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Review

Prosthodontic Treatment in Patients with Temporomandibular Disorders and Orofacial Pain and/or Bruxism: A Review of the Literature

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Abstract: Temporomandibular disorders are a group of conditions affecting the temporomandibular joints, the jaw muscles, and related structures. Patients with temporomandibular signs and/or symptoms frequently present with indications for prosthetic treatment. The management of these patients aims to achieve patient comfort, occlusal stability, and the complex restoration of the teeth. The goal of this review is to provide an overview of the relationship between prosthodontics and temporomandibular disorders and/or bruxism with a focus on the cause-and-effect implications and the strategies for planning prosthetic treatments in patients with temporomandibular disorders and/or bruxism.

Keywords: orofacial pain; biocompatibility; bruxism; temporomandibular disorders; prosthodontics; prosthesis; oral health

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1. Introduction

Temporomandibular disorders (TMDs) are a heterogeneous group of conditions affecting the temporomandibular joints (TMJs), the jaw muscles, and related structures [1–6]. They have a multifactorial cause, with an interaction of systemic, psychosocial [7], genetic [8,9], trauma-related [10], hormonal [11], neurological [12–14], and anatomic or facial morphology factors [15–18]. The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) are employed to diagnose patients. The DC/TMD protocol comprises two domains: a physical domain in Axis I (clinical condition) and a psychosocial domain in Axis II (psychosocial distress) [19]. The clinical examination for Axis I diagnostics requires pain history, assessed by a questionnaire, and a well-defined and structured clinical examination. The criteria for DC/TMD Axis I comprise TMJ arthralgia, masticatory muscle myalgia, headache attributed to TMD, degenerative joint disease, and TMJ disc displacements. DC/TMD Axis II assesses the patient's psychosocial function and distress as well as pain-related disability. Axis II is based on validated instruments (questionnaires) and interpretation guidelines. It includes instruments for assessing pain behavior, jaw function, and psychosocial functioning and distress. Several papers suggested that the relationship between TMDs and dental occlusion is weak [20,21]. Nevertheless, patients with TMD symptoms often need a prosthetic treatment, including partial edentulism, esthetic deficiencies, or functional problems [21,22]. Those patients should be managed carefully after a detailed evaluation [21–23]. Different

studies introducing iatrogenic changes to dental occlusion reported some interesting considerations [20,21]. Furthermore, as far as bruxism is concerned, several systematic reviews analyzing implant-supported restorations suggest that bruxism may be associated more with mechanical than biological causes [24–27]. The aim of this review is to provide an overview of the relationship between prosthodontics and TMD with a focus on the cause-and-effect implications and the strategies for planning prosthetic treatments in patients with TMD and/or bruxism.

2. Materials and Methods

The literature search was conducted in the Scopus, Web of Science, and PubMed electronic databases. Document type was limited to articles written in English, without time restrictions.

The review protocol was registered with PROSPERO (registration number CRD42022326411).

The search terms included "temporomandibular disorder", OR "TMD" OR "orofacial pain" OR "bruxism" combined with "prosthesis" OR "denture" OR "fixed prosthesis", OR "removable prosthesis" OR "implant-supported restorations" OR "laminate veneers".

The following inclusion criteria were used: articles in English, human studies, clinical trials, systematic and narrative review article, case series with more than 10 patients treated, and case reports. The following exclusion criteria were used: articles that did not answer the key questions, duplicate articles, books, letters to editors, and experimental studies.

The database search was further supplemented with a hand search of relevant articles in the reference lists.

A total of 1627 published articles were found from the electronic searches. Two independent reviewers (F.D. and G.M.) carried out the screening and selection process for the studies.

First, duplicate citations were removed. Then, the two authors independently reviewed the retrieved articles by the title and abstract of each citation to determine its suitability for inclusion. In the initial scan, articles were eliminated if they were clearly outside the aim of the review.

All titles were checked, and 647 articles were selected for abstract reading. Then, following the analysis of the abstracts, 571 articles that did not satisfy the eligibility criteria were excluded. Thus, 32 full-text articles were identified. In addition, checking the reference lists of the most recent systematic reviews produced three full-text studies, resulting in a total of 35 articles. Finally, 9 full-text articles satisfied the inclusion criteria. The features of the included studies are described in Table 1.

Table 1. Features of included studies.

Author	Year	Study Design	Topic
Levartovsky et al.	2019	Retrospective	TMD/Bruxism
Ribeiro et al.	2014	Retrospective	TMD
Yilmaz et al.	2019	Prospective	TMD
Al-Jabrah et al.	2006	Retrospective	TMD
Granell-Ruíz et al.	2014	Prospective	Bruxism
Koenig et al.	2019	Prospective	Bruxism
Brignardello et al.	2020	Retrospective	Bruxism
Faus-Matoses et al.	2020	Retrospective	TMD
Ortorp et al.	2009	Retrospective	Bruxism

The authors' decisions to include/exclude each article were compared. Discrepancies were discussed and an agreement was finally reached. The flowchart of data selection is shown in Figure 1.

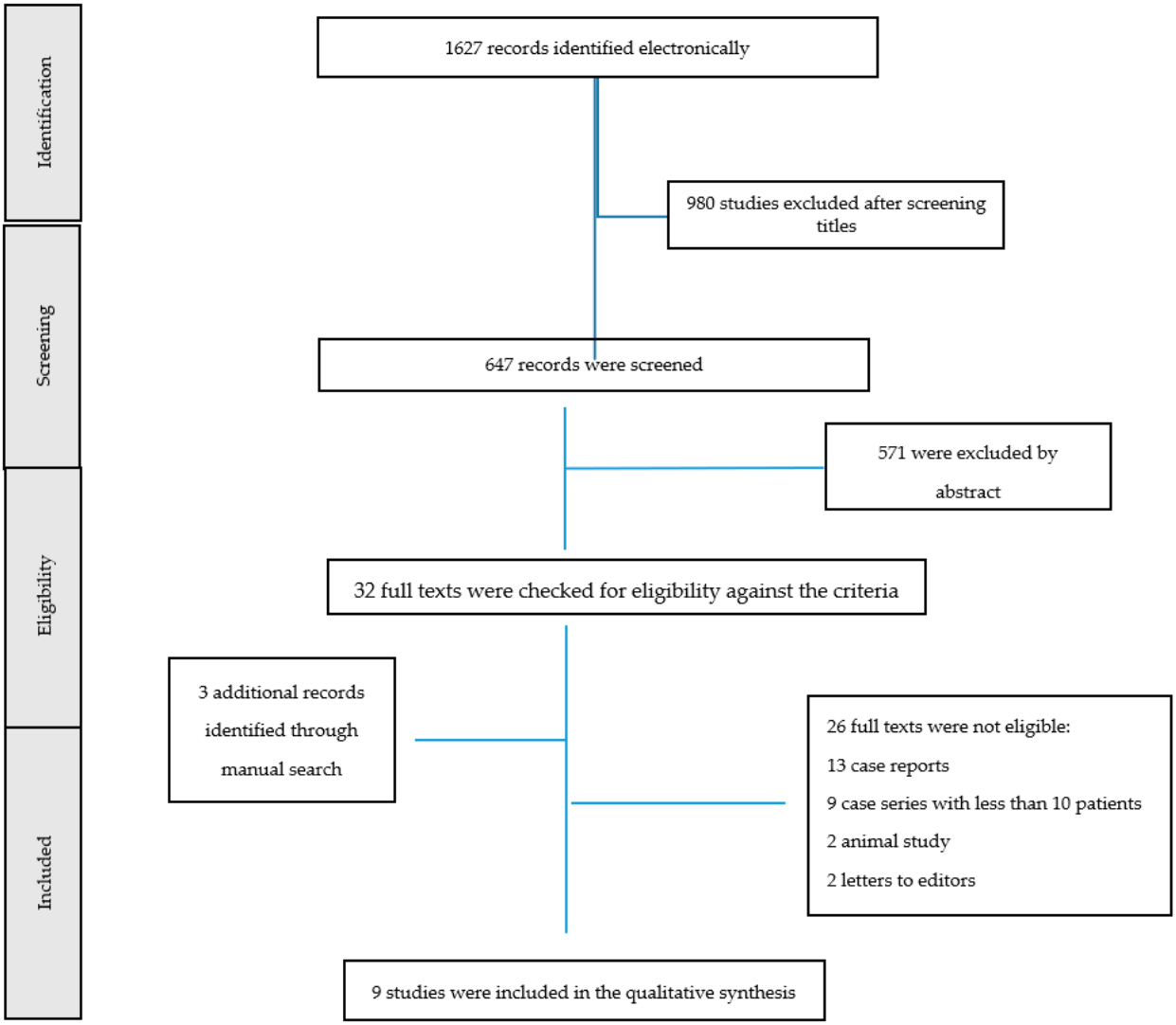

Figure 1. Flow diagram of the selection of the studies.

The quality of the included studies was evaluated independently by two reviewers (F.D. and A.L.). The quality of non-randomized clinical studies was assessed using the Newcastle–Ottawa Scale (NOS), as shown in Table 2 [28]. This scale uses a star system by which a study is judged on three broad aspects: the selection of the study groups (up to 4 points), the comparability of the groups (up to 2 points), and the exposure or outcome of interest for case–control or cohort studies, respectively (up to 3 points). Studies that met five or more of the NOS score criteria were considered as good quality and were included in the study. For other types of studies, the quality assessment was evaluated using a tool focusing on eight items developed by den Hartog et al. [29], as shown in Table 3. The studies scoring five or more plus signs were considered acceptable.

Table 2. Quality of included studies using Newcastle–Ottawa scale (NOS). Studies that met five or more of the NOS score criteria were considered as good quality (the number of * indicate the maximum score of each column accordingly to NOS questionnaire).

Study	Selection ****	Comparability **	Outcome ***	Score
Levartovsky et al.	****	*	***	8
Yilmaz et al.	****	*	***	8
Koenig et al.	****	*	***	8

Table 2. *Cont.*

Study	Selection ****	Comparability **	Outcome ***	Score
Brignardello et al.	****	*	**	7
Faus-Matoses et al.	****	**	**	8

Table 3. Quality of included studies using a tool developed by den Hartog et al., focusing on eight items. Studies scoring five or more plus signs were considered acceptable.

Study	1. Are the Characteristics of the Study Group Clearly Described?	2. Is there a High Risk of Selection Bias? Are the Inclusion and Exclusion Criteria Clearly Described?	3. Is the Intervention Clearly Described? Are all Patients Treated According to the Same Intervention?	4. Are the Outcomes Clearly Described? Are Adequate Methods Used to Assess the Outcome?	5. Is Blinding Used to Assess the Outcome?	6. Is there a Sufficient Follow-Up?	7. Can Selective Loss-to Follow-Up Sufficiently Be Excluded?	8. Are the Most Important Confounders or Prognostic Factors Identified and Are these Taken into Consideration with Respect to the Study Design and Analysis?
Ribeiro et al.	+	+	+	+	+	+	+	−
Granell-Ruíz et al.	+	+	+	+	+	+	+	−
Ortorp et al.	+	+	+	+	?	+	+	−
Al-Jabrah et al.	+	+	+	+	−	+	+	+

3. Results

3.1. Prosthodontic Treatment in Patients Affected by TMDs

Prosthetic treatments often produce a change in the interarch relationship, thus potentially requiring more adjustment. Changes in the interarch relationship may be induced by increases in the occlusal vertical dimension of occlusion (VDO) and mandible repositioning treatments [30]. The occlusal vertical dimension represents the distance between two anatomical or marked points in maximal intercuspal position. An increase in VDO might cause clinical drawbacks, such as elevation of bite forces, muscle hypersensitivity, symptoms of temporomandibular disorders, phonetic limitations, and teeth tenderness [31]. Some prosthetic therapies often need to increase the interarch distance and then modify the VDO in order to obtain optimal outcomes [32]. Several authors have showed that the VDO is a fixed and specific parameter that cannot be modified. Moreover, the increasing or decreasing of the VDO could cause serious problems such as muscle pain, temporomandibular joint (TMJ) disorders, headaches, tooth grinding, and clenching [33–35]. A recent literature review analyzing the association between TMJ disorders and modification of the VDO concluded that many commonly held concepts related to this topic were not supported by scientific evidence and that more studies are necessary to understand this relationship more accurately [32]. To date, there is a lack of evidence concerning the incidence of prosthetic and functional complications in patients treated with a VDO increase by means of teeth-supported, mixed, and implant-supported restorations [33,34]. However, the masticatory system has an excellent ability of adjustment, both to natural dental-skeletal irregularities and to iatrogenic variations [24]. Therefore, the safest prosthodontic strategy against the possible beginning of TMD symptoms is not to plan occlusal modifications that can negatively influence the capacity for accommodation. Rehabilitations based on organized occlusal schemes or interarch relations are not recommended, since they do not consider the muscle engrams and the functional adaptation that the neuromuscular system of an asymptomatic patient has created naturally [1]. The role of occlusion as a risk factor for temporomandibular disorders (TMDs) is controversial [21]. Nowadays, studies suggest that the cause of TMDs is less linked to occlusal morphology [23,36]. However, irreversible occlusal changes of prosthodontic or orthodontic rehabilitations cannot be recommended for the management or even the prevention of such conditions [21]. In healthy individuals, the placement of a restoration in supraocclusion can cause only a local lesion such as transient dental and/or muscle pain and can be solved through the removal of the interference [23,37]. Furthermore, there is a reduction in the EMG activity of the masseter muscles and no effect on the pressure pain threshold [10,17]. This indicates the establishment of an avoidance adaptation pattern, as confirmed by clinical observations that patients are not able to chew on restorations in supraocclusion and try to avoid contacts with that tooth.

Thus, TMD cannot be triggered by iatrogenic changes to dental occlusion [21]. Interestingly, patients with a history of TMD may suffer an increased risk for palpation-elicited muscle pain in response to artificially introduced occlusal interferences. This concept should be highlighted when carrying out rehabilitation treatments involving periods of occlusal instability due, for example, to interim restorations, increases in VDO, or shifting of teeth [11,21]. Several epidemiological studies reported TMD in complete denture wearers, highlighting that occlusal instability was one of the potential factors contributing to the development of TMD among complete denture wearers; in particular, the TMD signs and symptoms were correlated with the quality of the dentures and the denture wearing habits [38–41]. It has also been suggested that incorrect vertical dimension and centric relation were the most frequent causes of TMD [38]. Despite the multifactorial character of TMD and the controversial role of occlusal factors, some authors consider that it has been suggested to remodel poor dentures in denture-wearing patients affected by TMD [9,38,42]. Then, fitting new complete dentures had positive effects on the signs and symptoms of TMD. Reviewing the dental literature revealed that the influence of condylar disc position and defective occlusion on TMD remains a controversial issue, as does the influence of replacement by a new removable prosthesis [38]. Abdelnabi et al. showed that new dentures with corrected occlusion significantly improved clinical signs and symptoms of TMD in complete denture wearers and disc position [38]. Moreover, new complete dentures can also significantly reduce MRI signal intensification that corresponds to joint effusion [18].

In routine clinical practice, the existence of clicking disc displacement sounds does not represent a contraindication to occlusal rehabilitations. On the contrary, in patients with open-ended TMDs, their symptoms should be treated before beginning any prosthetic treatment. Patients affected by TMDs are very sensitive to stressors and may thus adapt less easily than healthy patients to the occlusal and psychological stress of a modification to their occlusal scheme because of their delicate psychophysiological equilibrium [18]. As far as the restorative materials are concerned, the literature does not support any clinical evidence [23,37]. The choice of material for an extensive rehabilitation in patients with TMDs is often based on the clinician's predilections and patient expectations. No evidence-based recommendations are available on how to perform the increasing of the original VDO in patients affected by bruxism or TMD [18,43]. The presence of severe tooth wear preventing retentive crown preparations, insufficient interarch space to restore or replace missing teeth, and esthetic reasons can represent prosthetic reasons which cause positional changes of the mandible and/or an increase in the vertical dimension of occlusion (VDO) [44,45]. The occlusal pattern of extensive rehabilitations in patients with bruxism or TMDs should be as simple as possible. Basic requisites such as a symmetrical distribution of interarch contacts, occlusal stability, and subjective comfort are generally enough to optimize function [18]. The reproducibility of any centric relation is not mandatory, and there is evidence that high neuroplasticity-based adaptability of the system is better supported rather than any real functional advantages of centric relation [46].

3.2. Prosthodontic Treatment in Patients Affected by Bruxism

Among the temporomandibular disorders and prosthodontics, bruxism needs to be evaluated in more detail. According to the American Academy of Orofacial Pain, bruxism is a diurnal or nocturnal parafunctional activity (recognized as non-functional jaw movements) which includes bracing, clenching, gnashing, and grinding of the teeth [11,47]. The biological hypothesis that a centrally mediated phenomenon such as bruxism may be caused by a prosthetic treatment is nonexistent [48]. Currently, no specific treatment exists that can stop bruxism, although a lot of treatments, including prosthetic treatment, have been tried over the years. Conversely, various treatments have been suggested based on behavior modification, such as habit awareness, habit reversal therapy, and relaxation techniques, which may eliminate awake bruxism [11]. Patients affected by bruxism can be treated with occlusal splints. In general, the occlusal splint is used to treat muscle hyperactivity [8,49,50]. Several studies showed that these splints can decrease bruxism

activity generated during periods of stress [12,46,47]. Therefore, the use of these devices is recommended in patients with suspected bruxism following prosthodontic treatment including full coverage crowns or with laminate veneers [47–53]. A functional design should have restorations installed in patients affected by some type of bruxism activity, especially in conditions where the patient has already lost some tooth structure. Furthermore, these restorations should be performed according to a correct anterior and canine guidance [47,54,55]. Some authors suggested that bruxism can represent a contraindication to these bonded restorations [47,56]. Granell-Ruíz et al. showed that the success rate for veneers is reduced to 60% in patients with bruxism activity [47]. Similarly, some studies showed this percentage for metal–ceramic restorations in the same clinical conditions [47,56]. If bruxism is controlled, the success rates may increase. Therefore, a preventive measure such as a nocturnal and/or diurnal splint is recommended in order to reduce the risk of failure, especially in patients affected by bruxism [57–59]. Studies analyzing the materials employed in patients treated with fixed dental prosthesis are scarce, and the choice often needs to be made on the basis of clinical experience rather than scientific data. With an opposing natural tooth, most clinicians agree that a metal occlusal surface, preferably one of high noble matter, should be selected in order to minimize wear of the natural dentition. The use of ceramics could be especially dangerous to opposing natural teeth. However, new ceramics such as zirconia have demonstrated improved mechanical properties in laboratory studies and may be promising in the treatment of bruxism-related tooth wear [60,61]. However, a systematic review of zirconia fixed dental prostheses (FDPs) has shown that complications can occur when clinicians meet realistic technical and clinical situations [62]. As for the relationship between implant-supported restorations and bruxism, several studies analyzing complications with implant-supported restorations suggested that bruxism may be associated more with mechanical causes (screw loosening, ceramic fracture or chipping, and abutment or fixture fracture) than biological (loss of marginal bone attachment) ones [55,59,63]. Clinical strategies can be engaged in order to decrease mechanical trauma, such as reducing cusp steepness, enlarging contact areas, and providing slight occlusal under-contact. From a practical viewpoint, the clinician should adopt a safe and cautionary approach to a patient with bruxism who needs a prosthetic treatment by employing strategies in order to reduce the potentially negative effects of bruxism [20]. These include both prosthetic (occlusal design) and surgical (number, size, and location of implants) aspects [22,26]. Connection between implants may provide a better load distribution and reduce peri-implant bone stress, and cantilevers and immediate-loading protocols should be avoided [26]. In addition, flatter cuspal planes are recommended in order to obtain a positive liberty of movements around the occlusal contact areas in maximum intercuspation and to protect the prosthesis during eccentric movements.

4. Discussion

The relationship between temporomandibular disorders and bruxism and prosthodontics is a topic requiring further discussion. The question of whether occlusion can represent a risk factor for temporomandibular disorders is controversial. Patients with temporomandibular disorders may adapt less easily than healthy patients to the occlusal and psychological stress of a modification to their occlusal scheme because of their delicate psychophysiological equilibrium. Thus, patients affected by TMDs or bruxism need a simple occlusal design. The biological hypothesis that a centrally mediated phenomenon such as bruxism may be caused by a prosthetic treatment is nonexistent. Restorations placed in patients affected by some type of bruxism activity should have a functional design, especially in circumstances where the patient has already lost some tooth structure and where these restorations support the patient. Patients with implant-supported restorations affected by bruxism may run into mechanical complications; thus, the choice of a metal occlusal surface as the material, connection between implants, and flatter cuspal planes are recommended, while cantilevers and immediate-loading protocols should be avoided [64].

5. Conclusions

The relationship between temporomandibular disorders and prosthesis requires further discussion. The role of occlusion as a risk factor for TMD is controversial. Studies analyzing the incidence of prosthetic and functional complications in patients treated with a VDO increase in teeth-supported, mixed, and implant-supported restorations should be conducted. On the other hand, patients affected by bruxism can be treated with occlusal splints, and a functional design of the restorations is recommended. Furthermore, prosthetic (occlusal design) and surgical (number, size, and location of implants) aspects have to be considered for implant rehabilitation in patients affected by bruxism.

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Abbreviations

TMD	Temporomandibular disorder
TMJ	Temporomandibular joint
EMG	Electromyography
MRI	Magnetic resonance imaging
VDO	Vertical dimension of occlusion
DC/TMD	Diagnostic Criteria for Temporomandibular Disorders
FDPs	Fixed dental prostheses

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