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Severity of Sleep Bruxism and its Implications for the Stomatognathic System in Healthy Subjects

Marcelo Palinkas[1,2,3]*, Natália Yanota Marin[1], César Bataglion[1], Edneia Corrêa de Mello[1], Graziela De Luca Canto[4], Ligia Maria Napolitano Gonçalves[1], Takami Hirono Hotta[1], Isabela Hallak Regalo[1], Jaime Eduardo Cecilio Hallak[3], Selma Siéssere[1], Simone Cecilio Hallak Regalo[1]

[1]Ribeirão Preto School of Dentistry, University of São Paulo, São Paulo, Brazil; [2]Anhanguera Faculty, Ribeirão Preto, São Paulo, Brazil; [3]National Institute and Technology - Translational Medicine; [4]Federal University of Santa Catarina, Florianopolis, Brazil

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***Correspondence:** Marcelo Palinkas, Ribeirão Preto School of Dentistry, University of São Paulo, Avenida do Café, s/n CEP: 14040-904, Ribeirão Preto, São Paulo, Brazil. E-mail: palinkas@usp.br
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Abstract

BACKGROUND: Sleep bruxism (SB) changes the functionality patterns of the stomatognathic system. However, its severity can be an aggravating factor in the function of this complex system.

AIM: The purpose of the study was to investigate the stomatognathic system of healthy subjects with different severity of SB, as determined by BiteStrip.

METHODS: Thirty-four subjects were divided into two groups: Mild SB (n = 15) and severe SB (n = 19). Electromyograph was used to evaluate the electromyographic activity of the right masseter (RM), left masseter (LM), right temporal (RT), and left temporal (LT) muscles at mandibular rest, right and left laterality, protrusion, and maximum voluntary contraction. Molar bite force was measured by the dynamometer. The data were tabulated and submitted for statistical analysis ($p < 0.05$).

RESULTS: Molar bite force was significantly lower in the severe SB group. There was a significant increase in electromyographic activity in the severe SB group for the mandibular rest tasks (RM, RT, and LT), protrusion (RM, LM, RT, and LT), and right and left laterality in the temporalis muscles. There was a significant decrease in electromyographic activity in the severe SB group in maximum voluntary contraction for the masseter and temporalis muscles.

CONCLUSION: Subjects with severe SB demonstrated greater functional impairment of the stomatognathic system, mainly affecting the electromyographic activity and molar bite force.

Introduction

The stomatognathic system consists of masticatory muscles, which control swallowing and facial expressions, as well as the neck, pharyngeal, palatine, and cervical muscles [1]. As an integral part of this system, the masseter and temporalis muscles act synergistically to mediate mandibular movement, acting in coordination with the structures of the temporomandibular joint [2].

When there are pathophysiological disorders, conditions involving the dopaminergic system, or neurophysiological problems that influence the function of the masticatory system, several problems can arise that promote an imbalance in muscle dynamics and force [3], [4].

Sleep bruxism (SB) is a pathophysiological factor characterized by the teeth clenching or grinding and/or bracing or thrusting of the mandible and associated with micro-awakening [5], [6]. SB was recently defined as a masticatory muscle activity, characterized as either rhythmic or non-rhythmic with behavior change that may be a risk factor for other clinical disorders [7].

SB has a high prevalence in adults [8], affecting 8–21% of the world population [9]. Clinical signs characteristic of SB includes wear of dental facets, painful tenderness in the masticatory muscles, morning headaches, fatigue, and temporomandibular dysfunction [10].

The study of the masticatory muscular function in subjects with an orofacial motor disorder is important as it may demonstrate possible alterations of the muscular pattern, which may be a contributing factor in the functional control of the sleep disorder [11].

Incorrect assessment of subjects with SB, associated with an inadequate diagnosis, may lead to irreversible damage to the stomatognathic system. Therefore, it is essential to rapidly detect and analyze the changes associated with different intensities of SB in the stomatognathic system.

The hypothesis of this study is that severe SB increases electromyographic activity in mandibular tasks and decreases the maximum molar bite force. Therefore, the objective of this study is to evaluate the stomatognathic system of subjects with different SB intensities through evaluation of electromyographic activity and molar bite force.

The results of this research will allow functional evaluation of the stomatognathic system of subjects with mild and severe SB, thereby facilitating diagnosis and prognosis and contributing to the dental scientific community for promoting more effective rehabilitation treatments.

Methods

Ethical aspects

This project was approved by the Research Ethics Committee of Ribeirão Preto School of Dentistry, University of São Paulo (number 02735812.9.0000.5419) in compliance with Resolution 466/12 of the National Health Committee. All subjects were informed about the experimental nature of the study. Informed consent was obtained from all subjects.

Population and sample

The *post hoc* was calculated considering the level of α = 0.05, 80% power for the main result of the electromyographic activity (μV/s) in maximum voluntary contraction (mean [SD] right masseter [RM] muscle: Group mild severity of SB, 1.06 [0.63] and group severe severity of SB, 0.59 [0.32]) with an effect size of 0.94. The minimum sample size was 30 subjects (15 for each group). The sample size was calculated using the G* Power 3.1.9.2 software (Franz Faul, Kiel University, Kiel, Germany).

The population of this study comprised subjects from the area of Ribeirão Preto, São Paulo, between 18 and 45 years of age, and included both genders. Of these, 85 subjects, healthy and with normal occlusion and without temporomandibular dysfunction or myofascial pain, which are the Research Diagnostic Criteria for Temporomandibular Disorders, were selected for inclusion in the sample.

Thirteen subjects were then excluded from the sample because they did not agree to undergo polysomnography. Finally, 72 subjects underwent polysomnography, and of these, 34 subjects presented a diagnosis of SB.

The findings of anamnesis and clinical examinations were used for guiding sample selection and determining inclusion/exclusion criteria. In the anamnesis, the information collected contained personal data, medical and dental history, premolars and molars present in the dental arches, and a hypothesis of developing SB (ranger and/or clenching teeth during sleep, as witnessed by relatives, and evaluation of dental facet wear).

The exclusion criteria included the absence of anteroposterior teeth and first permanent molars; presence of prostheses in the canine region; the previous diagnosis of sleep disorder; previous or current orthodontic treatment; ongoing speech therapy; ongoing otorhinolaryngological treatment; clinical history of systemic diseases or conditions requiring chronic medication; periodontal disease with dental mobility; use of drugs that could interfere with muscle activity; neurological (movement and psychiatric) disorders; and obesity.

Thirty-four subjects with SB were divided into a mild SB group (n = 15) and a severe SB group (n = 19). The groups were matched for age (years) and body mass index (kg/m^2). The mean (SD) age of the subjects in the mild SB group was 31.3 (6.2) years, and the mean body mass index was 25.5 (4.2) kg/m^2. In the severe SB group, the mean age was 24.82 (7.11) years, while the mean body mass index was 24.53 (4.10) kg/m^2. The two groups did not differ significantly in terms of age (p = 0.54) or body mass index (p = 0.17).

Polysomnographic examination

A full-night PSG was performed at the sleep laboratory, located in Ribeirão Preto, São Paulo, Brazil, using a digital system (Sonolab Polysomnograph 632 030003). The parameters used for SB diagnosis were electromyography of the masseter and temporalis muscles. The data were calibrated to account for physiological signals such as mandibular movements, coughing, swallowing, maximal voluntary contraction, and rhythmic contractions.

The evaluated characteristics of SB were phasic bruxism (grinding of the teeth), bruxism (clenching of the teeth), and bruxism mixed with phasic and tonic activity. To confirm the diagnosis of SB, the following criteria were required to be met: Presentation of more than four episodes of bruxism, which exceeded 20% of the maximum voluntary contraction per hour of sleep, with more than 6 outbreaks per episode or 25 outbreaks per hour of sleep, and two episodes of tooth grinding during sleep [12].

The polysomnographic examination was performed by the fixation of sensors, embedded in an electrolytic mass and affixed by hypoallergenic tape (3M™ Micropore™) on the scalp and the face of the subject, to enable the monitoring of sleep. The subject was accommodated in an air-conditioned room with attenuated external sounds. Sleep records started at about 11:00 pm and lasted approximately 6 h.

The subject could interrupt the examination at any time, for example, to go to the bathroom, where he disconnected the equipment source and the oximeter connector so as not to get wet and when he returned he connected the devices without promoting changes in the polysomnographic results, continuing the examination until morning. The factors inherent to the examination condition were considered, such as the bed, pillow, environment, and presence of sensors.

Evaluation of SB severity degree

The disposable instrument, BiteStrip, was used to indicate the clenching and grinding of teeth during sleep. For each subject, the BiteStrip was intended to record the activity of the masseter muscle during sleep. The examination was performed for three consecutive nights.

A digital electrochemical display recorded the results at the end of 5 h using the instrument during a night of sleep, showing values ranging from 0 to 3 to classify the SB severity degree as follows: 1 = 40 to 74 episodes (mild SB); 2 = 75 to 124 episodes (moderateSB); and 3 = above 125 episodes (severe SB) [13], [14]. The highest value among the three records was considered as the SB severity degree. No subjects with moderate SB were found in this study.

Electromyographic evaluation

Evaluation of the electromyographic activity (μV) for the masseter and temporalis muscles was performed using the Trigno™ Wireless EMG System (Delsys Inc., Boston, MA, USA) during the mandible rest (4 s), protrusion (10 s), right laterality (10 s), left laterality (10 s), dental clenching at maximum voluntary contraction (4 s), and dental clenching at maximum voluntary contraction with inert material (4 s). Electromyographic activity was measured once for each clinical condition.

The material used to perform the maximum voluntary contraction of the tooth was composed of folded (18 × 17 × 4 mm, weight 245 mg) paraffin wax (Parafilm M®, Pechiney Plastic Packaging, Batavia, IL, USA), which was placed between the occlusal faces of the first and second molars, on the right and left sides of the dental arch.

The Trigno (Delsys) sensors were adjusted to a range of 20–450 Hz and a standard mode rejection rate of 80 dB. The 27 × 37 × 15 mm sensor had four fixed contact areas of 5 × 10 mm, which was half the area of a Bagnoli sensor (10 × 10 mm) and were made of pure silver (99.9%).

The surface sensors were positioned according to the recommendations of the SENIAM (Surface EMG for Non-Invasive Assessment of muscles) [15]. It was necessary to clean the skin with alcohol to reduce the impedance, and the surface sensors were fixed after a few minutes [16].

During electromyographic activity recordings, a calm, quiet environment was maintained, with the subject sitting in a comfortable, upright posture, with the soles of the feet resting on the ground and the palms of the hands resting on the thighs. The head was positioned upright, keeping the plane of the head parallel to the ground. All necessary instructions and explanations were given, asking the research participant to remain calm and breathe slowly.

Molar bite force evaluation

The molar bite force data were obtained with the digital dynamometer (Kratos, Cotia, São Paulo, Brazil), with a capacity of up to 980.665 N, adapted for oral conditions. The measurement of the bite force was performed with subjects sitting with arms extended along the body and hands stretched out over the thighs. The dynamometer was cleaned with alcohol and protected with disposable latex finger cots (Wariper-SP), positioned on the bite rods of the device as a biosafety measure.

The subjects received instructions and then performed the tests in which they bit the equipment before the records were obtained, to ensure the reliability of the procedure. The measurements were made in the region of the first permanent right and left molar because it is the region where we developed the highest bite force [17]. The subject was asked to bite the device 3 times with maximum effort, with 2 min of rest between the records, alternating between the right and left sides, and with an interval of 2 min between each bite. It was considered the maximum bite force on both sides.

Method error

Dahlberg's formula was used to calculate the method error. Measurements of electromyographic activity and maximum bite force were calculated using the records of five subjects during two different sessions, with a 1-week interval between the sessions. The data showed small variations in the measurements between the first and second sessions in electromyographic activity (3.74%), and bite force (5.21%).

Data analysis

In the analysis of the results, the data showed normal distribution (Shapiro–Wilk normality test: $p \leq 0.05$). The data were evaluated using IBM SPSS

Statistics for Windows, version 22.0 (IBM SPSS, IBM Corp., Armonk, NY, USA). The data were normalized by dental clenching at maximum voluntary contraction with Parafilm M.

The results were obtained through the descriptive analysis (mean and standard deviation for each variable). The values were compared by Student's t-test for independent samples. The level of significance was set to $p < 0.05$.

Results

Table 1 shows the significant differences between the groups in this study. Myoelectrical activity was higher in the group with severe SB in rest mandibular (RM [p = 0.05], right temporal [RT] [p = 0.02], and left temporal [LT] [p = 0.01]), protrusion (RM [p = 0.05], left masseter [LM] [p = 0.04], RT [p = 0.01], and LT [p = 0.01]), right laterality (RT [p = 0.01] and LT [p = 0.05]), and left laterality (RT [p = 0.02] and LT [p = 0.001]). Myoelectrical activity was smaller in the group with severe SB in maximum voluntary contraction (RM [p = 0.009], LM [p = 0.007], RT [p = 0.004], and LT [p = 0.05]).

Table 1: Mean, standard deviation (±), and statistical significance (p<0.05) of the normalized electromyographic activity data (μV) of the RM, LM, RT, and LT muscles for mild SB and severe SB groups during the mandibular task

Mandibular tasks	Muscles	Mild SB	Severe sleep bruxism	p-value
Rest	RT	0.09 ± 0.01	0.17 ± 0.02	0.002
	LT	0.08 ± 0.01	0.15 ± 0.01	0.01
	RM	0.03 ± 0.004	0.08 ± 0.01	0.05
	LM	0.03 ± 0.002	0.09 ± 0.04	0.16
Protrusion	RT	0.07 ± 0.007	0.16 ± 0.02	0.05
	LT	0.09 ± 0.01	0.20 ± 0.03	0.04
	RM	0.08 ± 0.01	0.14 ± 0.02	0.01
	LM	0.07 ± 0.01	0.19 ± 0.05	0.01
Right laterality	RT	0.10 ± 0.01	0.17 ± 0.02	0.30
	LT	0.09 ± 0.01	0.15 ± 0.02	0.10
	RM	0.04 ± 0.006	0.08 ± 0.03	0.01
	LM	0.06 ± 0.009	0.14 ± 0.04	0.05
Left laterality	RT	0.06 ± 0.01	0.12 ± 0.02	0.24
	LT	0.10 ± 0.01	0.22 ± 0.02	0.34
	RM	0.07 ± 0.001	0.10 ± 0.03	0.02
	LM	0.05 ± 0.001	0.20 ± 0.04	0.001
Maximum voluntary contraction	RT	1.15 ± 0.13	0.72 ± 0.06	0.009
	LT	1.26 ± 0.17	0.83 ± 0.04	0.007
	RM	1.06 ± 0.16	0.59 ± 0.07	0.004
	LM	1.08 ± 0.014	0.65 ± 0.06	0.05

RM: Right masseter, LM: Left masseter, RT: Right temporal, LT: Left temporal, SB: Sleep bruxism.

Table 2: Mean, standard deviation (±), and statistical significance (p<0.05) of the right and left molar bite force (N) for mild SB and severe SB groups

Clinical conditions	Mild sleep bruxism	Severe sleep bruxism	p-value
Right molar	387 ± 57	267 ± 26	0.04
Left molar	400 ± 65	258 ± 30	0.04

SB: Sleep bruxism

The mean molar bite force (N) values in the right and left molar regions are shown in Table 2. There was a decrease in the right (p = 0.04) and left (p = 0.04) molar bite force in the severe SB group.

Discussion

Sensory receptors control the levels of skeletal striated muscle activity and the central nervous system. Changes in the functional balance of sensory receptors can lead to changes in masticatory muscle activity, directly interfering with the masticatory process [18]. This study is the first to analyze the normalized electromyographic activity of the masseter and temporalis muscles of subjects with SB considering the severity degree in mandibular tasks.

The results of this study demonstrate that subjects with mild SB had normal levels of electromyographic activity in the evaluated masticatory muscles [19]. In addition, the group with severe SB had higher electromyographic activity in the masseter and temporalis muscles at mandibular rest compared with the group with mild SB.

Studies have shown that, in favorable conditions, spasms and atypical muscular contractions can occur, which may modify the pattern of electromyographic activity by impairing their function [20]. A spasm muscle will always be in the ischemic process, which promotes vascular deficit in the belly, leading to increased muscle activity [21], [22].

During the protrusion condition, it was observed that the masseter and temporalis muscles of the severe SB group presented higher normalized electromyographic activity compared with the group with mild SB. In this condition, the adequate neuromuscular pattern for postural maintenance was not observed in both groups, where the masseter muscles should remain more active than the temporal ones [23].

In the disorders of the stomatognathic system, excessive occlusal load may occur [24], and with this, the masticatory musculature can respond with increased activation of muscle fibers. This, in turn, can cause unnecessary physiological and biochemical activity, depending on the stimuli to which muscle fibers are subjected, which may cause damage to this complex system [25].

In the left and right laterality movements, it is expected to record greater electromyographic activity for the temporal muscle on the same side of the mandibular movement (work side), whereas for the masseter muscle, the highest expected activity in the contralateral [19], [26]. In this study, the pattern of activation in the right laterality was observed in both groups. In the left laterality, the correct neuromuscular activation pattern was not observed in the group with severe SB. The highest values of normalized electromyographic activity for all the evaluated muscles were observed in the group with severe SB.

One hypothesis that may explain the alteration of muscle activity in the severe SB group compared to the mild SB group would be due to changes in the dopamine levels of the brain. Dopamine levels are known to mediate motivation-based behaviors in humans, which may affect the normal functional activity of the stomatognathic system in the group with severe SB [27].

It is known that the association of neurochemical substances such as the dopaminergic system with SB shows the relationship between the inhibition of spontaneous movements and manifestations of stress [28]. Therefore, decreased levels of this monoaminergic neurotransmitter triggered coordinated repetitive movements [29], suggesting greater involvement of the dopaminergic system and central neurotransmission with a severe sleep disorder [30].

This may increase heart rate, muscle tone, muscle activity, and creaking and/or clenching of the teeth [31]. In this study, we did not measure the dopamine levels of subjects with SB.

Another factor that may have promoted the increased activity of the masseter and temporalis muscles in the group with severe SB in the mandibular tasks at rest, protrusion, and right and left laterality, was the presence of the stress factor and the clinical consequences that directly affected muscle tension [32], [33].

Subjects with severe SB could present greater discrepancies between the daily life stress response capacity and the physiological recovery of the muscular system as a result of the pathological stimuli, thus promoting significant changes in the components of the stomatognathic system. This study did not evaluate the level of stress of subjects with mild and severe SB.

Existing evidence shows that subjects with SB have functional alterations of the masticatory muscles [34]. This finding agrees with our results as we observed that the higher is the severity of SB, the lower is the muscle function.

The function of the masticatory system involves forces that result from the association between muscular, bone, nervous, and dental function, and the evaluation of these forces is hugely significant in the diagnosis of disorders that affect the stomatognathic system[35].

This fact can be confirmed by our measurements of electromyographic activity in the masticatory muscles during the dental clenching in maximum voluntary contraction and the right and left maximal molar bite force conditions. Both variables presented lower functional efficiency in the group of subjects with severe SB.

One factor that should be considered to explain the lower functional levels of the stomatognathic system in subjects with severe SB, considering the results of the mild SB group, would be the regular and excessive consumption of alcohol. The use of this substance alters the functional behavior of skeletal striated muscles by the degradation of muscle protein synthesis, reducing gene activity, which causes muscle degeneration, promoting increased muscle activity and loss of force [36]. In this study, we did not evaluate whether subjects from either group were consuming alcohol.

The results of this study showed greater impairment of the stomatognathic system of subjects with severe SB when compared to mild SB may help in the planning of dental rehabilitation, such as implants, esthetic restorations, prostheses, and orthodontics. The dentist, when performing the dental rehabilitation will have to be more careful in the execution and finalization of the clinical treatment, because the masticatory muscles and the bite force of the subjects with severe SB are more compromised. Therefore, compromised function and without caution in planning dental rehabilitation may be contributed to worsen the clinical result of the patient with severe SB.

Some limitations of the present study should be recognized. The sleep position on the polysomnographic examination, dopamine levels in the body, stress levels, and alcohol consumption are all factors that could have influenced the differences between the two groups of the study. Furthermore, the effect of a single night's sleep by polysomnographic examination should also be considered in our results. For each subject, the BiteStrip was intended to record the activity of the masseter muscle during sleep. The biological variation of the subjects during the three nights was not evaluated.

Conclusion

The findings of this study suggest that the stomatognathic system of subjects with severe SB is more compromised than those of subjects with mild SB, influencing mainly the electromyographic activity of the masticatory muscles and the maximum molar bite force. Further studies should be encouraged to increase scientific knowledge in this field.

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