

Etiology of temporomandibular disorders: the journey so far

Sonia Bhat¹

Abstract

Temporomandibular disorder is a chronic self limiting pain disorder. Over the years several theories have been proposed regarding its etiology. However, none of them could account for all the disorders that have come under the umbrella term temporomandibular disorders. The evolution of the etiological concepts from biomedical to the current biopsychosocial model makes for an interesting read. Earlier researchers looked only for a somatogenic cause. However, current research shows that psychological and social factors also play a major role.

Keywords: *Temporomandibular disorder, etiology, parafunctional habits, bruxism, biopsychosocial disorder*

Introduction

Temporomandibular disorders (TMD) is one of the most intriguing and controversial subject in the world of dentistry. In particular, the etiology of TMD's has been a subject of intense debate for several years now. In spite of all the technological advancements in diagnostic sciences, a conclusive and unanimous agreement regarding the etiology of this disorder is yet to be drawn. The term "TMD" encompasses various conditions, such as pain in the face or temporomandibular joint (TMJ) area, headaches, earaches, dizziness, masticatory musculature hypertrophy, limited opening of the mouth, closed or open lock of the TMJ, abnormal occlusal wear, clicking or popping sound in the joint, and other complaints.¹

Most of us general practitioners, at some point have had patients with few or all of the aforementioned signs and symptoms. Today's fast paced modern lifestyle is

conducive to these chronic pain disorders. So, one can expect an increase in such patients in our clinic. One must at least learn the basic know how of diagnosis of TMD in order to give the patient a fair chance at proper referral and treatment if not treating the patient ourselves. Treatment of any condition involves an accurate diagnosis which in turn entails finding the exact etiology. Unfortunately for many of the chronic pain disorders including TMD's, the search for exact cause or the initiating process and thereby the sequence of progression has been difficult, due to the nature of the disease. This article is an attempt to make a general practitioner understand the various proposed concepts, the controversies and the present consensus.

Etiological Concepts

It is clear that the myriad of signs and symptoms, varying degree of impairment in various individual with relatively similar physical findings and varying responses of the patients to various treatment modalities have added to the confusion regarding the etiology of the disorder. The concepts have evolved over the ages from a pure biomedical view to the present biopsychosocial model.

The etiological concepts in its earlier days of inception, were purely mechanistic; attributing the various signs and symptoms to derangement of a particular anatomical

¹ MDS. Assistant Professor, Dept of Prosthodontics
K.L.E dental college and hospital, Tumkur road, Bangalore

Corresponding author:

Dr Sonia Bhat c/o Dr Deepak Prasanna
no.129, 1st N block, 4th main, Rajajinagar
Bangalore, Karnataka, India 560010
Phone no (R) 080-23379659 • (Mob) 9845418304
E-mail: sonubhat@rediffmail.com

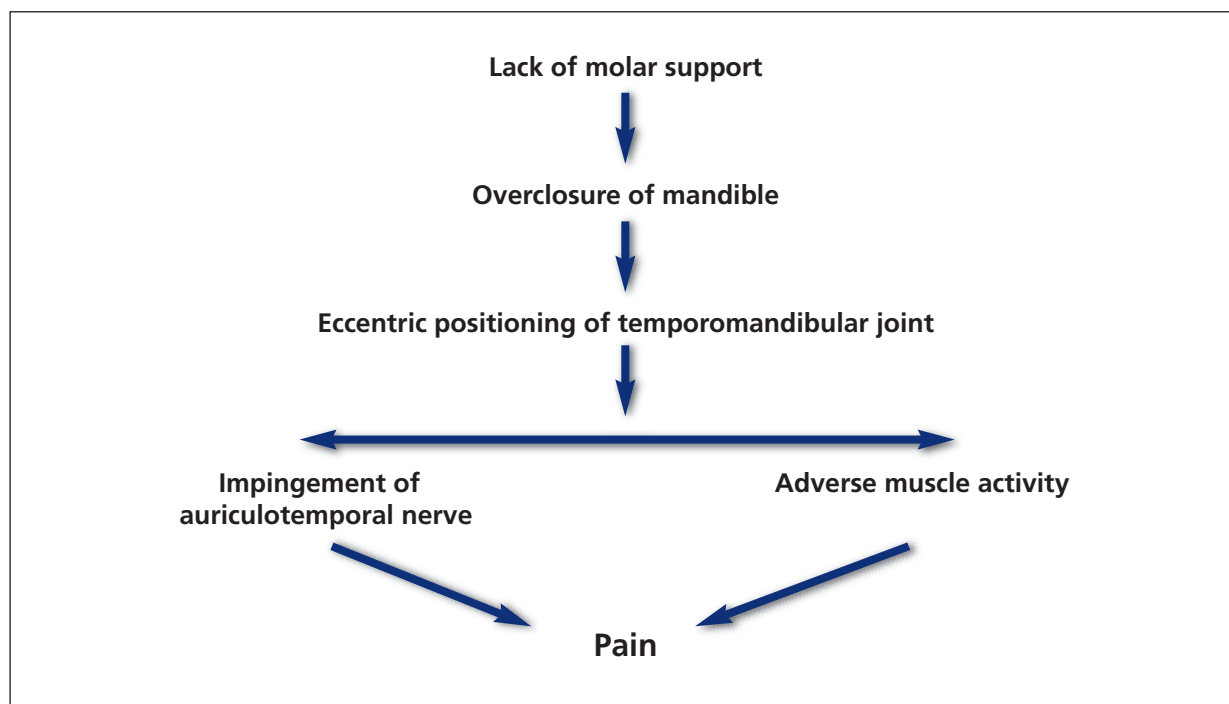


Figure 1: Mechanical Displacement Theory.

region (temporomandibular joint, muscles of mastication or the occlusion). The earlier theories were based on a biomedical model comprising

- The mechanical displacement theory
- The trauma theory
- The biomedical theory
- The osteoarthritic theory
- The muscle theory

The mechanical displacement theory hypothesized that the lack of molar support or functional occlusal prematurities caused a direct eccentric positioning of the condyle in the glenoid fossa, leading to pain, dysfunction and ear symptoms. The faulty condylar position led directly to adverse muscle activity (Figure 1). This theory gained momentum after Costen published his article focusing on occlusion as the most important causative factor for TMD. He proposed that due to the absence of molar support, the powerful elevating muscles of the mandible could press the condyles upward and backward causing damage to nerves and vessels including chorda tympani.²

The trauma theory proposed by Zarb and Speck³ considered micro-/macrotrauma as a principal factor that initiated pathologic processes and dysfunction in different parts of the stomatognathic system thus leading to the

symptoms of TMD. According to this theory any trauma which can cause structural alteration to the joint or the muscles is considered Macrotrauma. Microtrauma refers to any small force that is repeatedly applied to the joint structures over a long period of time. Consequently, even though the etiological premise of this theory was related to trauma, it was actually an earlier multidimensional etiological model. However, no critical appraisal for the multitude of factors involved was given in the causation of TMD.

The biomedical theory by Reade also supported the role of trauma in the initiation of the disorder. Once initiated, the condition will either resolve or in presence of certain factors like disrupted occlusion, parafunctional habits (particularly bruxism) and occupational activities, will progress further. Apart from factors causing increase or adverse functional loading, psychological elements were recognized as important maintaining influences. According to Reade (1984) "this theory would explain why similar occlusal interferences do not cause similar symptoms in different individuals and why all individuals with stress do not develop TMD".⁴

The osteoarthritic theory by Stegenga proposed osteoarthritis as the causative factor for TMD.⁵ According to this theory muscular symptoms and internal derangement were secondary to joint pathology.

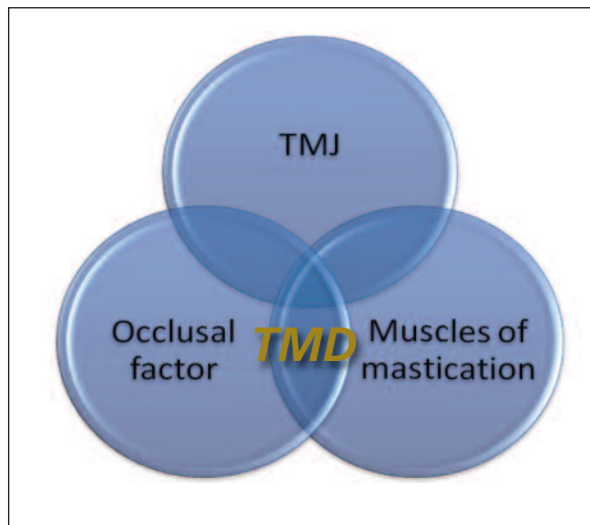


Figure 2: Theories related to physical factors can be summarized by this model.

Pathological changes in the TMJ could be induced by absolute or relative overloading. Absolute overloading of the joint can occur at the time of trauma. Relative overloading could happen if the adaptive capacity of the joint structures is reduced by inflammation and ageing. This theory can explain some subcategories of TMD, but lacks in its ability to explain all the other disorders under the TMD's.

The muscle theory supported by Travell and Rinzler, suggested that the primary etiologic factor was in the masticatory muscles themselves. It suggests that myalgia of masticatory muscles can refer pain to TMJ. The myalgia in the facial region is caused by chronic myospasm which is secondary to parafunctional habits. This theory placed the temporomandibular pain in the context of a wider general muscle disorder and denied any influence of the occlusion.⁶

The neuromuscular theory supported by Ramjford proposed that the occlusal interferences were the causative factor for the disorder. He noted that regional pain associated with bruxism and myalgia was completely eliminated in subjects after occlusal equilibration. This theory proposed that the occlusal interferences caused an altered proprioceptive feedback, leading to incoordination and spasm of some of the masticatory muscles.⁷ (Figure 2)

Slowly the idea of TMD's occurring outside the realm of physical factors started percolating through. Perhaps the very first attempt in this direction was made by Schwartz.

The psychophysiological theory by Schwartz and Laskin, suggested that the psychological factors are more important than the occlusal disturbances in initiating and

perpetuating TMD. Spasm of the masticatory muscles, caused by overextension, overcontraction or muscle fatigue due to parafunctions was used by patients as a means to relieve stress. According to this theory it is the interaction between physiological predisposition, and psychological stress which causes TMD. The effect on the individual depended on their ability to cope with stress.^{3,5}

Later several theories emerged based on the psychological and psychosocial factors. There is currently considerable evidence that psychological and psychosocial factors are of importance in the understanding of TMD as with other chronic pain disorders

The psychological theory proposed that emotional disturbances initiating centrally, induced muscular hyperactivity which led to parafunctional habits and so indirectly to occlusal abnormalities. It emphasizes emotional factors, particularly stress, whereby tense individuals clench their teeth creating a state of muscle contractility that leads to pain. In TMD patient the behavioural aspect of the patient needs to be studied. Several authors have confirmed the role of psychological factors in TMD.⁸⁻¹⁰ Various researchers have talked about the influence of personality,¹¹ mental attitude¹² and behavioral pattern¹³ of the patient on TMD. Despite ample support concerning the relevance of emotional and affective factors in TMD, it is still not clear whether they are the cause or the consequence of pain. Of importance is the recognition of somatization in the assessment and management of TMD, wherein there is a preoccupation with physical symptoms disproportionate to actual physical disturbance. Scientific literature confirms at least the following psychological and psychosocial dimensions as important in the assessment and management of TMD: affective disturbance (depression and/or anxiety), somatization and psychosocial dysfunction. Also poor correspondence between objective signs (peripheral dysfunctional aspects) and subjective symptoms (intrinsic and extrinsic central aspects of pain perception), maladaptive coping resources and excessive use of the health care system are considered important. There is now general agreement that all patients with TMD should be screened for psychological and psychosocial dysfunction.¹⁴

Gradually, concepts based on a single factor lost their scientific and clinical credibility. As it became more and more apparent that the etiology was multifactorial and that none of these theories in isolation could explain the etiologic mechanisms in TMD patients. The theories advanced from a pure mechanistic view, and expanded to a wider arena inclusive of psychological and behavioral

factors. This development also led to the conclusion that temporomandibular disorders were not a single disease but a collection of structural and/ or functional disorders resulting clinically in comparable and analogue complaints.¹⁵ It also became evident that, with respect to the multifactorial etiology, the same factor wielded a different importance in the etiologic process, by playing a role in initiation, precipitation or perpetuation of the symptoms.

The Multifactorial Concept

The TMJ and the stomatognathic system in general are affected by a large variety of pathological conditions with different prognosis. They often overlap with respect to their signs and symptoms thus making the differential diagnosis in the individual patient difficult resulting in diagnostic errors. It is now generally accepted that the etiology is multifactorial for TMD even though finding the primary etiologic factor can be difficult for the individual patient.^{16,17} It is likely that the etiology will be different in young and in older patients. With increasing age, there is an increased risk of age-related joint changes and systemic conditions affecting the TMJ.^{18,19} With ageing the reparative capacity of the articular cartilage is significantly reduced.²⁰ Also TMDs have been reported to be more common in females than males, with the highest prevalence among women of reproductive age.²¹

All the factors influencing the disorder have been categorized by Bell into the predisposing, initiating and perpetuating factors.²² The predisposing factors are generally subdivided into systemic, psychologic (personality, behavior) and structural (all types of occlusal discrepancies, improper dental treatment, joint laxity) factors. The initiating factors are trauma, micro and macro, adverse or overloading of joint structures, parafunctional habits. The perpetuating or sustaining factors include mechanical and muscular stress, behavioral, social and emotional difficulties (Figure 3).

The multifactorial theory was unable to explain the exact role the various factors played and could not differentiate whether the proposed factor were predisposing, activating or perpetuating in nature. This theory then gave way to the present biopsychosocial model of TMD.

In order to understand temporomandibular disorders, it is imperative that we learn the effect of various factors involved. Although the multifactorial model itself has been rejected, it is the integration of all these factors which cause TMD hence their relevance towards the study of this disorder still hold good and needs to be understood.

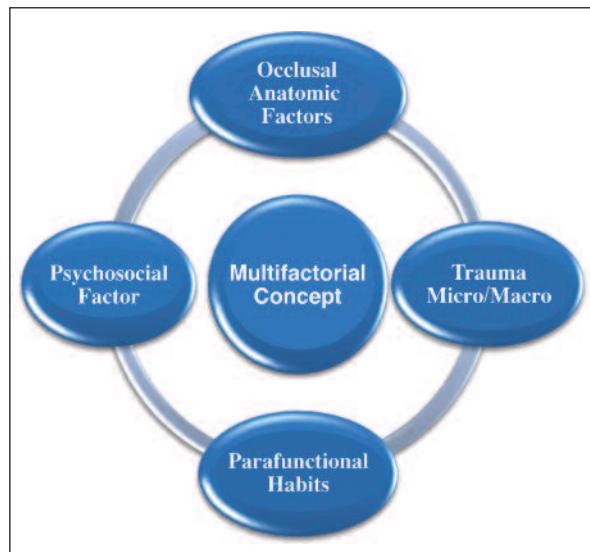


Figure 3: Model describing the multifactorial concept

Factors involved in temporomandibular disorders

a. Occlusal factors and anatomic predisposing factors

The etiologic role of occlusal factors is probably the most discussed and controversial one. Occlusal factors should, like all other factors, be considered as a contributing factor amongst the many causes and not as the single causative factor.^{7,23,24} The degree of occlusal disharmonies does not seem to be a good predictor for the severity of the dysfunction. Unstable occlusal conditions can be considered as a predisposing factor. Dolichofacial are likely to have an overload in the joints because a steep articular eminence has been reported to predispose for intracapsular derangement.²⁵

Studies on the influence of occlusion in TMD have described conflicting views with some clinical studies showing statistically significant correlations between the long-term influence of occlusal interferences and the occurrence and frequency of signs and symptoms of TMD,²⁶⁻³⁰ while others have proved that occlusal features have low predictive value to detect muscle disorders of stomatognathic system.³¹ The clinician should therefore assess the role of occlusal factors in initiating TMD only when all other factors have been ruled out.

Condylar position within the glenoid fossa also has been studied. Weinberg had showed a correlation between condylar position in the fossa and TMJ dysfunction (Figure 4). Anterior condylar displacement can affect the musculature by inducing over functional



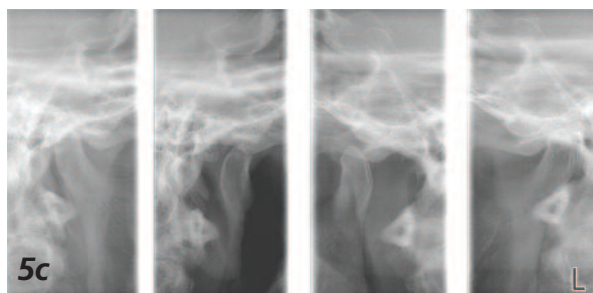
Figure 4: Orthognathic instability contributes to TMD; Note the asymmetrical mandible in this TMD patient.



5a



5b



5c

Figure 5a,b,c: Patient developed signs and symptoms of TMD post-traumatically; note the condylar subluxation on left side in The TMJ radiograph.

response in the proprioceptive system. Posterior condylar displacement usually results in an intrajoint response consisting of a disk derangement, reciprocal clicking, possible anterior disc dislocation, possible pathologic swallowing pattern and noxious stimulation to the proprioceptive system.³²

b. Role of parafunctional habits

Parafunctional habits such as grinding, clenching, nail and cheek biting are often mentioned as important co-factors in the etiology of TMD and can be classified under the group of neuromuscular factors.³³ Studies show that parafunctions, especially tooth grinding, are very common in the general population. This makes it difficult to evaluate clearly the impact of parafunctions on TMD in susceptible patients. Occlusal wear too has a multifactorial etiology, and bruxism is only one among many contributing factors.³⁴ Currently, bruxism is thought to be more related to stress and pain behavior than to structural components.³⁵ According to the psychophysiologic concept, vulnerable patients respond to stress with higher levels of masticatory muscle tension and show less habituation to stress. The concept that this hyperactivity of the masticatory muscles during nocturnal bruxism is correlated to TMD is reinforced because of the connection with bruxism and other psychophysiologic events of sleep.^{36,37}

c. Trauma

Trauma is an underestimated factor in the etiology of TMD. Trauma does not necessarily lead to intra-articular dysfunction and derangement but will have an influence on the masticatory muscles which are then more sensitive to palpation and show a high degree of tenderness. The trauma itself is, in most patients, an initiating etiologic factor.^{38,39} The anatomical asymmetry, which can be the sequel of a trauma, is most likely a sustaining factor because it leads to an asymmetric loading of the joints and thereby asymmetric contraction of the masticatory muscles. It is usually subdivided into microtrauma and macrotrauma.^{40,41}

Macrotrauma

Trauma is categorized as macrotrauma when any sudden force to the joint results in structural alterations. Epstein JB, in his study, found that nearly half of TMD-patients when investigated revealed a history of cervical hyperextension-hyperflexion injuries, blows to the jaw and the face, overextension of ligaments and joint capsule during prolonged dental treatment or general anesthesia.⁴² The

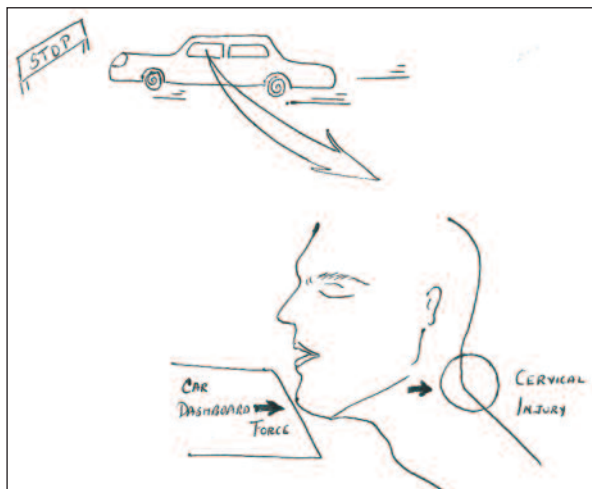


Figure 6 : Macrotrauma: whiplash injury: Sudden deceleration can cause injury to cervical spine which can later develop into TMD.

most common structural alterations affecting the TMJ are elongation of the discal ligaments. Macrotrauma can be further subdivided into two types; direct and indirect trauma.

Direct trauma to the mandible, such as a blow to the chin, can instantly create an intracapsular disorder. If such trauma occurs when the teeth are apart (open mouth trauma) the condyle can get suddenly displaced within the fossa and the sudden movement of the condyle is resisted by the ligaments, which then get elongated due to the high force, thereby altering the normal condyle-disc mechanics. The resulting increase in looseness can lead to discal displacement and to the symptoms of clicking and catching. Unexpected macrotrauma to the jaw (as might be sustained during a fall or in a motor vehicle accident) may lead to discal displacement or dislocation (Figure 5).

Macrotrauma can also occur when the teeth are together in intercuspatation (closed mouth trauma) and in such a scenario the intercuspatation of the teeth maintains the jaw position, resisting joint displacement. Closed mouth trauma is therefore comparatively less injurious to the condyle-disc complex. This reduction of potential injury becomes obvious when the incidence of injury associated with athletes who wear soft splints in mouth to keep teeth occluded all the time is taken into account.⁴³ Although ligaments may not be elongated in these cases, articular surfaces can certainly receive sudden traumatic loading altering the smooth sliding surfaces of the joint, causing adhesions.

Direct trauma may also be iatrogenically induced when the jaw is overextended, causing ligament elongation.⁴³ Individuals are more at risk for this type of injury if they have been sedated, altering the normal joint stabilization

by the supporting muscles. A few common examples of iatrogenic trauma are intubation procedures during general anesthesia, third molar extraction procedures, and a long dental appointment. Extended wide opening of the mouth such as during yawning, eating foods like burgers, sandwiches, etc has the potential of elongating the discal ligaments too.

Indirect trauma refers to injury that may occur to the TMJ secondary to a sudden force that does not directly impact or contact the mandible. The most common type is associated with cervical flexion-extension (whiplash) injuries seen in road traffic high speed accidents⁴⁴ (Figure 6). Although the literature reflects an association between whiplash and TMD symptoms, the data regarding the precise nature of this relationship is still lacking.⁴⁵ Patients with recent experiences of whiplash injuries have a greater incidence of TMJ pain, limited mouth opening, and masticatory muscle pain to palpation. All these symptoms can be explained as heterotropic symptoms associated with deep pain input from the cervical spine. Primary emphasis must therefore be directed to the management of the cervical injury.⁴⁶

Microtrauma

Microtrauma refers to any small force that is repeatedly applied to the joint structures over a long period of time. The dense fibrous connective tissues that cover the articular surfaces of the joints can well tolerate the loading forces but only within certain limits. The delivery of vital nutrients and the elimination of metabolic products by the synovial fluid may be impaired if articular tissues are subjected to excessive stress.^{47,48} If the loading exceeds the functional limit of the tissues, collagen fibrils become fragmented, resulting in a decrease in the stiffness of the collagen network. This allows the proteoglycan water gel to swell and flow out into the joint space, leading to a softening of the articular surface called chondromalacia.⁴⁸ This early stage of chondromalacia is reversible if the excessive loading is reduced. If, however, the loading continues to exceed the capacity of the articular tissues, irreversible changes can occur.

Microtrauma can result from joint loading associated with muscular hyperactivity such as bruxism or clenching. This may be especially true if the bruxing activity is intermittent and the tissues have not had an opportunity to adapt. Another type of microtrauma results from mandibular orthopaedic instability when the stable intercuspal position of the teeth is not in harmony with the musculoskeletally stable position of the condyles. When this condition exists, it results in microtrauma to the

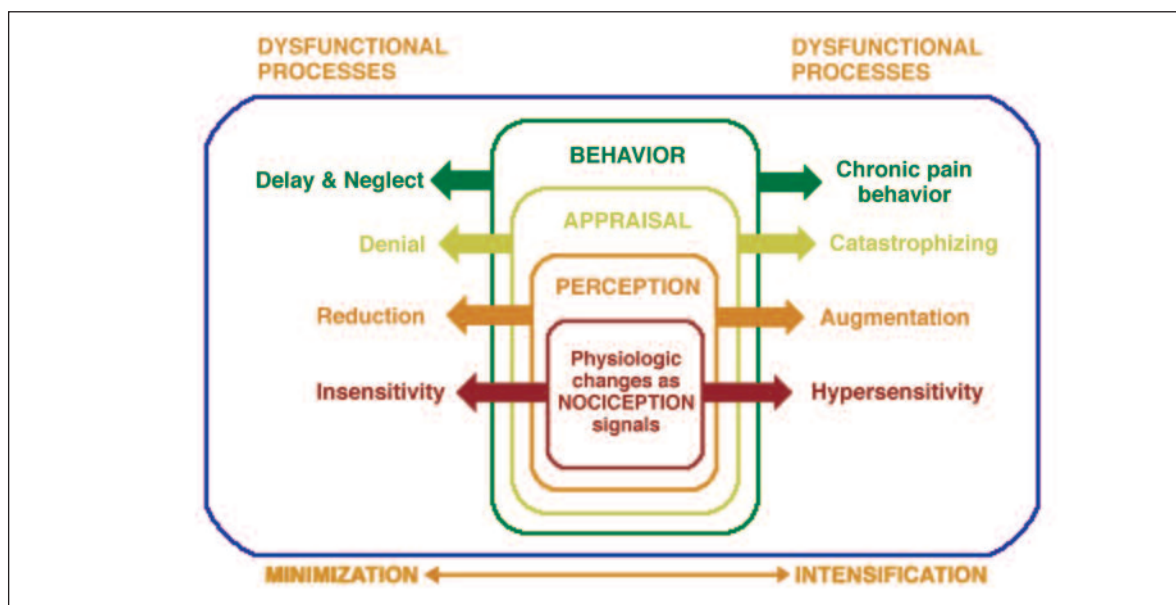


Figure 7: Biobehavioral Model of Pain by Dworkin et al., 1992.

joint. A common occlusal condition known to provide this environment is the skeletal class II deep-bite, which may be further aggravated with a division 2 anterior relationship. On the contrary Gesch in a review of population based studies on association of malocclusion and functional based occlusion with signs and symptoms of TMD had found that some occlusal factors were partly protective for TMD, ie, subjects with angle Class II malocclusion, deep bite, anterior crossbite, occlusal parameters showed fewer signs and symptoms of TMD.⁴⁹

d. Psychological and behavioral factors

It has now been established that psychological and behavioral aspects are strongly related to TMD not only as initiating but also as predisposing and perpetuating factors. In most studies it is a consistent finding that the TMD sufferers show more anxiety and, most likely, signs of depression too. Yemm, in a review of what type of persons suffer from mandibular dysfunction, stated "available evidence, as well as clinical impressions, suggests that temporary states of mind (emotional states) are more likely to be associated with the dysfunction condition, the most frequent of which is anxiety. Patients with higher anxiety levels have more excitable muscles than those with lower anxiety scores.⁵⁰ TMD patients also have a more increased muscular activity under experimental stress than a general increase in body muscular tonus. These patients have higher rates of depression, somatization and health care utilization.^{50,51}

The biopsychosocial Model

The biopsychosocial model attempts to integrate both the physical disorder factors, i.e., biological factors as well as the illness impact factors, i.e., psychological and social factors. In 1992, Dworkin and his colleagues reviewed epidemiologic and relevant clinical studies in TMD and presented a comprehensive biopsychosocial model of chronic pain development and experience that was especially applicable to TMD research and an understanding of TMD pain. It integrated dynamic and multilevel (physiologic, psychologic and social) factors at different stages in the development of pain and pain dysfunction thus reflecting for the first time comprehensive biopsychosocial perspective (multidimensional aspects) of TMD. More specifically, this model showed the dynamic nature of intrinsic intrapersonal factors (such as nociception, pain perception, pain appraisal) and extrinsic interpersonal factors (behaviour responses to pain, social roles for the person in pain within the context of the family, the health care delivery system, the workplace, and the social welfare system) in chronic pain, including TMD. The model showed how these factors could be intensified or minimized and how augmentation of pain perception, appraisal and pain behaviours can lead to chronic TMD pain dysfunction.⁵² One of the most widely studied instruments in this orientation is the RDC/TMD, which conceptualizes TMD according to a two-axis system, one for the physical disorder factors (Axis I) (Figure 7) and the other for the psychosocial illness impact factors (Axis II)

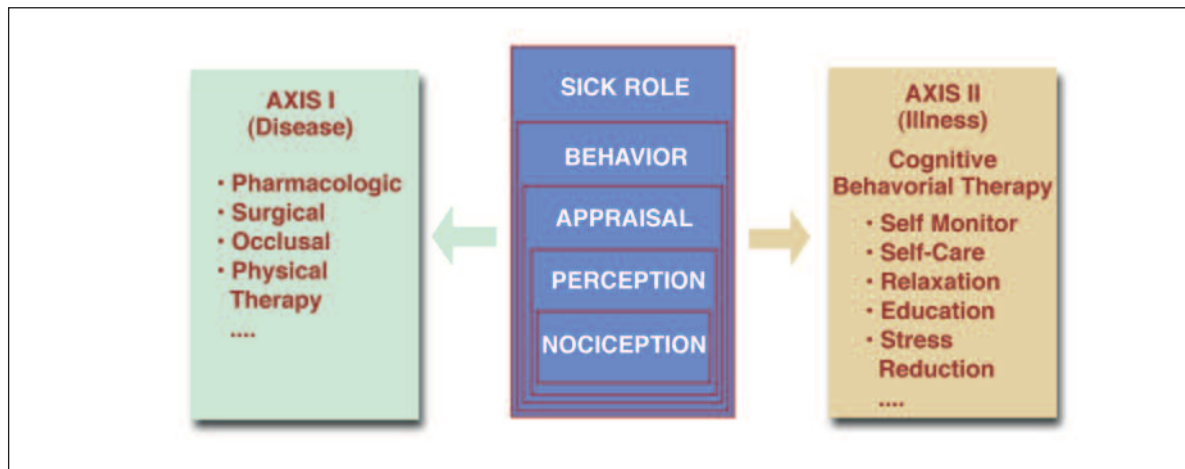


Figure 8: Biophysical Model Domains for Treatment Interventions.
 (Figures 7 and 8 taken from: *Interactive textbook on clinical symptom research Mitchell B Max MD& Joanne Lynn MD*)

(Figure 8). The RDC/TMD has been accepted in the scientific community worldwide, including the establishment of an international consortium of RDC/TMD-based researchers.⁵³

As there is now support that TMD are to be conceptualized as musculoskeletal biopsychosocial disorder with considerable chronicity, careful initial history taking is a key to successful assessment and management. It should parallel the medical model and include the chief complaint/s, associated symptoms/signs, history of present illness, medical history, dental history and personal history. All precipitating, initiating, alleviating, aggravating, contributing and maintaining factors should be carefully assessed, including psychosocial status and illness impact factors, as well as any previous treatment and their outcome. There are now general guidelines available for the screening purposes, for comprehensive clinical assessment and for research purposes, as well as for psychosocial illness impact assessment.^{8,10,54}

Conclusion

Over the years several theories have been proposed and rejected regarding the etiology of temporomandibular disorder. Currently the biopsychosocial model is the most accepted theory. The search for the etiology of the temporomandibular disorders is by no means over. In my opinion we are much closer to the answers today than we ever were. A more institutionalized approach wherein patient has access to specialist from numerous fields will definitely help us gain a better insight. Longitudinal prospective studies are required to test the role various factors play in initiating and propagating the disorder.

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