

The Diagnostic Value of Biometric Instruments

John Charles Radke & Gerardo Ruiz Velasco

Chapter 7: Biopsychosocial Factors & TMD

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Abstract

Temporomandibular Disorders (TMD) have long been a controversial subject. In 1969 it was first proposed that Myofascial Pain Dysfunction Syndrome (MPDS) results from emotional stress rather than from any physical condition. In fact, any physical dysfunction was attributed to the deleterious effects of stress in the forms of

clenching, bruxing, etc. This hypothesis lasted about 10 years, but was never substantiated with adequate data. In the 1980s a different approach suggested Temporomandibular Disorders (TMD) are a multifactorial category of at least 40 distinct physical conditions, that all treatments should be conservative and preferably reversible (just in case they failed to solve the painful condition).

In the 1990s a reversion to an emotional etiology occurred with the promulgation of the Research Diagnostic Criteria by Dworkin and LeResche. This theory proposed that the etiology of TMD is chronic illness behavior. Although this theory has been promoted for more than 25 years, after exhaustive and very expensive research, none of the results could validate the theory. It has now been replaced by the DC/TMD with suggestions how to improve the accuracy, but without any validation yet.

The problem of validation studies is the biased assumption of validity from the start. While the theory could have been tested by applying a psychological "cure" for TMD or by evaluating the emotional factors before and after physical treatments, neither was accomplished until very recently. The one study that evaluated emotional status prior to occlusal adjustment, three weeks after adjustment and again three months after adjustment, revealed the secondary nature of the emotional factors as they normalized after successful physical treatment. The depression level was reduced in every patient with strong statistical significance.

Neither the diagnosis nor the treatment of TMD is easy, since TMD are not one condition. It is necessary to spend more time on diagnosis than has been historically devoted in order to arrive at an individualized and effective treatment.

Temporomandibular Disorders (TMD)

There are at least forty specific reasons why TMD are always plural (Okeson, 1996). To diagnose and treat a TMD case accurately and successfully it is necessary to find the primary and usually several secondary conditions involved. The most common limitations in TMD practices are; 1) not enough time spent on diagnosis and 2) too much time spent applying “trial and error” treatments. Inasmuch as two TMD patients never have an identical set of conditions, it seems odd that anyone would imagine that one treatment could be applied successfully across the board to all TMD patients. Every TMD patient presents as a unique situation that requires accurate diagnosis before any successful treatment can begin.

The first step to success in treating TMD is to discard the old “One Size Fits All” approach that has never succeeded. Splints have probably been used the most to ameliorate painful symptoms, but they are not always successful. No treatment is going to work for every TMD patient, which means successful treatment will be predicated not on the treatment chosen, but on the ability of the provider to accurately and precisely diagnose the actual condition(s) present. Many TMD patients have more than one diagnosable condition that require multiple or combinational treatments. A TMJ dysfunction may alter the occlusion or the occlusion may be the source of the problem, but either case will disturb muscle function. The loss of posterior tooth support affects both of the TMJs as well as the muscles. Excessive occlusal wear will impact the TMJs, the musculature and the ability of the patient to masticate. Poor mastication may manifest as an Irritable Bowel Syndrome and altered nutrition. Occlusal malrelationships may alter head posture adding stress to neck and shoulder muscles. The masticatory system is intimately connected to and interactive with the rest of the body. Deleterious alterations to the masticatory system can have widespread ramifications.

Stress as the Etiology of TMD

In 1969 Laskin proposed his original theory of the *Myofascial Pain Dysfunction Syndrome* (Laskin, 1969). It described the supposition that traumatic and stressful life events could cause a person to clench and grind their teeth, which would lead to masticatory muscle pains and even possibly damage to the temporomandibular joints. This is the basis of the “Vicious Cycle Theory” (VCT) of TMD. The VCT assumed that; 1) stress leads to clenching, 2) clenching causes muscle pain and fatigues the muscles and 3) perpetually fatigued painful muscles add stress. MPDS was certainly presented with aplomb and garnered Laskin something on the order of a \$10,000,000, ten-year grant from NIDR to validate MPDS (back when 10 million dollars was a lot of money). Others quickly joined the stampede to validate the new theory (Greene, Lerman, Sutchter & Laskin, 1969; Lupton & Johnson, 1973; Goss, 1974; Butler, Folke & Bandt, 1975; Marbach & Dworkin, 1975), just to mention a few. While the MPDS theory suggested that MPDS should respond to psychological counseling, most of the treatment methods being used and showing good success at alleviating symptoms were applied to physical structures like the muscles, the occlusion and the temporomandibular joints (Gelb & Tarte, 1975; Beemsterboer, McNamara, Holden & Ash Jr, 1976; Vauthier & Spirgi, 1977; Carraro & Caffesse, 1978; Moran, Kaye & Fritz, 1979). During the decade after the hypothesis of MPDS was proffered, most of the published successful treatment studies used orthopedic approaches and splints or occlusal adjustment techniques with a biomechanical approach to treatment. The ADA surveyed the attendees of the 1973 Annual Session and found that most frequent form of treatment for both MPDS and bruxing habits was occlusal equilibration (Ayer, Machen & Getter, 1977). By the end of the decade following the proposal of MPDS a consensus had developed that TMD must be multifactorial (Weinberg, 1980) and not the result of a single factor such as emotional stress.

One of the first failures testing the MPDS theory included the sedative Meprobamate, a schedule

IV drug (US), (Greene & Laskin, 1971), which at the time was considered useful as a tranquilizer. Another psychotropic medication test failed a few years later (Gallardo, Molgo, Miyazaki & Rossi, 1975). In another study 4 of 23 MPDS patients were “helped by tricyclic antidepressants” (Gessel, 1975). Due to the lack of any definitive results, this was followed up by a failed test of eclectic group psychotherapy sessions “to observe the group dynamics for the operation of intra and interpersonal variables that might support the psychophysiological hypothesis for MPDS and *validate* [the emphasis is mine] the existence of personality characteristics that are associated with patients who have MPDS” (Marbach & Dworkin, 1975).

“Validation” rather than objective testing is a wrong-headed, unscientific approach that has been applied to MPDS and all other emotional etiology theories ever since. Continuing efforts to determine the relationship between MPDS and stress were pursued, but with the presumption that stress causes dysfunction rather than the reverse (Helöe, Helöe & Heiberg, 1977).

In 1978, Laskin, who coined the term MPDS and originally claimed the etiology was stress, used an Occlusograph to record the tooth tapping sounds of MPDS patients pre and post physical treatment and controls. Their claims included:

“Evaluation of the sound patterns showed a close correlation between the improvement in symptoms of MPD syndrome following treatment and the consistency of repeated occlusal contacts. The consistency following successful treatment of the subjects with MPD syndrome was equivalent to that of the control subjects (Edmiston & Laskin, 1978). This was certainly strong evidence against the stress etiology theory of MPDS and may have stimulated the movement away from it.

Historically, those who have assumed that MPDS is caused by stress, have focused on finding all manner of correlations between emotional factors and MPDS, but they have made no attempt to determine the causation. When two factors are

correlated, either one can be causative or neither one, because a third factor can be the etiology of both. Considering the number of correlation studies that have been done, it is curious that very few of them have even attempted to determine causation. Causation can be tested by treating one factor and measuring the effect on the other factor, then reversing the process. Stress and anxiety can be treated psychologically followed by an evaluation of the effect on the physical symptoms. Alternatively, the various physical symptoms of MPDS can be treated physically and the emotional status evaluated psychologically. The obvious question is, why hasn’t this been done?

The personality characteristics of 42 successfully physically treated and 42 unsuccessfully treated MPDS patients were evaluated using their composite Minnesota Multiphasic Personality Inventory (MMPI) profiles (Schwartz, Greene & Laskin, 1979). They concluded that: *“The pattern of deviation from normal for both groups was diagnostic of a psychophysiological disorder marked by repression and somatization.”* They stopped short of claiming that the etiology was psychological, probably due to the successful physical treatment responses of half of the total. In a separate concurrent study, greater masseter and frontalis activity from MPDS patients than controls after an experimentally induced stress were erroneously considered to be supportive of a psychophysiological theory of MPDS (Mercuri, Olson & Laskin, 1979). Another MPDS treatment study concluded that, a lack of improvement was attributed to; *“...stress denial, a mere somatic orientation regarding etiology of symptoms, a manner of giving oral history indicating a distanced relationship to their body, and an expressed disapproval of the psychiatric part of the examination” (Helöe & Heiberg, 1980).*

When a TMD patient has seen multiple providers and experienced no relief and then the latest one suggests that the problem may be psychological, it should not be surprising if the patient reacts negatively. Blaming the patient for the lack of successful treatment is not productive. About the

same time a separate MMPI study of 135 MPDS patients suggested that “a single scale to predict treatment outcome would be ineffective due to an **absence of consistent personality differences in MPD patients**” [emphasis mine] (Millstein-Prentky & Olson, 1979).

Nevertheless, in 1984 researchers attempted to discover predictors of TMD treatment outcome for MPDS patients by considering 46 variables (Lipton & Marbach, 1984). They published their results in the Journal of Prosthetic dentistry, which totally discounted any value to clinical factors, oral status and physical examination findings;

*“The first analysis was used to reduce the original group of 46 variables to 18 variables, which were labelled “potential” predictors. In the first analysis it was noted that clinical factors, such as oral status and physical examination findings, were irrelevant for predicting treatment outcome. Of the 16 clinical variables initially included for analysis, only the presence of clenching was included as a potential predictor. Patients’ psychologic status, as measured by their level of psychologic distress, was also not relevant. The greatest number of potential predictors was related to patients’ **sociocultural background, sociomedical orientation, symptom and treatment history, and behavior in response to and attitudes toward pain.** [emphasis is mine] These factors, then, appear to be more useful than clinical and physical data as indicators of the potential response of facial pain patients with either MPDS or organic TMJ deficits to treatment.”* It was not considered that the lack of a positive response to treatment might be related just to an inappropriate treatment selection.

Perhaps the first real test of the MPDS hypothesis was a treatment study, not analyzing for any correlations, but testing whether physical change could relieve patients’ painful MPDS symptoms (Wessberg, Carroll, Dinham & Wolford, 1981). The authors applied Ultra-low Frequency TENS to the Vth and VIIth cranial nerves to relax the entire masticatory muscles. Then they fabricated

a custom appliance that maintained the relaxed muscle status. Even in the complete absence of any form of psychotherapy, dramatic reductions occurred in the symptoms of the TMD patients.

By the mid-1980s MPDS was separated into TMJ internal derangements and muscle-oriented pain conditions. This was based upon the observation that MPDS patients with myogenic pain or atypical facial pain exhibited more significant psychopathologic factors than those with internal derangements (Eversole, Stone, Matheson & Kaplan, 1985). The myogenic pain patients also tended to report more pain and discomfort. What was not considered was whether the higher pain levels might be responsible for their increased depression and anxiety. Again, without applying any definitive treatment test, the supposition of causation is purely speculative.

By the mid-1980s, the lack of scientific evidence that stress could be the main etiology of MPDS, stimulated a concept of limiting TMD treatments to only “reversible physical treatments,” which was promoted very actively by those who coined MPDS (Greene & Laskin, 1983; Laskin & Block, 1986). The rationalization for using reversible methods was based upon the false assumption that reversible treatments could be completely undone and the patient returned back to “no worse off than their treatment starting point” whenever a treatment failed to produce positive results or made the symptoms worse. It was also suggested that escalation of therapy, starting with over-the-counter pain meds, heat, massage, etc., could be applied on a trial-and-error basis. It was concluded that only those patients who failed to respond to palliative treatments should be “escalated” to any more invasive treatments that are designed to remove causative factors.

By the late 1980s it had been demonstrated that reducing masseter and anterior temporal activity and decreasing interocclusal distance correlated with a reduction in symptoms, but not so with psychophysiological therapy (Burdette & Gale, 1988; Erlandson, Jr & Poppen, 1989). At this point in time authors were openly questioning the

emotional stress theory for the MPDS etiology (Hijzen & Slangen, 1985). Efforts at utilizing EMG Biofeedback were attempted, but did not result in a sustained, accepted MPDS treatment (Dalen, Ellertsen, Espelid & Grønningsaeter, 1986; Hijzen, Slangen & van Houweligen, 1986). It was also noted that misdiagnosis and inadequate management might be contributing to those frequent emotional factors that are present (Fricton, Kroening, Haley & Siegert, 1985). A few authors have suggested that ice and stretch of the masticatory and neck musculature could be a good short-term adjunctive therapy to control the MPDS pain without risk of any negative effects (Burgess, Sommers, Truelove & Dworkin, 1988). By this time the concept of MPDS had been completely replaced by the more general term *Temporomandibular Disorders*, referring to an acknowledged number of clearly identifiable physical conditions (Journal of the American Dental Association, 1983).

Internal Derangement of the TMJ

Although surgeons had been well aware of the existence of TMJ internal derangements for several decades (Burman & Sinberg, 1946; Kiehn, 1952), the general dental profession and the dentists that were attempting to treat MPDS patients (also TMJ dysfunction syndrome) non-surgically were generally not aware until after Farrar published in the early 1970s (Farrar, 1971; Farrar, 1972). This eventually led to various suggestions regarding the use of mandibular anterior advancement appliances to recapture anteriorly displaced disks that were reducing (Fox, Abrams, Williams & Doukoudakis, 1985; Anderson, Schulte & Goodkind, 1985; Pertes, Attanasio, Cinotti & Balbo, 1989). Although splint therapy had become the overwhelmingly most popular treatment for internal derangement of the TMJ, the down-side was deciding what to do after the patient became pain free. How to finalize the treatment (Keeling, Gibbs, Hall & Lupkiewicz, 1989). Simple removal of an appliance typically leads to relapse, which supports the concept that an irreversible “Phase II” (orthodontic, prosthetic, etc.) is often required

to maintain the success of appliance treatments (DeSteno, Vella, Attanasio & Cinotti, 1989; Le Bell & Kirveskari, 1990; Niemann, 1992; Marumo, Hatano, Kuraji & Yokozuka, 1990). Phase II treatment has been suggested using many different approaches; 1) gradually wean the patient from using the appliance (Al-Ani, Davies, Sloan, Gray, 2008), 2) prosthodontic partial or complete reconstruction, from as few as eight lower posterior teeth to the full mouth (Garino & Capurso, 1990), 3) a combination of orthodontic and orthopedic correction (Imai, Okamoto, Kaneko, Umeda, Yamamoto & Nakamura, 2000; Carano, Leone & Carano, 2001), 4) selected composite build-up of individual teeth (Niemann, 1991; Niemann, 1992), 5) the construction of removeable permanent metal-based appliance (Abduo & Lyons, 2012; Bataglion, Hotta, Matsumoto & Ruellas, 2012), 6) occlusal adjustments (Kerstein & Farrell, 1990; Kerstein & Wright, 1991), and 7) the successful recapture of certain anteriorly displaced disks (Summer & Westesson, 1997). In this last study it was found that horizontally displaced disks benefitted far less than anteriorly displaced disks from their technique. They did not find that the weaning approach retained their achievements obtained with an appliance. A survey of MPDS treatments by 302 providers indicated that the most common treatments were interocclusal splints, occlusal equilibration, diet counseling, anti-inflammatory medication, non-narcotic analgesics and muscle relaxants (Glass, McGlynn & Glaros, 1991). No application of psychotherapy was utilized by any of these active providers.

Concurrently, during the 1980s, the development of a meniscal replacement, the Teflon Proplast Implant (TPI), was produced and offered to the dental profession by the Vitek Corporation. From 1983 it was offered as a surgical solution for internal derangements. It was implanted into the TMJs of at least 27,000 + patients, many before, but also after it was approved by the FDA in 1989. Dr. Norman Mohl, an anatomist at the dental school of SUNY Buffalo and also the paid official dental consultant to the FDA for the

product panel meeting (where the approval was decided), recommended approval in spite of urgent warnings and failure data presented. The FDA issued its safety recall alert in December 1990, recommending removal of the device in the 90 % of all cases that developed a foreign body giant cell reaction, subsequent bone erosion and symptoms of a lymphadenopathy (Lypka & Yamashita, 2007). Although many of the implants were removed, some were left in place as patients were not well tracked. Production was withdrawn by Vitek in 1993 when the company was liquidated. Not every patient experienced a bad outcome, but there was a large percentage that did and no immediate solution was available for treatment of those failed cases.

As a result of the meniscal replacement fiasco, the National Institute for Dental Research (NIDR) increased their requests for proposals for research into possible treatments for TMD. This was seen by some as a huge bonanza for obtaining NIDR academic grants. The failure of TMJ implants, a physical approach, was leveraged to re-promote MPDS as a psychosocial disorder that might be treated successfully by psychotherapy, for those especially with no options of physical treatments. This idea re-appeared like a phoenix with the publication of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). (Dworkin & LeResche, 1992). This approach to TMD diagnosis suggested that a careful history and a clinical examination could be sufficient to diagnose any physical aspects of TMD patient (Axis I), while extensive anamnestic devices should be used to evaluate the emotional aspects of a patient's status such as depression, anxiety, somatization, dysthymia, etc. (Axis II). Instead of claiming stress as the etiology, as was the case with MPDS, the authors claimed that *Illness Behavior* was the likely culprit.

This approach to TMD was suggested in spite of the fact that these same authors had just published two years earlier a claim that the symptoms of TMD, including joint sounds, occlusal variables, muscle palpation tenderness and range of motion data were too variable to be used for diagnosis of

TMD (Dworkin, LeResche & Von Korff, 1990). Joint sounds were labeled as “episodic, fluctuating (seemingly spontaneously) over time” and like all of the other TMD physical variables, rather indistinguishable from their ranges of normal. No statistically significant data were presented to support these contentions.

Psychosomatic Illnesses

Mental illness is a complex subject and is not a topic to be taken lightly nor will it be thoroughly discussed in this chapter. However, there is one undeniable factor that must be recognized here. Psychosomatic illnesses typically exhibit the same types of physical symptoms (pain, fatigue, dizziness, etc.) as do physical maladies. And the symptoms are certainly real to the patients. Thus, it is an absolute requirement that physical causes must be denied before a psychosomatic diagnosis can be made. In medicine the psychiatrist relies on the family practitioner and medical specialists to eliminate the probability of a physical cause for the patient's symptoms. The dentist is not less important when it comes to TMD.

In the case of the RDC/TMD, the approach to documenting the physical factors (Axis I) was, perhaps unconsciously, reduced to a level that has been belatedly revealed eighteen years later as invalid (Look, John, Tai, 2010). Thus, the poor ability to diagnose a physical condition has advertently supported a psychological basis for the etiology of TMD. Without accurate physical evaluation, a reliable psychosomatic diagnosis is just not possible.

It is an unfortunate fact that all syndromes and idiopathic conditions without known etiologies are susceptible to regularly being overlooked or misdiagnosed. However, the symptoms of TMD are no longer referred to as *Costen's Syndrome*, *TMJ Dysfunction Syndrome* or *Myofascial Pain Dysfunction Syndrome* and many of the physical causes have been revealed. In light of these facts, a TMD diagnosis should be based on a thorough physical evaluation utilizing the best of modern technologies and techniques before reverting to a somatic symptom disorder (SSD) diagnosis.

The Hypothesis of TMD as One Entity

To test this hypothesis, a study was performed using dental hygienists and TMD specialists following detailed specifications and criteria for examining TMD patients and pain-free controls. The modest clinical examiner reliabilities that resulted were assumed to be due to clinical signs that are, "...unreliable, changing spontaneously over time and making it difficult to find the same sign on successive examinations." (Dworkin, LeResche, DeRouen & Von Korff, 1990). From an anamnestic evaluation of the pain status of HMO enrollees, it was stated: "Graded chronic pain status was associated with psychological impairment, unfavorable appraisal of health status, and frequency of use of pain medications and health care" (Von Korff, Dworkin & LeResche, 1990). Nothing in their data suggested that the psychological impairment was etiologic to the TMD condition, but that was the conclusion of the authors. No effort was made at that time to test this hypothesis by attempting to treat TMD patients with psychotherapy. The apparent goal was to apply for large *validation grants* from NIDR for testing the validity of the RDC/TMD.

Does it not seem rather oxymoronic that so many distinct physical disorders can all have the same criteria for diagnosis as indicated within the RDC/TMD? History suggests that the NIDR apparently did not think so. Since 1992 the NIDR (subsequently NIDCR) has awarded grants in sum estimated to have exceeded \$100,000,000. These taxpayer dollars have been granted for the express purpose of "validation" of the RDC/TMD (e.g. OPPERA-1 2005-2012, Impact Study 2011-2014, OPPERA-2 2012-2017, just to mention a few). See Table 1. in the appendix.

Validation of RDC/TMD

The approach of validation rather than objective testing for any hypothesis is a priori a form of bias with the assumption of validity before the fact. A search for "RDC/TMD AND validation" in PubMed found 45 studies. However, the reality admitted by the grant recipients themselves is that validation of the RDC/TMD has escaped even the

application of such vast sums of money (Look, John, Tai, et al, 2010; Truelove, Pan, Look, et al, 2010; Ohrbach, Turner, Sherman, et al, 2010). The use of RDC/TMD to diagnose TMJ disorders such as disk displacements without reduction has revealed a proclivity for false positive diagnoses when compared to MRI (Galhardo, da Costa-Leite, Gebrim, et al, 2013). A specificity of only 53 % tends to identify TMD when it is not present and tends to support the concept that TMD can have a psychosomatic etiology. In another study the rate of false positive RDC/TMD TM joint diagnoses compared to MRI was 42 % (Almășan, Hedeșiu, Băciuț, Leucuța & Băciuț, 2013). In yet another study using RDC/TMD to diagnose TMJ juvenile idiopathic arthritis only 33 % of the cases were correctly diagnosed when compared to CBCT (Ferraz Jr, Devito & Guimarães, 2012). The inability of RDC/TMD to diagnose correctly the many physical conditions that exist within the category of TMD, has most likely lead many researchers to false etiologic conclusions.

The RDC/TMD and its offspring DC/TMD

As a result of their inability to validate the RDC/TMD the grant recipients have suggested some "fixes" for it and changed the name of it to the Diagnostic Criteria for Temporomandibular Disorders or DC/TMD (Schiffman, Ohrbach, Truelove, et al, 2014; Ohrbach & Dworkin, 2016). In an apparent effort to create the impression of a consensus, they recruited 34 doctors and four institutions to add their names to the authorship of the publication. As a long-time member of the International Association for Dental Research, I suspect few of the 10,000+ or so members are even aware of the publication. As far as I know, NIDCR is not now interested in funding a new attempt to validate this new version (I could be wrong). A recent published evaluation still suggests that the DC/TMD falls short of validity (Steenks, Türp & de Wijer, 2018). One significant addition is the inclusion of TMJ imaging *when indicated*, an admission that clinical examination often fails to accurately identify TMJ internal derangements. However, their *indications for imaging* are not yet clear

(Pettersson, 2010). The indications seem to fall somewhere between always and never.

The Contributions of Stress

While it appears quite certain that stress is not the primary etiology for TMD, it most likely plays a role in some patients with respect to the severity of symptoms. Stress may also be a trigger for the onset of symptoms for some patients. Another likely role for stress is as one of the factors that perpetuate TMD-like symptoms (Okeson & de Leeuw, 2011; Steed & Wexler, 2001; Akhter, Hassan, Ohkubo, Tsukazaki, Aida & Morita, 2008). Although TMD most often results from detectable physiological conditions, emotional stress can exacerbate the symptoms. For the patient that has been referred from clinician to clinician with no significant relief, stress is likely to be enhanced (Glaros, Glass, Hayden, 1995). There have been several studies documenting the prevalence of highly disrupted emotional states within patients with TMD and there is very little doubt about that. Numerous correlations have been made between physical and emotional dysfunctions within the population (List, John, Ohrbach, Schiffman, Truelove & Anderson, 2012). However, a simple correlation means coexistence, not causation. It is possible for either factor in a correlation to be the cause or neither. In fact, a separate factor not even considered can be the real etiology. Thus, to take a jump from the presence of a correlation to the conclusion that dysfunctional emotional states are the main cause of TMD has never been warranted. When psychosocial factors are theorized to be the primary etiology of TMD, the proper test should be to apply psychological counselling and evaluate its effect. The only reason to avoid this scientific approach is to avoid a negative finding.

Testing the Psychological Etiology

This has actually been tried and has failed, but never have the results been published. In the mid-1990s NIDR provided \$9,000,000 to six U. S. university dental schools to set up tertiary TMD treatment centers (U. MI., U. MN., U. WA., SUNY Buffalo, UCSF, one more). This scheme

was devised by the promoters of the RDC/TMD as a sort of clinical trial of Cognitive Behavioral Therapy (CBT). Each center located in a major metropolitan area advertised for local dentists to refer their difficult TMD cases to the centers. As it happened, there were plenty of hard cases and the local dentists were quite willing to refer them. However, almost immediately enraged patients returned to their referring dentist with bitter complaints against the idea of being sent to a center that just asked them a lot of very personal questions and provided no real relief for their pains. Within about six months all six centers were closed due to a complete lack of referrals. It is not certain whether they gave any of the grant money back to NIDR, but no published results were ever released from the study.

If one hypothesizes that TMD are mainly due to stress, depression and somatization, this simple hypothesis must be tested. A simple approach to test the psychosocial hypothesis of the etiology of TMD; apply psychological counselling to a group of TMD patients and evaluate the efficacy of it. If the psychosocial factors are understood to be secondary to physical conditions, it is preferable to evaluate the emotional status of TMD patients (using a standardized method like the Beck Depression Inventory II) just prior to and again at multiple times after completion of a specific definitive physical TMD treatment. It is only this alternative approach that has been accomplished and only one time and by testing one approach to treatment. Patients with verified malocclusions were evaluated for depression using the common Beck Depression Inventory – II. To evaluate symptoms, the authors used a 5-point qualitative pain intensity scale, a 4-point pain frequency scale, a 4-point functional restriction scale and a 4-point headache frequency scale; 1) prior to treatment, 2) at 3 weeks post treatment and 3) at 3 months post treatment. The treatment applied was limited to the Immediate Complete Anterior Guidance Development (ICAGD), an occlusal enameloplasty method utilizing the T-Scan III and BioEMG III measurement systems. The post-treatment results showed a remarkably dramatic

reduction in painful symptoms and an equally dramatic reduction in the levels of depression (Thumati, Sutter, Kerstein, Yiannios & Radke, 2018). See Tables 1 & 2.

60 females & 23 males, (Ratio = 2.6:1)			
5 Symptom Pain Scale levels (0 to 4) (0 = none, 1 = mild, 2 = moderate, 3 = severe, 4 = extreme)	Pre-treatment	3 weeks post	3 months post
	Total Pain Score	Total Pain Score	Total Pain Score
Median Total Score	28	5	0
Mean Total Score	27	7	3
SD	8	5	4
95% confidence interval	25 - 28	6 - 8	2 - 4
Mann-Whitney U Test of 92 Total Scores	Pre-treatment to Three Weeks Post Treatment	Pre-treatment to Three Months Post Treatment	Three Weeks Post Treatment to Three Months Post Treatment
p	< 0.00001	< 0.00001	< 0.00001

Table 1. Dramatic reduction in painful symptoms after physical adjustment of the occlusions in eighty-three carefully diagnosed mal-occlusion cases. (Table used with permission from [Advanced Dental Technologies & Techniques](#))

Total Score	Pre-treatment # of subjects	3 weeks post-Tx # of subjects	3 months post-Tx # of subjects	Levels of Depression*
1 - 10	1	53	76	Ups and downs considered normal
11 - 16	10	4	5	Mild mood disturbance
17 - 20	7	2	2	Borderline clinical depression
21 - 30	22	13	0	Moderate depression
31 - 40	22	9	0	Severe depression
over 40	21	2	0	Extreme depression
	83	83	83	total subjects
	5 - 55	0 - 42	0 - 19	Range of scores

Table 2. The reduction in Beck Depression Inventory scores resulting from ICAGD applied to eighty-three TMD patients in 4 private practices. (Table used with permission from [Advanced Dental Technologies & Techniques](#))

The results of this one study indicated that the emotional factor (depression) of these TMD subjects can be considered as secondary to the physical factors. Although it could be suggested that the responses were due to a *placebo effect*, no study has demonstrated this level of response to any placebo and placebo effects do not usually continue to increase for 3 months post-treatment. This approach could have been done by anyone using any TMD treatment approach. The fact that the reduction of painful symptoms and functional limitations led to the remission of depressive symptoms refutes the previous assumption that emotional factors are primarily responsible for the etiology of TMD, at least as in this group

when occlusal factors are present. Of course, this type of study requires a very accurate diagnosis, to allow an appropriate treatment to be selected, a limitation for those who rely only on the RDC/TMD for their TMD diagnoses. When inaccurate diagnoses are obtained, inappropriate treatments are inevitable.

Admittedly it is not difficult to hypothesize that psychological stress can be the cause of orofacial pains and the development of TMD (Gameiro, da Silva-Andrade, Nouer & Arruda-Veiga, 2006). However, without any convincingly successful method of psychological treatment, the theory cannot be blindly accepted as a matter of science.

The Pharmacological Approach to TMD

Periodically during the 70s, 80s and especially the 90s several pharmacological approaches to the treatment of TMD were attempted (Greene & Laskin, 1971; Harkins, Linford, Cohen, Kramer & Cueva, 1991; Gallardo, Molgo, Miyazaki & Rossi, 1975; Gessel, 1975). An attempt at morphine injections did not produce clinically relevant results (List, Tegelberg, Haraldson & Isacson, 2001). The negative deleterious side effects including depression, liver dysfunction and addiction eventually precluded any further increases in the dosages (Dionne, 1997; Hersh, Balasubramaniam & Pinto, 2008). In the current context of rampant opioid overdoses, the application of narcotics to TMD as a solution may even be contraindicated. There is no doubt that the application of pain killers is effective in the short term, but they do not represent an effective long-term treatment for TMD (Kang, Lee, Park, Ro & Auh, 2018). One study found that clinicians treating pain have difficulty directing palliative treatments even in the presence of an accurate diagnosis (Hirooka, Miyashita, Morita, et al, 2014). With a vague diagnosis of conditions as is often associated with TMD, it may be even more difficult to develop effective palliative treatment.

Factors to consider when treating TMD

Here are some factors related to TMD that have been observed over the past 47 years:

Factor number 1: Do not expect any single treatment to be appropriate for all TMD patients. Develop a variety of treatment techniques.

Factor number 2: The quality of the outcome will be more dependent on the quality of the diagnosis than on a perfect treatment. It is more critical to provide the correct treatment than any particular treatment performed to perfection. The combined use of all information and all available technology will lead to a more accurate diagnosis.

Factor number 3: You will have to charge the patient for the significant time that will often be required to obtain an accurate and comprehensive diagnosis. Comprehensive diagnosis is not paid for by most Insurance. Occasionally an insurance company will pay by exception a provider that happens to have a great record of success when there is a long-term refractory patient involved.

Factor number 4: Expect many TMD patients to be emotionally depressed due to the chronic pain, and the unsatisfactory results from their several previous providers.

Factor number 5: When carefully evaluating the emotional status of a TMD patient, it will not usually be helpful to suggest that their condition is psychologic. If you suspect it as a precipitating or perpetuating factor, it will not aid in treatment to suggest the pain condition is psychosomatic.

Factor number 6: Numerous TMD treatments can be effective if applied to the patient with the appropriate condition. However, inappropriate selection of a patient will defeat any treatment.

Factor number 7: Familiarize yourself with as many different providers as you can and find out who is available to provide those treatments that you are not comfortable as a dentist offering.

Factor number 8: Don't be a stand-alone provider. Connect with your local medical community as they need you and you need them. ENTs and Chiropractors see a lot of TMD patients and often cannot resolve these cases. However, they can team together with you to produce successful results.

Patients Counseled out of TMD pain?

Patient counselling has been used successfully with chronic pain conditions, especially for those patients without any possibility of any physical correction (Aguerre, Bridou, Laroche, Csillik & Jensen, 2015). What is misconstrued with respect to TMD patients is the false assumption that they usually have chronic pain conditions without any possibility of physical correction. There are of course some "basket TMD cases," but a majority of TMD patients have conditions that can be physically corrected or at least improved to the point of minimizing their pain and dysfunction.

The assumption that patients with non-reducing internal derangements are self-curing and not in need of any treatment has been shown to be false (Lei, Han, Liu, Zhang, Yap & Fu, 2017). Even just within one month after the onset of non-reducing disk displacement, some indications of degenerative changes can be noted within the affected TMJ on CBCTs. However, when the RDC/TMD alone was used to diagnose the presence and type of TMJ internal derangement, no correlation could be found between the disk position and the presence of osteoarthritis or osteoarthrosis (Kim, Wojczyńska & Lee, 2016). The authors did find strong evidence of degenerative changes on CBCT within the TMD group at all ages, but without MRIs, the disk position could not be verified. Note: Not finding a correlation is not the same as determining that no correlation is present.

Interestingly, when searching the entirety of PubMed for "Cognitive Behavioral Therapy AND chronic pain" in February 2019, 1,728 references were found. When I added successful treatment to the search criteria, only 72 references appeared. Further limiting the search to the dental literature reduced the list to just two articles. One review concerned the psychological factors related to Burning Mouth Syndrome (BMS) (Kim & Kho, 2018) and one Randomized Clinical Trial (RCT) of psychological treatment of a group selected with minimal TMD-related psychosocial interference (Dworkin, Huggins, Wilson, et al,

2002). Searching for [Cognitive Behavioral Therapy AND chronic pain AND successful treatment AND TMD] in the complete medical literature of PubMed brought up only the Dworkin article. This study only concluded; “Use of RDC/TMD psychosocial assessment criteria can contribute to successful clinical decision-making for the management of TMD.” The authors did not conclude that psychosocial assessment could lead to an effective treatment even for their subjects with minimal psychosocial interference to whom they applied CBT.

One quality assessment by systematic review concluded the literature on CBT as a treatment for TMD is methodologically of very low quality (Liang, Gulibaha, Liu & Han, 2011). In any case, it is clear that while counselling can be effective in certain cases to reduce emotional strain, we can all agree that it does not provide any correction or improvement to underlying physical conditions. When appropriate physical treatment is desired, a more precise diagnosis with adequate specificity is needed before an effective treatment can be selected. Precise diagnosis requires more time than is usually allotted to this process (e.g. It is naive to imagine that one can evaluate the exact dysfunction of a TMJ merely by palpating it, listening for any noise and measuring the ROM with a ruler as suggested by the RDC/TMD).

The Significance of Adaptation

As a matter of fact, not all internal derangements are created equal. Some patients successfully adapt to bilateral disk displacement without reduction and are subsequently able to function very well. However, the next patient in line may develop degenerative joint disease, which destroys the components of the TMJ and leads to dysfunction. Some patients in crossbite adapt to it and are able to function very well, but others do not. A severely worn dentition, obviously over-closed, can appear in a patient with or without painful symptoms. It is the patient’s adaptability that determines the presence and the degree of severity of any symptoms. Of course, there is also a mental component to each patient’s ability to

adapt. This component is the part that may be susceptible to psychological counselling.

Some Physical Aspects of TMD

There are no primary muscle diseases (MPDS) outside of systemic myopathy or neuropathy that can be included in list of TMD. The muscle pains commonly associated with TMD are usually secondary to a biomechanical condition. This is one of the reasons why muscle pain in the absence of myopathy or neuropathy has been mistakenly attributed to emotional stress and anxiety.

The mandible can be analogized as a three-legged stool with two condyles and one occlusion. If either condyle is damaged or its disk displaced, the stool is no longer flat and the occlusal plane becomes canted. This represents a biomechanical mal-condition and is sufficient to precipitate a painful (so-called muscular) TMD in a patient. Without good functioning bilateral joints, good masticatory function is unlikely to also be present (Radke, Kull & Sethi, 2014). Note: Successful adaptation is more likely when non-reducing disk displacements are bilateral than unilateral due to the symmetry of that condition.

The overall skeletal relationship of the mandible to the maxilla may not develop normally (e.g. Angle’s Class II and Class III malocclusions are usually skeletal). If a mal-relationship gradually occurs during development the masticatory system may be able to adapt to the condition asymptotically. However, if the relationship develops due to TMJ degenerative processes, loss of teeth, trauma, occlusal wear, or other factors in adult life, the system may not adapt fast enough to prevent the painful muscular symptoms associated with TMD. Numerous physical corrections can be successful treatments, at least in reducing symptoms and improving function, whereas counselling will mainly help the patient to “live with or tolerate the condition.”

One specific occlusal factor that can precipitate TMD muscular symptoms is the interference to functional movements. The benefits of removing specific occlusal contacts occurring during lateral

excursions from the intercuspal position have been demonstrated repeatedly (Kerstein & Farrell, 1990; Kerstein & Wright, 1991; Kerstein & Radke, 2012; Thumati, Kerstein & Thumati, 2017; Haralur, 2013; Wang & Yin, 2012). To comprehend the functional significance of these interferences it is only necessary to understand that both the closing and opening pathways are simulated by left and right lateral excursions from Centric Occlusion (CO). Prodigious amounts of counselling will not mitigate the deleterious effects of real occlusal interferences. However, finding the locations and intensities of real interferences first requires a method such as the T-Scan III to identify them.

The presence of occlusal interferences to function causes the CNS to attempt to avoid them. If they are within the adaptive range of the patient, then successful avoidance occurs. However, when the interferences exceed the adaptive range of the patient, the CNS messages to the musculature becomes chaotic.

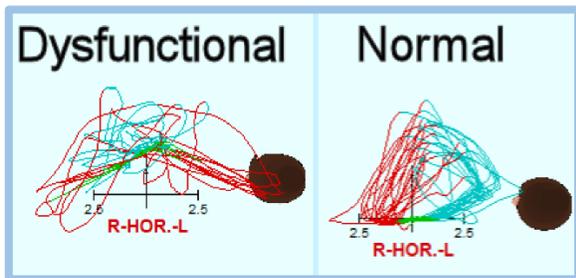


Figure 1. The horizontal pattern of chewing gum from a dysfunctional subject and a normal subject. A chaotic pattern appears with dysfunction as the CNS keeps trying unsuccessfully to find an efficient pattern.

One very obvious indication of the presence of occlusal interferences is the presence of Silent Period (exteroceptive suppression) nociceptive reflex responses occurring regularly within the EMG measurements of chewing. In normal subjects an occlusal contact only occurs on average about once in 30 cycles of chewing gum. However, when a patient is dysfunctional, one can find Silent Periods occurring in every cycle. This fact can be a red flag waving, indicating the need for occlusal adjustment.

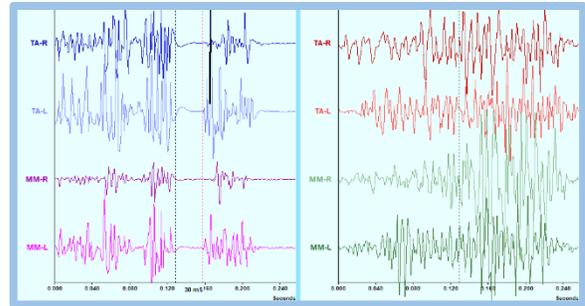


Figure 2. The presence of Silent Periods in the EMG of chewing gum indicates the presence of unavoidable occlusal interferences (left side). When a normal subject occasionally produces a Silent Period it usually lasts only 10 – 20 milliseconds. Dysfunctional subjects most often produce longer Silent Periods as in this one at 30 milliseconds.

Understanding a patient’s emotional state

For every dentist that provides TMD treatments it is necessary to recognize the emotional aspects that each patient brings into the practice. The painful nature of TMD can be very depressing. Beck Depression Inventory- II has been in use for decades and has periodically been updated. [Beck Depression Inventory – II](#) is available on-line and easy for any patient to fill out. However, it is important to explain to the patient in advance that this is used only to evaluate the extent that their *real TMD condition* is negatively affecting their quality of life and is not used to psychoanalyze the patient. Any hint to the patient that a diagnosis of somatization may be considered will most often negatively affect the patient’s confidence in the provider and any physical treatment offered.

Anxiety is not an uncommon emotion whether TMD is present or not. Anxiety is often present even when asymptomatic patient visits a dentist. If a TMD patient appears to be anxious and some degree of evaluation is desired, the [Beck Anxiety Inventory](#) can also provide an estimate of its extent. The Beck Anxiety Inventory is not in the public domain, but it is available for purchase on-line at www.pearsonassessments.com. This is another 21 questions with 0-3 grading that is easy to use, but also has the same risks of alienating the patient. These psychological tests are more often used in medicine to evaluate patients that

have been diagnosed with chronic physical conditions, than to diagnose psychosomatic disorders. If indeed one suspects the patient truly has any form of mental illness, it behooves the dentist to just refer the patient to an appropriate provider.

A diagnosis of somatization disorder (now referred to as Somatic Symptom Disorder) cannot and should not be determined by a dentist. Thus, a TMD or other patient, that is not responding to a seemingly appropriate physical treatment, that might also benefit from a referral to a licensed counseling professional should be given that opportunity, regardless of the precise diagnosis.

Acknowledgements: Too many of the authors cited in this chapter have contributed greatly to exposing the myth of TMD as a psychosomatic illness to be able to name them individually. However, I feel very indebted to their tireless work and their willingness to pursue this topic.

References:

- Abduo, J. & Lyons, K. (2012). Clinical considerations for increasing occlusal vertical dimension: a review. *Aust Dent J.* 57(1), 2-10. PMID: 22369551
- Aguerre, C., Bridou, M., Laroche, F., Csillik, A. & Jensen, M. (2015). Specifications of motivational interviewing within a cognitive-behavioral therapy of chronic pain]. *Encephale.* 41(6), 515-20. PMID: 25526811
- Akhter, R., Hassan, N. M., Ohkubo, R., Tsukazaki, T., Aida, J. & Morita, M. (2008). The relationship between jaw injury, third molar removal, and orthodontic treatment and TMD symptoms in university students in Japan. *J Orofac Pain.* 22(1), 50-6. PMID: 18351034
- Al-Ani, Z., Davies, S., Sloan, P. & Gray, R. (2008). Change in the number of occlusal contacts following splint therapy in patients with a temporomandibular disorder (TMD). *Eur J Prosthodont Restor Dent.* 16(3), 98-103. PMID: 1905155
- Almășan, O. C., Hedeșiu, M., Băciuț, G., Leucuța, D. C. & Băciuț, M. (2013). Disk and joint morphology variations on coronal and sagittal MRI in temporomandibular joint disorders. *Clin Oral Investig.* 17(4), 1243-50. PMID: 22868824
- Anderson, G. C., Schulte, J. K. & Goodkind, R. J. (1985). Comparative study of two treatment methods for internal derangement of the temporomandibular joint. *J Prosthet Dent.* 53(3):392-7. PMID: 3857335
- Ayer, W. A., Machen, J. B. & Getter, L. (1977). Survey of myofascial pain-dysfunction syndrome and pathologic bruxing habits among dentists. *J Am Dent Assoc.* 94(4), 730-2. PMID: 265336
- Bataglion, C., Hotta, T. H., Matsumoto, W. & Ruellas, C. V. (2012). Reestablishment of occlusion through overlay removable partial dentures: a case report. *Braz Dent J.* 23(2), 172-4. PMID: 22666777
- Beemsterboer, P. L., McNamara, D. C., Holden, S. & Ash, M. M. Jr. (1976). The effect of the bite plane splint on the electromyographic silent period duration. *J Oral Rehabil.* 3(4), 349-52. PMID: 1068245
- Burdette, B. H. & Gale, E. N. (1988). The effects of treatment on masticatory muscle activity and mandibular posture in myofascial pain-dysfunction patients. *J Dent Res.* 67(8):1126-30. PMID: 3165408
- Burgess, J. A., Sommers, E. E., Truelove, E. L. & Dworkin, S. F. (1988). Short-term effect of two therapeutic methods on myofascial pain and dysfunction of the masticatory system. *J Prosthet Dent.* 60(5), 606-10. PMID: 3199321
- Burman, M. & Sinberg, S. E. (1946). Condylar movement in the study of internal derangement of the temporomandibular joint. *J Bone Joint Surg Am.* 28:351-73. PMID: 21020239
- Butler, J. H., Folke, L. E. & Bandt, C. L. (1975). A descriptive survey of signs and symptoms associated with the myofascial pain-dysfunction syndrome. *J Am Dent Assoc.* 90(3), 635-9. PMID: 1054051
- Carano, A., Leone, P. & Carano, A. (2001). Orthodontic finalization strategies in dysfunctional adult patients. *Cranio.* 19(3), 195-213. PMID: 11482832
- Carraro, J. J. & Caffesse, R. G. (1978). Effect of occlusal splints on TMJ symptomatology. *J Prosthet Dent.* 40(5), 563-6. PMID: 281508
- Dalen, K., Ellertsen, B., Espelid, I. & Grønningsaeter, A. G. (1986). EMG feedback in the treatment of myofascial pain dysfunction syndrome. *Acta Odontol Scand.* 44(5), 279-84. PMID: 3468737
- DeSteno, C. V., Vella, M., Attanasio, R. & Cinotti, W. R. (1989). Phase II rehabilitation of the tempo-

- mandibular joint dysfunction patient. *Clin Prev Dent.* 11(5):29-32. PMID: 2638952
- Dionne, R. A. (1997). Pharmacologic treatments for temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 83(1), 134-42. PMID: 9007937
- Dworkin, S. F., Huggins, K. H., Wilson, L., Mancl, L., Turner, J., Massoth, D., LeResche, L & Truelove, E. (2002). A randomized clinical trial using research diagnostic criteria for temporomandibular disorders-axis II to target clinic cases for a tailored self-care TMD treatment program. *J Orofac Pain.* 16(1), 48-63. PMID: 11889659
- Dworkin, S. F. & LeResche, L. (1992). Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *J Craniomandib Disord.* 6(4), 301-55. PMID: 12987670
- Dworkin, S. F., LeResche, L., DeRouen, T. & Von Korff, M. (1990). Assessing clinical signs of temporomandibular disorders: reliability of clinical examiners. *J Prosthet Dent.* 63(5), 574-9. PMID: 2338670
- Dworkin, S. F., LeResche, L. & Von Korff, M. R. (1990). Diagnostic studies of temporomandibular disorders: challenges from an epidemiologic perspective. *Anesth Prog.* 37(2-3), 147-54. PMID: 2085194
- Edmiston, G. F. & Laskin, D. M. (1978). Changes in consistency of occlusal contact in myofascial pain-dysfunction (MPD) syndrome. *J Dent Res.* 57(1), 27-30. PMID: 277493
- Erlandson, P. M. Jr. & Poppen, R. (1989). Electromyographic biofeedback and rest position training of masticatory muscles in myofascial pain-dysfunction patients. *J Prosthet Dent.* 62(3):335-8. PMID: 2810139
- Eversole, L. R., Stone, C. E., Matheson, D. & Kaplan, H. (1985). Psychometric profiles and facial pain. *Oral Surg Oral Med Oral Pathol.* 60(3):269-74. PMID: 3862039
- Farrar, W. B. (1971). Diagnosis and treatment of anterior dislocation of the articular disc. *N Y J Dent.* 41(10):348-51. PMID: 5288441
- Farrar, W. B. (1972). Differentiation of temporomandibular joint dysfunction to simplify treatment. *J Prosthet Dent.* 28(6):629-36. PMID: 4508486
- Ferraz, A. M. Jr., Devito, K. L. & Guimarães, J. P. (2012). Temporomandibular disorder in patients with juvenile idiopathic arthritis: clinical evaluation and correlation with the findings of cone beam computed tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 114(3), e51-7. PMID: 22771410
- Fox, C. W., Abrams, B. L., Williams, B. & Doukoudakis, A. (1985). Protrusive positioners. *J Prosthet Dent.* 54(2):258-62. PMID: 3863933
- Fricton, J. R., Kroening, R., Haley, D. & Siegert, R. (1985). Myofascial pain syndrome of the head and neck: a review of clinical characteristics of 164 patients. *Oral Surg Oral Med Oral Pathol.* 60(6), 615-23. PMID: 3865133
- Galhardo, A. P., da Costa-Leite, C., Gebrim, E. M., Gomes, R. L., Mukai, M. K., Yamaguchi, C. A., Bernardo, W. M., Soares, J. M. Jr., Baracat, E. C. & Gil, C. (2013). The correlation of research diagnostic criteria for temporomandibular disorders and magnetic resonance imaging: a study of diagnostic accuracy. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 115(2), 277-84. PMID: 23312922
- Gallardo, F., Molgo, J., Miyazaki, C. & Rossi, E. (1975). Carisoprodol in the treatment of myofascial pain-dysfunction syndrome. *J Oral Surg.* 33(9), 655-8. PMID: 1097611
- Gameiro, G. H., da Silva-Andrade, A., Nouer, D. F. & Ferraz-de Arruda-Veiga, M. C. (2006). How may stressful experiences contribute to the development of temporomandibular disorders? *Clin Oral Investig.* 10(4), 261-8. PMID: 16924558
- Garino, G. B. & Capurso, U. (1990). Orthodontics and prosthetics: finishing dysfunctional cases. *Mondo Ortod.* 15(3), 341-9. PMID: 2215490
- Gelb, H. & Tarte, J. (1975). A two-year clinical dental evaluation of 200 cases of chronic headache: the craniocervical-mandibular syndrome. *J Am Dent Assoc.* 91(6), 1230-6. PMID: 1059698
- Gessel, A. H. (1975). Electromyographic biofeedback and tricyclic antidepressants in myofascial pain-dysfunction syndrome: psychological predictors of outcome. *J Am Dent Assoc.* 91(5):1048-52. PMID: 1058915
- Glaros, A. G., Glass, E. G. & Hayden, W. J. (1995). History of treatment received by patients with TMD: a preliminary investigation. *J Orofac Pain.* 9(2), 147-51. PMID: 7488984
- Glass, E. G., McGlynn, F. D. & Glaros, A. G. (1991). A survey of treatments for myofascial pain dysfunction. *Cranio.* 9(2), 165-8. PMID: 1802426

- Greene, C. S. & Laskin, D. M. (1971). Meprobamate therapy for the myofascial pain-dysfunction (MPD) syndrome: a double-blind evaluation. *J Am Dent Assoc.* 82(3):587-90. PMID: 4924956
- Greene, C. S. & Laskin, D. M. (1983). Long-term evaluation of treatment for myofascial pain-dysfunction syndrome: a comparative analysis. *J Am Dent Assoc.* 107(2), 235-8. PMID: 6578265
- Greene, C. S., Lerman, M. D., Sutcher, H. D. & Laskin, D. M. (1969). The TMJ pain-dysfunction syndrome: heterogeneity of the patient population. *J Am Dent Assoc.* 79(5):1168-72. PMID: 5259143
- Goss, A. N. (1974). The myofascial pain dysfunction syndrome. I. Aetiology and diagnosis. *N Z Dent J.* 70(321), 192-8. PMID: 4530935
- Haralur, S. B. (2013). Digital Evaluation of Functional Occlusion Parameters and their Association with Temporomandibular Disorders. *J Clin Diagn Res.* 7(8), 1772-5. PMID: 24086910
- Harkins, S., Linford, J., Cohen, J., Kramer, T. & Cueva, L. (1991). Administration of clonazepam in the treatment of TMD and associated myofascial pain: a double-blind pilot study. *J Craniomandib Disord.* 5(3), 179-86. PMID: 1812146
- Helöe, B. Heiberg, A. N. (1980). A follow-up study of a group of female patients with myofascial pain-dysfunction syndrome. *Acta Odontol Scand.* 38(3):129-34. PMID: 6932158
- Helöe, B., Helöe, L. A. & Heiberg, A. (1977). Relationship between sociomedical factors and TMJ-symptoms in Norwegians with myofascial pain-dysfunction syndrome. *Community Dent Oral Epidemiol.* 5(5), 207-12. PMID: 269766
- Hersh, E. V., Balasubramaniam, R. & Pinto, A. (2008). Pharmacologic management of temporomandibular disorders. *Oral Maxillofac Surg Clin North Am.* 20(2), 197-210. PMID: 18343325
- Hijzen, T. H. & Slangen, J. L. (1985). Myofascial pain-dysfunction: subjective signs and symptoms. *J Prosthet Dent.* 54(5), 705-11. PMID: 3863947
- Hijzen, T. H., Slangen, J. L. & van Houwelingen, H. C. (1986). Subjective, clinical and EMG effects of biofeedback and splint treatment. *J Oral Rehabil.* 13(6), 529-39. PMID: 3467047
- Hirooka, K., Miyashita, M., Morita, T., Ichikawa, T., Yoshida, S., Akizuki, N., Akiyama, M., Shirahige, Y. & Eguchi, K. (2014). Regional medical professionals' confidence in providing palliative care, associated difficulties and availability of specialized palliative care services in Japan. *Jpn J Clin Oncol.* 44(3), 249-56. PMID: 24407834
- Imai, T., Okamoto, T., Kaneko, T., Umeda, K., Yamamoto, T. & Nakamura, S. (2000). Long-term follow-up of clinical symptoms in TMD patients who underwent occlusal reconstruction by orthodontic treatment. *Eur J Orthod.* 22(1), 61-7. PMID: 10721246
- Journal of the American Dental Association. (1983). Report of the President's Conference on the Examination, Diagnosis, and Management of Temporomandibular Disorders. 106(1), 75-7. PMID: 6574170
- Kang, S. K., Lee, Y. H., Park, H., Ro, J. Y. & Auh, Q. S. (2018). Effects of intramuscular morphine in men and women with temporomandibular disorder with myofascial pain. *Oral Dis.* 24(8), 1591-1598. PMID: 29920852
- Keeling, S. D., Gibbs, C., Hall, M. B. & Lupkiewicz, S. (1989). Internal derangement of the TMJ: changes associated with mandibular repositioning and orthodontic therapy. *Am J Orthod Dentofacial Orthop.* 96(5):363-74. PMID: 2816836
- Kerstein, R. B. & Farrell, S. (1990). Treatment of myofascial pain-dysfunction syndrome with occlusal equilibration. *J Prosthet Dent.* 63(6), 695-700. PMID: 2102663
- Kerstein, R. B. & Radke, J. (2012). Masseter and temporalis excursive hyperactivity decreased by measured anterior guidance development. *Cranio.* 30(4), 243-54. PMID: 23156965
- Kerstein, R. B. & Wright, N. R. (1991). Electromyographic and computer analyses of patients suffering from chronic myofascial pain-dysfunction syndrome: before and after treatment with immediate complete anterior guidance development. *J Prosthet Dent.* 66(5), 677-86. PMID: 1805009
- Kiehn, C. L. (1952). Meniscectomy for internal derangement of temporomandibular joint. *Am J Surg.* 83(3):364-73. PMID: 14903392
- Kim, M. J. & Kho, H. S. (2018). Understanding of Burning Mouth Syndrome Based on Psychological Aspects. *Chin J Dent Res.* 21(1), 9-19. PMID: 29507908
- Kim, K., Wojczyńska, A. & Lee, J. Y. (2016). The incidence of osteoarthritic change on computed tomography of Korean temporomandibular disorder patients diagnosed by RDC/TMD; a retrospective

- study. *Acta Odontol Scand.* 74(5), 337-42. PMID: 26881919
- Laskin, D. M. (1969). Etiology of the pain-dysfunction syndrome. *J Am Dent Assoc.* 79(1):147-53. PMID: 5254545
- Laskin, D. M. & Block, S. (1986). Diagnosis and treatment of myofascial pain-dysfunction (MPD) syndrome. *J Prosthet Dent.* 56(1), 75-84. PMID: 3522884
- Le Bell, Y. & Kirveskari, P. (1990). Treatment of reciprocal clicking of the temporomandibular joint with a repositioning appliance and occlusal adjustment--results after four and six years. *Proc Finn Dent Soc.* 86(1):15-21. PMID: 2385578
- Lei, J., Han, J., Liu, M., Zhang, Y., Yap, A. U. & Fu, K. Y. (2017). Degenerative temporomandibular joint changes associated with recent-onset disc displacement without reduction in adolescents and young adults. *J Craniomaxillofac Surg.* 45(3), 408-413. PMID: 28108240
- Liang, Q., Gulibaha, M., Liu, H. & Han, L. (2011). Quality evaluation of randomized controlled trials on treatment of cognitive-behavioral therapy on temporomandibular disorders. *Hua Xi Kou Qiang Yi Xue Za Zhi.* 29(5), 509-13. PMID: 22165121
- Lipton, J. A. & Marbach, J. J. (1984). Predictors of treatment outcome in patients with myofascial pain dysfunction syndrome and organic temporomandibular joint disorders. *J Prosthet Dent.* 51(3):387-93. PMID: 6584609
- List, T., John, M. T., Ohrbach, R., Schiffman, E. L., Truelove, E. L. & Anderson, G. C. (2012). Influence of temple headache frequency on physical functioning and emotional functioning in subjects with temporomandibular disorder pain. *J Orofac Pain.* 26(2), 83-90. PMID: 22558607
- Look, J. O., John, M. T., Tai, F., Huggins, K. H., Lenton, P. A., Truelove, E. L., Ohrbach, R., Anderson, G. C. & Schiffman, E. L. (2010). The Research Diagnostic Criteria For Temporomandibular Disorders. II: reliability of Axis I diagnoses and selected clinical measures. *J Orofac Pain.* 24(1), 25-34. PMID: 20213029
- List, T., Tegelberg, A., Haraldson, T. & Isacson, G. (2001). Intra-articular morphine as analgesic in temporomandibular joint arthralgia/osteoarthritis. *Pain.* 94(3), 275-82. PMID: 11731064
- Lupton, D. E. & Johnson, D. L. (1973). Myofascial pain-dysfunction syndrome: attitudes and other personality characteristics related to tolerance for pain. *J Prosthet Dent.* 29(3), 323-9. PMID: 4405710
- Lypka, M. & Yamashita, D. D. (2007). Exuberant foreign body giant cell reaction to a teflon/proplast temporomandibular joint implant: report of a case. *J Oral Maxillofac Surg.* 65(9):1680-4. PMID: 17719383
- Marbach, J. J. & Dworkin, S. F. (1975). Chronic MPD, group therapy and psychodynamics. *J Am Dent Assoc.* 90(4):827-33. PMID: 1055152
- Marumo, Y., Hatano, Y., Kuraji, N. & Yokozuka, S. (1990). Craniomandibular disorders management (1) Treatment planning. *Shigaku.* 78(1):150-7. PMID: 2134955
- Mercuri, L.G., Olson, R. E. & Laskin, D. M. (1979). The specificity of response to experimental stress in patients with myofascial pain dysfunction syndrome. *J Dent Res.* 58(9):1866-71. PMID: 290651
- Millstein-Prentky, S. & Olson, R. E. (1979). Predictability of treatment outcome in patients with myofascial pain-dysfunction (MPD) syndrome. *J Dent Res.* 58(4), 1341-6. PMID: 285104
- Moran JH, Kaye LB, Fritz ME. (1979). Statistical analysis of an urban population of 236 patients with head and neck pain. Part III. Treatment modalities. *J Periodontol.* 1979 Feb;50(2):66-74. PMID: 284115
- Niemann, W. W. (1991). Bicuspid buildup (convertible) splint. *Cranio Clin Int.* 1(2):143-61. Review. PMID: 1811803
- Niemann, W. (1992). The bicuspid buildup as an alternative in Phase II treatment of craniomandibular dysfunction. *Funct Orthod.* 9(5):38-9, 41-4, 46. PMID: 1452060
- Ohrbach R, Dworkin SF. (2016). The Evolution of TMD Diagnosis: Past, Present, Future. *J Dent Res.* 2016 Sep;95(10):1093-101. PMID: 27313164
- Ohrbach R, Turner JA, Sherman JJ, Mancl LA, Truelove EL, Schiffman EL, Dworkin SF. (2010). The Research Diagnostic Criteria for Temporomandibular Disorders. IV: evaluation of psychometric properties of the Axis II measures. *J Orofac Pain.* 2010 Winter;24(1):48-62. PMID: 20213031
- Okeson, J. (1996). *Orofacial Pain: Guidelines for Assessment, Diagnosis and Management.* Retrieved from <https://trove.nla.gov.au/version/45738205>

- Okeson, J. P. & de Leeuw, R. (2011). Differential diagnosis of temporomandibular disorders and other orofacial pain disorders. *Dent Clin North Am.* 55(1), 105-20. PMID: 21094721
- Pertes, R. A., Attanasio, R., Cinotti, W. R. & Balbo, M. (1989). Occlusal splint therapy in MPD and internal derangements of the TMJ. *Clin Prev Dent.* 11(4):26-32. PMID: 2605864
- Petersson, A. (2010). What you can and cannot see in TMJ imaging--an overview related to the RDC/TMD diagnostic system. *J Oral Rehabil.* 37(10), 771-8. PMID: 20492436
- Radke, J. C., Kull, R.S. & Sethi, M. S. (2014). Chewing movements altered in the presence of temporomandibular joint internal derangements. *Cranio.* 32(3), 187-92. PMID: 25000160
- Schiffman, E., Ohrbach, R., Truelove, E., Look, J., Anderson, G., Goulet, J. P., List, T., Svensson, P., Gonzalez, Y., Lobbezoo, F., Michelotti, A., Brooks, S. L., Ceusters, W., Drangsholt, M., Ettl, D., Gaul, C., Goldberg, L. J., Haythornthwaite, J. A., Hollender, L., Jensen, R., John, M. T., De Laat, A., de Leeuw, R., Maixner, W., van der Meulen, M., Murray, G. M., Nixdorf, D. R., Palla, S., Petersson, A., Pionchon, P., Smith, B., Visscher, C. M., Zakrzewska, J., Dworkin, S. F., International RDC/TMD Consortium Network, International Association for Dental Research, Orofacial Pain Special Interest Group, International Association for the Study of Pain. (2014). Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. *J Oral Facial Pain Headache.* 28(1), 6-27. PMID: 24482784
- Schwartz, R. A., Greene, C. S. & Laskin, D. M. (1979). Personality characteristics of patients with myofascial pain dysfunction (MPD) syndrome unresponsive to conventional therapy. *J Dent Res.* 58(5):1435-9. PMID: 285956
- Steed, P. A. & Wexler, G. B. (2001). Temporomandibular disorders--traumatic etiology vs. nontraumatic etiology: a clinical and methodological inquiry into symptomatology and treatment outcomes. *Cranio.* 19(3), 188-94. PMID: 11482831
- Steenks, M. H., Türp, J. C. & de Wijer, A. (2018). Reliability and Validity of the Diagnostic Criteria for Temporomandibular Disorders Axis I in Clinical and Research Settings: A Critical Appraisal. *J Oral Facial Pain Headache.* 32(1), 7-18. PMID: 29370321
- Summer, J. D. & Westesson, P. L. (1997). Mandibular repositioning can be effective in treatment of reducing TMJ disk displacement. A long-term clinical and MR imaging follow-up. *Cranio.* 15(2), 107-20. PMID: 9586512
- Thumati, P., Kerstein, R.B. & Thumati, R. P. (2017). Disclusion time reduction therapy in treating occluso-muscular pains. *J Indian Prosthodont Soc.* 17(1), 95-98. PMID: 28216853
- Thumati, P., Sutter, B., Kerstein, R. B., Yiannios, N., Radke, J. (2018). Changes in the Beck Depression Inventory – II scores of TMD subjects after measured occlusal treatment. *Adv Dent Tech,* 1(1), 2 – 13. ISSN 2640-1932
- Truelove, E., Pan, W., Look, J. O., Mancl, L. A., Ohrbach, R. K., Velly, A. M., Huggins, K. H., Lenton, P. & Shiffman, E. L. (2010). The Research Diagnostic Criteria for Temporomandibular Disorders. III: validity of Axis I diagnoses. *J Orofac Pain.* 24(1):35-47. PMID: 20213030
- Vauthier, F. & Spirgi, M. (1977). The occlusal bite splint and its effect on the centric relation of the maximal opening and closing movement in cases of temporomandibular joint syndrome]. *SSO Schweiz Monatsschr Zahnheilkd.* 87(3), 189-208. PMID: 265618
- Von Korff, M., Dworkin, S. F. & LeResche, L. (1990). Graded chronic pain status: an epidemiologic evaluation. *Pain.* 40(3), 279-91. PMID: 2326094
- Wang, C. & Yin, X. (2012). Occlusal risk factors associated with temporomandibular disorders in young adults with normal occlusions. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 114(4), 419-23. PMID: 22841427
- Weinberg, L. A. (1980). The etiology, diagnosis, and treatment of TMJ dysfunction-pain syndrome. Part III: treatment. *J Prosthet Dent.* 43(2), 186-96. PMID: 6153219
- Wessberg, G. A., Carroll, W. L., Dinham, R. & Wolford, L. M. (1981). Transcutaneous electrical stimulation as an adjunct in the management of myofascial pain-dysfunction syndrome. *J Prosthet Dent.* 45(3), 307-14. PMID: 6971327

Additional reading

Clemente, M. P., Mendes, J., Moreira, A., Vardasca, R., Ferreira, A. P. & Amarante, J. M. (2018). Wind Instrumentalists and Temporomandibular Disorder:

From Diagnosis to Treatment. *Dent J* (Basel). 6(3), pii: E41 PMID: 30142910

Fernandes-Azevedo, A. B., Câmara-Souza, M. B., Dantas, I. S., de Resende, C. M. B. M. & Barbosa, G. A. S. (2018). Relationship between anxiety and temporomandibular disorders in dental students. *Cranio*. 36(5), 300-303. PMID:28791932

Gierk, B., Kohlmann, S., Kroenke, K., Spangenberg, L., Zenger, M., Brähler, E. & Löwe, B. (2014). The Somatic Symptom Scale-8 (SSS-8) A Brief Measure of Somatic Symptom Burden. *JAMA Intern Med*. 174(3), 399-407. PMID: 24276929

Kocalevent, R. D., Hinz, A. & Brähler, E. (2013). Standardization of a screening instrument (PHQ-15) for somatization syndromes in the general population *Gen Hosp Psychiatry*. 35(5):551-5. PMID: 23664569

Liu, M. Q., Lei, J., Han, J. H., Yap, A. U. & Fu, K. Y. (2017). Metrical analysis of disc-condyle relation with different splint treatment positions in patients with TMJ disc displacement. *J Appl Oral Sci*. 25(5), 483-489. PMID: 29069145

Takashima, M., Arai, Y., Kawamura, A., Hayashi, T. & Takagi, R. (2017). Quantitative evaluation of masseter muscle stiffness in patients with temporomandibular disorders using shear wave elastography. *J Prosthodont Res*. 61(4), 432-438. PMID: 28188109

Key Words and Definitions

Anxiety Disorders: Conditions that form a category of mental health diagnoses that lead to excessive nervousness, fear, apprehension, and worry (Medical News Today).

Depression: A mood disorder that causes a persistent feeling of sadness and loss of interest and can interfere with your daily functioning (Mayo Clinic).

Disclusion Time Reduction (DTR): The process of reducing the time that a patient requires to complete a lateral excursive movement.

Dysthymia: A neurotic, chronic depression. A mood disorder with the same cognitive and physical symptoms as depression, but less severe with longer-lasting symptoms.

Immediate Complete Anterior Guidance Development (ICAGD): The process of removal of all posterior occlusal interferences to function using the T-Scan III.

Internal Derangement of the TMJ: Any TMJ with a disk that has been displaced, with or without reduction, away from its normal close relationship to the condyle.

Research Diagnostic Criteria/TMD: A theory proposed by SF Dworkin et al in 1992 suggesting that the one etiology of TMD is illness behavior and not physical in nature.

Somatization: The conversion of a mental state (such as depression or anxiety) into physical symptoms (Merriam-Webster).

Temporomandibular Disorders: A category of at least 40 distinct physical conditions within the stomatognathic system characterized by orofacial pains and masticatory dysfunction.

Validation Studies: The process of trying to prove the correctness of a theory or approach rather than using the accepted Scientific Method, which aims to disprove a theory.

Appendix to chapter 7

Some of the Sunk Costs of TMD/Chronic Orofacial Pain Research

Searching on the internet resulted in the listing in Table 1, which was compiled from various sources. It may not be entirely accurate, but it clearly indicates the huge extent of the funding

applied to the theory that TMD and chronic pain result from depression, from anxiety and/or due to somatization.

Grantee	Description	Agency	Date	Amount
DeRouen TA	Internatoional Collaborative Oral Health Research Planning	NIDCR	1999-2004	7,517,485.00
Drangsholt M	Hormonal cycles in women	NIDCR	2008-2011	127,440.00
Dworkin SF	Biobehavioral methods	NIDR	1994-1999	3,035,097.00
Dworkin SF	Biobehavioral methods	NIDR	1994-1999	1,441,034.00
Dworkin SF	Menstrual cycle and blood pressure effects on acute pain	NIH	2000-2002	150,000.00
Dworkin SF	Internationasl collaborative oral health research planning	NIDCR	2000-?	
LeReache L	RDC; reliability and validity	NIDCR	2004-2009	
LeReache L	Mestrual cycle effects on TMD painand other symptoms	NIDCR	1999-2006	4,260,420.00
LeReache L	Comprehensive Oral health research center of discovery	NIDCR	1998-2004	1,383,246.00
LeReache L	Longitudinal studies:clinical/chronic pain syndromes	NIDR	1994-1999	936,942.00
LeReache L	second renewal Longitudinal studies;clinical/chronic pain syndrones	NIDR	1999-2004	1,353,287.00
LeReache L	Hormonal cycles in women; effects on TMD pain and symptoms	NIDCR	2004-2009	
Levy R	Clinical, public helath & Behavioral oral health researching training for Thailand	NIH	2007-2013	1,278,278.00
Levy R	Psychosocial interventoin for children with Inflammatory Bowel Disease	NIH	2007-2013	1,278,278.00
Ohrbach R	Research Diagnostic Criteria: Reliability and Validity	NIDCR	2001-2008	5,200,000.00
Ohrbach R	Supplementaly award	NIDCR	?	2,900,000.00
Ohrbach R	TMJ Intra-articular disorders; impact on functioning and disability	NIDCR	2011-2014	3,299,445.00
Ohrbach R	Joules, Genes, and Behaviors: A Multifactorial Assessment of TMD Risk Factors	NIDCR	2011-2016	2,606,953.00
Ohrbach R	An Ontology for Pain and Related Disability, Mental Health and Quality of Life	NIDCR	2011-2013	518,975.00
Ohrbach R	Orofacial Pain: Prospective Evaluation and Risk Assessment	NIDCR	2005-2012	3,300,000.00
Ohrbach R	OPPERA I w/ co-PI Maixner	NIDCR	2005-2012	19,100,000.00
Ohrbach R	OPPERA II w/ co-PI Maixner	NIDCR	2001-2008	16,000,000.00
Ohrbach R	Psychophysiological Assessment of Stress in Chronic Pain	NIDR	1989-1994	291,968.00
Schiffman E	Claims Various grants	NIDCR	2001-2013	12,000,000.00
Von Korff MR	w/Dworking & LeReache; Cognitive-Behavioral Therapy for Arthritis Pain and Insom.	NIA	2008-2013	3,500,000.00
Von Korff MR	w/Dworkin & LeReache; Group Health Research Award	GHRI	?	1,600,000.00
Von Korff MR	Transition to long-term opioid use among older adults with chronic pain	NIA	2010-2015	3,000,000.00
Von Korff MR	GHRI Award (?)	GHRI	?	2,300,000.00
Von Korff MR	Identification of opioid misuse and abuse using medical records	Pfizer	2013-2014	249,000.00
Von Korff MR	GHRI Award (?)	GHRI	?	249,000.00
Von Korff MR	Transition from Acute to Chronic Pain: Planning and Pilot	J & J	2009-2011	764,000.00
Von Korff MR	GHRI Award (?)	GHRI	?	521,000.00
Von Korff MR	A Randomized Trial of Liaison Psychiatry in Primary Care	GHC	1991-1995	1,100,404.00
Von Korff MR	Renewal; A Randomized Trial of Liaison Psychiatry in Primary Care	GHC	1995-2000	1,545,707.00
Von Korff MR	Renewal; A Randomized Trial of Liaison Psychiatry in Primary Care	GHC	2000-2005	2,423,124.00
Von Korff MR	Renewal; A Randomized Trial of Liaison Psychiatry in Primary Care	GHC	2006-2012	3,000,000.00
Von Korff MR	Long-term opioid management of chronic pain: Trends and risks	NIDA	2006-2011	2,500,000.00
Von Korff MR	GHRI Award (?)	GHRI	?	1,000,000.00
Von Korff MR	Depression-diabetes care disparities, adverse outcomes	NIMH	2005-2010	2,000,000.00
Von Korff MR	CHS Award	CHS	2004-2008	1,600,000.00
Von Korff MR	Social role disability and mental-physical comorbidity	NIMH	2004-2008	2,200,000.00
Von Korff MR	CHS Award	CHS	?	1,100,000.00
Von Korff MR	w/Dworkin; Epidemiologic Studies of Temporomandibular Disorders	NIDR	1985-1988	165,489.00
Von Korff MR	w/Dworkin; TMD Longitudinal Studies: Clinical/Chronic Pain Syndromes	NIDR	1989-1993	606,654.00
Von Korff MR	w/LeReche; renewal TMD Longitudinal Studies: Clinical/Chronic Pain Syndromes	NIDR	1994-1999	936,942.00
Von Korff MR	w/LeReche; second renewal TMD Longitudinal Studies: Clinical/Chronic Pain Synd.	NIDR	1999-2004	1,353,287.00
Von Korff MR	Project on Chronic Pain Management in Primary Care within Program Project	AHCPR	1989-1992	834,503.00
Von Korff MR	Renewal; Project on Chronic Pain Management in Primary Care within Program Proj.	AHCPR	1993-1994	398,778.00
Von Korff MR	w/Levy R; Intergeneration transmission of illness behavior	NICHHD	1999-2002	215,307.00
Von Korff MR	numerous other grants w/ various co-PI	various	1992-2019	
Total				123,142,043.00

Table 1. A list of the major players and some of their grants awarded for research into the possibility that a psychological etiology is responsible for TMD and/or chronic orofacial pain over the past 30 years or so. Von Korff, M. R. at the University of Washington has been associated with Dworkin, S. F. and LeResche, L. in a number of these studies. The dollar amounts of some of these grants could not be determined and other grants were likely not found.

An exhaustive search of the literature did not reveal one study attempting to substantiate the theory by testing it purely with any psychological treatment. Although a search for [RDC/TMD] in PubMed listed not less than 462 articles, the erroneous assumption of validity is clearly present in those that are not the few who have been critical of it. Considering the amount of money allocated, one could expect at least some objective testing of the theory. Although that has not yet happened, it most likely will in the future.

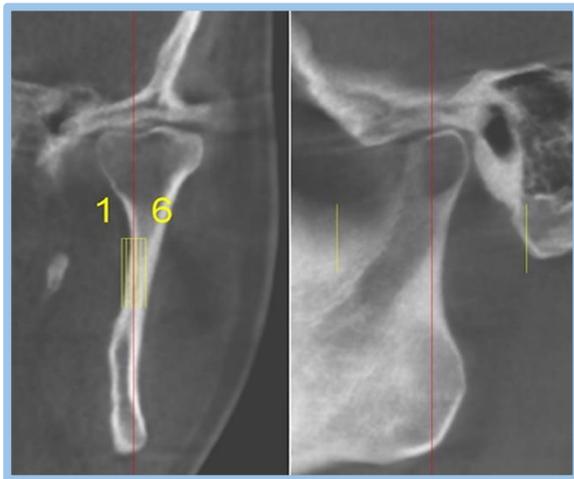


Figure 1. A mild example of degenerative joint disease in the presence of disk displacement with the damage to the condylar head and reduced joint function. Although the patient is not complaining of pain, the quality of masticatory function has been reduced. See chapter 6.

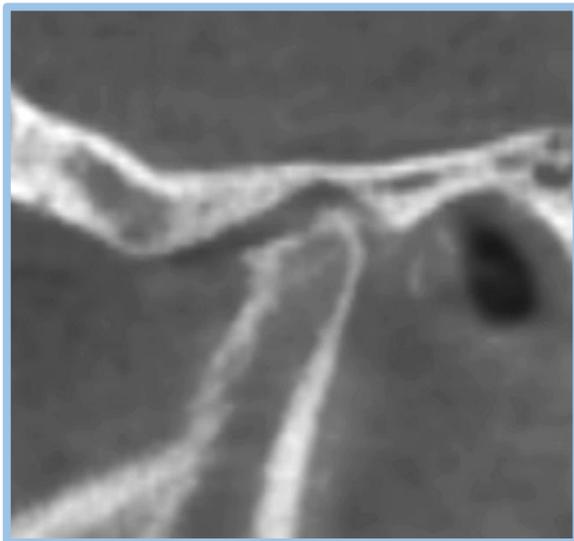


Figure 2. Advanced degenerative joint disease

One of the most deleterious conclusions that has been ultimately arrived at from the plethora of RDC/TMD validation studies is the conclusion that the progression of disease in the TMJ has no clinical relevance (Chantaracherd, John, Hodges & Schiffman, 2015). It has been demonstrated repeatedly that the presence of disk displacement with reduction or disk displacement without reduction too often leads to degenerative changes within the TM joint and represents a progression of disease within many TMD patients (Schellhas, Wilkes, Omlie, et al, 1988; Sülün, Akkayan, Duc, Rammelsberg, Tuncer & Gernet, 2001). Figure 1.

The process of degenerative joint disease (DJD) is not predicable with any degree of certainty. A safe approach is to monitor the process and refrain from any definitive dental treatments until the process is completed and stabilization is present. Appliance therapy is an option to counter the effects of DJD until the TMJs stabilize. Ignoring the situation and assuming the patient will adapt successfully is analogous to sticking one's head in the sand. In a few cases it has been demonstrated that some regrowth of the condyle is possible (He, Zheng, Yu, Zhou & Chen, 2018; Mauricio & Omar, 2018).

Apparently, as long as the patient is still able to chew, the quality of masticatory function is not considered important by many. The reality is that TMD patients with internal derangements are not usually able to function normally (Radke, Kull & Sethi, 2014). Asking a TMD patient to report the quality of their ability to masticate is dubious at best and certainly not as definitive as has been presumed. The patient's report of a functional restriction is a purely subjective assessment and limited in its usefulness. In the absence of a traumatic incident, the gradual deterioration of masticatory function occurs imperceptibly to the patient. The rate of change is too slow to allow the patient to remember the starting point years in the past. With the initial occurrence of a non-reducing TMJ disk displacement, the occlusion is altered and the ability to masticate is clearly and measurably reduced. However, since the process of adaptation is slow, by the time the patient is chronically stable, the patient usually cannot even remember precisely the pre-condition quality of function.

An interesting similarity between patients that are diagnosed with TMD and those diagnosed with somatoform disorders includes the long length of time or chronicity of their conditions (Herzog, Shedden-Mora, Jordan & Löwe, 2018). Many diagnosed TMD patients exhibit an extensive history of complaints as well as a plethora of unsuccessful treatments from a large number of providers (Hedenberg-Magnusson, Ernberg & Kopp, 1999). This would seem to reflect an insufficiency in the realm of diagnosis leading to ineffective treatments.

The Measurement of Somatization

Some questions currently asked for the purpose of detecting somatization are listed in PHQ-15. See Table 2.

During the <u>past 4 weeks</u> , how much have you been bothered by any of the following problems?			
	Not bothered at all (0)	Bothered a little (1)	Bothered a lot (2)
a. Stomach pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Back pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Pain in your arms, legs, or joints (knees, hips, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Menstrual cramps or other problems with your periods WOMEN ONLY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Headaches	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Chest pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Dizziness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Fainting spells	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Feeling your heart pound or race	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. Shortness of breath	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
k. Pain or problems during sexual intercourse	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
l. Constipation, loose bowels, or diarrhea	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
m. Nausea, gas, or indigestion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
n. Feeling tired or having low energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
o. Trouble sleeping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Table 2. The PHQ-15 survey lists some conditions that are often considered when evaluating a patient for somatization and has good test-retest consistency and inter-rater reliability for Somatic Symptom Disorder (SSD) diagnosis as defined within DSM-5. However, without first eliminating all of the possible physical alternative diagnoses, it is not useful.

This anamnestic survey has been shown to have excellent test-retest consistency and inter-rater reliability for the detection of Somatic Symptom Disorder (SSD), a relatively new diagnosis under DSM-5 (Chaturvedi & Desai, 2013). The previously applied diagnosis from DSM-IV and

the ICD-10, a Somatoform Disorder, was considered to not be inclusive enough (Hüsing, Löwe & Toussaint, 2018). However, each condition in the list also corresponds to more than one physical alternative etiology. Thus, the key to determining whether the symptoms indicate somatization is a precise process of elimination of any alternative physical diagnoses.

Looking at Table 2, it is not surprising that many of the painful symptoms listed are also present in TMD patients. For an example, dizziness and vertigo, two of the common somatic symptoms, (Limburg, Sattel, Radziej & Lahmann, 2016; Limburg, Sattel, Dinkel, Radziej, Becker-Bense & Lahmann, 2017) are also very commonly noted complaints from TMD patients along with otalgia, ear stuffiness, tinnitus and hearing loss (Porto De Toledo, Stefani, Porporatti, et al., 2017). Often, none of these symptoms can be attributed to a physical disease by an ENT physician. If there was greater competence within dentistry with respect to the accurate physical diagnosis of TMD, the ENT physicians could confidently refer these patients to a dental TMD treatment provider as the ENT Dr. James Costen did back in 1934.

The lack of physical diagnostic capability within the RDC/TMD has likely misled some to over-diagnose somatoform disorder associated with TMD. The refusal of those associated with the RDC/TMD to consider advanced technology as an aid in physical diagnosis has been a severe limitation. A misdiagnosis of TMD as SSD (or a somatoform disorder) cannot be blamed on the psychiatrist, but rather on the dentist or another clinician, who fails to adequately identify the physical contributions to a patient's TMD. The so-called biopsychosocial approach to TMD must necessarily start with Biology first (Enck, P. & Mazurak, N. (2018).

The comprehensive approach to diagnosis uses every available means to make the diagnosis as accurate and detailed as possible. Only this approach can lead to the selection of the most appropriate and individualized treatment. (E.g. A cardiologist seeing an abnormal EKG may order an echocardiogram. If that does not reveal the problem, he/she may order a stress test.). In most cases the pursuit will not stop until an answer is

found. This is an escalation in diagnosis and should always precede any escalation in therapy.

References:

Chantaracherd, P., John, M. T., Hodges, J. S. & Schiffman, E. L. (2015). Temporomandibular joint disorders' impact on pain, function, and disability. *J Dent Res.* 94(3 Suppl), 79S-86S. PMID: 2557211

Chaturvedi, S. K. & Desai, G. (2013). Measurement and assessment of somatic symptoms. *Int Rev Psychiatry.* 25(1), 31-40. PMID: 23383665

Enck, P. & Mazurak, N. (2018). The "Biology-First" Hypothesis: Functional disorders may begin and end with biology-A scoping review. *Neurogastroenterol Motil.* 30(10), e13394. PMID: 29956418

Hedenberg-Magnusson, B., Ernberg, M. & Kopp S. (1999). Presence of orofacial pain and temporomandibular disorder in fibromyalgia. A study by questionnaire. *Swed Dent J.* 23(5-6), 185-92. PMID: 10901602

He, H. J., Zheng, L. L., Yu, J. F., Zhou, J. P. & Chen, J. (2018). Bone remodeling in patients with juvenile condylar resorption after stabilization splint treatment]. *Zhonghua Kou Qiang Yi Xue Za Zhi.* 53(12), 832-837. PMID: 30522207

Herzog A, Shedden-Mora MC, Jordan P, Löwe B. (2018). Duration of untreated illness in patients with somatoform disorders. *J Psychosom Res.* 2018 Apr;107:1-6. PMID: 29502757

Hüsing, P., Löwe, B. & Toussaint, A. (2018). Comparing the diagnostic concepts of ICD-10 somatoform disorders and DSM-5 somatic symptom disorders in patients from a psychosomatic outpatient clinic. *J Psychosom Res.* 113, 74-80. PMID: 30190052

Limburg, K., Sattel, H., Dinkel, A., Radziej, K., Becker-Bense, S. & Lahmann, C. (2017). Course and predictors of DSM-5 somatic symptom disorder in patients with vertigo and dizziness symptoms - A longitudinal study. *Compr Psychiatry.* 77, 1-11. PMID: 28535434

Limburg, K., Sattel, H., Radziej, K. & Lahmann, C. (2016). DSM-5 somatic symptom disorder in patients with vertigo and dizziness symptoms. *J Psychosom Res.* 91, 26-32. PMID: 27894459

Mauricio, M. C. & Omar, R. G. (2018). Mandibular Condylar Aplasia Treated with a Functional

Appliance: A Five years Follow Up. *J Clin Pediatr Dent.* 42(5), 398-400. PMID: 29763346

Porto De Toledo, I., Stefani, F. M., Porporatti, A. L., Mezzomo, L. A., Peres, M. A., Flores-Mir, C. & De Luca-Canto, G. (2017). Prevalence of otologic signs and symptoms in adult patients with temporomandibular disorders: a systematic review and meta-analysis. *Clin Oral Investig.* 2017 Mar;21(2):597-605. PMID: 27511214

Radke, J. C., Kull, R.S. & Sethi, M. S. (2014). Chewing movements altered in the presence of temporomandibular joint internal derangements. *Cranio.* 32(3), 187-92. PMID: 25000160

Schellhas, K. P., Wilkes, C. H., Omlie, M. R., Peterson, C. M., Johnson, S. D., Keck, R. J., Block, J. C., Fritts, H. M. & Heithoff, K. B. (1988). The diagnosis of temporomandibular joint disease: two-compartment arthrography and MR. *AJR Am J Roentgenol.* 151(2), 341-50. PMID: 3260725

Sülün, T., Akkayan, B., Duc, J. M., Rammelsberg, P., Tuncer, N. & Gernet, W. (2001). Axial condyle morphology and horizontal condylar angle in patients with internal derangement compared to asymptomatic volunteers. *Cranio.* 19(4), 237-45. PMID: 11725847