

Role of Psychosocial Factors in the Etiology of Bruxism

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***Aims:** To summarize literature data about the role of psychosocial factors in the etiology of bruxism. **Methods:** A systematic search in the National Library of Medicine's PubMed Database was performed to identify all peer-reviewed papers in the English literature dealing with the bruxism-psychosocial factors relationship. All studies assessing the psychosocial traits of bruxers (by using questionnaires, interviews, and instrumental and laboratory exams) and reviews discussing the contribution of those factors to the etiology of bruxism were included in this review. **Results:** A total of 45 relevant papers (including eight reviews) were retrieved with a search strategy combining the term "bruxism" with the words stress, anxiety, depression, psychosocial and psychological factors. The majority of data about the association between psychosocial disorders and bruxism came from studies adopting a clinical and/or self-report diagnosis of bruxism. These studies showed some association of bruxism with anxiety, stress sensitivity, depression and other personological characteristics, apparently in contrast with sleep laboratory investigations. A plausible hypothesis is that clinical studies are more suitable to detect awake bruxism (clenching type), while polysomnographic studies focused only on sleep bruxism (grinding type). **Conclusion:** Wake clenching seems to be associated with psychosocial factors and a number of psychopathological symptoms, while there is no evidence to relate sleep bruxism with psychosocial disorders. Future research should be directed toward the achievement of a better distinction between the two forms of bruxism in order to facilitate the design of experimental studies on this topic. J OROFAC PAIN 2009;23:153-166*

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Bruxism is a stereotyped oral motor disorder characterized by awake and/or sleep-related grinding and/or clenching of the teeth.¹ It is considered the most detrimental among all the parafunctional activities of the stomatognathic system, causing tooth wear and representing a major risk factor for temporomandibular disorders (TMD) as well. Nevertheless, despite the importance of its clinical effects, there are still many unsolved issues concerning the etiology of bruxism itself.

The etiology of bruxism is a complex and controversial issue. Most authors have suggested a central etiology for bruxism, as pointed out by reviews suggesting a conceptual shift from peripheral (ie, occlusal) to central (ie, stress, emotion, personality)

Table 1 Medline Search Strategy

Search Word(s)	Citations	Reviews
Bruxism	2,039	238
Bruxism and stress	267	43
Bruxism and anxiety	70	11
Bruxism and depression	49	9
Bruxism and psychological factors	22	5
Bruxism and psychosocial factors	9	0

regulation.²⁻⁶ Psychosocial factors could be involved in the etiopathogenesis of bruxism, but the theory that occlusal interferences represent a neuromuscular stimulus capable of triggering non-functional masticatory movements has not been completely abandoned.⁷ Many etiological theories have been proposed over the years, and a multifactorial model to explain bruxism etiology seems to be the most plausible hypothesis, according to which psychosocial and pathophysiological factors interact with morphological-peripheral ones.⁸⁻¹⁰

The study of the etiology of bruxism is complicated by some diagnostic and taxonomic aspects which have prevented an acceptable standardization of diagnosis to be achieved until recently. A major concern for researchers approaching this phenomenon is the definition of bruxism itself, which is a term grouping different entities.³ For example, “sleep bruxism” and “awake bruxism” seem as such to recognize a different pathogenesis but are difficult to clinically distinguish between⁹; similarly, a clearer distinction between detected bruxism and perceived bruxism should be made.¹¹ Unfortunately, bruxism as a pathophysiological entity can only be detected by means of polysomnographic recordings, the use of which is limited by the high costs and the low number of adequately equipped sleep laboratories.⁵ Nonetheless, even though a clinical approach to the diagnosis of bruxism still remains incomplete, not allowing a distinction between the different types of this disorder, it is the easiest and most adopted method to gather data in large-sample studies. In particular, studies based on clinical diagnosis of bruxism have provided a detailed description of some temperamental traits that characterize bruxers (eg, aggressiveness, hostility, perfectionism, sensitivity to stress), and also have pointed out a high prevalence of psychosocial disorders in populations of bruxers.¹² These observations seem to strengthen the widespread opinion among practitioners that a

bruxism-psychosocial factors relationship does exist. Nonetheless, research studies seem to provide contrasting suggestions with respect to the clinical setting, being unable to demonstrate such relationships. For these reasons, there is a need to summarize data from the literature about the role of psychosocial factors in the etiology of bruxism, which will be the focus of this systematic review.

Materials and Methods

On January 9, 2008, a systematic search in the National Library of Medicine’s PubMed Database was performed to identify all peer-reviewed papers in the English literature dealing with the bruxism-psychosocial factors relation (Table 1). The search strategy used the combination of the text word “bruxism” (which yielded 2,039 citations if used alone), with the words “stress”, “anxiety”, “depression”, “psychological factors”, or “psychosocial factors”.

Two types of studies were selected and included for discussion in this review: (1) research studies addressing the psychosocial traits of bruxers (by using questionnaires, interviews, and instrumental and laboratory exams), and (2) studies reviewing the available literature on the contribution of these factors to the etiology of bruxism.

Titles and abstracts obtained from the above search were screened according to the type of study for possible admittance in the review: all studies that appeared to fall within one of the above-described categories were then retrieved as complete articles. Abstracts providing unclear data were also retrieved as full text articles in order to avoid excluding papers of possible relevance.

The search strategy provided a total of 267 abstracts, including 43 reviews, for the combined search words “bruxism and stress.” Screening of the abstracts showed that 40 papers (including eight reviews) were relevant and satisfied the inclusion criteria. The search words “bruxism and anxiety” yielded 70 citations, partly overlapping with those identified with the “bruxism and stress” search, and allowed to retrieve two other relevant citations, neither of which was a review. Three further relevant citations (zero reviews) were obtained by the words “bruxism and depression”, which yielded a total of 49 citations. The combined words “bruxism and psychological factors” (22 citations) and “bruxism and psychosocial factors” (nine citations) only yielded references that were already included within other searches, so that no other relevant citations were retrieved by using

Table 2 Bruxism and Psychosocial Factors: Studies with EMG and/or Polysomnographic Diagnosis of Sleep Bruxism

Authors	Sample size	Bruxism diagnosis	Psychosocial diagnosis	Objective*	Authors' main conclusions*
Takemura ⁴³	17 sleep bruxers; 10 non-bruxers	Sleep diagnosis; Criteria not specified	Rosenzweig Picture- Frustration test	Personality and behavioral traits of bruxers and masticatory muscle disorder patients	Bruxers are intra- aggressive and unable to cope with stress
Van Selms ²⁰	1 myogenous TMD patient	Sleep bruxism; Nocturnal single- channel EMG activity	Experienced/ anticipated stress annotation	Study of the risk factors for craniomandibular pain	Experienced stress may be related to daytime clenching
Watanabe ²²	12 sleep bruxers	Sleep bruxism; Nocturnal intra-oral piezoelectric appliance	Self-assessment of daily stress	To test whether sleep bruxism is correlated with daily behaviors	Bruxism is not strongly related to daytime activities
Pierce ²¹	100 bruxers	EMG activity	Stress (self-reported)	Assessment of the relationship between stress and bruxism	Correlation between EMG measures and self- reported stress is significant for 8 out of 100 subjects
Clark ¹⁶	20 bruxers; 10 control subjects	Nocturnal EMG activity	Stress (urinary catecholamine levels)	Assessment of the hypothesis that nocturnal bruxism is related to periods of increased emotional stress	Positive relationship between increased epinephrine content and high levels of nocturnal EMG activity
Rao and Glaros ⁸⁶	8 diurnal bruxers; 8 non-bruxers	EMG activity	Responsiveness to stress and psycho- logical status (stressful stimuli)	Comparison of diurnal bruxists and normals in responsiveness to stress and on psychological status	Bruxers respond more to stress than normals, while there are no differences in the psychological status

*Pertinent to bruxism and psychosocial factors. EMG = electromyographic.

these combined search terms. The search was also extended to the related articles in the Medline Plus database, but no other papers satisfying the inclusion criteria were identified. Thus, a total of 45 relevant papers (including eight reviews) were obtained as full-reports and discussed in the review (Tables 2 through 5).

In this review, for the convenience of the readership, “psychosocial factors” will be used as an umbrella term to group together all those psychological (eg, stress, anxiety and mood disturbances, temperamental traits, and emotions) and social (eg, workplace satisfaction, marital status, cultural and economic conditions, social behaviors, and expectations) agents that may have an effect on an individual’s health. Actually, most literature on the bruxism-psychosocial factors association is focused on the study of psychological aspects rather than social ones, so the former will be the main focus of this review. The word “bruxism”, when used alone, will be adopted as an umbrella

term to group together both sleep and awake bruxism as well as teeth grinding and clenching, since the majority of papers did not specify which type of bruxism was under investigation. Whenever possible throughout this review, and in particular in the final section, a distinction between sleep bruxism and awake bruxism and grinding and clenching was made, in the attempt to provide specific information about the relation between TMD and the different types of bruxism.

The discussion of data from the literature will start with an appraisal of the available findings about the association between bruxism and stress, which for many years was the main etiological concept to explain bruxing behavior. Profiles of bruxers, derived mainly from questionnaire studies adopting several different psychometric tools, will also be described along with the presentation of some shortcomings of the current literature and considerations for future research.

Table 3 Bruxism and Psychosocial Factors: Studies with Clinical and/or Self-report Diagnosis of Bruxism

Authors	Sample size	Bruxism diagnosis	Psychosocial diagnosis	Objective*	Authors' main conclusions [†]
Winocur ⁴⁵	77 psychiatric patients; 50 healthy controls	Clinical	Patients under treatment for different psychopathologies	Assessment of bruxism and TMD prevalence among psychiatric patients	Bruxism and TMD have a higher prevalence in psychiatric than in non-psychiatric patients
Schneider ¹⁰⁷	75 sleep bruxers; 38 non-bruxers	Clinical (dental examination)	German coping questionnaire	Assessment of coping strategies in bruxers	Deficit of functional coping strategies in bruxers
Tahara ¹⁰⁶	17 healthy subjects	Not applicable	Not applicable	Investigation of the effect of chewing and clenching on stress	Clenching promotes relaxation in subjects under stress
Lurie ¹⁰⁵	35 military pilots; 22 military officers	Tooth wear	Battery of psychological questionnaires	Evaluation of the potential of work-related stress and psychosocial factors to induce bruxism	Coping strategies of bruxers are more emotional than non-bruxers
Marthol ¹⁰⁴	20 sleep bruxers; 20 healthy volunteers	Clinical	Not applicable	Evaluation of sympathetic cardiac activity in bruxers	Sympathetic cardiac activity of bruxers is higher than non-bruxers, suggesting a role of stress
Antonio ¹⁰³	2 bruxers (children)	Clinical (tooth wear)	Life histories	Discussion of risk factors	In both cases, bruxism seems to be triggered by psychological disturbances
Casanova-Rosado ¹⁰²	506 subjects of general population	Interview	Stress, anxiety questionnaires	Identification of risk factors for bruxism and TMD	The effect of stress on TMD is related to bruxism and anxiety presence
Camparis and Siqueira ⁶¹	100 sleep bruxers	Clinical	RDC/TMD, EDOF-HC	Evaluation of long-standing sleep bruxism patients	Depression and somatization levels are different between bruxers with and without facial pain
Ahlberg ¹⁰¹	1,500 employees of a broadcasting company	Interview (perceived bruxism)	Stress and psychosocial status questionnaires	Identification of risk factors for bruxism and association with restless leg syndrome	Perceived bruxism may be a sign of a stressful situation
Manfredini ³⁹	38 bruxers; 67 non-bruxers	Clinical	MOODS-SR	Assessment of the existence of an association between bruxism and mood psychopathology	Bruxers' scores are higher than non-bruxers for the evaluation of both manic and depressive symptoms
Manfredini ³⁰	34 bruxers; 64 non-bruxers	Clinical	PAS-SR	Investigation for an association between anxiety and bruxism	Clinically diagnosed bruxism is associated with panic symptoms and increased stress sensitivity
Glaros ⁸⁰	96 TMD patients	Self-assessment	Questionnaires for mood and stress levels	Examination of the role of para-functional and emotional status on TMD symptoms	Parafunctional behaviors and emotional states are predictors of jaw pain levels
Manfredini ²⁹	34 bruxers; 51 non-bruxers	Clinical	PAS-SR, MOODS-SR	Investigation for associations between clinically diagnosed bruxism and psychopathological symptoms	Both mood and anxiety spectra symptoms differentiate bruxers from non-bruxers
Ahlberg ²⁵	211 employees of a broadcasting company	Interview (perceived bruxism)	Stress and psychosocial status questionnaires	Identification of risk factors for bruxism and TMD	Psychosocial factors and stress are interrelated with bruxism and TMD

Table 3 continued

Authors	Sample size	Bruxism diagnosis	Psychosocial diagnosis	Objective*	Authors' main conclusions [†]
Ahlberg ²⁴	1,500 employees of a broadcasting company	Interview (perceived bruxism)	Stress and psychosocial status questionnaires	Assessment of association between bruxism and work-place satisfaction	Dissatisfaction with one's workshift schedule increases stress and bruxism
Melis and Abou-Atme ²⁸	1,014 subjects of general population	Interview (perceived bruxism)	Stress (perceived stress)	Description of bruxism habits	Bruxism seems not related to stress
Ahlberg ²³	1,339 employees of a broadcasting company	Interview (perceived bruxism)	Stress and psychosocial status questionnaires	Assessment of association between bruxism and stress experience	Bruxism may reveal ongoing stress in normal work life
Molina and dos Santos ⁴²	100 TMD/bruxers; 40 non-TMD/non-bruxers	Clinical	Cook-Medley Inventory, Beck Depression Inventory	To test whether there are differences in hostility between TMD/bruxism and non-TMD/non-bruxism patients	Support to the relationship between moderate to severe bruxism and hostility has been provided
Ohayon ²⁶	13,057 inhabitants of UK, Germany, Italy	Interview	Interview	Assessment of risk factors for bruxism in the general population	Anxiety and stress (Odds ratio 1.3:1) are risk factors for bruxism
Vanderas ¹⁰⁰	314 children	Clinical and interview diagnosis	Stress (urinary catecholamine levels)	Assessment of urinary catecholamine levels in children with and without bruxism	Epinephrine and dopamine levels have a significant association with bruxism
Da Silva ³⁷	45 with tooth wear; 45 without tooth wear	Tooth wear	Modified and Perceived Stress Scale State-Trait Anxiety Inventory	Investigation of association between psychosocial factors and tooth wear	Tooth-wear patients have higher levels of trait anxiety than controls
Kampe ³⁸	29 subjects	Clinical	KSP personality inventory	Comparison of personality patterns of bruxers and non-bruxers	Bruxers are more anxiety prone, had higher vulnerability, and were less socialized
Fischer and O'Toole ⁴⁴	74 bruxers; 38 non-bruxers	Clinical (not specified)	Personality tests (battery)	Assessment of the personality traits of bruxers	Chronic bruxers were, among others, shy, stiff, cautious, apprehensive
Harness and Peltier ⁵¹	Not available	Clinical (not specified)	MMPI	To test whether bruxism is a useful predictor of psychopathology in a facial pain population	Bruxism is not associated with psychological disturbance as measured by MMPI
Hicks and Conti ²⁷	511 undergraduate students	Interview	Stress (interview)	Evaluation of stress contribution to the etiology of bruxism	Subjects who identified themselves as bruxers reported more symptoms of stress than non-bruxers
Funch and Gale ⁹⁹	1 sleep bruxer	Clinical	Anxiety (battery of test)	Evaluation of the role of anxiety in bruxing behavior (ancillary objective)	Bruxism resulting from anxiety is not as important as anticipatory anxiety resulting in bruxism
Heller and Forgione ³⁶	27 bruxers; 7 non-bruxers	Clinical and radiographic	Taylor Manifest Anxiety Trait, Multiple Affective Adjective Checklist	Differences between bruxers and non-bruxers in anxiety state and traits	Bruxers differed from non-bruxers only in anxiety state
Olkinuora ⁴¹	Not available	Interview	Battery of questionnaires	Assessment of personality of bruxers	Bruxers are emotionally out of balance and tend to develop more psychosomatic disorders

[†]Pertinent to bruxism and psychosocial factors. RDC/TMD = Research Diagnostic Criteria for Temporomandibular Disorders, EDOF-HC = University of Sao Paulo orofacial pain clinical questionnaire, MOODS-SR = Mood Spectrum-Self Report, PAS-SR = Panic-Agoraphobic Spectrum-Self Report., KSP = Karolinska Scales of Personality, MMPI = Minnesota Multiphasic Personality Inventory.

Table 4 Bruxism and Psychosocial Factors: Studies on Animal Models

Authors	Sample size	Bruxism diagnosis	Psychosocial diagnosis	Objective*	Authors' main conclusions*
Rosales ⁴⁸	60 (group 1) + 36 (group 2) rats	Brux-like activity in rats	Emotional and fear-like stress	To clarify the relationship between emotional stress and bruxism	Emotional stress induces brux-like activity in the masseter muscle of rats
Gomez ¹⁰⁸	45 rats	NFMA [†]	Physical stress (tail pinch)	Expression of NFMA during stress and assessment of its relation with striata dopamine metabolism	The expression of parafunctional masticatory activity attenuates the effects of stress on central catecholaminergic neurotransmission
Gomez ⁴⁶	30 rats	NFMA [†] (incisal attrition)	Biochemical stress (injection of apomorphine)	Investigation of the role of different risk factors for bruxism	Partial support of the role of central dopaminergic system in bruxism and suggestion that stress is not important for tooth wear

*Pertinent to bruxism and psychosocial factors.

[†]Non-functional masticatory activity.

Table 5 Bruxism and Psychosocial Studies: Reviews

Authors	Type of review	Main conclusions*
Lobbezoo ⁶	Analytic review of bruxism etiology and effects of bruxism on dental implants	The body of evidence for a possible causal relationship between bruxism and various psychosocial factors is growing, though not yet conclusive
Bracha ¹¹¹	Discussion of the clenching-grinding spectrum from a neuropsychiatric/neuroevolutionary perspective	There is a need for early detection of the clenching-grinding spectrum in anxiety disorders
Manfredini ⁷	Review of theories on the etiopathogenesis of oral parafunctions	There is a need to further clarify the role of psychic factors in the etiopathogenesis of bruxism
Lobbezoo and Naeije ³	Review of the etiology of bruxism	Bruxism is mainly regulated centrally, not peripherally
Bader and Lavigne ⁹	Overview of knowledge on sleep bruxism	Attempts to specify the personality traits of bruxers gave controversial results
Molin ¹¹⁰	Personal view on the role of stress in the etiology of oral parafunctions and masticatory muscle pain	A clear line is found from past peripherally based etiologic theories to psychologic and psychosocial concepts of bruxism and masticatory muscle pain etiology
Hicks ¹⁰⁹	Review of the etiologic theories on nocturnal bruxism	Psychological variables may play a role in the development of nocturnal bruxism
Rugh ¹⁷	Review of the evidence for the belief that psychological stress is a key factor in the etiology of bruxism	Periods of muscle hyperactivity seem to be correlated with specific daily activities, but there is great variability between patients

*Pertinent to psychosocial factors.

Bruxism and Stress

According to recent suggestions, stress can be defined as a real or interpreted threat to the physiological or psychological integrity of an individual that results in physiological and/or behavioral responses.¹³ Such a definition implies the existence of an input, which may be physiological or psychological, and an output, which may also have a physiological as well as a psychological component. In the psychology literature, both input and output components are commonly referred to as stress,¹⁴

thus contributing to the confusion on the topic. Therefore, for the readers' convenience, the term stress will be used in this review to indicate the stressful stimuli or events generating the response (ie, the above-mentioned input).

It must be pointed out that it is a common opinion that sleep bruxism, and bruxism in general, is related to stress. This belief is typical of patients, who usually report an increase in their nighttime teeth grinding during stressful life periods, as well as of clinicians, who often attribute a patient's bruxing behavior to an increase in stress. This the-

ory is based on some early case series that reported a relationship between stressful daily events and an increase in nocturnal masseter muscle activity.¹⁵⁻¹⁸ In particular, a case report of a young woman whose nocturnal electromyographic (EMG) activity was recorded over a 140-day period in relation to her daily pain and stress levels contributed considerably to strengthen convictions that a stress-bruxism relationship existed.¹⁹ This single case report showed that nocturnal EMG activity increased immediately after a stressful event (school exam, meeting with parents, fights with partner, etc) and that pain levels increased shortly later. At present, studies by Rugh et al are the only papers in which nocturnal EMG activity was reported to increase with stress. Indeed, as described later in this section, successive case studies and experimental studies^{20,21,22} have failed to demonstrate such an association.

Apart from the early studies by Rugh et al, the bruxism-stress association has been reported by some investigations adopting a self-reported diagnosis of bruxism. Ahlberg et al²³ investigated the association between perceived bruxism and stress experience in the work environment. In a sample of 1,784 employees of a broadcasting company, the authors investigated the frequency of bruxism with a self-assessed question, reporting that frequent bruxers reported more stress. Successive papers by the same group^{24,25} reported similar findings, such that the authors stated that bruxism may reveal an ongoing stress in normal work life. Another large-scale population study in which self-assessment was taken as the criterion to diagnose bruxism reported that a "highly stressful life" may be a significant risk factor for bruxism.²⁶ These findings supported those of a questionnaire-based investigation on 511 undergraduate students, who reported more stress in association with bruxism,²⁷ but they were not in line with those from a similarly designed large-sample study reporting no association between awareness of bruxism and age, gender, marital status, occupation, and stress in general.²⁸

As for the clinical diagnosis of bruxism, no paper has addressed the specific issue of the bruxism-stress relationship by the adoption of standardized clinical criteria. However, an increase in stress sensitivity with respect to non-bruxers was shown in a group of clinically diagnosed bruxers who completed a battery of tests investigating the whole anxiety spectrum.^{29,30}

The above-described studies do not allow conclusions to be drawn due to a number of factors that affect their design and limit the generalization

of their findings. The most striking limitations of these studies are represented by the subjectivity of the self-report diagnosis of bruxism and by the lack of information on whether they are studying sleep or awake bruxism. Several studies have shown that a patient's self-report of bruxism is not reliable diagnostically, since it may be influenced by both the clinician's and patient's conviction of having a bruxing behavior.^{11,31} Furthermore, cross-study comparisons are hard to be carried out, since homogeneity of diagnostic criteria for both bruxism and stress levels exist only within studies by the same group of researchers. Thus, definitive findings on this issue are not likely to be achieved with self-report and clinical research alone, which based both bruxism and stress diagnoses on criteria that are hard to standardize in the clinical setting.

At present, polysomnographic recordings in adequately equipped sleep laboratories represent the standard of reference for the diagnosis of bruxism,^{5,9,32} but it has found less application than expected because of obvious logistic and economic problems. Portable EMG devices, which allow the recording of EMG activity of masticatory muscles during sleep in the habitual environment, reduce costs and limit patient discomfort, representing an acceptable instrument in the research setting.^{22,33} Unfortunately, only a few longitudinal investigations have been performed to study the bruxism-stress association.²⁰⁻²² Two of them used an EMG-based diagnosis of bruxism,^{20,21} while one adopted a telemetric-based system to diagnose bruxism when forces at or above 10 percent of maximum voluntary clenching were applied onto an intraoral appliance.²² Taken together, these studies accounted for a total of 113 patients, with a mean of 15.8 recordings per patient. In general, the available data do not support findings from the early report by Rugh and Harlan,¹⁸ since no relation between EMG-detected sleep bruxism and either experienced (the day before the recording night) or anticipatory (the day following the recording night) stress was described.

Pierce et al,²¹ in a study on 100 sleep bruxers over a 15-night recording period, found a lack of association between bruxism and stress in 92% of the study population. Similarly, Watanabe et al,²² found no relation of bruxism to any of the daytime self-monitored activities (among which, stress levels and sleep quality) of the subjects in a 3-week study on 12 sleep bruxers. These findings were also supported by the single case study by Van Selms et al,²⁰ which is noteworthy in the attempt to describe fluctuations in the daytime and nighttime

EMG masseter activity over a long time period. Interestingly, Lobbezoo and Naeije³ and Lobbezoo et al⁶ suggested that the presence of 8% of subjects who did show a stress-bruxism association in the study by Pierce et al²¹ can be interpreted as the possibility that certain bruxers are “sensitive” to stress, while others (that were the large majority) are not sensitive. Such a hypothesis is also in line with successive clinical works by Manfredini et al,^{29,30} who showed that stress sensitivity is one of the domains in the anxiety spectrum that mostly differentiate bruxers from non-bruxers. Thus, it seems that available data from EMG-based research studies do not support the hypothesis of a strict bruxism-stress relationship, thus contrasting with studies based on clinical and/or self-reported diagnoses of bruxism.

These considerations must be taken with caution since, as in the case of clinical studies, generalization of results from EMG-based investigations is not possible due to the paucity of investigations, patients, and research groups involved. A more widespread use of portable devices to achieve home EMG recordings is needed to perform representative-samples studies within the future, and to help overcome problems of small sample sizes which currently characterize many experimental studies. Their use might also promote a standardization of bruxism diagnosis and a comparison of results between different investigations. The problem of standardization affects the definition and diagnosis of stress as well. Several different criteria have been adopted in the literature, varying from dichotomic (stressed/not stressed) to ordinal (ie, nominative rating scales) and numerical (ie, visual analog scale [VAS] ratings) variables. Inter-study inhomogeneity should also be reduced in future research, possibly with the adoption of a VAS scale, at least until some other assessment instrument is validated and shown to be superior in both the clinical and research settings.

The conflicting findings between clinical and EMG-based studies on bruxism-stress may be explained by at least two biologically plausible hypotheses. First, the relation is much more complex than previously imagined, involving many other complex psychosocial aspects and disorders, such as anxiety, depression, and personality traits. Second, a clearer distinction between sleep bruxism and awake bruxism and between grinding and clenching types of bruxism has to be made at the diagnostic level in an attempt to identify the actual pathogenesis underlying these conditions. These hypotheses are not mutually exclusive and will be discussed below.

Bruxism and Other Psychosocial Disorders

Despite controversial aspects that have yet to be defined, studies on the bruxism-stress relationship maintain the suggestion that peripheral sensory influences play only a minor role in the etiopathogenesis of bruxism,^{4,34} while central nervous system-related factors are given much more importance.^{5,9} Among these, an interesting topic is represented by the study of the other psychosocial disorders that may be associated with bruxism. As in the case of the bruxism-stress studies, the majority of the literature is based upon self-reported or clinical diagnoses of bruxism. The work by Pierce et al²¹ has been the only EMG study in this field, and found no association between sleep bruxism and personality variables, such as anxiety, depression, and irritability. By contrast, in a controlled polysomnographical study related to vigilance and reaction time, an increased level of anxiety was found in sleep bruxers.³⁵

Clinically oriented studies have shown that some symptoms related to anxiety disorders have a significantly higher prevalence in bruxers than in non-bruxers^{30,6–38} and that a number of both depressive symptoms and manic symptoms of the mood spectrum seem to characterize bruxers.^{29,39} Clinically or self-diagnosed bruxism has also been associated with emotional tension,⁴⁰ psychosomatic disorders,⁴¹ hostility,⁴² intra-aggressiveness,⁴³ apprehension and tendency to worrying,⁴⁴ and psychiatric disorders such as schizophrenia.⁴⁵

Interestingly, investigations using animal models by Gomez et al,⁴⁶ Areso et al,⁴⁷ and Rosales et al⁴⁸ have raised a possible physiological mechanism that enables psychosocial factors to cause a movement disorder such as bruxism. Indeed, chronic stress, due to physical^{46,47} as well as emotional stimuli,⁴⁸ is able to activate the dopaminergic system,⁴⁹ which may cause the occurrence of non-functional masticatory movements. In particular, the capacity of stress to induce bruxism seems to depend upon the stressors' influence on dopaminergic pathways activation, which in turn depends upon the type and duration of the stressors. For instance, rats that underwent repeated emotional fear-like stress in a communication box⁴⁸ showed a strongly significant higher number of brux-like episodes compared to controls. Moreover, the same study described the effectiveness of diazepam to reduce such brux-like activity depending upon emotional stress. This is in contrast with previous findings by Pohto,⁵⁰ who found that such a drug was not effective in reducing brux-like activity triggered by a combination of apomorphine and a

peripheral stimulus, such as the insertion of occlusal interferences. Therefore, taken together, results from clinical studies are supportive of an association between bruxism and a number of psychosocial disorders, and suggestions from animal models seem to provide plausible pathophysiological explanations for such an association.

The above-described observations are in contrast with the early results of Harness and Peltier⁵¹ who found that bruxism was not associated with psychological disturbance as measured by the Minnesota Multiphasic Personality Inventory (MMPI). This investigation was performed on a sample of chronic facial pain patients, thus making an unequivocal comparison with findings from other studies impossible and preventing conclusions to be drawn about the actual relation between bruxism and psychological factors. Indeed, it is well recognized that facial pain is associated with a number of psychiatric and psychosocial disorders.^{52–56} Such an association applies mainly to anxiety disorders in the acute stage of pain and depressive disorders in the chronic phase,⁵⁷ and does not depend upon pain location.⁵⁸ Nonetheless, facial pain may be associated with bruxism as well.^{59,60} Thus, the study of the bruxism-psychosocial disorder relationship is complicated by the association that both variables have with facial pain. One example supporting this consideration has come from the study by Camparis and Siqueira⁶¹ who reported significant differences in the psychosocial profile of bruxers with and without chronic facial pain.

It is a common belief among general practitioners that bruxism is a cause of TMD pain due to empirical clinical observations that pain in the muscles of mastication is a frequent symptom in bruxers. Nevertheless, pain is not present in every bruxer and the existence of a bruxism-related pain is a controversial issue. Data have come mostly from studies assessing the prevalence of muscular and temporomandibular joint pain in populations of subjects who were reported to be bruxers and from investigations of the prevalence of bruxism in samples of patients with or without facial pain. Even though some support for the association between teeth clenching and facial pain has been provided,^{60,62–65} some studies reported no association between bruxism and muscle sensitivity, finding an association between clenching and joint sounds only^{66,67}; thus, the argument of a cause-and-effect relationship between bruxism and TMD pain is still much debated.⁵⁹ Such suggestions from clinical investigations seem to be confirmed by experimental studies,^{68–70} but evidence proving a

causal relationship is still lacking.⁵⁹ Indeed, the temporal criterion for a causal relationship is hardly demonstrable due to the daily fluctuations of bruxism events^{2,9,71,72} as well as TMD symptoms,^{73–75} and it has a poor correspondence in the epidemiological characteristics of TMD.⁵⁹ Besides, Lavigne et al⁷⁶ found that bruxers with concomitant jaw muscles pain have fewer bruxing episodes per hour of sleep than bruxers without myofascial pain, suggesting that bruxism is not the primary cause of jaw muscle pain and emphasizing the need to investigate if the reduced hourly number of bruxing episodes is pain-related or if it is due to an influence of pain on sleep. In line with such findings, a recent investigation found no significant relationship between self-reported bruxism and TMD pain.⁷⁷

Thus, an improved understanding of the bruxism-pain relationship should be useful also for the study of the possible association between bruxism and psychosocial factors. The selection of subjects to be included in a population of bruxers has often been based on the presence of jaw pain as a criterion to diagnose bruxism. This preconceived idea might lead to a biased selection of bruxers with facial pain as representative of all bruxers. Thus, as discussed below, findings about the psychosocial profiles of bruxers might have been influenced by the relationship that psychosocial factors have with pain.

Discussion

Taken together, the above-described findings illustrate the complexity of the problem and emphasize the need for achieving a better distinction between the many forms of bruxism, which are probably related at different levels with both psychosocial factors and painful symptomatology. Bruxism can occur during both wakefulness and sleep. Bruxism during wakefulness is commonly characterized by a clenching-type activity, while sleep bruxism by a combination of clenching and grinding-type activity.^{5,9} Despite being usually grouped together and generically referred to as “bruxism,” these disorders may involve a different etiology and be influenced by different local and systemic factors. Also, there is some consensus that clenching-type activity during the day is associated more with jaw pain than tooth grinding during sleep, even though experimental studies on tooth clenching as well as studies adopting tooth wear levels as an indicator of tooth grinding suffer from some methodological shortcomings.^{78–80}

Thus, considering the uncertainties and the lack of definite conclusions about many issues concerning bruxism, it appears logical that efforts should be made to discriminate between sleep bruxism and awake bruxism at the etiologic, diagnostic, and therapeutic levels.

The study of the bruxism-psychosocial disorder-pain relationship, which is also exposed to several biases due to the relationship that each variable has with the others, may have some benefit from an approach taking into account differences between awake bruxism versus sleep bruxism and grinding versus clenching. Indeed, given the findings described in this review and the role of stress and psychosocial factors in the etiology of bruxism, it is likely that divergences in opinions and results depend upon the inhomogeneity of bruxer populations. This may be the reason why the early findings¹⁵⁻¹⁸ have never been confirmed by subsequent EMG studies of sleep bruxers.²⁰⁻²² The case reports of Rugh et al described bruxers who were recruited on the basis of the presence of painful symptoms, while the subsequent EMG studies included sleep bruxers with or without pain in the facial area. The selection of a group of pain-referring bruxers is a possible source of bias affecting the early reports on the bruxism-stress association, since a third variable (ie, pain) was introduced without assessing its effect size (ie, influence) on the two variables under study (ie, bruxism and stress). This consideration seems to be strengthened by the subsequent research of the same group⁸¹ which reported a lack of habituation to experimentally induced stress in subjects with TMD. The historical importance of these studies cannot be underestimated, since they described a stress response by bruxers with facial pain¹⁵⁻¹⁸ and, later, placed this response in relation to the presence of TMD pain.⁸¹ Such findings, which provided support for the hypothesis that TMD patients and healthy subjects respond differently to stress in terms of habituation to stressful stimuli, have been strengthened by a number of publications,⁸²⁻⁸⁴ thus indicating that the stress-bruxism relationship described in the early EMG studies was likely dependent upon the inclusion of TMD patients only.

Also a selection bias may be at the basis of differences between findings of studies adopting self-diagnosis of bruxism and those performing home EMG recordings or polysomnographic recordings in sleep laboratories. Self-referral of bruxism is mainly based on patients' perception of pain in the muscles of mastication in the morning, which is related to daytime clenching (a sort of post-exercise soreness⁸⁵) and not to sleep bruxism.²² These

observations suggest that the association between bruxism and a number of psychosocial disorders described in many studies may depend upon the criteria used to select patients, which are more suitable to detecting daytime clencher rather than sleep bruxers. On the other hand, the polysomnographic diagnosis of bruxism actually detects sleep grinders, since increases in EMG activity, to be clearly identified as bruxism, have to be correlated to the loud "grinding sound."⁵ Therefore, data may actually reflect an association of stress and psychosocial disorders with clenching and not with bruxism as a whole. This hypothesis was already suggested by Olkinuora,⁴¹ who claimed that daytime clenching is a response to stress and that daytime clencher's scores on psychological tests would be higher in emotional disturbances than subjects who brux and grind their teeth nocturnally. To support this hypothesis, an EMG-based study by Rao and Glaros⁸⁶ suggested that emotional and situational factors may be important in the etiology of awake bruxism. Taken together, these observations point toward the possibility that awake (clenching) bruxism and sleep (grinding) bruxism have to be considered two different disorders.

Sleep bruxism has been repeatedly demonstrated to be part of a complex arousal response of the central nervous system,^{1,2,87-89} which occurs during changes in sleep depth and is accompanied by gross body movements, the appearance of K complexes in the electroencephalogram, an increased heart rate, respiratory changes, peripheral vasoconstrictions, and increased muscle activities.⁹⁰ Unfortunately, at present there are no definitive findings about the possible influence of emotional factors on such an activation, and a scarce literature exists about their influence on other parasomnias as well. Therefore, future studies on the sleep bruxism-stress (and/or psychosocial disorders) association might take advantage of parallel investigation on the other parasomnias, since many considerations expressed for sleep bruxism in this review (ie, poor correspondence between self-reported symptoms and objective findings; poor correspondence between findings of experimental and clinical studies; diagnostic difficulties) can be extended to other parasomnias, such as restless leg syndrome.⁹¹

By contrast, bruxism during wakefulness (clenching) is likely to be a result of emotional tension or psychosocial disorders that force the subject to respond with a prolonged contraction of his/her masticatory muscles. According to this viewpoint, recent findings of a possible association with the complex spectrum of mood disorders^{29,39} are worthy of further investigation. An awake

bruxism-depression association was quite unpredictable, and it was detected almost casually with the administration of a complete battery of tests for the evaluation of two psychopathological spectra, which aimed primarily at evaluating the bruxism-anxiety association.²⁴ The hypothesis that wake clenching is strictly related to depression, or may be an expression of a depressed mood, is fascinating and has found some support in the psychiatric literature suggesting that bipolar patients are characterized by disturbances in the central neurotransmitter system which may also be involved in the etiology of bruxism.⁹²⁻⁹⁵ Future research should try to describe common neurological deficits or pathogenetic pathways between manic and depressive disorders and bruxism, if existing. In this sense, there is a need to clarify the role of some neurotransmitters, and dopamine in particular, which are seen as key factors in the etiopathogenesis of both bipolar disorders and bruxism.

Similarly, the actual link between anxiety and stress and awake bruxism has to be better defined. Indeed, awake bruxism may be the result of a transitory anxious reaction to stressful daily events (state anxiety) or a phenomenon related to a more complex psychopathological disorder (trait anxiety). Data based on the use of questionnaires have linked bruxism to both types of anxiety,^{29,37,38,86} even though most data have come from studies adopting psychiatric instruments that are mainly suitable to detect trait anxiety. These considerations seem to suggest the existence of an awake bruxism personality profile, strictly related to the sphere of mood and anxiety disorders, even though it has not yet been defined.

Unfortunately, some issues complicate the investigation of the above-discussed aspects. Indeed, the difficulties to objectively diagnose awake bruxism,¹¹ the difficulties to standardize the psychosocial diagnoses outside the psychiatric setting,^{96,97} and the complexity of the relation that both bruxism and psychosocial disorders may have with pain,^{59,98} make standardization and comparison of results from different studies difficult and represent an obstacle to the design of unbiased investigations. Nevertheless, although definitive proofs are still lacking, there are several indications that the importance of emotional and psychosocial factors is different in awake bruxism and in sleep bruxism, thus suggesting that efforts have to be made toward a better definition of these disorders at both the etiologic and diagnostic levels.

Conclusions

The role of psychosocial factors in the etiology of bruxism is probably one of the most debated issues concerning this disorder. Although the first studies on this argument date back to more than 30 years ago, definite conclusions cannot yet be drawn. Factors such as the concurrent presence of pain, which may be strongly linked to psychopathology, act as confounding variables that complicate the study of the bruxism-psychosocial factors relation. Indeed, the selection of heterogeneously diagnosed samples of bruxers is the main reason for the different findings that have been reported in the literature.

Even though most data on the etiology and characteristics of bruxism have come from sleep laboratory studies, there is a paucity of literature on the role of stress and psychosocial disorders in polysomnographically monitored bruxers. These few studies have failed to demonstrate an association with any of the investigated psychosocial factors, so dismantling the early hypothesis of a strict bruxism-stress relation. By contrast, the majority of data about the association between psychosocial disorders and bruxism have come from studies adopting a clinical and/or self-report diagnosis of bruxism. In general, this kind of study has shown some sort of association of bruxism with anxiety, stress sensitivity, depression, and other personality characteristics, apparently in contrast with sleep laboratory investigations. A plausible hypothesis is that clinical studies are more suitable to detecting awake bruxism (clenching type), while the classical polysomnographic studies focused only on sleep bruxism (grinding type).

In conclusion, awake clenching may be mainly associated with psychosocial factors and a number of psychopathological symptoms, while there seems to be no evidence to relate sleep bruxism with psychosocial disorders. Future research should be directed toward the achievement of a better distinction between the two forms of bruxism in order to facilitate the design of studies on this topic.

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