Association between sleep bruxism and stress sensitivity in an experimental psychological stress task

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ABSTRACT
The objective of this study was to examine the association between sleep bruxism and psychological stress. The subjects consisted of 76 volunteers, who were divided into those with and without bruxism according to the diagnostic criteria for sleep bruxism outlined by the American Academy of Sleep Medicine (AASM). Stress sensitivity was evaluated before and after an experimental stress task, which involved simple mathematical calculations. It was assessed objectively by measuring the subjects’ salivary chromogranin A (CgA) levels and subjectively using a ten-division visual analog scale (VAS). Compared with those observed before the stress task, the mean salivary CgA levels of the non-bruxism group (n = 54) were not significantly increased after the stress task. Conversely, the mean salivary CgA levels of the bruxism group (n = 22) were significantly increased after the stress task (P < 0.01). The mean VAS scores of the groups without (n = 54) and with (n = 22) bruxism were significantly increased (P < 0.01) after the stress task compared with those observed before the stress task, but no differences were detected between the two groups in the stress task. These findings suggest that there is an association between sleep bruxism and psychological stress sensitivity.

Oral habits such as bruxism are thought to affect temporomandibular disorders (TMD) and might have a relatively strong effect on the durability of prosthetic appliances (20, 30). Bruxism, which is defined as clenching or grinding of the teeth, or a combination of both, is a diurnal or nocturnal para-functional activity and has long been regarded as requiring treatment (5).

It is thought that bruxism is associated with psychological stress (1, 2, 8, 10, 22). On the other hand, some studies did not find any association between bruxism and stress (15, 19). The following reasons might explain this disagreement. In most of the above studies, diurnal bruxism and sleep bruxism were not distinguished from each other, and there were variations in the methods used to evaluate oral habits. In addition, differing definitions of stress and various methods for assessing stress were employed in these studies (17). Also, in these studies, stress was evaluated subjectively, such as by self-reporting, questionnaires, etc. Thus, the relationship between bruxism and stress is much more complex than previously imagined and involves many psychosocial factors (17).

When humans are exposed to psychological stressors, the hypothalamic-pituitary-adrenal (HPA) axis and the sympathoadrenal medullary (SAM) system are activated (9, 13, 26). This results in changes of biomarkers, e.g., cortisol and/or chromogranin, etc., being secreted into the serum or saliva. Therefore, stress can be objectively evaluated by analyz-
ing these biomarkers. Contrary to tests requiring blood collection, performing a quantitative analysis of salivary chromogranin A (CgA) does not place any additional stress on the subject. Also, the validity of measuring salivary CgA levels has been confirmed through critical examination in the literature (21). The CgA level is not affected by physical stress, but it is sensitive to psychological stress (21). Therefore, the CgA level is an excellent quantitative index of psychological stress.

We must clarify the association between bruxism and psychological stress. However, little information is available about this association. In particular, there are few studies (6, 28) in which stresses were evaluated using biomarkers.

The objective of this study was to examine the relationship between sleep bruxism and psychological stress. In the present study, we used an experimental stress task to induce stress in the subjects and then attempted to assess their stress sensitivity by measuring their salivary CgA levels.

MATERIALS AND METHODS

Subjects. The subjects consisted of 76 volunteers (36 males, mean age: 23.3 years; 40 females, mean age: 24.2 years). Each subject gave their informed consent prior to the start of the study. The patients were free to end their participation in the study at any time and for any reason. The present study was approved by an ethical committee at Hiroshima University.

The following selection criteria were applied: the subjects had to be healthy except for mild signs or symptoms of TMD, to have a full complement of teeth excluding the third molars, to not display severe malocclusion, to not be receiving medication, and to not be suffering from any systemic or psychiatric disease.

Diagnostic criteria for sleep bruxism. In the present study, the diagnostic criteria for sleep bruxism outlined by the American Academy of Sleep Medicine (AASM) were used to diagnose sleep bruxism (3): i.e., the patient reports or is aware of tooth-grinding sounds or tooth-clenching during sleep; one or more of the following is present:
1) abnormal wear of the teeth
2) jaw muscle discomfort, fatigue, or pain and jaw locking upon awakening
3) masseter muscle hypertrophy upon voluntary forceful clenching

The observed jaw muscle activity is not better explained by another current sleep disorder, a medical or neurological disorder, medication use, or substance use disorder.

Procedure. In order to evaluate the reproducibility of CgA levels in resting conditions in 34 subjects, saliva samples were collected at the same time in the afternoon; i.e., between 13:00h and 14:00h, on two different days separated by a one week interval.

In the second experiment, 76 subjects performed the following stress task. The Uchida-Kraepelin test, which involves simple mathematical calculations and is generally used in clinical psychology and occupational mental health studies, was used as an experimental stress task. In the Uchida-Kraepelin test, the subjects are requested to add a random series of horizontally aligned single digits. They have a maximum of 1 minute to complete each calculation, after which they must move on to the next series of digits. This process is continuously repeated for 15 minutes. However, the digit series are designed so that the calculations cannot be completed within a minute; therefore, the test is considered to induce stress in the participants. Before and after the Uchida-Kraepelin test, small saliva samples were collected by placing cotton rolls in the subjects’ mouths. The cotton rolls were collected using Salivette salivary collection tubes (Sarstedt Inc., Germany). The CgA levels of the saliva samples collected before and after the stress task were analyzed.

In addition, stress was measured subjectively before and immediately after the stress task using a ten-division visual analog scale (VAS) (27).

Saliva analysis. All of the salivary samples were centrifuged at 3000 × g for 5 min and stored at −30°C until the analysis, and for the salivary analysis, the YK070 ELISA kit (Yanaihara Institute Inc., Japan) and protein assay kit (Bio-Rad Inc., USA) were used according to manufacturer’s protocol. All samples were analyzed in duplicate. The CgA concentrations of the saliva samples were corrected to the total protein concentration and expressed as pmol/mg protein.

Statistical analysis. The reproducibility of the CgA levels measured on the two examination days was tested using Pearson’s correlation coefficient. Paired t-tests were performed to determine the difference between the CgA levels detected before and after the experimental stress task. A nonparametric method, the Wilcoxon signed-rank test, was used to ana-
Sleep bruxism and stress sensitivity

lyze the results of our subjective analysis; i.e., the VAS scores. Statistical significance was set at the 0.05 probability level.

RESULTS

Reproducibility of CgA levels
The CgA measurements obtained on different days showed sufficient reproducibility (Pearson’s correlation coefficient: 0.77) (Fig. 1).

The changes in CgA levels
The mean salivary CgA levels of the non-bruxism group (n = 54; 25 males: 29 females) were not significantly increased after the stress task compared with those observed before the experimental stress task. On the contrary, the mean salivary CgA levels of the bruxism group (n = 22; 11 males: 11 females) were significantly increased after the stress task compared with those observed before the experimental stress task (P < 0.01) (Fig. 2).

The changes in the ten-division VAS scores
The VAS scores of both the non-bruxism groups (n = 54) and bruxism (n = 22) groups were increased after the stress task compared with those observed before the task (P < 0.01), but there were no differences between the two groups in the stress task (Fig. 3).

DISCUSSION
Sleep bruxism and diurnal bruxism are recognized to have different pathogeneses (17); therefore, a clearer distinction between the two types of bruxism should be made. Failure to distinguish the two types of bruxism is the main reason for the different findings regarding the correlation between bruxism and stress in the literature (17). To date, there are various tools for assessing bruxism. Overall, the diagnosis of bruxism based on clinical findings has its limitations (17). However, the definition proposed by the American Sleep Disorder Association (4) and revised by the American Academy of Sleep Medicine (3) is considered to be one of the best descri-
tions of sleep bruxism for both clinical and research purposes (14, 16). In the present study, we adopted these criteria for sleep bruxism.

The present study used the Uchida-Kraepelin test to evaluate stress sensitivity. Similar tests are commonly used in clinical psychology studies (12, 13, 29). Salivary CgA is a sensitive and quantitative index of the activity of the sympathetic nervous system (11, 21). Salivary CgA levels peak upon awakening and then quickly decrease. They then remain at a low level throughout the day (7). Therefore, all of the salivary samples were collected at the same time in the afternoon. In addition, the test-retest results indicated good reproducibility.

The present study demonstrated an association between sleep bruxism and stress sensitivity. The bruxism-stress theory is based on some early case series that reported a relationship between stressful daily events and an increase in nocturnal masseter muscle activity (6, 25). In the 20 bruxers and 10 control subjects, a positive relationship between increased urinary catecholamine levels and high levels of nocturnal electromyographic (EMG) activity was recognized (6). Rugh et al. reported that nocturnal EMG activity increased with stress (17). In addition, a study of 20 clinically diagnosed sleep bruxers and 20 healthy volunteers found that the sympathetic cardiac activity of the bruxers was higher than that of the non-bruxers, suggesting that the bruxers were affected by stress (18).

On the contrary, in a study of 100 sleep bruxers performed over a 15 night recording period, Pierce et al. found no association between bruxism and stress (23). Similarly, Watanabe et al. (29) found no relationship between bruxism and any self-monitored stress level in a 3-week study of 12 sleep bruxers. These recent studies disagreed with our results, but the fact that 8% of subjects showed a stress-bruxism association in the study by Pierce et al. (23) suggests that certain bruxers are sensitive to stress. This hypothesis is also in line with the clinical studies by Manfredini et al. (16), who showed that stress sensitivity is one of the domains in the anxiety spectrum that is most able to differentiate bruxers from non-bruxers (17).

The definition of psychological stress implies the existence of an input, which could be physiological or psychological, and an output, which could also have physiological as well as psychological components (17). Subjective self-reporting of stress could be considered to evaluate input stress, whereas measurements of CgA levels could be considered to be an output of stress. Thus, the disagreement between our results and those of Pierce et al., who evaluated stress by self-reporting, can be attributed to differences in the method used to analyze stress. In the present study, a subjective evaluation using a ten-division VAS did not indicate any differences between the bruxers and controls, as was reported by Pierce et al.

While our findings indicate that an association exists between sleep bruxism and psychological stress, our research does have some limitations. Sleep bruxism and diurnal bruxism are difficult to clinically distinguish (17). At present, polysomnographic recordings in adequately equipped sleep laboratories represent the gold-standard method for diagnosing bruxism (3, 25). There are no definitively reliable methods for assessing bruxism that display sufficient diagnostic validity, technical validity, and cost-effectiveness to be used in the clinical setting (14). In the present study, stress reactions to only one stressor, simple mathematical calculations, were analyzed. It is unclear which types of experimental stress task are appropriate for evaluating stress sensitivity. Further investigations are required to clarify the association between bruxism and stress.

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REFERENCES