When should sleep bruxism be considered in the diagnosis of temporomandibular disorders?

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Objective. Both temporomandibular disorders (TMDs) and sleep bruxism (SB) are known to be destructive to the masticatory system. However, the association between the 2 conditions is poorly understood. The aim of our study was to assess the relationship between TMD and SB through the signs and symptoms in 2 patient groups: TMD only and TMD with SB.

Study Design. A retrospective chart review was conducted from November 1, 2015, to April 1, 2018, on patients with completed International Network for Orofacial Pain and Related Disorders Methodology history questionnaires and Diagnostic Criteria for Temporomandibular Disorder clinical examinations. Fifty-two patients, including 12 with TMD only and 40 with TMD with SB, met the study criteria. Subjective descriptions and objective measurements of patient symptoms were investigated. The χ^2 test and Fisher's exact test were used for statistical analysis.

Results. The TMD with SB group exhibited increased oral behaviors compared with the TMD-only group ($P = .0004$). The TMD with SB group also experienced more headaches compared with the TMD-only group ($P = .045$).

Conclusions. Our results revealed that patients with jaw pain who self-report increased oral behaviors and/or exhibit temporal headaches should be evaluated for sleep bruxism. (Oral Surg Oral Med Oral Pathol Oral Radiol 2020;130:645−650)

The term *temporomandibular disorders* (TMDs) refers to a cluster of clinical conditions involving the masticatory muscles, temporomandibular joint (TMJ), and associated structures. Patients suffering from the disorder commonly experience pain of the masticatory muscles, clicking or crepitation sounds of the TMJ, limited jaw opening and movements, and orofacial pain. According to the National Institute of Dental and Craniofacial Research, as much as 5% to 12% of the general population is affected by TMDs.[1] In fact, other studies have found that up to 75% of the general population has at least 1 symptom of abnormality in TMJ function, and up to 33% present with facial pain.[2] Although several etiologic factors, including trauma, malocclusion (caused by anterior open bite or missing molars), hormonal factors, joint abnormalities, and parafunctional activities, have been associated with TMDs, the precise causal link between these factors and TMDs has yet to be established. Thus, the aim of our study was to assess the relationship between TMDs and a frequently cited major risk factor: bruxism.

Bruxism is defined as "a repetitive jaw muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible," resulting in symptoms that range from minor tooth sensitivity and chronic pain to destruction of the dentition and loss of masticatory function. Bruxism has 2 distinct circadian manifestations: (1) It can occur during sleep (indicated as *sleep bruxism* [SB]); and (2) it can occur during wakefulness (indicated as *awake bruxism* [AB]).[3] AB is generally diagnosed thorough medical history taking and clinical examinations and is managed with behavioral modifications; in contrast, SB has no standard for diagnosis, and patients with this condition often present with subclinical signs and symptoms. Because SB is much more challenging to diagnose and has been associated with many other medical conditions, including TMDs and musculoskeletal disorders, our study will focus only on SB, and not on AB, in our discussion of bruxism.

Studies have found that during sleep, protective neuromuscular reflexes that are operational during the waking hours appear to be suppressed.[4] Furthermore, clenching or grinding forces can often exceed the amplitude of maximum voluntary bite force in the

Statement of Clinical Relevance

Sleep bruxism should be considered in the differential diagnosis of temporomandibular disorder when patients with the chief complaint of jaw pain are concurrently presenting with increased oral behaviors and temporal headache.

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Received for publication Jun 5, 2020; returned for revision Aug 5, 2020; accepted for publication Aug 23, 2020.
Published by Elsevier Inc.
2212-4403/$-see front matter
https://doi.org/10.1016/j.oooo.2020.08.029

awake state, contributing to the destructive nature of SB.[5] The exact etiology of SB is still unknown, but it is linked to microarousal episodes, genetics, and psychosocial factors.[6] Numerous studies have paid particular attention to emotional stress as a psychosocial factor contributing to SB. For example, elevated levels of perceived psychological stress, salivary cortisol, and urinary catecholamine have all been observed in patients with SB.[7] Prevalence of SB in the general population ranges from 8% to 31%, and as much as 65% of patients with TMD have been reported to have bruxism.[8] Researchers have postulated that repeated overuse of the TMJ during bruxism causes damage to the articular disk and, thus, contributes to the development of TMDs.[9] Nonetheless, the exact causal link between TMDs and SB remains undefined.

The etiologies of TMDs and SB are complex and poorly understood. Often, the only treatment option available for patients with these conditions is management of symptoms. In fact, no criteria currently exist for the assessment and diagnosis of SB. However, a set of evidence-based tools is available to assess patients with a possible diagnosis of TMDs: Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). Made available by the International Network for Orofacial Pain and Related Disorders Methodology (INfORM), DC/TMD is a dual-axis instrument used by trained clinicians. Axis I consists of a set of physical examinations to assess patients' range of motion, incisal overlap, midline deviation, jaw mobility, TMJ clicking/crepitus, and the presence of joint pain, muscle pain, and familiar pain upon digital palpation. Axis II consists of a series of patient history questionnaires to assess pain-related behaviors and psychosocial functioning (i.e., the presence of clenching/grinding, physical symptoms/function, depression, and anxiety and its influence on daily activities). The intent of DC/TMD is to provide a physical diagnosis and, at the same time, to capture patient habits and behaviors that could affect the expression and, thus, management of TMDs.[10] Importantly, DC/TMD also captures specific information on SB. Self-reported nighttime clenching, presence of temporal headache, and jaw muscle fatigue, for example, are all risk factors of SB[11] and are evaluated in the DC/TMD.

Therefore, our study aimed to assess the relationship between TMDs and SB on the basis of DC/TMD and was performed at the University of Texas School of Dentistry (UTSD; Houston, TX). Specifically, we evaluated the signs and symptoms in patients with TMD only and in those with TMD with SB. It is hoped that an enhanced understanding of the nuanced clinical manifestations of TMDs and SB would help guide clinicians toward more accurate diagnoses and effective treatments of these two conditions.

MATERIALS AND METHODS

Permission to carry out this study was obtained from the Institutional Review Board (HSC-DB-18-0334) at the UTSD.

In this study, we conducted a retrospective chart review by using axiUm (Exan, Las Vegas, NV), the electronic health record (EHR) system at the UTSD. We queried the EHRs for the period November 1, 2015, through April 1, 2018, to include patients with a chief complaint of jaw pain, referred to and seen by the Clinical Investigator at the UTSD Faculty Practice. Our study included only those patients referred to and seen by the Clinical Investigator because of his credentialed training and calibration by the INfORM consortium. Although our single-clinician setup yielded a limited sample size, our goal in doing so was to achieve reliable and comparable diagnostic results. Additional patient inclusion criteria were (1) their completion of a history questionnaire from the INfORM and (2) completion of a standardized clinical examination based on the DC/TMD by the Clinical Investigator. All of the patients who met the aforementioned study criteria were deidentified and randomly assigned a study identification number. Four patients were excluded from our query because of missing history questionnaires and DC/TMD assessment forms in their EHRs, and this resulted in the final total of 52 patients included in the study.

The DC/TMD clinical examination consists of a series of diagnostic techniques to assess range of motion, incisal overlap, midline deviation, jaw mobility, TMJ clicking and crepitus, and presence of joint pain, muscle pain, and familiar pain upon palpation; the history questionnaire provides subjective descriptions of symptoms, such as self-reported pain, headache, TMJ noise, locking of the jaw, and the influence of these symptoms on daily activities and stress levels. All of the patients in this study were given a TMD diagnosis based on the DC/TMD examination and its Axis I diagnostic algorithm, and the presence of SB was self-reported in the questionnaire and/or clinically diagnosed and documented in the EHR progress notes.

Currently, some practitioners use polysomnography (PSG) recordings for the detection of SB. However, because of the high costs associated with PSG and because of lack of availability of sleep laboratory equipment, clinical diagnoses and patient self-reports remain the most adopted sources for gathering SB data.[12] We believe that PSG also introduces variable confounding factors in the diagnosis of SB, making the validity and reliability of this instrument questionable.[13] In our study, patients were considered positive for the presence of SB if (1) the provider confirmed the patient's subjective symptoms with objective clinical findings, stating the clinical diagnosis of SB in the EHR progress notes, or (2) the patient self-reported

clenching or grinding of teeth during sleep on the Oral Behavior Checklist. Thus, each subject was assigned to one of the following 2 groups:

- *TMD-only group:* Patients with an Axis I TMD diagnosis but without a clinical diagnosis or self-report of SB
- *TMD with SB group:* Patients with an Axis I TMD diagnosis and a clinical diagnosis and/or self-report of SB. Specifically, 17 of our patients self-reported SB in their INfORM history questionnaire, whereas 23 were diagnosed with SB during their clinical examination by the Clinical Investigator.

The variables used to assess the relationships between these 2 groups of patients included subjective descriptions and objective measurements of patient symptoms. Investigated variables and their corresponding rationales for inclusion are summarized in Table I.

All clinical examination forms and history questionnaires were initially documented on paper and then scanned into patients' EHRs. To analyze the data in these scanned documents, we created identical electronic forms and questionnaires in the Qualtrics survey software (Qualtrics, Provo, UT), and all scanned data were transcribed into it. Additionally, all patients' EHR progress notes were reviewed to determine whether these patients were clinically diagnosed with SB. Data from Qualtrics were extracted into Excel and analyzed by using R statistical software (R Core Team 2017, Vienna, Austria). The χ^2 test and Fisher's exact test were used for statistical analysis, and the level of significance was set at $P < .05$.

RESULTS

Patients who had TMD with SB reported significantly a higher number and/or frequency of oral behaviors, such as clenching, grinding, chewing gum, and so on during the sleep and waking hours compared with patients who had TMD only ($P = .0004$) (Figure 1). The daytime oral behavior that was reported with the highest frequency was chewing food on one side only, whereas the nighttime oral behavior reported with the highest frequency was sleeping in a position that puts pressure on the jaw.

Patients who had TMD with SB exhibited significantly more signs and symptoms of headache attributed to TMD compared with patients who had TMD only ($P = .045$) (Table II).

DISCUSSION

The Oral Behavior Checklist captures the frequency with which patients engage in such activities as grinding, clenching, resting the chin in the hand, pressing tongue forcibly against teeth, sleeping in a position that puts pressure on the jaw, and so on during sleeping and waking hours. In our patient population, the oral activities reported with the highest frequencies were "sleeping in a position that puts pressure on the jaw (e.g., on stomach, on the side)" and "Chewing food on one side only." These behaviors may lead to physical straining of the head, neck, and masticatory musculature, consequently causing malalignment of the mandible, TMJs, and associated structures. To realign the masticatory system, the masseter and lateral pterygoid muscles can, in turn, become hyperactivated and symptomatic with myofacial pain, truisms, myalgia, and other musculoskeletal conditions. Although triggering the activity of the masseter and lateral pterygoid muscles may explain the increased oral behaviors seen in patients with TMDs and SB compared with those with TMDs only, our results do not establish the temporality in which the 2 conditions occurred. Further studies are required to evaluate the role of oral behaviors in the initiation of TMDs and SB. Nonetheless, our results agree with the findings of Molina et al., who suggested that patients with TMDs and bruxism, compared with those without bruxism, present additional oral jaw habits that may increase masticatory muscle activity and lead to TMD signs and symptoms.[14] Miyake et al. in their study of Japanese university students similarly found that chewing on one side and clenching of teeth increase risk of TMJ noise, TMJ pain, and impaired mouth opening.[15] Findings from our study suggest that the use of the Oral Behavior Checklist can aid clinicians in evaluating the connection between patients' oral behaviors and the symptoms present in the masticatory and cervical apparatuses. Moreover, when patients self-report increased number and frequency of oral behaviors, SB should be included in the differential diagnosis.

For the purpose of this study, the term "headache" is limited to pain located in the temporalis muscles, either bilaterally or unilaterally, and to pain attributed to TMDs. Our results demonstrated that patients who exhibit signs and symptoms of temporal headaches are more likely to have both TMDs and SB than to have TMDs only. Several other studies also found that the concurrent presence of SB and TMDs greatly increased the risk for episodic migraine, episodic tension-type headache, and chronic migraine.[16] Furthermore, when Costa et al. evaluated the frequency of bruxism in patients diagnosed with TMJ internal derangement, they found 3 times the frequency of bruxism in those suffering from headaches compared with those without any headaches.[17] A likely explanation for the increased prevalence of headaches in patients with TMDs and SB in our study and in other studies is that bilateral overuse of the masticatory system in SB may have a synergistic effect on TMDs, manifesting as additional pain. In contrast, TMDs may only involve unilateral pain and, thus, are less likely to produce additive effects, such as headaches. In summary, our findings suggest that when headache in the temporal region is confirmed during examination, not only should "headache attributed to

Table I. Tested variables and rationales for variable inclusion

Variable	*Corresponding survey question and answer*	*Rationale*
1. Age	N/A; calculated from patient birth date in EHR	To understand the demographic characteristics of patients with TMDs and bruxism
2. Sex	N/A; obtained from patient EHR	To understand the demographic characteristics of patients with TMDs and bruxism
3. Marital status	Q: What is your current marital status? A: Married, Living as married, Divorced, Separated, Widowed, Never married	To understand the demographic characteristics of patients with TMDs and bruxism
4. Ethnicity	Q: What is your ethnicity? A: Hispanic or Latino, Not Hispanic or Latino, Unknown	To understand the demographic characteristics of patients with TMDs and bruxism
5. Race	Q: What is your race? Mark all that apply. A: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific, White	To understand the demographic characteristics of patients with TMDs and bruxism
6. Level of education	Q: What is the highest grade or level of schooling that you have completed? A: Through high school, Some college, College graduate, Professional or Postgraduate level	To understand the demographic characteristics of patients with TMDs and bruxism
7. Income	Q: What is your family's current annual household income? Please include all sources of income for all family members, such as wages, salaries, investments, etc.	To understand the demographic characteristics of patients with TMDs and bruxism
8. Pain frequency	Q: In the last 30 days, which of the following best describes any pain in your jaw, temple, in the ear, or in front of the ear on either side? A: No pain, Pain comes and goes, Pain is always present	To understand pain frequency differences in patients with SB and TMDs
9. Headache in temple area	Q: In the last 30 days, have you had any headaches that included the temple areas of your head? A: Yes/No	Previous studies found positive associations between primary headaches and patients with bruxism and TMDs[16] Increased psychosocial factors, such as elevated stress, associated with SB patients have also been shown to induce headaches[18]
10. Level of energy	Q: Over the last 2 weeks, how often have you been bothered by feeling tired or having little energy? A: Not at all, Several days, Nearly every day, More than half the days	Previous studies found that SB exhibited the highest activity during REM sleep, during which parts of the encephalon (i.e., limbic system) is most active[19]
11. Quality of sleep	Q: Over the last 2 weeks, how often have you been bothered by trouble falling or staying asleep, or sleeping too much? A: Not at all, Several days, Nearly every day, More than half the days	Previous studies found that SB exhibited the highest activity during REM sleep, during which parts of the encephalon (i.e., limbic system) is most active[19]
12. Patient health questionnaire—total score	See complete questionnaire here: http://www.iadr.org/Portals/69/docs/Groups/INfORM/PHQ-9_2013-05-12.pdf	To compare mental health status of patients with SB and TMDs using a validated screening tool
13. Anxiety—total score	See complete questionnaire here: http://www.iadr.org/Portals/69/docs/Groups/INfORM/GAD-7_2013-05-12.pdf	To compare level of anxiety of patients with SB and TMDs using a validated screening tool
14. Nonspecific somatic pain—total score (Patient Health Questionnaire-15: Physical Symptoms)	See complete questionnaire here: http://www.iadr.org/Portals/69/docs/Groups/INfORM/PHQ-15_2013-05-12.pdf	To compare severity of somatic symptoms of patients with SB and TMDs using a validated screening tool
15. Perceived stress— total score	See complete questionnaire here: https://das.nh.gov/wellness/docs/percieved%20stress%20scale.pdf	To compare perceived stress levels of patients with SB and TMDs using a validated screening tool
16. Pain catastrophizing scale (PCS)—total score	See complete questionnaire here: http://sullivan-painresearch.mcgill.ca/pdf/pcs/Measures_PCS_Adult_English.pdf	To compare the state of mind of patients who are in pain as a result of SB and TMDs; PCS is a validated screening tool

(*continued*)

Table I. Continued

Variable	*Corresponding survey question and answer*	*Rationale*
17. Oral behavior—total score	See complete questionnaire here: https://ubwp.buffalo.edu/rdc-tmdinternational/wp-content/uploads/sites/58/2017/01/Oral-Behavior-Checklist_2013-05-12.pdf	To compare the frequency of oral behaviors of patients with SB and TMDs using a validated screening tool
18. Horizontal incisal overlap	Recorded in millimeters	To understand the role of occlusion in patients with SB and TMDs
19. Vertical incisal overlap	Recorded in millimeters	To understand the role of occlusion in patients with SB and TMDs
20. Pain-free opening of jaw	Recorded in millimeters	To understand the role of TMJ and associated masticatory muscles in patients with SB and TMDs
21. Maximum unassisted opening of jaw (MUO)	Recorded in millimeters	To understand the role of TMJ and associated masticatory muscles in patients with SB and TMDs
22. Maximum assisted opening of jaw (MAO)	Recorded in millimeters	To understand the role of TMJ and associated masticatory muscles in patients with SB and TMDs
23. Sum of lateral and protrusive movements of jaw	Recorded in millimeters	To understand the role of TMJ and associated masticatory muscles in patients with SB and TMDs
24. Presence of headache attributed to TMD	DC/TMD Axis I Diagnosis	Previous studies found positive associations between primary headaches and patients with bruxism and TMD.[16] Increased psychosocial factors, such as elevated stress, associated with patients with SB have also been shown to induce headaches[18]
25. Number of medical diagnoses	N/A; obtained from patient EHR	To compare the overall systemic health of patients with SB and TMDs

EHR, electronic health record; *REM,* rapid eye movement; *SB,* sleep bruxism; *TMD,* temporomandibular joint disorder; *TMJ,* temporomandibular joint.

TMD" be included in the differential diagnosis, but the patient should also be evaluated for SB. The clinical implication of this finding is significant because in patients with both SB and TMDs, different treatment options will have to be considered for the management of symptoms.

Although our study, like others, attempted to offer guidance for clinicians to recognize the signs and symptoms associated with SB, lack of diagnostic and treatment standards for SB resulted in limitations with regard to (1) clear differentiation between patients with bruxism and those without and (2) comparison of our results with those of other studies. Thus, the validity of current methods for diagnosing SB, including the use of PSG, self-reports, and clinical judgment, requires continual evaluation as the research and clinical communities continue to define diagnostic and treatment criteria for SB. Two other limitations of our study are our small sample size (<100) and the cross-sectional design. Future studies are needed to validate our findings with a larger sample size and to overcome the limitations of the cross-sectional design, which hindered our ability to establish the temporality between the development of SB and that of TMDs. Our goal for future studies is to investigate whether SB is a risk factor of TMDs or is a separate disorder requiring its own treatment. Nevertheless, we believe that if clinicians are able to identify the primary cause of the symptoms, the

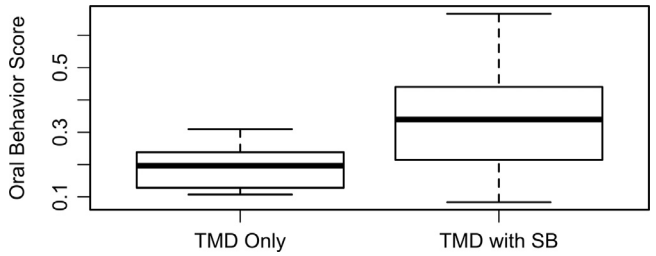

Fig. 1. Oral behavior scores of patients with temporomandibular disorders (TMDs) only and those with TMDs with sleep bruxism (SB). Patients with TMDs with SB reported significantly a higher number and/or frequency of oral behaviors (clenching, grinding, chewing gum, etc.) compared with patients with TMD only ($P = .0004$).

Table II. Prevalence of headache attributed to TMD*

	(−) Headache attributed to TMDs	*(+) Headache attributed to TMDs*
TMDs only	17.3%	5.8%
TMDs with SB	28.8%	48.1%

SB, sleep bruxism; *TMD,* temporomandibular joint disorder.
*Patients who had TMDs with SB exhibited significantly more signs and symptoms of headache attributed to TMDs compared with patients who had TMDs only (P = .045).

prognosis based on the chosen treatment (i.e., sleep posture corrections, oral behavior reductions, physical therapy, appliance therapy, etc.) will improve significantly.

CONCLUSIONS

We believe that the results of our study provide the clinical evidence needed by clinicians to diagnose and treat patients with TMDs and SB. Our study results suggest that the Oral Behavioral Checklist can help clinicians identify patients who self-report increased oral behaviors and assess them for SB. For patients with temporal headaches attributed to TMDs, clinicians should also consider SB while making the diagnosis. Early detection of SB can prevent destruction of the hard and soft tissues of the masticatory apparatus and preserve the oral and overall health of the patient.

ACKNOWLEDGMENT

This project would not have been possible without the help of Krishna K. Kookal, from the UTSD Department of Technology Services and Informatics, with data acquisition; and Janet C. Peri, from the UTSD Department of Technology Services and Informatics, with acquisition of images and references.

FUNDING

This study was financially supported entirely by the University of Texas Health Science Center School of Dentistry Student Research Program. The authors of this research have no conflicts of interest to declare, with the exception of Dr. Adibi, who has a patent issued for a Bruxnostic Device (US-2019-0069837-A1).

PRESENTATION

A poster of this study was presented at the 2018 University of Texas Health Science Center School of Dentistry Annual Student Research Showcase; the 2018 Hinman Student Research Symposium in Memphis, Tennessee; and the 2019 IADR/AADR/CADR General Session in Vancouver, British Columbia, Canada.

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