Risk Factors for Sleep Bruxism in Japanese Dental Students

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ABSTRACT

Introduction: There is a consensus about the multifactorial nature of the etiology of bruxism. Psychological and behavioral factors are frequently reported in relation to bruxism; however, research has yielded controversial results.

Objectives: The aim of this study was to investigate if any psychological and behavioral factors were associated with bruxism as measured by electromyographic (EMG) activity.

Methods: A total of 94 dental students (44 males and 50 females, 23.8 ± 2.1 years of age) participated in this study. These subjects recorded EMG activity from the right masseter muscle by means of a portable device at home for 6 consecutive nights. All EMG elevations above 20% of each subject's maximum voluntary contraction level were quantified with regard to duration per hour. After a preliminary study, 5 psychosocial and 2 behavioral factors, which included life events, mood state, personality trait, coping strategies, type A behavior, cigarette smoking, and alcohol intake, were chosen to be investigated and assessed using questionnaires. Multiple stepwise regression analyses were conducted between the questionnaire-based variables and bruxism variable.

Results: The results of the analyses revealed that the amount of alcohol and mood of anger-hostility were positively associated with bruxism and the tendency to escape from stressful events was negatively associated with bruxism in female subjects (adjusted $R^2 = 0.21$, $P = 0.005$). In addition, the characteristic of self-transcendence was positively associated with bruxism in male subjects (adjusted $R^2 = 0.07$, $P = 0.039$).

Conclusions: Alcohol, anger-hostility mood, escape-avoidance coping, and self-transcendence might have the potential to affect the intensity of bruxism.

INTRODUCTION

Sleep bruxism (SB) is an oral habit charac-

Table 1. Multiple Regression Models for Male Subjects.

Sum of squares	Degree of freedom	Mean square error	R^2	Adjusted R square
13298.53	45	295.52	0.0911	0.0709
Parameter	**Estimate**	**Sum of square**	**F-value**	***P***
Intercept	30.50	0	0	1.0
ST score of TCI	0.9856	1332.56	4.509	0.0392

terized by a rhythmic activity of the masticatory muscles that causes a forced contact between dental surfaces during sleep.[1] SB has been linked to temporomandibular disorders, premature loss of teeth due to excessive attrition and mobility, and sleep disruption of the individual as well as his or her bed partner.[2,3] The prevalence of SB has been reported to be 8% to 10% of the general population.[4]

Depending on the practitioner's concept of the etiology of SB, a variety of treatment methods have been proposed.[5-8] The most commonly cited risk factors for SB include psychosocial factors such as specific personality,[4,9-12] behavioral pattern,[13,14] level of stress,[4,8,14-18] and cigarette smoking or alcohol use.[19-21] These factors have been neither proven nor disproven, resulting in much controversy. For example, some studies proposed a positive association between psychosocial factors such as reaction to frustrating experiences,[4,10] anxiety,[9,10,12] stress,[4,14,15] and Type A behavior[13,14] and self-reported SB. Others reported that neither stress nor personality was associated with the bruxism level, as measured by EMG,[17] and that non-specific personality characteristics of people with bruxism have never been identified.[12,22] Furthermore, cigarette smoking or alcohol use[19-21] may increase the likelihood of SB but were seldom investigated.

It should be emphasized that without a clear definition of SB and an accurate measurement methodology,[1,7,23-25] it is difficult to remain objective in evaluating the literature concerning bruxism's etiology. For example, the evaluation of SB using self-reporting[12,26,27] is not very reliable and tooth attrition status may not be sensitive enough to capture current ongoing SB.[27,28] Moreover, studies that performed actual recordings of SB by using electromyographic activity[29-34] showed that there is a limited number of multiple night recording data. Obtaining this data is fundamental to understanding SB due to the significant night-by-night fluctuation of this behavior.[34,35]

In this study, risk factors for SB were examined to determine whether they can be associated with the SB level, utilizing data from multiple night EMG recordings. The null hypothesis of this study was that "any psychosocial factors were not related to bruxism level."

MATERIALS AND METHODS

Study Protocol

Subjects were asked to perform the following procedures: (1) fill out 5 psychometric questionnaires; (2) fill out 2 behavioral questionnaires every night before nightly EMG recordings; (3) fill out a sleep diary every morning upon awakening; and (4) utilize an electromyographic recording device that was attached to their masseter muscle all night for 6 consecutive nights.

Subjects

Subjects were recruited from dental students enrolled at Tokyo Medical and Dental University. A total of 94 consecutively listed students (44 males and 50 females, average age 23.8 ± 2.1) participated in this study. Each subject was provided with a full verbal description of the study and those who elected to enroll signed a University-approved consent form. Enrolled subjects met the inclusion and exclusion criteria described below.

Table 2. Multiple Regression Models for Female Subjects.

Sum of squares	Degree of freedom	Mean square error	R^2	Adjusted R square
6591.55	40	164.79	0.2704	0.2157
Parameter	**Estimate**	**Sum of square**	**F-value**	***P***
Intercept	27.83	0	0	1.0
Amount of alcohol intake	0.4258	1431.12	8.685	0.0053
Anger-hostility score of POMS	0.5124	834.04	5.061	0.0300
Escape avoidance score of SCI	-1.9110	775.53	4.706	0.0361

KEY: POMS: Profile of Mood States; SCI: Stress Coping Inventory

The inclusion criteria were:
Self-rated as being in good physical health.
Between the ages of 22 and 32 years.
Exclusion criteria:
(1) Using prescription medication(s).
(2) Dependent on alcohol.
(3) Undergoing dental treatment or having dental infection or other local dental disease that needed urgent treatment.
(4) Currently having orthodontic treatment.

Bruxism Data

Masseter Muscle EMG Recording. In order to measure SB, a portable EMG recording system was utilized. EMG signals from the right superficial masseter muscle were amplified and digitized at a sampling frequency of 200 Hertz and then stored on a personal computer for off-line analysis. Subjects were instructed on how to handle the device as well as the placement of the electrodes and then asked to bring the recording system to their home in order to perform nightly EMG recordings. At the beginning of each recording night the subject was instructed on how to perform 3 brief (2-second duration) maximum voluntary contractions (MVC) in maximum intercuspation. After the recording session, subjects brought the system back to our office and data were downloaded to our laboratory computer.[36]

Sleep Diary. In order to determine the actual sleeping time, the subjects were asked to record in a sleep diary additional information upon waking. Subjects recorded the time between when they turned on the recorder and when they actually fell asleep; the time between when they woke up and when they turned off the recorder; the number, durations, and reason for any awakenings during the recording period.

Data Reduction. The first-night EMG data were excluded from the analysis in order to avoid the first night effect.[37] The remaining 5 nights of EMG data recorded during sleep diary-based sleeping time were analyzed in the following fashion. First, the data were conditioned using a semi-automated custom software program that performed rectification and smoothing of the data signal. All EMG periods above a minimum threshold level were considered potential bruxism events. This threshold level was set at 20% of each subject's individually established MVC level. In addition, interval and duration criteria were utilized to further condition bruxism events as follows: (1) every 2 events with an interval less than 2 seconds were linked together and (2) events with duration shorter than 2 seconds were excluded. Data cleaning was performed to remove any EMG signal artifact. This involved displaying raw EMG activity of remaining data on the computer screen. Two scorers, who were calibrated for the ability to precisely and accurately discriminate artifact signals from bruxism signals, observed the data. Every signal that was

judged to be an artifact was excluded from further analysis in a blind-to-subject-status fashion. Finally, the cleaned data were conditioned by the interval and duration criteria once again. Using this analysis method, a final count of all bruxism events was established. The total duration of SB per hour across the second to sixth 5-night study period were averaged for each subject.[36]

Questionnaire Data

Five questionnaires were administered in order to evaluate life events such as scale of stressor, mood, personality, and behavioral pattern of the subjects. Reliability of these questionnaires was reported to be sufficient as a psychometric instrument for a student population.[38-43]

Stress Level. In order to evaluate the stress level the subjects were experiencing, the College Life Experience Scale (CLES), modified student version, was used. [38] This scale measured the impact of life events experienced by college students in the past 6 months. Subjects were asked to respond to 67 questions regarding their perception of a life event and to give a 7-point score ranging from -3 to +3. Events given -3 to -1 scores were regarded as negative events: -1 was a little bit unhappy, -2 bitter or hard, -3 extremely hard. Events given 1 to 3 scores were regarded as positive events: 1 was a little bit happy, 2 fairly happy, and 3 completely happy. If subjects felt indifferent about the event, a score of 0 was given. The scores of positive events and negative events were added, and then 2 variables, which were positive and negative event ratings, were obtained.[38]

Coping Skills. Coping was defined as the person's constantly changing cognitive and behavioral efforts to manage specific external and internal demands that were appraised as taxing or exceeding the person's resources.[44] The Stress and Coping Inventory (SCI) is a self-report questionnaire, which evaluates the subject's coping skill in response to a stressful event by assessing the use of 8 coping patterns: problem solving through planning, confrontational coping, seeking social support, accepting responsibility, self-control, escape-avoidance, distancing, and positive reappraisal. Each subcategory has 8 questions, scored from 0 to – 2, and subtotaled (scores range from 0 to –16). Higher scores indicate stronger degrees of measured coping.[42]

Mood. Mood was assessed by the Japanese version of a standardized psychiatric self-report questionnaire, the Profile of Mood States (POMS).[45] The POMS consists of a 65-item checklist that assesses 6 emotional subscales: tension-anxiety, depression-dejection, anger-hostility, vigor, fatigue and confusion, referring to the previous 7 days. The number of questions used in the calculation of each emotional subscale are 9, 15, 12, 8, 7, and 7, respectively. Six out of 65 questions are used as dummy items in the questionnaire. In the checklist, subjects were asked to respond to each question using the 5-point scale raging from 0 (not at all) to 4 (extremely).[45]

Personality. Personality was assessed using the Temperament and Character Inventory (TCI), a self-report questionnaire based on Cloninger's 7-factor model.[46-48] The Japanese version of TCI includes 240 items that discriminate 4 temperament and 3 character scales. The temperament dimensions included novelty seeking, harm avoidance, reward dependence, and persistence, while the character dimensions assessed self-directedness, cooperativeness, and self-transcendence. The subjects responded to each item by answering 'true" or "false" and a total score for each temperament and character dimension was calculated, which ranged between 0 and 40 for novelty seeking, 0 and 35 for harm avoidance, 0 and 24 for reward dependence, 0 and 44 for persistence, 0 and 44 for self-directedness, 0 and 42 for cooperativeness, and 0 and 33 for self-transcendence.[39]

Type A behavior. The Type A behavior pattern is characterized by enhanced competitiveness, aggressiveness, feeling pressured by time, and a sense of hyper-responsibility.[49] Jenkins Activity Survey (modified student version) (JAS) was used to measure the Type A behavior pattern, which included a 44-item questionnaire. The scoring produces a compound Type A-B score and 2- factor analytically derived subscales (impatience and speed; hard-driving and competitiveness). We used a modified version that includes Type A-B behavior pattern, resulting in a total score of 21 questions[40,41] and each response was assigned a numerical point based on the product of the item regression weight and the optimal scaling weight for that response. The sum of the points for the 21 items constituted exclusively the Type A behavior scale.[40,41,50]

Alcohol and Smoking. Two additional questionnaires were administered to quantify the amount of alcohol and cigarettes consumed during the period of study. Smoking was quantified by asking the subjects to report the number of cigarettes smoked every day and calculate the average value for 5 days (second to sixth day). Alcohol consumption was quantified by first asking the subjects the type and amount of alcohol consumed every day. Total ethanol weights were then calculated using a standard conversion table for alcoholic beverages; the ethanol concentration was multiplied by the reported amount of alcohol consumed on each day. The average value over 5 days (second to sixth day) was calculated.[51,52]

Data Analysis

The EMG data were considered the dependent variable and the 26-item questionnaire data were considered independent variables. Since age and gender were regarded as potential confounding factors, these 2 variables were included as independent variables as well.

The level of significance was set to 0.05, and correlation analysis and multiple stepwise linear regression analysis were used to evaluate associations between dependent variables and independent variables. In the multiple regression analysis, significant probability to enter a regressor in a forward step was 0.1 and to leave in a backward step was 0.05. All statistical analyses were conducted using JMP version 5.1J (SAS Institute Inc, Cary, NC).

RESULTS

Two of 94 subjects could not complete 6 consecutive night recordings because of time conflicts. Furthermore, 3 subjects' data were excluded from the analysis because of missing data. A multiple stepwise linear regression analysis revealed that no significant correlations were seen from the questionnaire data. However, the effect of gender difference showed only significant effect with longer SB duration in the male group than female group. The second multiple stepwise linear regression analysis was then performed using only questionnaire variables in male and female groups, separately. This analysis showed two significant models. The ST score of TCI results were positively associated with the bruxism level in the male group. The anger-hostility score of POMS and the amount of alcohol intake were positively associated and the escape avoidance score of SCI was negatively associated with the bruxism level in the female group (Tables 1 and 2).

DISCUSSION

The first multiple regression analysis revealed that only gender was a significant regressor, which suggests that there was different causation of SB in gender. Therefore, we performed the second analysis stratified by gender. This data allowed us to partially reject the null hypothesis that "any psychosocial factors were not related to the bruxism level." Specifically, the amount of alcohol intake and mood state of anger-hostility were positively associated with SB and a tendency to escape from or avoid stressful events was negatively asso-

ciated with SB in the female group. The character of self-transcendence was positively associated with SB in the male group; however, this later association was very weak.

The strengths of this study were the number of subjects (n = 89) and the number of nights (n = 5) of actual masseter EMG data collected, excluding the first night data. Moreover, bruxism levels were quantified using high resolution, artifact-cleaned masseter muscle EMG recordings, which were performed in the subject's home sleeping environment. These study aspects are important since limited high-resolution EMG-based bruxism data are available. Even the best study in the literature that used nocturnal polysomnography (NPSG) examined bruxism levels in only 36 subjects across 2 nights.[29] Prior to this, 100 people with bruxism were investigated for 10 to 14 consecutive days in the home sleeping environment. Unfortunately they utilized a low-resolution monitoring EMG method to assess masseter muscle activity.[17] Furthermore, they exclusively studied the subjects with bruxism, which made it impossible to evaluate the risk factors for SB. When considering studies that evaluated analogs of SB (e.g., tooth attrition, self-report), the sample sizes were larger than our sample, but the merit of tooth attrition as an indicator of actual ongoing bruxism is weak and the ability of the subject's awareness of SB has limitations.[27-29]

This study's weakness was primarily that the methods we selected to use did not allow EEG-based sleep staging. This limitation makes the self-reported sleep time duration less reliable. Of course, home environment recording allows more data collection than is traditionally done in NPSG and the subjects' comfort level is better. Second, the subjects in this study were not a probability based sample and there were no active bruxism cases. However, we note that age of our university students put them squarely in the risk group of our target population. Moreover, based on our experience, we have found this group far more able to successfully complete all recording procedures required in the difficult study. Finally, we fully recognize that with our study design, we cannot infer a cause-and-effect relationship between our independent and dependent variables.

With regard to the gender difference in bruxism level, a previous study noted that male subjects exhibited more tooth attrition than females,[27] while other studies, which evaluated self-reported SB status, did not find this difference.[9,15,53,54] In this study, males exhibited significantly longer ongoing bruxism than females as measured by EMG. To our knowledge, this is the first study to find a significant gender difference in bruxism level based on the actual multiple night recordings.

With regard to the stress-bruxism relationship, we were not able to find a significant association between them as a group. This is in agreement with a previous study, which performed multiple night recordings in 100 bruxism subjects,[17] but not in agreement with a questionnaire-based epidemiological study.[4, 15] This inconsistency may be due to the methodological difference in the evaluation of both stress and the bruxism level. Our finding, however, is not to say that SB is not related to stress. It might indicate the difference in subject's response to stressful events due to variability of coping styles. For instance, one study has provided evidence that stress is correlated with SB only in conjunction with Type A behavior patterns,[14] which is a coping style that can be characterized as an extreme desire to control life events.[44] Since life events do not always yield to such control, Type A individuals are likely to encounter periods of extreme stress and, therefore, have been correlated with bruxism.[13,14,16] The present study did not demonstrate these associations. However, bruxism level was correlated with lower escape-avoidance coping style and mood of anger-hostility. It should be noted that both were reported to be related to a Type A behavior pattern.[42,44, 54-57]

The data showed a positive correlation for the amount of alcohol intake, in support of previous studies.[4, 18] This association, however, was only valid in the female group, which might be due to reported higher sensitivity of females to the effects of alcohol than males.[58]

With regard to cigarette smoking, although it has been significantly and positively associated with SB in population-based studies,[4,20] our study results did not support this association. One possible explanation for this might be the difference in measurement methodology as described above. Another explanation might be the difference in the population. Our subjects are not representative of the general population but of dental students, where the rate of smokers was much lower (12.5 %) than the epidemiological study report (38%).[4]

Considering all of these issues, our study should clearly be considered as an exploratory investigation on the risk factors for SB. Logically, confirmatory studies with a probability sample would be done only after several studies like ours find and suggest a significant relationship. With regard to the strength of these findings, it should be noted that the associations found in this study were weak, with low R-square values. Nevertheless, the variables shown to be related to bruxism levels are important and worthy of additional study for better understanding of SB. These study results suggest that SB might be well managed by changing behavioral patterns, which include coping style, emotional mood, and alcohol intake.

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