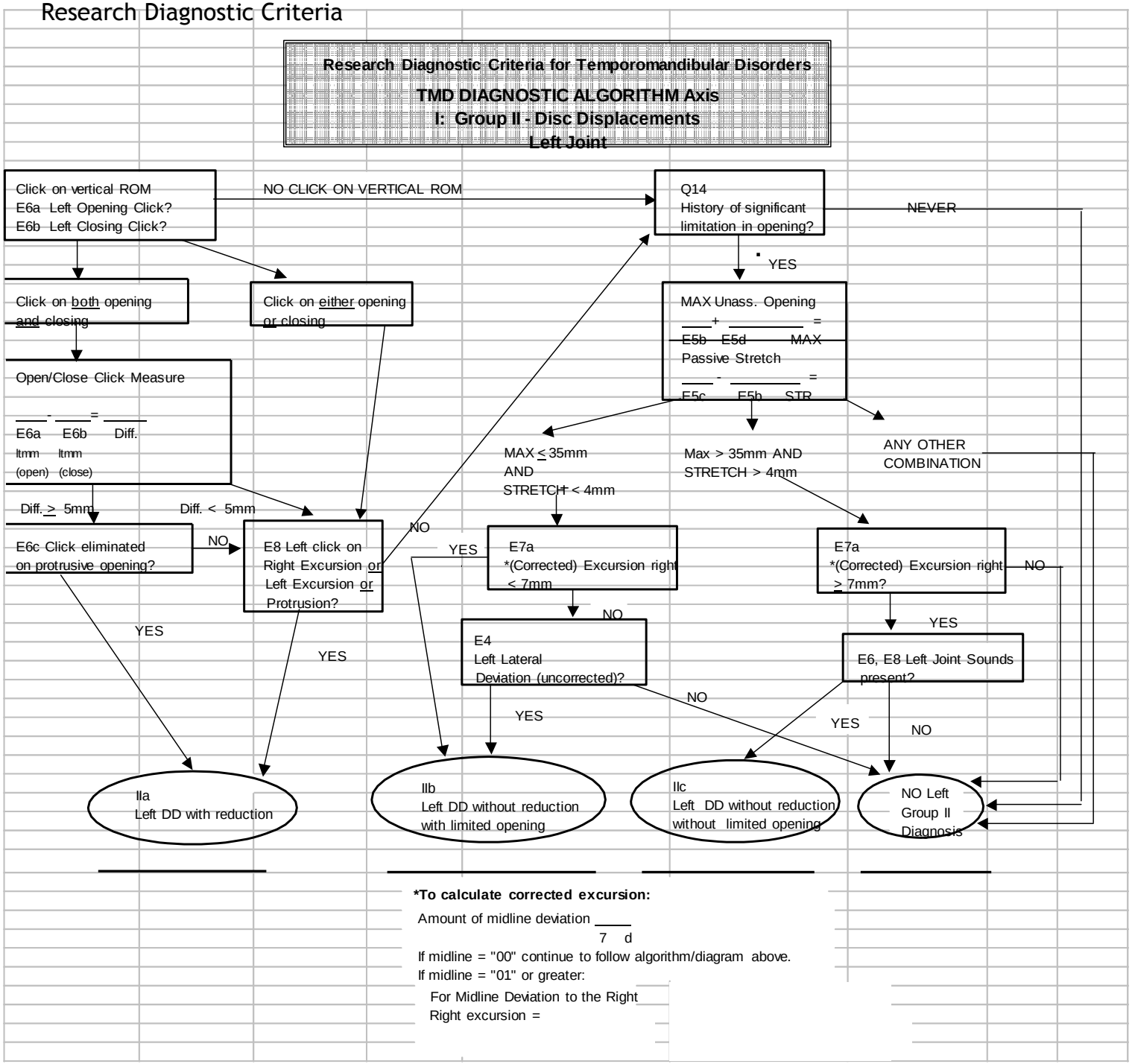
b. *Tendon of Temporalis.* After completing the lateral pterygoid, rotate your index finger laterally near the coronoid process, ask the subject to open slightly, and move your index finger up the anterior ridge of the coronoid process. Palpate on the most superior aspect of the process. *Note:* If it 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

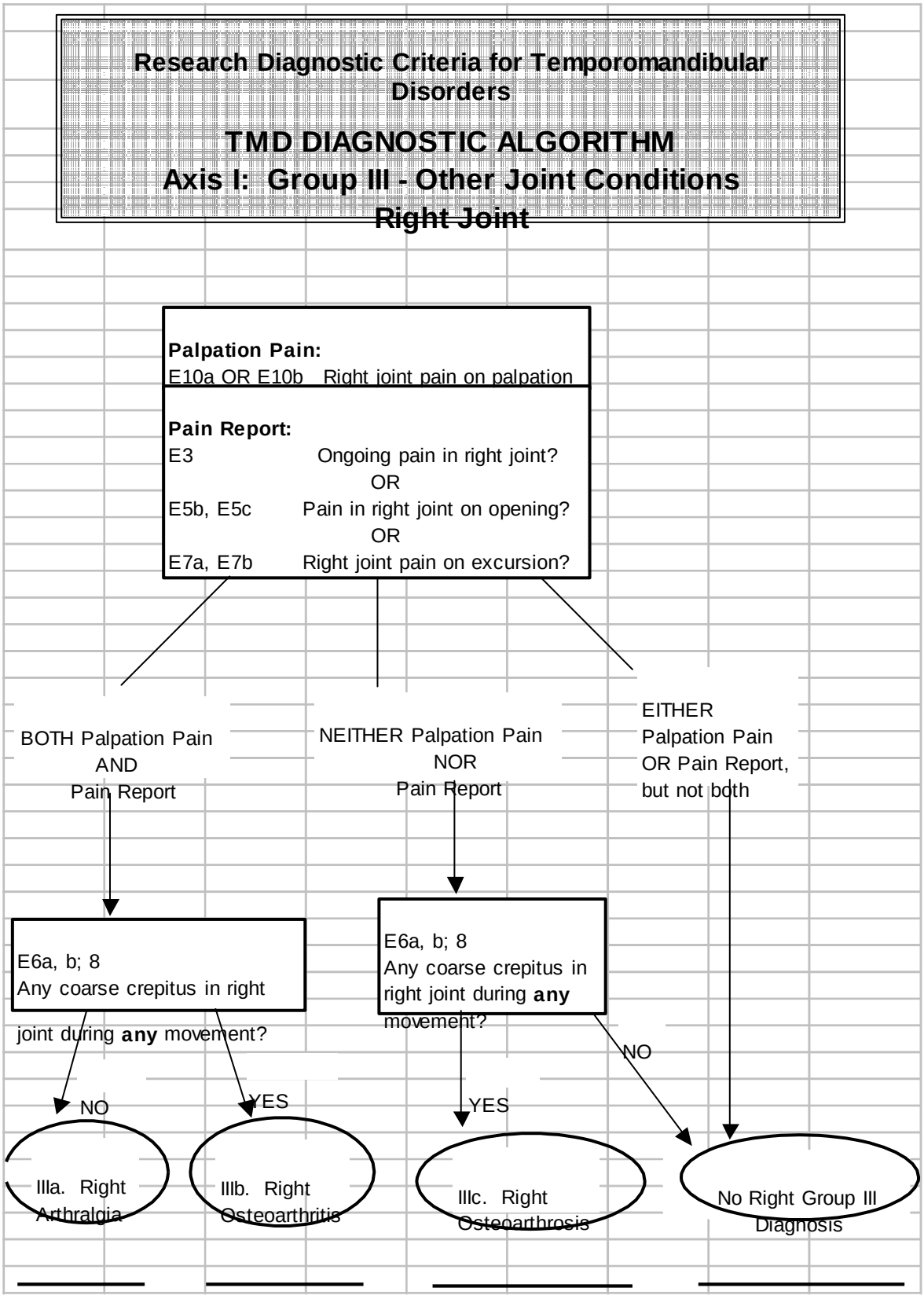
Part 3

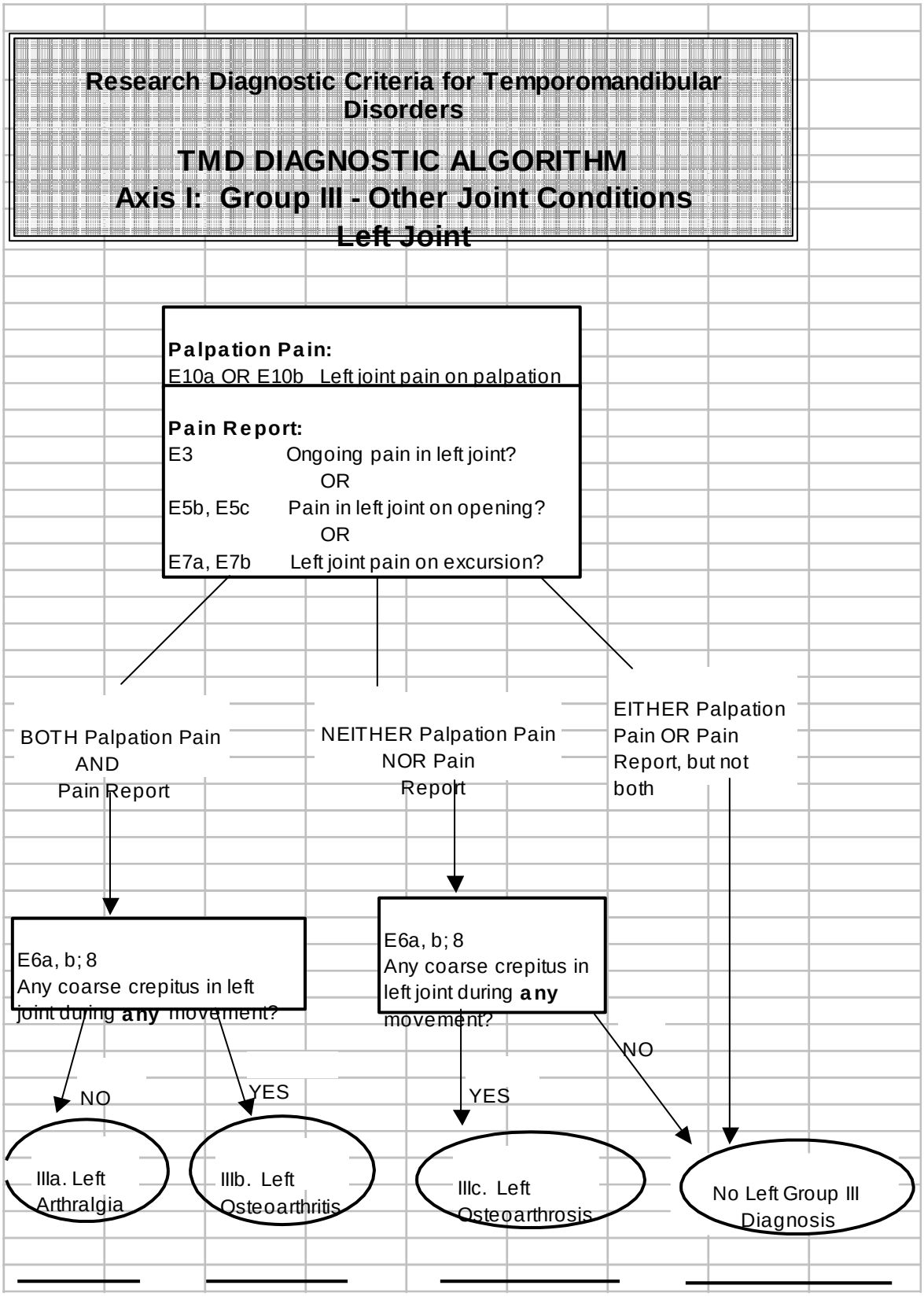
SCORING THE RDC


Research Diagnostic Criteria for Temporomandibular Disorders
TMD DIAGNOSTIC ALGORITHM
Axis I: Group I
Q3 Ongoing Pain?
NO
YES
E9 + E11 rt. lt. total
tender muscle sites ___ + ___ = ___
< 3 SITES TOTAL
3+ SITES TOTAL
E2 Ongoing pain on same side as palpation pain?
NO
YES
Pain-free opening
___+ ____= _____mm
E5a E5d
<40 mm
≥ 40 mm
Passive Stretch
___- ____= _____mm
E5c E5a
< 5 mm
5 mm +
Ia
Myofascial Pain
Ib
Myofascial Pain with limited opening
No Group I dx
NOTE: Q refers to History Questionnaire item number; E refers to Axis I Clinical Examination Form item number.


Research Diagnostic Criteria for Temporomandibular Disorders
TMD DIAGNOSTIC ALGORITHM Axis
I: Group II - Disc Displacements
Right Joint
Click on vertical ROM
E6a Right Opening Click?
E6b Right Closing Click?
NO CLICK ON VERTICAL ROM
Q14
History of significant limitation in opening?
NEVER
YES
Click on both opening and closing
Click on either opening or closing
MAX Unass. Opening
___+ _____ =
E5b E5d MAX
Passive Stretch
___- _____=
E5c E5b STR
Open/Close Click Measure
_____-
___=___ E6a
E6b Diff.
rt mm rt mm
(open) (close)
MAX ≤ 35mm AND STRETCH < 4mm
Max > 35mm AND STRETCH > 4mm
ANY OTHER COMBINATION
Diff. ≥ 5mm
Diff. < 5mm
E6c Click eliminate on protrusive opening?
NO
E8 Right click on Right Excursion or Left Excursion or Protrusion?
NO
YES
E7b
*(Corrected) Excursion left < 7mm
E7b
*(Corrected) Excursion left > 7mm?
NO
YES
NO
YES
YES
E4
Right Lateral Deviation (uncorrected)?
E6, E8 Right Joint Sounds present?
NO
YES
YES
NO
IIa
Right DD with reduction
IIb
Right DD without reduction with limited opening
IIc
Right DD without reduction without limited opening
NO Right Group II Diagnosis
*To calculate corrected excursion:
Amount of midline deviation ____
7 d
If midline = "00" continue to follow algorithm/diagram above.
If midline = "01" or greater:


Research Diagnostic Criteria for Temporomandibular Disorders
TMD DIAGNOSTIC ALGORITHM Axis
I: Group II - Disc Displacements
Left Joint
Click on vertical ROM
E6a Left Opening Click?
E6b Left Closing Click?
NO CLICK ON VERTICAL ROM
Q14
History of significant limitation in opening?
NEVER
YES
Click on both opening and closing
Click on either opening or closing
MAX Unass. Opening
E5b E5d MAX
Passive Stretch
E5c E5b STR
Open/Close Click Measure
E6a E6b Diff.
ltmm ltmm
(open) (close)
MAX ≤ 35mm AND STRETCH < 4mm
Max > 35mm AND STRETCH > 4mm
ANY OTHER COMBINATION
Diff. ≥ 5mm
Diff. < 5mm
E6c Click eliminated on protrusive opening?
NO
E8 Left click on Right Excursion or Left Excursion or Protrusion?
NO
YES
E7a
*(Corrected) Excursion right < 7mm
E7a
*(Corrected) Excursion right ≥ 7mm?
NO
YES
NO
E4
Left Lateral Deviation (uncorrected)?
YES
E6, E8 Left Joint Sounds present?
NO
YES
YES
NO
IIa
Left DD with reduction
IIb
Left DD without reduction with limited opening
IIc
Left DD without reduction without limited opening
NO Left Group II Diagnosis
*To calculate corrected excursion:
Amount of midline deviation
7 d
If midline = "00" continue to follow algorithm/diagram above.
If midline = "01" or greater:
For Midline Deviation to the Right
Right excursion =


Research Diagnostic Criteria for Temporomandibular Disorders
TMD DIAGNOSTIC ALGORITHM
Axis I: Group III - Other Joint Conditions
Right Joint
Palpation Pain:
E10a OR E10b Right joint pain on palpation
Pain Report:
E3 Ongoing pain in right joint?
OR
E5b, E5c Pain in right joint on opening?
OR
E7a, E7b Right joint pain on excursion?
BOTH Palpation Pain AND Pain Report
NEITHER Palpation Pain NOR Pain Report
EITHER Palpation Pain OR Pain Report, but not both
E6a, b; 8
Any coarse crepitus in right joint during any movement?
E6a, b; 8
Any coarse crepitus in right joint during any movement?
NO
YES
YES
NO
IIIa. Right Arthralgia
IIIb. Right Osteoarthritis
IIIc. Right Osteoarthrosis
No Right Group III Diagnosis


Research Diagnostic Criteria for Temporomandibular Disorders
TMD DIAGNOSTIC ALGORITHM
Axis I: Group III - Other Joint Conditions
Left Joint
Palpation Pain:
E10a OR E10b Left joint pain on palpation
Pain Report:
E3 Ongoing pain in left joint?
OR
E5b, E5c Pain in left joint on opening?
OR
E7a, E7b Left joint pain on excursion?
BOTH Palpation Pain AND Pain Report
NEITHER Palpation Pain NOR Pain Report
EITHER Palpation Pain OR Pain Report, but not both
E6a, b; 8
Any coarse crepitus in left joint during any movement?
E6a, b; 8
Any coarse crepitus in left joint during any movement?
NO
YES
YES
NO
IIIa. Left Arthralgia
IIIb. Left Osteoarthritis
IIIc. Left Osteoarthrosis
No Left Group III Diagnosis

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:	(12)	☐	+	☐	=	☐
Nonspecific physical symptoms (pain items included):	(8)	☐	+	☐	=	☐
Nonspecific physical symptoms (pain items excluded):	(5)		+		=	

Tooth Wear Index

0 = Little or no wear in enamel

1 = Obvious wear of enamel or wear through the enamel to the dentin in single spots

2 = wear of the dentin up to one-third of the crown height

3 = wear of the dentin up to more than one third of the crown height

Questionnaire on Oral Hygiene

Oral health

1. How many times a week do you brush your teeth? _____

2. Do you use toothpaste when brushing your teeth? Y N

3. What kind of toothpaste do you use? _____

4. What kind of toothbrush do you use? _____

5. What hand do you use to brush your teeth? Right Left

6. How often do you floss each week? _____

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