Review Article

Beyond Occlusion: The Biopsychosocial Paradigm of Temporomandibular Disorders – A Periodontal Perspective with Orthodontic Implications

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Abstract:

Background:

Temporomandibular disorders (TMD) represent a heterogeneous group of musculoskeletal conditions affecting the temporomandibular joint (TMJ), masticatory muscles, and associated structures. Historically, orthodontics was closely linked to TMD causation, with occlusal discrepancies once believed to be primary etiological factors. Contemporary evidence, however, rejects this simplistic mechanistic view, instead supporting a biopsychosocial framework that acknowledges the interplay of biological, psychological, and social determinants.

Aim:

To provide a comprehensive review of the biopsychosocial paradigm of TMD and critically examine its implications for orthodontic diagnosis, treatment planning, and patient management.

Methods:

A narrative literature review was conducted using evidence from systematic reviews, meta-analyses, consensus guidelines, DC/TMD publications, and orthodontic-TMD outcome studies published between 1990 and 2025.

Results:

Modern research indicates that occlusion plays a minor, non-causal role in most TMD cases. Psychological stress, central sensitization, maladaptive behaviors, joint pathology, systemic disorders, and genetic predisposition are more influential determinants. Orthodontic treatment neither predisposes patients to TMD nor cures existing TMD, although specific biomechanical considerations are required in symptomatic individuals. The DC/TMD classification provides a robust framework for standardized diagnosis and biopsychosocial assessment.

Conclusion:

Orthodontic practice must incorporate TMJ screening, risk assessment, patient stratification, and interdisciplinary referral protocols. The biopsychosocial paradigm offers a more accurate and clinically relevant understanding of TMD, guiding orthodontists toward safer and evidence-based decision-making.

Keywords: Temporomandibular disorders, TMJ, orthodontics, occlusion, biopsychosocial model, DC/TMD, psychological factors.

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INTRODUCTION:

Temporomandibular disorders (TMD) represent a multifaceted and heterogeneous group of musculoskeletal conditions affecting the temporomandibular joint (TMJ), masticatory muscles, and associated craniofacial structures. Clinically, TMD manifests as pain, restricted jaw function, joint sounds, and functional limitations, often impacting quality of life. Historically, the etiology of TMD was predominantly attributed to malocclusion and orthodontic treatment, with these factors considered central to the development and progression of the disorder[1,2]. Early research emphasized occlusal discrepancies, variations in joint morphology, and dental interferences as key contributors to TMD pathogenesis[3,4]. This occlusion-centric perspective shaped clinical practice for decades, leading to interventions such as selective grinding, orthodontic correction, and orthognathic procedures aimed at preventing or alleviating TMD. However, accumulating evidence over the past three decades has challenged this simplistic mechanistic model. Systematic reviews and longitudinal studies demonstrate that occlusal factors account for only a minor proportion of TMD risk, and that their presence alone is insufficient to predict the onset or severity of symptoms[5,6]. Increasingly, research supports a **biopsychosocial paradigm**, recognizing TMD as a multifactorial disorder influenced by the dynamic interaction of biological factors (such as joint pathology, muscle dysfunction, systemic conditions, and genetic predisposition), psychological variables (including stress, anxiety, depression, and pain catastrophizing), and social determinants (such as socioeconomic status, cultural norms, and occupational stress)[7-10]. For orthodontic clinicians, this paradigm shift underscores the importance of moving beyond occlusion-focused assumptions. A comprehensive understanding of TMD requires integration of **risk assessment, patient stratification, and interdisciplinary management**, ensuring that treatment decisions are evidence-based, patient-centered, and sensitive to the multifactorial nature of the disorder. Appreciating the biopsychosocial etiology of TMD allows orthodontists to identify at-risk individuals, tailor treatment mechanics appropriately, and collaborate effectively with other healthcare providers to optimize both functional and quality-of-life outcomes.

Historical Perspective: From Occlusion-Centric Theory to Multifactorial Etiology

For decades, occlusal disharmonies such as overjet, crossbite, or missing posterior support were considered major TMD determinants[11,12]. Interventions including selective grinding, orthodontic correction, or orthognathic surgery were proposed to prevent or treat TMD[13]. Systematic reviews in the 1990s and early 2000s began questioning these associations, demonstrating inconsistent correlations between malocclusion and TMD prevalence[14–16]. Modern meta-analyses confirm that occlusal factors account for <10% of TMD variance, and that psychosocial stressors, central pain sensitization, and parafunctional habits exert far greater influence[17–19]. This shift underscores the necessity for a broader, biopsychosocial lens. (Table 1)

The Biopsychosocial Model of TMD

The biopsychosocial model integrates three domains:

1. Biological Determinants

- TMJ pathology: Disc displacement, degenerative changes, and hypermobility[20].
- Musculoskeletal factors: Muscle hyperactivity, myofascial pain, postural imbalances[21].
- Genetic and systemic predisposition: Polymorphisms affecting pain perception, connective tissue disorders[22].
- Neurological mechanisms: Central sensitization and altered pain modulation pathways[23]. (Table 2)

2. Psychological Determinants

Psychological factors significantly influence the onset, intensity, and persistence of TMD symptoms:

- **Stress and anxiety:** Chronic stress increases muscle tension, parafunctional activity, and pain perception[24].
- **Depression:** Associated with heightened symptom reporting, disability, and poor coping[25].
- **Pain catastrophizing:** Excessive focus on pain, rumination, and perceived helplessness amplify symptom severity[26].
- **Behavioral factors:** Poor sleep, maladaptive coping strategies, and hypervigilance to jaw function exacerbate TMD outcomes.

Psychological screening tools such as the **Patient Health Questionnaire (PHQ-4)** and **Jaw Functional Limitation Scale** are recommended in clinical practice for early identification of high-risk individuals[27].

3. Social Determinants

Social and environmental factors contribute to symptom perception, healthcare-seeking behavior, and treatment outcomes:

- **Socioeconomic status:** Limited access to care and educational resources can delay diagnosis and treatment[28].
- **Occupational stress:** Jobs involving repetitive jaw movements, prolonged computer work, or high stress increase risk of TMD[29].
- **Cultural influences:** Cultural attitudes toward pain expression and health-seeking behavior modulate symptom reporting and compliance.

Recognition of social determinants is essential for **patient-centered care**, tailored counseling, and realistic expectation management.

TMD and Occlusion: Evidence-Based Understanding

The relationship between occlusion and temporomandibular disorders (TMD) has been extensively studied for decades. Historically, occlusal discrepancies such as deep bite, overjet, crossbite, and missing posterior support were believed to directly cause TMD symptoms[11,12.] Orthodontic interventions, selective grinding, and restorative adjustments were widely used to correct these occlusal traits with the expectation of preventing or alleviating TMD[13.] However, contemporary evidence challenges this assumption and highlights a far more nuanced relationship. Recent systematic reviews and meta-analyses consistently indicate that occlusal factors play a minor role in the development or progression of TMD[5,6,17–19.] Key findings include:

1. **Weak association with malocclusion:** Most occlusal traits, including overjet, overbite, molar classification, and crossbite, show minimal correlation with TMD prevalence. The predictive value of occlusal discrepancies for TMD onset is low.
2. **Orthodontic treatment and TMD risk:** Longitudinal studies confirm that properly

executed orthodontic treatment does not increase the risk of developing TMD, nor does it reliably prevent TMD.[18,19.]

3. **Symptomatic individuals:** In patients with pre-existing TMD, orthodontic treatment may require modifications in mechanics to avoid exacerbating symptoms, but it is neither curative nor causative. (Table 3)

Mechanistic Insights

Although occlusion may influence joint loading and mandibular kinematics, its contribution is often modulated by individual susceptibility, including:

- **Parafunctional behaviors** (e.g., bruxism, clenching) that increase muscular load.
- **Psychological stressors** that amplify muscle hyperactivity and pain perception.
- **Central sensitization** and altered nociceptive processing, which may exacerbate minor mechanical imbalances.

These factors collectively explain why occlusal discrepancies are neither necessary nor sufficient to cause TMD.

Clinical Implications

- **Screening and assessment:** Orthodontists should assess occlusion as part of a broader evaluation but avoid overemphasizing its causal role.
- **Patient counseling:** Educate patients that malocclusion is rarely the sole cause of TMD and that orthodontic treatment does not guarantee prevention or cure.
- **Individualized mechanics:** In symptomatic patients, biomechanics should be adapted to reduce joint or muscular stress.
- **Interdisciplinary care:** Collaboration with physiotherapists, pain specialists, and psychologists may be warranted for chronic or complex cases.

Diagnostic and Clinical Implications

The recognition of TMD as a multifactorial disorder under the biopsychosocial paradigm has important implications for diagnosis, risk assessment, and clinical management in orthodontic practice. Moving beyond an occlusion-centric approach allows clinicians to provide evidence-based, patient-centered care.

1. Comprehensive Assessment

A thorough evaluation should include:

- **Medical and dental history:** Prior trauma, systemic disorders, previous orthodontic or dental interventions, and family history of musculoskeletal pain.
- **TMJ and muscular examination:** Palpation of masticatory muscles, joint sounds, range of motion, deviation on opening, and mandibular function tests.
- **Psychosocial evaluation:** Screening for stress, anxiety, depression, and pain catastrophizing using validated tools (e.g., PHQ-4, Jaw Functional Limitation Scale)[27].
- **Functional and behavioral assessment:** Observation of parafunctional habits such as bruxism or clenching, postural evaluation, and occupational influences.

The DC/TMD protocol provides a standardized framework for combining clinical and psychosocial assessment, enhancing diagnostic accuracy and inter-clinician reliability[8,27].

2. Risk Stratification

Identifying patients at higher risk of TMD or symptom exacerbation is critical for planning orthodontic interventions:

- High-risk individuals may include those with chronic pain, high psychosocial stress, systemic conditions affecting musculoskeletal health, or pronounced parafunctional behaviors[7,24–26].

- Risk stratification guides treatment planning, allowing orthodontists to modify mechanics, adjust force application, or consider staged interventions to minimize potential aggravation of symptoms. (Table 4)

4. Interdisciplinary Management

A multidisciplinary approach is recommended for optimal outcomes:

- **Physiotherapy:** Jaw exercises, posture correction, and myofascial release.
- **Pain management specialists:** Pharmacologic interventions, nerve modulation, or occlusal splints as appropriate.
- **Psychology / behavioral therapy:** Cognitive behavioral therapy, stress management, and coping strategies for chronic pain[10,24].

5. Orthodontic Considerations

- **Treatment planning:** Orthodontic therapy should prioritize function, esthetics, and patient comfort rather than TMD prevention.
- **Mechanics modifications:** In symptomatic patients, lighter forces, shorter activation intervals, and careful monitoring of TMJ function can reduce risk of exacerbation[18,19].
- **Patient education:** Counseling on parafunctional habits, stress management, and realistic expectations is essential. (Table 5)

5. Follow-up and Monitoring

Effective follow-up is essential in the management of patients with temporomandibular disorders (TMD), particularly when undergoing orthodontic treatment. Given the multifactorial nature of TMD, continuous monitoring allows early identification of symptom exacerbation, ensures timely intervention, and supports long-term functional outcomes.

Key Components of Follow-up

1. **Regular TMJ and Muscular Evaluation**
    - Assess range of motion, deviations on opening, joint sounds (clicking, crepitus), and muscle tenderness at each visit.
    - Document any changes from baseline to identify early signs of dysfunction.
    - Early detection allows modification of mechanics or referral to specialists before symptoms worsen.

2. **Periodic Psychosocial Assessment**
    - Monitor stress, anxiety, depression, and pain-related behaviors using validated tools (e.g., PHQ-4, Jaw Functional Limitation Scale)[27].
    - Identify psychosocial triggers that may exacerbate TMD symptoms and address them through counseling or referral to psychologists.

3. **Monitoring Parafunctional Habits and Behavioral Triggers**
    - Track patient-reported habits such as clenching, bruxism, or nail-biting.
    - Reinforce behavioral modifications and provide adjunctive devices (e.g., stabilization splints) if necessary.

4. **Adjustment of Orthodontic Mechanics**
    - In symptomatic patients, periodically review and modify orthodontic forces, archwire sequences, and appliance design to minimize TMJ or muscular stress[18,19].
    - Consider staged mechanics or reduced force levels in high-risk individuals.

5. **Interdisciplinary Coordination**
    - Maintain communication with physiotherapists, pain specialists, and psychologists for patients with persistent or worsening symptoms.
    - Ensure that all interventions are coordinated and patient-centered.

6. **Documentation and Outcome Tracking**
    - Maintain detailed records of symptoms, psychosocial status, mechanical adjustments, and interventions at each follow-up visit.
    - Use standardized scales to track pain intensity, jaw function, and quality-of-life measures over time. (Table 6)

Clinical Implications

- Systematic follow-up allows early detection of new or worsening TMD symptoms during orthodontic treatment.
- It facilitates dynamic adjustment of treatment mechanics tailored to patient tolerance.
- Integrating psychosocial monitoring ensures a holistic approach, aligning with the biopsychosocial paradigm of TMD.
- Close monitoring in high-risk patients improves outcomes, prevents chronicity, and supports safe orthodontic interventions[7-10,18,19,27].

Discussion

Temporomandibular disorders (TMD) represent a clinically complex and heterogeneous set of conditions, the understanding of which has evolved considerably over the past seven decades. Historically, occlusion and orthodontic interventions were considered the principal determinants of TMD[11,12,13]. The prevailing occlusion-centric model suggested that malocclusions caused abnormal loading of the TMJ and masticatory muscles, prompting treatments such as selective grinding, orthodontic realignment, and orthognathic surgery[13]. However, systematic reviews and cohort studies in the 1990s and early 2000s demonstrated inconsistent and weak associations between malocclusion and TMD, highlighting the limitations of a purely mechanical perspective[14–16]. Modern meta-analyses confirm that occlusal factors account for less than 10% of TMD variance, whereas psychosocial stressors, central sensitization, and parafunctional habits are stronger predictors of symptom onset and chronicity[17–19]. This evidence underscores the necessity of adopting a biopsychosocial paradigm that recognizes the interplay of biological, psychological, and social determinants[7–10]. Biological factors, including joint pathology, myofascial dysfunction, systemic conditions, and genetic predisposition, interact with psychological traits such as stress, anxiety, depression, and pain catastrophizing to modulate symptom expression[20–26]. Social and environmental factors further influence symptom reporting, healthcare-seeking behavior, and treatment adherence[28,29].

Implications for Orthodontic Practice

The evolving understanding of TMD has several critical implications for orthodontists:

1. **Occlusion is not a primary causal factor:** Orthodontic treatment is generally safe and does not predispose patients to TMD[18,19]. Routine attempts to correct minor malocclusion solely for TMD prevention are not evidence-based.
2. **Screening and risk stratification:** Comprehensive assessment using TMJ and muscular examination, psychosocial screening tools (e.g., PHQ-4, Jaw Functional Limitation Scale), and evaluation of parafunctional habits is essential for identifying patients at risk of chronic or severe TMD[7–10,27]. High-risk patients benefit from individualized treatment mechanics and interdisciplinary care.

3. **Individualized biomechanics:** Symptomatic patients require careful adaptation of orthodontic forces, archwire sequences, and appliance design to avoid exacerbating TMJ or muscle stress[18,19,20].
4. **Interdisciplinary management:** Collaboration with physiotherapists, psychologists, pain specialists, and primary care providers enhances outcomes in complex cases and aligns with the biopsychosocial model[7,10,29].
5. **Follow-up and monitoring:** Periodic TMJ and muscular assessment, psychosocial evaluation, and documentation of parafunctional behaviors are vital throughout orthodontic treatment. This allows early detection of symptom changes, timely adjustment of mechanics, and coordinated referral when necessary[7–10,18,19,27].

Integrating Evidence into Clinical Workflow

By combining risk stratification, orthodontic considerations, and follow-up protocols, clinicians can optimize treatment outcomes while minimizing TMD-related complications. For example, low-risk patients may follow standard orthodontic protocols, whereas moderate- and high-risk patients require modified mechanics, closer monitoring, and interdisciplinary interventions (Tables 1–3). This structured approach aligns with evidence from systematic reviews, meta-analyses, and DC/TMD studies[5,6,17–19,27].

Conclusion

TMD is a complex, multifactorial condition where occlusion plays a minor role. The biopsychosocial paradigm offers a clinically relevant framework, guiding orthodontists toward safer, evidence-based practices. Incorporating screening, risk stratification, interdisciplinary collaboration, and individualized biomechanics ensures optimized patient care while avoiding unnecessary interventions.

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