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The Impact of Bruxism on Orthodontic Treatment: A Literature Review

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ABSTRACT

Dentists now utilize clear aligners and adjunctive therapies, such as botulinum toxin, to treat heavy occlusal forces during orthodontic treatment. There is some evidence suggesting that applying light, continuous forces while protecting occlusion with an occlusal guard (or other protective appliances) enables safe tooth movement in patients with severe bruxism. In this research, there is an attempt to differentiate between the clinical situations, which guarantee good prognosis for orthodontic forces in bruxing patients, and those, which are considered poor. Through literature review, this paper tries to determine the real clinical limits for orthodontic forces. Studies found that modern appliances are indicated for bruxing patients, with success rates comparable to those of traditional orthodontic therapies. They are a highly effective alternative in preventing external apical root resorption (EARR) and managing muscle-related joint pain. With neuromuscular modifications, it is now possible to achieve stable tooth alignment in patients with heavy grinding. In many cases, unmanaged temporomandibular joint pain is a contraindication for active movement due to the threat of iatrogenic complications during force application. The long-term interaction between aligned teeth and continuous grinding forces is unpredictable. Some evidence suggests a risk of late relapse. Managing orthodontic patients with bruxism is a reliable treatment in specific scenarios. It is a predictable treatment when using light continuous forces and hybrid retention. Bruxism management in orthodontics is a rapidly changing field that needs attention from practitioners. Recent progress shows potential, but more studies are required to make these protocols the new standard.

Keywords: bruxism; bruxism during sleep; orthodontic treatment; clear aligner therapy; root resorption

1. INTRODUCTION

Pathophysiology and Effects of Bruxism on Orthodontic Biomechanics

Aesthetic issues, malocclusions, and other problems motivate people to pursue orthodontic treatment (Thymi et al., 2021). The presence of bruxism inevitably compromises the stability of dental structures and alters the forces applied to orthodontic appliances. A patient with active bruxism does not have quiet jaw relationships. Their teeth and supporting tissues lose their natural rest periods, resulting in severe wear and an increased risk of appliance breakage (Koyano et al., 2008). The absence of control over these heavy forces can allow dental wear to

progress asymptomatically until joint or muscle pain occurs (Manfredini et al., 2015).

Etiology and Neuromuscular Concept: From Dental Pathology to CNS Activity

Although dental malocclusions were once considered the primary cause of bruxism, recent findings show that masticatory muscle activity originates in the central nervous system (Carra et al., 2012). This condition has since been defined as a muscle activity rather than a simple dental pathology (Lobbezoo et al., 2018). Previously, researchers believed that a corrected orthodontic bite, achieved using orthodontic appliances (like braces), would automatically eliminate teeth grinding (Winocur et al., 2003). More recent studies on patients receiving orthodontic treatment show that altering dental occlusion can temporarily affect muscle sensation; however, it does not stop the central nervous system activity, which is the actual source of bruxism.

Modern Orthodontic Strategies and Rationale for Review

New orthodontic techniques rely on substances that do not affect the treatment, and thus, clear aligners can be utilized. At times, neuromodulators can control high force levels in different patients (Miyawaki et al., 2004; Restrepo et al., 2011). Apart from focusing on the prevention of joint pain, novel treatment techniques are also concerned with the protection of dental tissues from high lead levels (Lavigne et al., 2008). Treating bruxing patients with orthodontic appliances is a potential therapeutic solution provided there are well-defined standards that include proper risk assessment and treatment safety. This article reviews how bruxism influences orthodontic treatment, an area that continues to intrigue and challenge clinicians. An overview of recent literature should reveal to us the most commonly used procedures and help distinguish when a situation is uncertain and more information is required. The ultimate goal of this research is to identify scenarios in which treatments can give expected results and to pinpoint areas that require further studies.

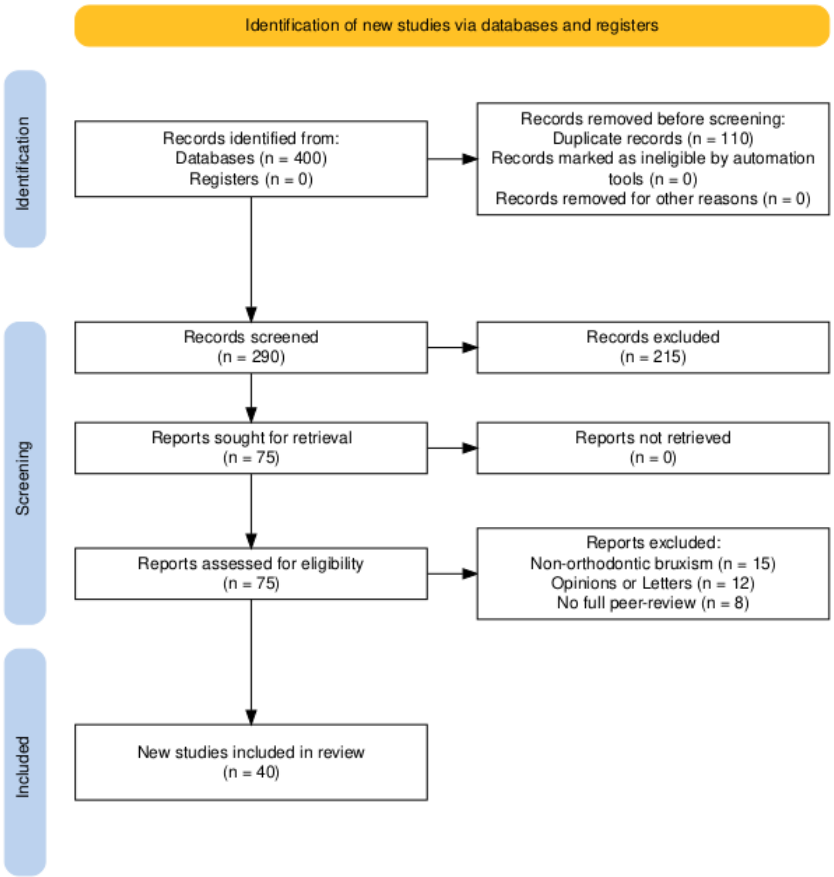

Figure 1. PRISMA Flow Diagram for Literature Screening

2. REVIEW METHODS

This study is a narrative literature analysis. Scientific publications were identified through database searches, including PubMed and Google Scholar repositories. The keywords used in searching the literature were: "bruxism", "sleep bruxism", "orthodontic treatment",

"clear aligners", and "temporomandibular disorders". The inclusion criteria for choosing articles were that the papers should be published in a peer-reviewed journal, dealing with the effects, problems, and/or management of bruxism during orthodontic treatment. The authors excluded articles that focused solely on non-orthodontic bruxism management, opinions, letters to the editor, and articles without full peer review. A total of 40 publications were selected for analysis (Figure 1).

3. RESULTS AND DISCUSSION

Impact of Bruxism on Orthodontic Appliances and Force Management

Orthodontic treatments require stable and continuous forces to move teeth to their correct positions (Rossini et al., 2015). However, bruxism generates heavy and unpredictable loads rather than gentle, controlled forces (Castroflorio et al., 2021). Such an excess force causes a significant threat to the stability of the orthodontic appliance. Grinding at night and clenching during the day raise the likelihood of experiencing some mechanical problems that can include disengagement of brackets and fracture of the wire (Tepedino et al., 2023). Conventional orthodontic treatment effectiveness strongly depends on the interaction between occlusal forces and the appliance (Lombardo et al., 2019; Rauch et al., 2020). It means that appropriate control of these forces is required in order to finish the treatment process in a timely manner (Tai et al., 2024).

Clinicians question whether modern aesthetic options are contraindicated when dealing with severe bruxism. Some perspectives suggest that clear aligners could be a better alternative when traditional brackets are affected by frequent debonding (Levrini et al., 2020). In such cases where there is a high risk of bracket loss, aligners can reduce the need for emergency appointments (D'Antò et al., 2024). Aligners offer a way to protect teeth from wear because the plastic material covers the occlusal surfaces (Shpack et al., 2025). Unfortunately, these advantages apply only if the plastic material can withstand the heavy forces (Kassas et al., 2023).

Heavy grinding significantly threatens the physical properties of aligners, ultimately leading to material failure (Kassas et al., 2023). In addition, controlling the precise movement of teeth, which is the whole idea behind the treatment process, is a difficult task (Rossini et al., 2015). It is suggested that cyclic forces associated with bruxism may not be safe for thin plastic materials (Tepedino et al., 2023). In addition, basic aligner designs call for a highly tailored approach to delay or at least prevent wear (Lombardo et al., 2019). However, precise guidelines for material selection are necessary to evaluate material wear during therapy accurately (Tai et al., 2024). Manufacturer guidelines vary regarding the ideal thickness of the sheets used in the procedure (Tepedino et al., 2023).

Furthermore, there is limited evidence demonstrating that traditional metal brackets are superior to clear aligners in patients with severe bruxism. For a treatment to be selected as the gold standard for bruxist patients, it must exhibit high survival rates in clinical trials, which, if available, concern mainly short-term observation (Jamilian et al., 2022).

Orthodontic Treatment and Risk of External Apical Root Resorption (EARR) Orthodontically induced root resorption occurs when the natural homeostasis between teeth and the alveolar bone is disrupted. Under normal conditions, permanent teeth remain immune to osteoclasts because of the protective outer layer of cementum (Weltman et al., 2010). When mechanical or physical factors damage these protective barriers, the RANK-RANKL/OPG system is activated. That leads to the differentiation of osteoclasts and odontoclasts. These cells destroy dental hard tissues by dissolving mineral components and then breaking down organic structures of the root (Heo et al., 2022).

In cases of external apical root resorption (EARR), heavy forces from active bruxism concentrate in the apical third of the periodontal ligament (Srivastav et al., 2018). This triggers a rapid and progressive loss of root structure (Harris et al., 1997). The condition is especially dangerous due to its usual lack of symptoms. In most cases, only routine radiographic screening can lead to the diagnosis (Weltman et al., 2010).

The other, highly relevant factor important to this review is referred to as occlusal trauma. It involves micro-cracks and hyalinization zones located within the periodontal ligament, which undergo pathological changes under heavy loads (Brudvik et al., 2002). This process, fueled by cyclic nocturnal grinding if left untreated, eventually leads to severe root shortening (Roscoe et al., 2015). While traditional orthodontic therapy can effectively move teeth by utilizing light forces, current standard treatments cannot always control the heavy loads generated during grinding. This limitation has led to the exploration of light force protocols as a preventive alternative (Owman-Moll et al., 1995). The novel approach can preserve the integrity of mature teeth affected by these conditions (Wehrbein et al., 2011).

Recent clinical evidence suggests that light, continuous forces are a practical and potentially beneficial alternative for managing patients with heavy occlusal loads (Table 1) (Wehrbein et al., 2011). One broad micro-CT study found that lighter forces successfully minimized root damage and resolved resorptive risks in almost all cases, achieving a stable and functional tooth (Roscoe et al., 2015). It

also suggested that low force protocols may be the only prospect to inhibit progressive EARR, yet this aspect needs more clinical research (Consolaro et al., 2014).

Another review showed that lighter forces require significantly longer monitoring intervals than the standard protocol. This is a factor that could improve tissue healing (Weltman et al., 2010). Newer clinical studies and series provide evidence for successful management of bruxist patients using light forces with longer follow-up periods (Wehrbein et al., 2011). Use of three-dimensional radiographic monitoring and CBCT is worth noting (Roscoe et al., 2015). These methods show up frequently in recent studies (Heo et al., 2022).

The results are promising, but more studies are needed. Only a few clinical trials and no meta-analyses exist on this specific topic (Consolaro et al., 2014). Current research consists of retrospective studies and finite element models (Srivastav et al., 2018). These types of articles mainly report r teeth and resorption from orthodontic intrusion (Chan et al., 2005). The effectiveness of lighter forces in posterior teeth or resorption due to extrusion needs more attention from the scientific community (Consolaro et al., 2014).

Based on the available literature, anterior teeth with active bruxism appear as a high-risk group for orthodontic resorption and rival the classic trauma patients (Harris et al., 1997). Protheoretical outcomes and are susceptible to bias. Another issue is the lack of a standard force limit for bruxist patients. Some practitioners use heavy forces that could damage the cementum, and others follow the more conservative approach (Owman-Moll et al., 1995). Most studies are limited to anteriomising but lacking broad verification is the use of clear aligners to prevent EARR (Roscoe et al., 2015). The application of light forces in severe grinding cases could be groundbreaking, but this remains a hopeful contemplation (Consolaro et al., 2014).

Other types of resorptions do not involve orthodontic movement and are therefore excluded from this review (Weltman et al., 2010). Severe EARR with pulpal involvement has not been fully explored within the context of preventive splints, which represents a potential avenue for future research (Consolaro et al., 2014).

Table 1. Selected force protocols and root resorption risks

Resorption Risk / Condition	Standard Orthodontic Treatment	Treatment with Light Forces & Bruxism Management	Notes
Excessive Bite Forces	Conventional continuous loading	Reduced intermittent forces combined with occlusal splints	Radiological monitoring using CBCT is highly recommended.
Deep Bite Correction (Intrusion)	Conventional intrusion biomechanics	Ultra-light force application combined with BoNT-A therapy	Elevated susceptibility to root apex shortening.
Anterior Segment Leveling	Rapid leveling mechanics	Gradual leveling supported by nocturnal splinting	Controlled pace minimizes cementum degradation.
Posterior Clenching Habits	Unaltered aligner design	Integration of bilateral posterior bite ramps	Shields dental restorations and preserves aligner structure.

Management of Temporomandibular Disorders and Botulinum Toxin Integration

Managing temporomandibular disorders (TMD) and orthodontic treatment are closely intertwined domains, both focusing on establishing proper maxillo-mandibular relationships and maintaining occlusal harmony (Manfredini et al., 2011). Clinical management of the interaction between these conditions remains challenging. Orthodontic outcomes can be compromised by unpredictable masticatory muscle activity as well as structural changes within the joint (Michelotti et al., 2010). Nowadays, orthodontic planning is a thorough process requiring accurate preoperative assessment that would prevent joint overload and muscle ache (Emodi-Perlman et al., 2023).

A central determinant for successful treatment in these patients is the neuromuscular activity (Manfredini et al., 2011). Historically, it was believed that successful orthodontic treatment was unpredictable or even harmful to the temporomandibular joint if the patient presented with active bruxism (Michelotti et al., 2010). However, more recent clinical data suggest that this threat is not absolute, as properly controlled tooth movement can successfully allow for stable outcomes without worsening joint symptoms in the majority of patients (Türp et al., 2016).

Recent advancements in clinical gnathology have questioned the assumption that orthodontic treatment of bruxing patients inevitably results in temporomandibular disorders (Türp et al., 2016). Healthy joints in young patients have a high potential for adaptation. Treating mature patients, however, presents different challenges. This particular study helps us understand the process of

muscle fatigue and sudden joint pains (Manfredini et al., 2011). According to various scientific researches conducted by researchers, it has been proved that using a certain type of supplementation methods, such as injections with BoNT-A, is very efficient in relaxing jaw muscles of adult patients (Jadacka-Sarna et al., 2024; Sendyk et al., 2021). Type A botulinum toxin (BoNT-A) injection is commonly made into the masseter muscle with the aim of reducing peak bite force. The procedure employs small needles and anatomy-based techniques. Controlled muscle weakening optimizes the mechanical environment for periodontal structures but also functions as a means of removing causes and sources of excess occlusal trauma (Al-Sabbagh et al., 2020).

After the injection, the patient is left with reduced muscle tension. The next step is to proceed with the planned tooth movement. The final phase involves designing a durable retention appliance (Lindauer et al., 2015). This modification reduces the risk of bracket failure. It also shortens the overall duration of the active treatment phase.

The clinical benefits of achieving successful neuromodulation with this method are significant when compared to standard treatment (Table 2). Relying only on standard splints as a protocol to prevent complications in a bruxing patient results in a difficult orthodontic setup. The physical bulk of standard splints limits tooth movement. Conventional splinting takes a lot of time within the clinic setting. In cases where stabilization is successful, the restoration of function and comfort becomes crucial because this is what ensures the stability of the teeth in the long run (Al-Sabbagh et al., 2020). The success of treatment is reflected in the stability of the teeth's position during follow-ups (Emodi-Perlman et al., 2023). This stability progresses steadily over time and begins immediately after the active phase. This leads to long-term success. Some months after surgery, the stabilization of the joint can be confirmed by clinical examination or magnetic resonance (Manfredini et al., 2011).

Case reports demonstrate that this modification can be a practical alternative to traditional stabilization protocols (Sendyk et al., 2021). Criticism of botulinum toxin has been motivated by shortcomings in research and dependence on the injection skills of the operator. Skill dependence is negligible if standard injection points are utilized, yet this needs to be further backed up by broad studies. Before 2020, fewer clinical studies were conducted on this topic, and since then, a surge in research interest has been noted. At this stage, it is too early to call for routine BoNT-A injections in all orthodontic patients as a primary indication. Nevertheless, this approach is very promising, and advancements in this topic are worth observing with great interest.

Unlike the surgical modification method outlined, nowadays, hybrid retention systems use both fixed wires and vacuum-formed splints following active movement (Lindauer et al., 2015; Littlewood et al., 2017). On one hand, this combination helps keep the teeth together and prevents tooth wear; however, it is substantially more expensive, time-consuming, and technically demanding. In contrast, standard retention relies solely on a fixed wire, leaving the occlusal surfaces uncovered.

Table 2. Bruxism management protocols comparison

Bruxism Management Protocol	Appliance & Tooth Protection	Masticatory Muscle Relaxation	Cost / Financial Load	Treatment / Effect Duration	Required Instruments & Materials
Standard Occlusal Splint	High	Moderate	Low	Continuous nocturnal wear during retention	Conventional acrylic or vacuum-formed polymers
Botulinum Toxin Type A (BoNT-A)	Indirect protection	High	High	Transient effect (requires re-injection every 4–6 months)	Fine-gauge needles, BoNT-A vials
Hybrid Retention System (Fixed Wire + Splint)	Very High	Moderate	Moderate	Long-term protocol	Multi-strand orthodontic wire, composite, thick thermoformed sheets

Retention Strategies and Long-Term Stability in Bruxist Patients

Clinicians use various protocols to align teeth, but there is a lack of evidence on the long-term complications after orthodontic tooth movement in severe bruxists (Johnston et al., 2002). Only a small number of mostly retrospective studies explore this interaction (Littlewood et al., 2017). There is even less data focusing on the survival of retainers. One recent study shows the successful use of thicker vacuum-formed retainers after a standard healing period following orthodontic movement (Lindauer et al., 2015). The authors

suggested that the newly designed hybrid retainers can protect mature teeth from relapse. Other researchers reported varied and sometimes contradictory outcomes. This conflict in research should raise caution.

A case series investigated whether standard fixed retainers have a long life in bruxing patients. It showed that in more than 50% of cases, debonding or wire fracture happens after active treatment (Littlewood et al., 2017). Another report documented late complications that appeared several years after the removal of active braces. Progressive crowding and tooth wear were the complications observed by the authors. Conflicting findings indicate that the dental community still does not fully understand the long-term interaction of orthodontic appliances and heavy grinding forces (Johnston et al., 2002).

Before applying retention forces, authors suggest waiting for complete bone remodeling. The active retention should be highly durable. The use of thicker clear aligner materials was proposed as beneficial for its ability to resist wear. At this moment, it is impossible to deduce whether orthodontic treatment is contraindicated if the patient refuses to wear nighttime splints. It is well established that continuous clinical and radiographic follow-up is the only way to detect late complications such as relapse or joint pain, which may have been latent for years (Emodi-Perlman et al., 2023). It is strongly advised that dentists identify and refrain from admitting non-compliant patients at the outset of treatment planning. Patients must be adequately informed of the risks involved when teeth repositioning is being done with forceful appliances before being offered the treatment (Johnston et al., 2002).

Challenges, Limitations, and Future Perspectives

Notwithstanding the increasing number of scientific approaches that focus on addressing the problem of managing orthodontic patients with bruxism, a number of major methodological and therapeutic problems still arise. One of the major problems in the present-day literature is the lack of evidence-based randomized controlled trials (RCT) exploring the optimal force thresholds for the active tooth movement in bruxist patients. Due to the lack of RCTs, most of the clinical evidence includes observational studies, case series, or expert opinions, which decreases the external validity of the force application and retention protocols. Moreover, the diagnosis of the exact force vector in the course of paroxysmal parasomnambulic occlusion is difficult without utilizing sophisticated and complicated polysomnography or EMG recording in sleep.

One of the possible options for an additional therapy, such as injection of Botulinum Toxin Type A (BoNT-A) into the masseter and temporalis muscles, has certain advantages and drawbacks. First, it allows reducing the maximal voluntary bite force and alleviates the symptoms of TMD due to its relaxing effects. However, the effect of the toxin is temporary and lasts 4 to 6 months. Thus, multiple injections will be needed. The long-term effect of BoNT-A injection raises questions concerning the cost-effectiveness, the risk of muscle atrophy, and the functional adjustment of the mastication apparatus. Importantly, it should be emphasized that BoNT-A injection does not eliminate the problem of the CNS-mediated bruxism.

Another ongoing issue relates to long-term retention and patient's compliance (non-compliance). While thermoformed clear aligners and custom occlusal splint provide protection against attrition and wear on fixed braces, the success of the approach is determined by the consistent use of the aligners or splint. In the cases of severe or hyperdivergent bruxism, the high-cycle loads will lead to the degradation of material or brackets debonding.

Future Directions

In order to fill this clinical void, further research is needed in such areas as:

- Longitudinal High-Evidence Studies: Executing prospective RCTs comparing treatment outcomes, apical root resorption (EARR) incidence, and appliance failure rates between fixed appliances and clear aligners in stratified bruxist populations.
- Smart Intraoral Monitoring: Designing of intelligent digital splints with micro-force sensor capabilities and telemetry functions to perform non-invasive measurement of real-time occlusal loads during orthodontic movement.
- Standardized Clinical Guidelines: Creation of clinically proven treatment guidelines concerning the choice of biomechanical forces, algorithms for BoNT-A dose calculations, and personalized retention programs for high-load neuromuscular profiles.

4. CONCLUSION

While in recent years the relationship between bruxism and orthodontic treatment became better understood, its clinical management is a vague topic. The newest literature provides evidence for some guidelines to emerge, while others remain topics that need further exploration. The study suggests that bruxist patients may benefit from the following special treatment protocols: employing clear aligners for mild to moderate cases, using light and constant forces while actively correcting issues, and finally, introducing hybrid

retention systems. Complementary treatments, such as botulinum toxin type A injections, are a novel and promising method to limit muscle overuse, particularly during the most important periods of the treatment.

At this state of knowledge, it is hard to distinguish between absolute contraindications and areas that require elevated caution. These cases include patients with active temporomandibular joint pain, where orthodontic movement should be delayed until the joint is stable. Thin alveolar bone and reduced root lengths are also conditions predisposed to iatrogenic complications like severe root resorption under heavy grinding loads. Bruxism that is completely unmanaged is outside the current scope of safe orthodontic therapy. The role of aligners in managing severe sleep bruxism remains a field with clear potential, but lacks long-term clinical trials. Finally, while not a definitive contraindication, the future requirement for lifelong retention demands high clinical caution and regular monitoring due to the risk of relapse in the long term.

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Erwin Górski: conceptualization, writing – review and editing.
Amelia Sobanek: conceptualization. Filip Szewczyk: methodology. Jakub Deptuch: formal analysis. Stanisław Janczarski: investigation, writing – review and editing. Aleksandra Pietrzyk: writing – original draft preparation. Stanisław Janczarski: data curation. Amelia Sobanek: supervision. Aleksandra Pietrzyk: writing – review and editing.
All authors have read and approved the final version of the manuscript.

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Conflict of interest
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Data and materials availability
All data associated with this study will be available based on the reasonable request to the corresponding author.

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