



## Review

# Temporomandibular Disorders: Fundamental Questions and Answers

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### Main points:

- Orthodontic treatment does not appear to either prevent or relieve temporomandibular disorder (TMD) to a great degree.
- Occlusal splints accompanied by occlusal reconstruction have shown satisfactory results in treating TMD.
- The occlusion should be treated using a holistic approach, that acknowledges the dynamic, morphological and functional interrelationship between occlusion, joint and muscles.
- Panoramic radiograph is not a reliable method to evaluate the bony structures of the temporomandibular joint.
- Depressed mood is fairly common in patients with chronic TMD.

## ABSTRACT

This review aimed to present the current evidence-based answers to a questionnaire which was developed to evaluate the beliefs and knowledge of dental professionals concerning temporomandibular disorder (TMD). A literature review was conducted using the PubMed/Medical Literature Analysis and Retrieval System Online (MEDLINE), Cochrane, Google Scholar, and Scopus search engines from January 1980 to June 2020 corresponding to TMD diagnosis, causes, management, and consequences. A total of 50 articles were considered relevant and selected for full review. The etiology of TMD is multifactorial and complicated and involves several direct and indirect factors. Orthodontic treatment does not appear to either prevent or relieve TMD to a great degree. Nevertheless, condylar and occlusal stability reduces the risk of TMD development. As a result, an assessment of the function of masticatory system prior to beginning orthodontic therapy is fundamental. If signs and symptoms of TMD are significantly present, they should be managed before any orthodontic intervention. Moreover, psychological disorders are strongly associated with joint and facial pain. Thus, professionals who work with chronic TMD patients need to be aware of the psychological aspects of chronic pain and refer the patient for psychological evaluation when warranted. Future research elucidating a cause-effect relationship and neurobehavioral processes underlying chronic pain should be performed.

**Keywords:** Diagnosis, etiology, questionnaire, temporomandibular disorder, treatment

## INTRODUCTION

Temporomandibular disorder (TMD) is a broad term referring to all neuromuscular and musculoskeletal conditions of the masticatory muscles, temporomandibular joint (TMJ), and the adjacent structures (1). TMD is described as the most common orofacial pathology of non-dental origin, and it affects mostly women and those aged 20-45 years (2). The most frequent clinical features are chronic myofascial pain, masticatory muscle pain, and limited range of mouth opening (3). However, other symptoms, such as earache, headache, neuralgia, and toothache, may also be present (4). Although the etiology of TMD is complicated, it is likely multifactorial with biomechanical, neuromuscular, psychosocial, and biological influences. Plausible causes involve trauma, functional shift, parafunctional habits, occlusal overloading, increased joint friction, depression, stress, anxiety, and alexithymia (5). The role of each of these potential components is still controversial, and they can contribute either independently or collectively (6). TMD treatment is classified as non-invasive, mini-invasive, and invasive. Although each of these treatment modalities provides favorable results in reducing TMJ pain, no specific therapy

has been shown to be predominantly effective over the other (7). Moreover, one determinant of successful TMD treatment, which is frequently overlooked, is the practitioner's knowledge and beliefs concerning the disorder itself. Thus, patients are often misdiagnosed and undergo various therapies for unrelated disorders; a fact that often leads to frustration, dissatisfaction, and compromised quality of life (8).

In 1993, Le Resche, Truelove, and Dworkin (9) developed a survey to evaluate the knowledge and beliefs of general dentists. The questionnaire included 4 fields of study: pathophysiology, chronic pain, psychophysiology, and psychiatric disorders. Items were answered on an 11-point scale, ranging from 0 "strongly disagree" to 10 "strongly agree." Since then, multiple scientific articles have used the questionnaire for surveying either general dentists and/or orthodontists (10, 11). In 2016, the questionnaire was modified by Porto et al. (12) to meet the current diagnostic and treatment standards. The aim was to evaluate the changes in experts' knowledge and beliefs about TMD after the administration of the first such survey by Le Resche, Truelove, and Dworkin in 1993. The results showed that the knowledge and beliefs related to TMD have not significantly changed in the past 20 years. Thereafter, the specific updated survey has been used again to assess the awareness of both general dentists and orthodontists about TMD (13).

This study aimed to answer the 38 questions of the questionnaire of Porto et al. (12) as an attempt to update the knowledge of dental professionals, as well as, to present the current evidence-based knowledge concerning the etiology, diagnosis, consequences, and management of TMD. A literature review was conducted using the PubMed, Medical Literature Analysis and Retrieval System Online (MEDLINE), Cochrane, Google Scholar, and Scopus search engines from January 1980 to June 2020 corresponding to TMD diagnosis, causes, management, and consequences. A total of 50 articles were considered relevant and selected for full review.

## CLINICAL AND RESEARCH CONSEQUENCES

In this study, the questionnaire of Porto et al. (12) was used as a reference point to answer controversial issues of TMD in the following 4 domains: pathophysiology (Table 1), chronic pain (Table 2), psychophysiology (Table 3), and psychiatric disorders (Table 4).

### Pathophysiology Domain of Temporomandibular Disorder

#### Occlusal equilibration

Occlusal equilibration involves selective iatrogenic grinding of dental surfaces to increase intercuspation in the centric relationship or to enhance guidance during excursions. Treatment objectives include the establishment of an acceptable centric relation with a harmonious intercuspation position and an acceptable lateral and protrusive guidance. However, clinicians are recommended to avoid this method as an initial TMD therapy in the absence of restorative prematurities, because it is not confirmed by any solid biological background or analogy with other musculoskeletal

**Table 1.** Pathophysiology domain and the most highly rated answers among orthodontists in the questionnaire of Porto et al. (12)

Statement	Score (%)
Occlusal equilibration is a useful early treatment for TMD.	50.4 disagree
Orthodontic treatment can prevent the onset of TMD.	59.8 disagree
Arthroscopic surgery is almost completely effective in repositioning the disc in patients with internal derangements.	58.1 disagree
Orthodontic therapy is the best treatment to resolve TMD in a patient with a skeletal malocclusion.	67.5 disagree
TMD caused by trauma is much more difficult to treat and has a far worse prognosis than other types of TMD.	33.1 agree
Panoramic film is a reasonable method to evaluate the bony structures of the TMJ.	66.7 disagree
When bony changes are seen on a panoramic film, a tomogram is mandatory to define the treatment plan.	45.7 agree
The presence of arthritic changes on tomograms, along with crepitus in the joint, indicates the need for treatment.	48.5 disagree
The position of the condyle in the fossa as seen on the tomogram is a very accurate indicator of internal derangement.	53.8 disagree
Mandibular repositioning splints are more effective than maxillary repositioning splints.	47.5 disagree
Splint therapy is only effective when the splint is used for more than 16 hours/day.	40.8 disagree
Nocturnal bruxism is caused by occlusal interference.	71.2 disagree
Ice packs and/or heat packs and passive muscle stretching are good early treatments for TMD.	74.7 agree
All individuals with clicking TMJs require treatment.	96.2 disagree
Balancing interference is commonly related to TMD.	34.5 agree

TMD: Temporomandibular disorder; TMJ: Temporomandibular joint

**Table 2.** Chronic pain domain and the most highly rated answers among orthodontists in the survey of Porto et al. (12)

Statement	Score (%)
PRN narcotics ("as needed" for pain) are a treatment of choice when TMD pain is severe.	55.3 disagree
Antidepressants are never indicated in the management of TMD.	60.1 disagree
An extensive history of previous treatment failures in a patient with TMD is usually an indication for surgery.	55.7 disagree
Chronic pain is a behavioral as well as a physical problem.	63.4 agree
Although some patients with TMD have psychological problems, these problems are usually unrelated to their pain.	70.8 disagree
Poor quality of sleep is a major factor in the development of TMD.	21.1 agree
Difficulty with sleep is a common finding in chronic pain.	72.2 agree
Some patients use pain as an excuse to avoid unpleasant chores.	41 agree
Behavior modification treatments are appropriate for patients with chronic TMD pain.	69.4 agree
Patients with chronic TMD should be advised to rest and limit their work and social activities when they are experiencing pain.	34.1 disagree

TMD: Temporomandibular disorder; PRN: Pro re nata

**Table 3.** Psychophysiology domain and the most highly rated answers among orthodontists

Statement	Score (%)
The mechanisms of acute and chronic pain are the same.	82.6 disagree
Biofeedback can be useful for treating TMD.	64.9 agree
Oral parafunction habits are often significant in the development of TMD.	71 agree
Patients with TMD who clench/brux do so either during the day or at night, but not both.	78.6 disagree
Stress management is indicated in many patients with TMD.	89.8 agree
Stress is a major factor in the development of TMD.	78.3 agree
Tension and stress increase jaw muscle EMG levels in susceptible patients.	79.6 agree
Progressive muscle relaxation is not an effective treatment for TMD.	61 disagree
Information on the daily pattern of the TMD symptoms can be helpful for identifying contributing factors.	91.7 agree

TMD: Temporomandibular disorder; EMG: Electromyography

**Table 4.** Psychiatric domain and the most highly rated answers among orthodontists

Statement	Score (%)
Clinical depression is rare in patients with chronic TMD.	65.2 disagree
Depressed mood is fairly common in patients with chronic TMD.	70.1 agree
Anxiety disorders are more common in patients with TMD than in the population at large.	49.7 agree
Depression can be an important etiologic factor in chronic pain.	73.5 agree

TMD: Temporomandibular disorder

areas. The two major drawbacks are the irreversibility of the technique and the possible development of tooth sensitivity (14).

### Cryotherapy

Cryotherapy includes the application of the local use of low temperatures in a traumatic and/or inflammatory region. Local effects involve vasoconstriction and reduction of inflammation, pain, and muscle spasms. Nonetheless, scientific data proving its efficacy are insufficient, probably owing to the introduction of more updated techniques, such as ultrasound and transcutaneous electrical stimulation (15).

### Orthodontics and Temporomandibular Disorder

Whether abnormal skeletal characteristics cause TMD or vice versa has not been clearly clarified yet in the literature. Although, TMD has been associated with posterior crossbite, anterior open bite, Angle Class II and III malocclusions, and increased overjet (16). Some acute malocclusions (sudden occlusal changes) might also arise as a consequence of a joint or muscle disorder. Even though, recent studies have concluded that orthodontic treatment cannot prevent TMD to a great degree. Since, the difference of TMD incidents between orthodontically treated and

untreated subjects was not statistically significant (2, 17, 18). Orthodontists should recognize how occlusion can become a risk factor for TMD and incorporate an orthopedic approach in cases of TMD symptomatology to establish both condylar and occlusal stability. In more detail, occlusal splints accompanied by occlusal reconstruction have shown satisfactory results in treating TMD (19-21). Imai et al. (21) concluded that 60% of patients achieved pain relief following the aforementioned approach. Moreover, TMD symptoms are not likely to reoccur following the establishment of balanced occlusion and proper alignment after orthodontic treatment.

### The Role of Panoramic Radiography in the Temporomandibular Disorder Diagnosis

Although panoramic radiography is the most common initial diagnostic tool in dentistry; it fails to exclude significant morphological abnormalities in TMJ. More specifically, due to the superimposition of the skull base and the zygomatic arch, only excessive alterations in the articular tubercle can be observed. Therefore, bony changes, such as erosions and osteophytes, are difficult to be detected in conventional radiographs. Cone-beam computed tomography (CBCT) is considered superior to 2D radiography in illustrating the condylar head morphology and evaluating the presence of condylar deformities, such as osteoarthrosis. On the other hand, magnetic resonance imaging (MRI) is the recommended imaging modality for the evaluation of the disc-condyle relationship, the soft tissues, and for the diagnosis of the disc displacement (22). As a result, the use of fused MRI and CBCT images to visualize the TMJ in a single display can significantly improve the examiners' reliability and accuracy of assessment of disc positions.

### Temporomandibular Osteoarthritis

When osteoarthritic changes are observed in 2D radiographs, an extended and detailed inspection of the patient's medical history and a scrupulous physical examination should be performed as well. Clinical features indicating TMD include joint tenderness, crepitus, and pain during mouth opening and lateral movements. The information gathered should be integrated with CBCT imaging to exclude any differential diagnosis. Radiographically, the disease includes cortical bone erosion and degenerative bone changes, such as sclerosis, flattening, subchondral cysts and osteophytes. The abovementioned signs of temporomandibular osteoarthritis (OA) correspond to different disease stages. Erosive lesions and reduction in joint space indicate acute or early stages; whereas sclerosis, flattening, subchondral cyst, and osteophytes illustrate the later stages of OA (23). However, even when the aforementioned radiographic changes are observed, TMD treatment is indicated only if both symptomatology and considerably limited function are present.

### Occlusal Splint Therapy

Dental occlusal splints have been the mainstay of TMD treatment over the past decades in cases of discopathies and inflammatory/degenerative changes. The advantages of occlusal splints include occlusal stability, balance in centric relation, as well as reduction of tension and pain in the joint and the adjacent tissues. The opinion that splints must be used for at

least 16 hours/day to be effective has not been proved yet in the literature (24). Thus, a prospective study could clarify the relationship between the hours of application of occlusal splints and their effectiveness in establishing condylar stability. Moreover, clinical comparisons between the maxillary and mandibular occlusal splints have shown no significant differences in their treatment outcomes. More specifically, maxillary and mandibular splints seem to be equally beneficial in reducing TMD signs and symptoms. The maxillary appliance provides a better stabilization than the mandibular appliance because all of the mandibular teeth can contact against a flat surface. The choice of maxillary or mandibular splint depends mostly on clinical observations. As a case in point, fabricating the appliance on the arch with missing teeth increases the intercuspal contacts and thus equilibrates the occlusion. Furthermore, in patients who are expected to benefit from daytime application, a mandibular splint, which is rather less noticeable and produces fewer speech problems, is more fitting. While, in cases of severe overjet, the construction of anterior and lateral canine guidance is easier established with maxillary stabilization splint. If the appliance is to be worn only during sleep, the majority of dentists choose maxillary occlusal splints, although this choice is considered more like a pattern of tradition (25).

#### Clicking of the Temporomandibular Joint

Clicking occurs when the condylar head extends over the edge of the displaced articular disc during mouth opening and/or closing. Thus, clicking alone is not an indication for TMD treatment. However, when clicking sounds are noted, a detailed clinical evaluation should be performed. This includes evaluation of the occlusion, detection of occlusal interferences, joint palpation, and assessment of the masticatory muscles (26).

#### Arthroscopy

TMJ arthroscopy serves as either a diagnostic procedure or a minimally invasive TMD treatment for internal derangement with arthroscopic lysis or lavage. Joint visualization ensures accurate stage diagnosis and identification of OA. Moreover, arthroscopy includes fluid infusion under pressure to expand the TMJ and to break any adhesions that are liable for reduced condyle movements. The success rate in internal derangement cases is high in terms of pain relief and maximum mouth opening. In a recent systematic review, arthroscopy lysis and lavage were found to have superior efficacy in functional outcome and degree of pain control than arthrocentesis (27).

#### Balancing Interference

The relation between occlusal interference and TMD shows no consensus in the literature yet. Though, it has been proven that occlusal interferences might cause minor transient changes in the myoelectric contraction patterns of the jaw muscles and short-term clinical symptoms and signs, such as pain and fatigue of the jaw muscles, headache and clicking (28). Other studies support the individual differences in vulnerability to occlusal interference, such as a previous history of TMD or even psychological factors. Therefore, further research and more updated methods are required (29).

#### Trauma Cases and Temporomandibular Disorder

Trauma can be divided into macrotrauma (for example, whip-lash-type injury) and microtrauma (for example, parafunctional habits). Traumatic microlesions of the masticatory muscle fibers release local inflammatory mediators, such as bradykinin, prostaglandins, substance P, and histamine. These substances can transmit nociceptive impulses to the central nervous center, triggering both peripheral and central sensitization. Trauma is defined as a predisposing or initiating cause of TMD. A study including 400 patients with TMD revealed that TMJ pain was directly related to a positive history of whiplash trauma in 24.5% of the patients (30). However, there are no scientific data to confirm that treating patients with TMD with a trauma history is a more arduous task than treating patients with TMD with differential diagnosis (14).

#### Chronic Pain Domain of Temporomandibular Disorder

##### Medical Treatment of Temporomandibular Disorder

Pharmaceutical treatment of TMD includes non-opioid analgesics (acetaminophen), mild opiates (tramadol hydrochloride), anti-inflammatory drugs (ibuprofen and diclofenac), and/or muscle relaxants (tetrazepam).

Pro re nata (PRN) narcotics can be prescribed to alleviate acute pain symptoms when non-steroidal anti-inflammatory drugs are contraindicated. In any case, both careful selection of patients and prescription at regular intervals for a specific period (for example, 3 times a day for 10 days) are mandatory. Owing to the significant reduction in intracapsular pain, opioids may also be injected intra-articularly. List et al. (31) concluded that intra-articular morphine increases the pain threshold of the affected joint. Narcotics prescribed to alleviate chronic pain associated with TMD should be eschewed due to the increased risk of abuse, tolerance, and addiction.

Antidepressants can alleviate TMD pain because of their analgesic impact on chronic pain, independently of their antidepressant effect. Tricyclic antidepressants (TCAs) appear to be the most efficient in controlling chronic pain; 25 mg/day of amitriptyline is adequate in reducing pain and discomfort in patients with TMD (32). However, it has been suggested that the effects of amitriptyline are equal to those illustrated in the placebo groups. Thus, the reported benefits of amitriptyline are plausibly based on the difficulty most patients have in measuring subjective sensations of pain and discomfort. Moreover, typical side effects include xerostomia, sedation, memory impairment, constipation, and orthostatic hypotension (33).

Other antidepressants, which are frequently prescribed to patients with TMD, are selective serotonin reuptake inhibitor antidepressants (SSRIs). These medications provide greater compliance rates owing to the reduced incidence of side effects than TCAs. Moreover, SSRIs result in fewer antihistaminergic, anticholinergic, and antiadrenergic incidences. However, gastrointestinal disturbances, headache, sexual dysfunction, dry mouth, and excessive sweating are some of the adverse drug reactions (34).



### Indications of Invasive Temporomandibular Disorder Treatment

Absolute indications of surgical interventions include ankylosis (fibrous or osseous joint fusion), neoplasia (osteochondroma), developmental disorders (condylar hyperplasia), and dislocation (chronic or recurrent), whereas relative indications are internal derangement, arthritic conditions, and trauma (35).

### Psychological Disorders and Temporomandibular Disorder

TMD is a somatic and psychological condition involving fatigue, sleep disturbances, anxiety, and depression. Psychological problems (e.g. depression and anxiety) may cause stress to the TMJ and masticatory muscles via the stimulation of the sympathetic nervous system (36). In addition, current research has confirmed the relationship between psychological disorders/dysfunctions and chronic pain (37). At this point, it should be noted that patients with a high level of psychological distress benefit from multimodal treatment approaches (38).

### Sleep Quality in Patients with Temporomandibular Disorder

The relationship between pain and sleep quality in patients with TMD is well documented. Patients with TMD show a high prevalence of sleep disorders. Nevertheless, whether TMD is the cause rather than the result of sleep disorders has not been clarified yet in the literature (39). According to a recent systematic review, patients with TMD have two or more sleep disorders in a percentage of 43%, with insomnia (36%) and sleep apnea (28.4%) as the most frequent (40).

### Behavioral modification

Although, the effectiveness of behavioral modifications in chronic pain management is unable to be demonstrated scientifically, owing to the lack of a standard treatment methodology; in general, the combination of cognitive-behavioral treatment concentrating on somatization, readiness, and self-efficacy provides beneficial outcomes in managing chronic TMD pain (41).

Moreover, despite the consequences of TMD pain on physical and psychological health, practitioners should encourage their patients to maintain an adequate activity level and correct posture, abstain from excessive rest, and perform various chores when physically feasible.

### Psychophysiology Domain of Temporomandibular Disorder

#### Pain mechanisms

The mechanisms of acute and chronic pain differ greatly from one another. The alteration from acute to chronic pain occurs in a pathophysiological and histopathological manner. The stimuli initiating a nociceptive response vary; however, the mechanism of interaction between the receptors and the peripheral internal defense system is similar (42).

#### Biofeedback

As mentioned earlier, psychological factors, such as stress, mental tension, anxiety, or depression, may be involved in TMD. To improve the effectiveness of TMD treatment, patients should overcome their stress and other TMD-associated psychological factors via bio-behavioral treatment and other treatment ap-

proaches, such as therapeutic education, cognitive-behavioral therapy, and methods of physiological self-regulation.

Biofeedback regulates muscle tension and decreases muscle pain. This method provides extrinsic feedback that otherwise would be unknown to the recipient. Thus, patients acquire supplementary information in addition to the intrinsic feedback, which is naturally acquired.

Electromyography (EMG) biofeedback is the technique of getting feedback from the body to measure the frequency, intensity and duration of muscle spasms. It can be used to either enhance the activity of weak muscles or to attenuate the tone of muscle spasms (43). Shedden Mora et al. (44) have found that patients undergoing biofeedback-based cognitive-behavioral therapy showed greater improvement in pain coping skills and increased satisfaction than those following an occlusion-centered approach.

#### Parafunctional habits

Parafunctional functions are one of the main evidence-based causes of TMD. Oral parafunctions include bruxism, clenching, excessive gum chewing, lip/nail biting, and non-nutritive sucking. A recent study has shown that excessive gum chewing (more than 4 hours/day) is positively correlated with auricular pain and either clicking or clenching. It should also be noted that 87.5% of individuals with disc displacement and TMD pain are bruxers (14).

#### Electromyography Levels of Patients with Temporomandibular Disorder

It has been proven that stress and tension are associated with increased EMG levels in the jaw muscle. Tsai et al. (45) concluded that the EMG activity of the masticatory muscles was increased significantly under conditions of induced stress. Therefore, progressive muscle relaxation is considered an effective therapeutic method for TMD to increase the range of motion and decrease pain.

Identifying the factors contributing to TMD and educating the patients to relieve stress is one of the most challenging aspects. Preferably, a daily symptom pattern should be used as a guide. However, when the identification of the daytime contributing factors cannot be accomplished, patients should record the incidents of pain, clenching, and masticatory muscle tension together with the associated events on an hourly basis. This often helps the patients to identify which events are mostly related to their pain. Patients may require additional psychological support in ways to relax and/or break habits (46).

#### Psychiatric Domain of Temporomandibular Disorder

##### Depression

TMD is strongly associated with elevated levels of depression and anxiety, and women are more susceptible to severe depression. Women show an increased level of monoamine oxidase, an enzyme that metabolizes norepinephrine, serotonin, and dopamine, owing to premenstrual and postmenstrual hormonal changes (47). However, depression is also associated with articular pain (48).

## Anxiety

The link between chronic pain and mental balance seems to have a bidirectional etiology, with pain-causing fluctuations in mental balance and vice versa. The level of anxiety is directly associated with muscle hyperactivity and facial pain. Nevertheless, anxiety shows no significant differentiation between the sexes (49). Moreover, conditions such as generalized anxiety disorders and social anxiety disorder increase the risk of developing TMD (50).

## CONCLUSION

TMD is the most frequent type of non-odontogenic orofacial pain, which often results in compromised welfare of individuals with TMD. As a result, it has been the stimulus for a plethora of research investigations. However, despite the plethora of studies, there is a lack of comprehensive, unified, and systematic characterization of the etiology, diagnosis, and treatment of TMD. On the positive side, a consensus has been reached on four points: First, orthodontic treatment does not appear to either prevent or relieve TMD to a great extent. Nevertheless, condylar and occlusal stability reduces the risk of TMD development. Second, panoramic X-rays do not show valid morphological changes in the TMJ. Third, PRN narcotics and antidepressants can both be prescribed for pain relief to TMD patients. Psychological disorders, such as depression and anxiety, are strongly associated with joint and facial pain. Finally, yet importantly, current evidence supports the positive effect of biofeedback-based cognitive-behavioral therapy on the pain coping skills of individuals with TMD. Future research elucidating the cause-effect relationship and neurobehavioral processes underlining chronic pain is warranted.

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