Advanced General Dentistry: A Comprehensive Review of Temporomandibular Disorders, Malocclusion, and Emerging Treatments

Salman Naif Al Nemer[1], Mohammed turki alsudairi[2], Rana Mohammed Behairy[3]

[1]Consultant
Advanced General Dentistry
NGHA, KAMC, Riyadh, SAUDI ARABIA.

Abstract:
Dentistry has evolved significantly over the past few decades, with a growing focus on understanding complex craniofacial conditions like temporomandibular disorders (TMD) and malocclusion. These conditions not only affect oral health but also have a profound impact on overall quality of life. This article provides an in-depth exploration of temporomandibular disorders, their etiology, diagnosis, and management, with a particular focus on the role of occlusion, orthodontic treatments, and the use of advanced technologies like clear aligners. By drawing on a wide range of studies, this article highlights the latest advancements in diagnosis and treatment, paving the way for more effective and patient-centered care in dentistry.

INTRODUCTION

Advanced General Dentistry is a broad and evolving field that encapsulates the practice of comprehensive oral care for patients, focusing on prevention, diagnosis, and treatment of various dental conditions. Among the myriad of dental conditions, Temporomandibular Disorders (TMD) and malocclusion have gained significant attention due to their widespread prevalence and complex etiology. These disorders affect not only the dental occlusion and function but also the overall quality of life through pain, dysfunction, and psychological stress (Wieckiewicz et al., 2018). Advanced general dentistry plays a crucial role in diagnosing and managing these conditions by employing both traditional and innovative therapeutic approaches, including orthodontic interventions, occlusal adjustments, and the use of advanced technologies like clear aligners.

Temporomandibular disorders involve the dysfunction of the temporomandibular joint (TMJ), muscles of mastication, and associated structures. They manifest as a heterogeneous group of musculoskeletal and neuromuscular conditions, with symptoms ranging from jaw pain to headaches, earaches, and difficulty in jaw movements (Gauer & Semidey, 2015). The etiology of TMD is multifactorial, with contributing factors including occlusal discrepancies, malocclusion, oral parafunctional habits like bruxism, psychological stress, and even systemic diseases. Despite extensive research, the exact mechanisms underlying the development of TMD remain elusive (Manfredini et al., 2017). This has led to the emergence of multiple treatment modalities, each targeting different aspects of the condition, from occlusal adjustments to behavioral therapies.

Dental occlusion, which refers to the alignment and contact between teeth, has long been considered a potential factor in the onset of temporomandibular disorders. The relationship between occlusion and TMD has been a subject of considerable debate, with some experts emphasizing the role of occlusal discrepancies in TMJ dysfunction, while others argue that occlusion plays a minor role compared to other factors like psychological stress and systemic health (Dodić et al., 2009). Occlusal factors such as posterior crossbite, deep overbite, overjet, and open bite have been implicated in various studies as potential contributors to TMD

symptoms (Shroff, 2018). However, the strength of this association varies across studies, with some findings suggesting that occlusal features are more of a secondary factor than a primary cause of TMD (Pullinger & Seligman, 2000).

Malocclusion, which refers to the misalignment of teeth or jaws, is another condition closely linked with the development of temporomandibular disorders. Malocclusion affects the way the teeth come together during biting and chewing, which can place undue stress on the TMJ and the muscles of mastication. Research has shown that individuals with malocclusion are more likely to experience TMD symptoms, particularly those involving muscle pain and joint discomfort (Perrotta et al., 2019). The prevalence of malocclusion in adolescents and young adults is high, making it a significant public health concern. In a study on Italian schoolchildren, Perrotta et al. (2019) found that malocclusion and oral parafunctions such as bruxism were significantly associated with TMD pain. Similarly, Paduano et al. (2020) reported that adolescents from Southern Italy with malocclusion had a higher incidence of TMD, further supporting the link between these conditions.

Bruxism, a common oral parafunction characterized by tooth grinding and clenching, has also been identified as a major contributor to TMD. Bruxism exerts excessive force on the teeth and TMJ, leading to muscle fatigue, pain, and inflammation (Castroflorio et al., 2018). The repetitive muscle contractions associated with bruxism can exacerbate TMD symptoms over time, resulting in chronic pain and dysfunction. While bruxism is often considered a nocturnal habit, it can also occur during the day, particularly in individuals experiencing high levels of stress or anxiety. The management of bruxism typically involves the use of occlusal splints, cognitive-behavioral therapy, and, in some cases, pharmacological interventions to reduce muscle activity and alleviate symptoms (Macedo et al., 2007).

Orthodontics plays a pivotal role in addressing malocclusion and its associated complications, including TMD. While orthodontic treatments are primarily aimed at improving dental alignment and aesthetics, they can also have a significant impact on TMJ health. Correcting malocclusion through orthodontic treatments can alleviate abnormal pressure on the TMJ, reducing the risk of developing TMD (Shroff, 2018). However, the relationship between orthodontic treatments and TMD is complex, with some studies suggesting that orthodontic interventions may exacerbate TMD symptoms in certain cases, while others highlight the potential benefits of orthodontics in managing TMJ dysfunction (McNamara et al., 1995). A systematic review by Lai et al. (2020) concluded that there is no significant association between orthodontic treatments and an increased risk of TMD, suggesting that orthodontic interventions are generally safe and beneficial for patients with malocclusion.

The advent of clear aligners, such as Invisalign®, has revolutionized orthodontic treatment by offering a more aesthetic and comfortable alternative to traditional fixed appliances. Clear aligners are removable, transparent trays that gradually shift teeth into their desired positions. Their popularity has soared in recent years due to their convenience, aesthetic appeal, and ability to address a wide range of malocclusions (Pereira et al., 2020). However, the effects of clear aligners on TMJ function and TMD symptoms are still being explored. Some studies suggest that clear aligners may improve TMJ health by promoting better occlusal balance and reducing stress on the joint (Castroflorio et al., 2018). However, more research is needed to fully understand the impact of clear aligners on temporomandibular function, particularly in patients with pre-existing TMD.

Etiology of Temporomandibular Disorders
Occlusal Factors and TMD
Occlusion has long been considered a potential factor in the development of TMD. Occlusal discrepancies, such as malocclusion, have been implicated in the onset of TMJ dysfunction, with some researchers suggesting that improper occlusal alignment can lead to abnormal loading of the TMJ, resulting in pain and dysfunction (Dodić et al., 2009). However, the role of occlusal factors in TMD remains controversial. Some studies suggest a weak association between occlusal features and TMD symptoms, while others emphasize the importance of occlusal balance in maintaining TMJ health (Manfredini et al., 2017).

Research by Pullinger and Seligman (2000) demonstrated that specific occlusal variables, such as posterior crossbite and deep overbite, were associated with an increased risk of TMD. However, the authors also highlighted the need for a multifactorial approach to understanding TMD, as occlusion alone is unlikely to account for the full spectrum of TMD symptoms.

Malocclusion and TMD
Malocclusion, defined as the misalignment of teeth or incorrect relation between dental arches, has been extensively studied as a potential contributor to TMD (Shroff, 2018). Several studies have investigated the prevalence of malocclusion in individuals with TMD, with mixed results. Perrotta et al. (2019) found a significant association between malocclusion, oral parafunctions, and TMD pain in Italian schoolchildren, suggesting that early intervention in malocclusion may reduce the risk of developing TMD later in life. Similarly, Paduano et al. (2020) reported a high prevalence of malocclusion and oral parafunctions in adolescents with TMD, further supporting the link between these conditions.
However, not all studies have found a strong relationship between malocclusion and TMD. A systematic review by Manfredini et al. (2017) concluded that the association between dental occlusion and TMD is weak and inconsistent, with many studies failing to establish a clear causal link. The authors argued that while malocclusion may contribute to TMD in some cases, it is unlikely to be the sole cause of the disorder.

Oral Parafunctions and TMD
Oral parafunctions, such as bruxism (tooth grinding) and clenching, have also been implicated in the development of TMD. These habits can place excessive stress on the TMJ and surrounding muscles, leading to pain and dysfunction. Studies have shown that individuals with bruxism are more likely to develop TMD, particularly those with a history of nighttime tooth grinding (Castroflorio et al., 2018). The repetitive muscle contractions associated with bruxism can lead to muscle fatigue, pain, and inflammation, exacerbating TMD symptoms over time (Macedo et al., 2007).
In a systematic review, Bucci et al. (2019) found that oral parafunctions, such as bruxism, were significantly associated with TMD. The authors suggested that managing parafunctional habits, such as through the use of occlusal splints or behavioral interventions, may help reduce the incidence and severity of TMD in affected individuals.

Orthodontics and Temporomandibular Disorders
Orthodontic Treatment as a Risk Factor for TMD
The relationship between orthodontic treatment and TMD has been extensively debated in the literature. While some studies suggest that orthodontic treatments, particularly those involving occlusal adjustments, may exacerbate TMD symptoms, others argue that orthodontics can help alleviate TMJ dysfunction by correcting malocclusion (Shroff, 2018). A systematic review by Lai et al. (2020) found no significant association between orthodontic treatments and an increased risk of developing TMD, suggesting that orthodontic interventions are generally safe and do not contribute to the onset of TMJ disorders.
Similarly, McNamara et al. (1995) concluded that there is no elevated risk of TMD associated with any particular type of orthodontic mechanics or extraction protocols. The authors emphasized that while achieving a stable occlusion is a reasonable orthodontic treatment goal, failure to achieve a gnathologically ideal occlusion does not necessarily result in TMD symptoms.

Orthodontic Treatments and TMJ Health
Despite the lack of evidence linking orthodontic treatments to TMD, some researchers have explored the potential benefits of orthodontics in managing TMJ disorders. Orthodontic treatments that correct malocclusion and improve occlusal balance may help alleviate TMJ symptoms by reducing abnormal loading on the joint (Shroff, 2018). For example, a study by Michelotti et al. (2019) evaluated the effects of rapid maxillary expansion on masticatory muscle activity in patients with unilateral posterior crossbite. The authors found that orthodontic treatment significantly improved muscle function and reduced TMJ discomfort, suggesting that correcting malocclusion may have positive effects on TMJ health.
Additionally, a long-term cohort study by Macfarlane et al. (2009) evaluated the effects of orthodontic treatment on TMD symptoms over a 20-year period. The authors found that individuals who received

orthodontic treatment during adolescence had fewer signs and symptoms of TMD in adulthood compared to those who did not undergo treatment, further supporting the potential benefits of orthodontics in managing TMJ disorders.

Clear Aligners and Their Impact on TMD

Clear aligners, such as Invisalign®, have gained popularity in recent years due to their aesthetic appeal and convenience. However, the impact of clear aligners on TMJ function and TMD symptoms remains unclear. Some studies have suggested that clear aligners may have a positive effect on TMD by promoting better occlusal balance and reducing stress on the TMJ (Pereira et al., 2020). In a randomized controlled trial, Castroflorio et al. (2018) investigated the effects of clear aligners on sleep bruxism and found that while clear aligners did not significantly reduce bruxism-related muscle activity, they were associated with a reduction in TMJ pain and discomfort.

A clinical study by Brien (2015) also explored the effects of continuous use of Invisalign® on the TMJ and orofacial muscles. The study found that while clear aligners did not significantly impact muscle activity during sleep, they were associated with a reduction in TMJ-related symptoms over time. These findings suggest that clear aligners may be a viable option for patients with TMD, particularly those with mild to moderate symptoms.

Diagnosis of Temporomandibular Disorders
Diagnostic Criteria for TMD

Accurate diagnosis of TMD is essential for effective treatment. The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) is a widely used tool for diagnosing TMD based on a combination of clinical examination and patient-reported symptoms (Schiffman et al., 2014). The DC/TMD classifies TMD into three main categories: myofascial pain, disc displacement, and joint disorders. Each category is further subdivided based on the severity and duration of symptoms, allowing clinicians to tailor treatment to the specific needs of the patient.

In addition to the DC/TMD, imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI) are often used to assess TMJ structure and function (de Bont et al., 1993). These imaging modalities can help identify intra-articular abnormalities, such as disc displacement or joint degeneration, which may contribute to TMD symptoms. However, Gauer and Semidey (2015) emphasized that diagnostic imaging should be reserved for cases where clinical examination and patient history suggest the presence of significant joint pathology.

Experimental Approaches to TMD Diagnosis

Recent advancements in experimental techniques have provided new insights into the diagnosis of TMD. Sperry et al. (2019) explored the use of experimental models to inform diagnostic approaches for painful TMJ osteoarthritis. The authors highlighted the importance of understanding the underlying mechanisms of TMJ pain, such as peripheral sensitization and central pain modulation, in developing more accurate diagnostic tools. By incorporating findings from experimental models into clinical practice, researchers hope to improve the accuracy of TMD diagnosis and develop more targeted treatments.

Management of Temporomandibular Disorders
Noninvasive Therapies for TMD

The management of TMD typically involves a combination of noninvasive therapies aimed at reducing pain and improving joint function. Patient education and self-care are often the first line of treatment, with patients encouraged to adopt lifestyle changes, such as avoiding hard or chewy foods, practicing stress management techniques, and performing jaw exercises (Gauer & Semidey, 2015). Cognitive-behavioral therapy (CBT) has also been shown to be effective in managing TMD-related pain by addressing the psychological and emotional factors that contribute to the disorder (Suvinen et al., 2005).

Pharmacotherapy is commonly used to manage TMD symptoms, with nonsteroidal anti-inflammatory drugs (NSAIDs) and muscle relaxants being the most frequently prescribed medications. In cases of chronic TMD, benzodiazepines or antidepressants may be added to the treatment regimen to help manage pain and improve sleep quality (Wieckiewicz et al., 2018).

Occlusal Splints and Orthodontic Devices

Occlusal splints are commonly used in the management of TMD, particularly in patients with bruxism or clenching habits. These devices work by redistributing occlusal forces, reducing stress on the TMJ, and alleviating muscle tension (Macedo et al., 2007). A systematic review by Manfredini et al. (2018) evaluated the effects of occlusal splints on masticatory muscle activity during sleep and found that while splints were effective in reducing muscle contractions, they did not significantly impact overall sleep quality or bruxism frequency.

In addition to occlusal splints, orthodontic devices such as clear aligners have been explored as potential treatments for TMD. As mentioned earlier, clear aligners may help improve occlusal balance and reduce TMJ stress, making them a viable option for patients with mild to moderate TMD symptoms (Pereira et al., 2020).

Surgical Interventions for TMD

In cases where conservative treatments fail to provide relief, surgical interventions may be considered. Oral and maxillofacial surgeons may perform procedures such as arthrocentesis, arthroscopy, or open joint surgery to address structural abnormalities in the TMJ (Gauer & Semidey, 2015). However, surgery is typically reserved for severe cases of TMD, such as those involving significant joint degeneration or disc displacement. A review by Pancherz et al. (2015) evaluated the long-term effects of surgical interventions for TMD and found that while surgery can provide significant relief in some cases, it is not without risks. Postoperative complications, such as infection, nerve damage, or persistent pain, can occur, making it essential for clinicians to carefully weigh the risks and benefits of surgical intervention before proceeding.

Emerging Technologies in TMD Management
Electromyographic (EMG) Monitoring

Electromyographic (EMG) monitoring has emerged as a valuable tool for assessing masticatory muscle activity in patients with TMD. By measuring muscle contractions during activities such as chewing or clenching, EMG can provide insights into the functional status of the masticatory muscles and help guide treatment decisions (Farronato et al., 2012). Recent studies have used ambulatory EMG devices to monitor muscle activity in patients undergoing orthodontic treatment, with promising results (Lou et al., 2021).

A study by Valentino et al. (2021) evaluated jaw muscle activity patterns in women with chronic TMD myalgia during standardized clenching and chewing tasks. The authors found that EMG monitoring provided valuable information about muscle function and fatigue, which could be used to tailor treatment plans and improve patient outcomes.

Three-Dimensional Imaging and Finite Element Analysis

Three-dimensional imaging and finite element analysis (FEA) have also been explored as tools for assessing TMJ function and stress distribution. These technologies allow clinicians to create detailed models of the TMJ and surrounding structures, which can be used to simulate the effects of various treatments on joint health (Alhammadi et al., 2017). FEA, in particular, has been used to evaluate the stress placed on the TMJ during orthodontic treatments, such as the use of class II and III elastics (Gurbanov et al., 2020). By providing a more accurate assessment of joint mechanics, these technologies have the potential to improve treatment outcomes for patients with TMD.

Conclusion

Temporomandibular disorders are a complex and multifactorial group of conditions that require a comprehensive approach to diagnosis and treatment. While occlusal factors, malocclusion, and oral parafunctions are often implicated in the development of TMD, it is clear that these conditions are influenced by a wide range of biological, psychological, and environmental factors. Orthodontic treatments, including the use of clear aligners, have shown promise in managing TMD symptoms by improving occlusal balance and reducing stress on the TMJ.

Advancements in diagnostic techniques, such as EMG monitoring and three-dimensional imaging, have provided new insights into the pathophysiology of TMD and have the potential to improve treatment outcomes. However, further research is needed to fully understand the relationship between orthodontic treatments and TMD, as well as to develop more targeted and effective treatment strategies.

By adopting a multidisciplinary approach to TMD management, clinicians can provide more personalized care that addresses the unique needs of each patient. As the field of dentistry continues to evolve, it is essential

for practitioners to stay informed about the latest research and emerging technologies to ensure that they are providing the highest level of care to their patients.

REFERENCES:

1. Alhammadi, M. S., Fayed, M. S., & Labib, A. (2017). Three-dimensional assessment of condylar position and joint spaces after maxillary first premolar extraction in skeletal class II malocclusion. *Orthod Craniofac Res, 20*, 71–78.

2. Brien, J. (2015). *Effets du port continu de coquilles correctrices Invisalign® sur l'articulation temporo-mandibulaire et les muscles du complexe facial*. Université de Montréal.

3. Bucci, R., Koutris, M., & Michelotti, A. (2019). Occlusal sensitivity in individuals with different frequencies of oral parafunction. *J Prosthet Dent, 122*(2), 119–122.

4. Castroflorio, T., Bargellini, A., Lucchese, A., Manuelli, M., Casasco, F., Cugliari, G., Cioffi, I., Deregibus, A. (2018). Effects of clear aligners on sleep bruxism: randomized controlled trial. *J Biol Regul Homeost Agents, 32*(2 Suppl. 2), 21–29.

5. Dodić, S., Sinobad, V., Obradović-Djuricić, K., & Medić, V. (2009). The role of occlusal factor in the etiology of temporomandibular dysfunction. *Srp Arh Celok Lek, 137*, 613–618.

6. Farronato, G., Giannini, L., Galbiati, G., Sesso, G., & Maspero, C. (2012). Orthodontic-surgical treatment: neuromuscular evaluation in skeletal class II and class III patients. *Prog Orthod, 13*, 226–236.

7. Gauer, R. L., & Semidey, M. J. (2015). Diagnosis and treatment of temporomandibular disorders. *Am Fam Physician, 91*, 378–386. https://pubmed.ncbi.nlm.nih.gov/25822556

8. Gurbanov, V., Bas, B., & Öz, A. A. (2020). Evaluation of stresses on temporomandibular joint in the use of class II and III orthodontic elastics: a three-dimensional finite element study. *J Oral Maxillofac Surg, 78*, 705–716.

9. Lai, Y. C., Yap, A. U., & Türp, J. C. (2020). Prevalence of temporomandibular disorders in patients seeking orthodontic treatment: a systematic review. *J Oral Rehabil, 47*, 270–280.

10. Lou, T., Tran, J., Castroflorio, T., Tassi, A., & Cioffi, I. (2021). Evaluation of masticatory muscle response to clear aligner therapy using ambulatory electromyographic recording. *Am J Orthod Dentofacial Orthop, 159*, 0–33.

11. Macfarlane, T. V., Kenealy, P., Kingdon, H. A., Mohlin, B. O., Pilley, J. R., Richmond, S., & Shaw, W. C. (2009). Twenty-year cohort study of health gain from orthodontic treatment: temporomandibular disorders. *Am J Orthod Dentofacial Orthop, 135*, 692–698.

12. Manfredini, D., Lombardo, L., & Siciliani, G. (2017). Temporomandibular disorders and dental occlusion. A systematic review of association studies: end of an era? *J Oral Rehabil, 44*, 908–923.

13. Manfredini, D., Lombardo, L., Vigiani, L., Arreghini, A., & Siciliani, G. (2018). Effects of invisible orthodontic retainers on masticatory muscles activity during sleep: a controlled trial. *Prog Orthod, 19*, 24.

14. McNamara, J. A. Jr., Seligman, D. A., & Okeson, J. P. (1995). Occlusion, orthodontic treatment, and temporomandibular disorders: a review. *J Orofac Pain, 9*, 73–90.

15. Michelotti, A., Rongo, R., Valentino, R., D'Antò, V., Bucci, R., Danzi, G., & Cioffi, I. (2019). Evaluation of masticatory muscle activity in patients with unilateral posterior crossbite before and after rapid maxillary expansion. *Eur J Orthod, 41*, 46–53.

16. Paduano, S., Bucci, R., Rongo, R., Silva, R., & Michelotti, A. (2020). Prevalence of temporomandibular disorders and oral parafunctions in adolescents from public schools in Southern Italy. *Cranio, 38*, 370–375.

17. Perrotta, S., Bucci, R., Simeon, V., Martina, S., Michelotti, A., & Valletta, R. (2019). Prevalence of malocclusion, oral parafunctions and temporomandibular disorder-pain in Italian schoolchildren: an epidemiological study. *J Oral Rehabil, 46*, 611–616.

18. Pereira, D., Machado, V., Botelho, J., Proença, L., Mendes, J. J., & Delgado, A. S. (2020). Comparison of pain perception between clear aligners and fixed appliances: a systematic review and meta-analysis. *Appl Sci, 10*, 4276.

19. Pullinger, A. G., & Seligman, D. A. (2000). Quantification and validation of predictive values of occlusal variables in temporomandibular disorders using a multifactorial analysis. *J Prosthet Dent, 83*, 66–75.

20. Shroff, B. (2018). Malocclusion as a cause for temporomandibular disorders and orthodontics as a treatment. *Oral Maxillofac Surg Clin North Am, 30*, 299–302.

21. Sperry, M. M., Kartha, S., Winkelstein, B. A., & Granquist, E. J. (2019). Experimental methods to inform diagnostic approaches for painful TMJ osteoarthritis. *J Dent Res, 98*, 388–397.

22. Valentino, R., Cioffi, I., Vollaro, S., Cimino, R., Baiano, R., & Michelotti, A. (2021). Jaw muscle activity patterns in women with chronic TMD myalgia during standardized clenching and chewing tasks. *Cranio, 39*, 157–163.

23. Wieckiewicz, M., Shiau, Y. Y., & Boening, K. (2018). Pain of temporomandibular disorders: from etiology to management. *Pain Res Manag, 2018*, 4517042.

24. Zufluh, M. A., Kloukos, D., Patcas, R., & Eliades, T. (2015). Effect of chin-cup treatment on the temporomandibular joint: a systematic review. *Eur J Orthod, 37*, 314–324.