Bruxism Levels and Daily Behaviors: 3 Weeks of Measurement and Correlation

Tatsutomi Watanabe, DDS, PhD
Assistant Professor
Showa University
Faculty of Dentistry
Department of Geriatric Dentistry
Tokyo, Japan

Kenich Ichikawa, DDS, PhD
Toyoharu Dental Office
Saitama, Japan

Glenn T. Clark DDS, MS
Professor
Oral Biology and Medicine
University of California Los Angeles
Los Angeles, California

Correspondence to:
Dr Glenn T. Clark
Oral Biology and Medicine
University of California Los Angeles
43-009 Center for the Health Sciences
Los Angeles, CA 90095-1668
USA
Phone: 310-825-6406
Fax: 310-206-5539
E-mail: glennc@dent.ucla.edu

Aims: *To test whether 3-week duration recordings of sleep bruxism are correlated with daily behaviors.* ***Methods:*** *Twelve patients with a sleep bruxism disorder were monitored to see if any daily behaviors (stress, physical activity, anger), jaw-pain/headache symptoms, or sleep quality were correlated with their sleep bruxism levels. A telemetric-based system was used for monitoring bruxism levels, which were detected with an intra-appliance piezoelectric film system. Bruxism was defined as a force applied to the occlusal surface of the splint at or above a level of 10% maximum voluntary contraction. Bruxism levels were recorded at night for at least 3 weeks on the 12 subjects in this study (6 females and 6 males). Patients used standard (100 mm) visual analog scaling methods during this period to rate their daily behaviors, sleep quality, and jaw-pain/ headache symptoms in a diary. Correlation analysis was performed between these recorded variables.* ***Results:*** *The subjects demonstrated both bruxism and sleep disturbance, and the mean bruxism score for the male subjects was significantly higher than that for the female subjects. Overall, no single diary variable was consistently correlated with the bruxism levels in these subjects.* ***Conclusion:*** *These data support the conclusion that bruxism is not strongly related to any of the subject's self-monitored daytime activities or sleep quality.*
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Key words: bruxism, sleep quality, piezofilm

Sleep-state motor behaviors (ie, bruxism) have been suggested as important etiologic factors in temporomandibular disorders (TMD) and morning-onset tension-type headache.[1] Sleep bruxism involves strong and often rhythmical contractions of the jaw muscles during sleep.[2–4] These contractions can be rhythmical or continuous isometric contractions, lasting from several seconds to as much as 5 minutes each night.[5,6] Actually, the relationship between bruxism and headache pain has a moderate amount of associational evidence. For example, Molina and colleagues evaluated 133 consecutive TMD patients and 133 non-TMD dental-patient controls and, based on both an examination and history, categorized subjects as having none, mild, moderate, and severe bruxism.[7] They also categorized their subjects as having tension, combined, or migraine headaches. They reported that both bruxism (57% vs 37%) and headaches (76% vs 49%) were more prevalent in the TMD subjects than the controls.

The relationship between bruxism and daily stressful life events is more tenuous. Vanderas evaluated 386 children (aged 6 to 10) and found that the presence of unpleasant life events did not correlate with oral parafunction.[8] Vanderas also examined the level of catecholamines (epinephrine and dopamine) in the urine of 167 children (aged 6 to 8) who could be identified as either positive or negative for bruxism.[9] Using a logistic multiple-regression analysis, they showed that epinephrine and dopamine had a significant and strong association with bruxism. The major weakness of the above data is that these investigators used self-report of bruxism rather than actual measurement of the behavior. In a much earlier study on 30 adult subjects, Clark and colleagues measured both urinary catecholamine levels and nocturnal electromyographic (EMG) activity in bruxism patients and found a significant relationship between the 2 variables.[10]

Using a single-channel EMG recorder, Pierce et al measured nocturnal masseter muscle activity levels as an indicator of bruxism in 100 adult self-proclaimed bruxers.[11] They recorded over a 15-consecutive-day period and they also collected self-reported stress, and several personality variables. Interestingly, and completely contrary to conventional wisdom at the time, the correlation analysis of these data revealed no overall relationship between the EMG levels and the personality variables nor between EMG levels and self-reported stress levels. Da Silva and colleagues also examined psychosocial markers of anxiety and stress and correlated these against the level of attrition (as an indicator of bruxism) in 45 patients with moderate tooth wear and 45 age- and gender-matched nonwear control subjects.[12] These investigators used a between-groups multivariate analysis of variance and reported that the 2 groups did not differ significantly on the combined psychosocial factors ($P > .05$), while the univariate F-test analysis showed that tooth-wear patients presented significantly more trait anxiety than controls ($P < .05$). Of course, attrition level measurements are not indicative of active, ongoing bruxism. Nevertheless, the above studies are in apparent conflict since self-reported unpleasant life events in bruxers are not correlated but physiologic measures of stress (catecholamine levels) are correlated. These studies raise a serious question about the relationship between daily behavioral events and sleep-state jaw motor events.

A lack of correlation between daytime stress and anxiety and bruxism would not diminish the claimed adverse effects of this behavior on the muscle and joints, but it would raise questions about the therapeutic approaches that should be used to manage this behavior. The exact relationship between daytime stress and anxiety and nighttime bruxism can only be answered by analysis of longer-term data collected on sleep state in bruxism subjects. Such data would allow a thorough investigation of the relationships between specific behaviors, stress, muscle activity, and pain. Unfortunately, these data are not currently available because even in the studies where bruxism has been actually measured, the data collected are usually for short time periods. For example, with sleep-laboratory–based polysomnographic methods, bruxism data are typically collected for only 1 or 2 days, and with single-channel portable devices, the data are usually 1 week in duration. The purpose of our study was to evaluate the null hypothesis that there is no correlation between night-to-night bruxism levels (determined by a piezoelectric film-based intraoral appliance force-detection method) and daily life-events (determined by diary). The recorded events were stress, headache, anger, sleep quality, and physical activity levels across the experimental period.

Materials and Methods

Subjects. Subjects were selected from volunteers on the basis of the following criteria:

1. Subjects or their bed partners had to report that they exhibited frequent and active bruxism. Note that no definition/constraints were given to the subjects/partners on these terms.
2. Subjects had to exhibit generalized tooth attrition, with attrition-induced dentin exposure on the occlusal or incisal surface of at least 1 tooth.
3. Subjects could not exhibit substantial dental or periodontal disease (except for bruxism-related tooth pain or jaw muscle pain).
4. Subjects could not exhibit symptoms of arthritis or internal derangement of the temporomandibular joint (TMJ).
5. Subjects had to be in good health without serious systemic disease.

No medications were allowed during this study period (other than birth control pills). Moreover, no subject was enrolled with a reported sleep disturbance (other than bruxism), or neurologic or psychiatric disorder based on a standard medical history questionnaire review and examination. Subjects were excluded if they reported or exhibited strong and persistent daytime oral habits (eg, gum chewing or lip/cheek biting), and each subject was observed for these behaviors during their initial interview and examination.

Fig 1 Full-arch acrylic occlusal appliance with an embedded piezoelectric film.

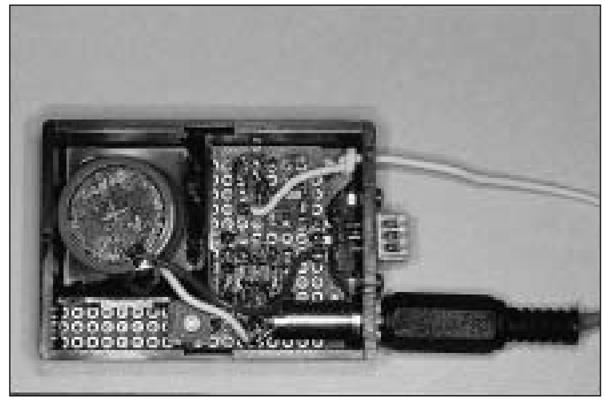

Fig 2 Telemetry transmitter unit, which was connected to the occlusal appliance with a 2-foot-long thin cable.

Study Design. Twenty subjects responded to our advertisements for subjects and from these, 16 were enrolled in the study and were considered eligible to participate (ie, matched our study criteria). Each subject filled out a medical and dental questionnaire and was examined. The subject's intraoral and extraoral findings (including TMJ function, noise and pain, neuromotor examination, and neurosensory information) were recorded. Specific examination of the teeth for attrition and the tongue and cheeks for scalloped tongue or indented cheeks was performed. A thorough palpation of the masticatory muscles for evidence of jaw muscle pain was also performed. This study had the approval of the appropriate institutional review board governing human subject experimentation, and all eligible subjects signed a written consent form before participating in the experiment.

Recording Device. In order to measure bruxism levels, an occlusal stabilization appliance was fabricated for the qualified subject from heat-cured acrylic resin, according to a previously described and validated method.[13,14] The appliance was adjusted using the following guidelines: *(1)* no excessive tightness of the teeth upon insertion or with nightly use; *(2)* bilaterally equivalent, posterior tooth contacts in both habitual and in the subject's centric relation jaw position; and *(3)* canine guidance provided in lateral excursion on the appliance. Embedded within the appliance was a piezoelectric film (MTLZAD, AMP Co Ltd) that was activated by a loading force of approximately 10% of maximum voluntary contraction (MVC) level or higher (Fig 1). The appliance was fabricated to be thick enough not to fracture with use and yet not be so thick that it would unduly open the subject's mouth when worn. These appliances were fabricated with a thickness between 3 and 5 mm in the premolar region.

The piezofilm worked as a detector of forceful closure on the appliance since deformation of the film by biting pressure produced a measurable electrical signal. This distortion produced sufficient voltage between each surface of the film to allow the force above threshold to be monitored. The sensitivity of the piezofilm was not adjustable and was largely determined by how far beneath the acrylic the film was positioned. This distance was standardized to always be 1 mm beneath the surface. Even though this aspect of the method is not adjustable, the trigger level of the transmitter for sending an "on" signal to the receiver could be adjusted (see below). After the piezofilm was placed in the appliance and attached to the small transmitting unit (Fig 2), the appliance was inserted and adjusted again to ensure proper fit. The appliance-transmitter components, excluding the computer-receiver system, were given to the subject for a period of 1 week to ensure that the patient was comfortable and habituated to the device.

After the 1-week period, the computer-receiver system was provided and adjusted so that the resulting signal produced was amplified and transmitted to a bedside telemetric receiver unit (Fig 3). The battery-operated amplifier-transmitter was connected to the appliance with a flexible wire. In Fig 2 it is possible to see the threshold level adjustment component below the battery of the telemetry transmitter unit. This allowed us to check the appliance-transmitter device for sensitivity before the study recording began and every week when the subject returned the computer-receiver unit.

Fig 3 All components of the recording. From top to bottom: portable laptop computer with an A/D card, an antenna, and a receiver.

Before recording any subject, the threshold was arbitrarily set so that it was never triggered when the subject: *(1)* swallowed with the teeth together; *(2)* rubbed his/her teeth lightly across the splint surface; and *(3)* lightly rested the teeth on the splint. Based on our experience with this device, once the threshold level was set, it was very stable across the experiment. The signal was transmitted on a VHF band (frequency 67 MHz) FM (frequency modulation) radio wave.

The radio wave was transmitted to a receiver (IC-R1, Icom) via an antenna that was positioned next to the subject's bed. The band frequency of the receiver was set to the particular value for each subject by the examiner before he/she started recording. Once the signal was received it was processed and transmitted for storage to a portable laptop computer (Libretto, Toshiba) via an A/D card (DAQCard-500, National Instruments Corporation) at a sampling frequency of 2 Hz (Fig 3). The transmitted information was plotted and these plots revealed a signal, which was either "on" or "off." The difference between an "on" data point and an "off" data point was typically a rapid 2.5 voltage shift in baseline (Fig 4).

Recording Protocol. Each subject was trained thoroughly on how to use the system and demonstrated his/her ability to set up and use the system successfully in the presence of the examiners before he or she was issued the recording device. Each appliance was tested for functionality (ie, that it would not trigger with light touch but would trigger at or above a level of 10% MVC). Using the accompanying computer, each subject was also shown how to perform nightly checks of the appliance for successful operation. Any subject who found the device not operating as previously demonstrated was instructed to forgo recording that night and call the laboratory the next morning to arrange a repair or replacement. Several times in the experiment, wires came loose or the transmitter was not connected properly.

Bruxism activity was recorded nightly at each subject's home across a 28-day period. The procedure itself was very simple and required the subject to perform the following steps: *(1)* insert the occlusal appliance; *(2)* turn on the transmitter; *(3)* turn on the bedside receiver and the computer; *(4)* verify a successful installation by checking the computer program signal; *(5)* go to sleep. During the night, if the subject needed to get up for any reason (such as to go to the bathroom), he/she was instructed to wear the appliance and carry the telemetry unit. During the recording phase of the experiment, subjects returned once a week to the laboratory so that an examiner could check the appliance, change the battery of the telemetry unit, and collect data from the computer.

Diary Recordings. Subjects completed a diary for each day/night of recording. This diary included self-perceived levels of headaches, stress, physical activity, and daily anger. Each component was recorded on a 100-mm visual analog scale (VAS). Subjects also indicated (on a diagram) the specific region of any pain in the head and neck if such pain was present prior to bedtime. Once the subject awoke, he or she recorded the following sleep information: the estimated time asleep; any difficulty falling asleep (a yes/no question); the number of nighttime awakenings; and the level of sleep disturbance. As with the other variables, sleep disturbance was scored on a 100-mm VAS. Five VAS scales used the words "No pain," "No stress," "No activity," "No anger," and "No problem sleeping" to anchor the left side of the line. On the right side of the respective line were the words "Most severe pain imaginable," "Most severe stress imaginable," "Most physical activity imaginable," "Most anger imaginable," and "Severe sleep disturbance." To determine if the subjects were following the protocol, 1 of the authors made telephone contact with the subjects once each week of the study. The subjects also were required to return to the laboratory on a weekly basis to have the collected data downloaded and the devices checked for proper functioning. At these visits the subjects' diaries were examined and new diaries were issued. While this protocol did not amount to day-to-day monitoring of adherence, it did serve to identify subjects who were having problems with either the diary or bruxism recording system, thus allowing the experimenters to take timely corrective measures.

Data Processing and Analysis. An "on event" was triggered by a force applied to the occlusal surface of the splint at or above a level of 10% MVC. Thus, a triggered event would produce a 2.5-volt shift in the telemetric data being transmitted to the desktop computer. All recorded data were transferred to a spreadsheet and the "on" data points were detected using a spreadsheet, macro program. This macro program evaluated the voltage recordings, and an "on" data point was considered present only if the voltage shift was at least 60% of the difference between the minimum baseline ("off") value and the maximum ("on") value of the output (approximately a 2.5-volt difference). The reason for the establishment of these criteria was to compensate for the baseline noise that is typically found with electronic-based telemetry system recordings. Thus, a minimum amplitude criteria was set for an "on" event that was high enough (60% of the shift between baseline voltage and the "on" voltage level) to ensure that no "noise" would be detected as a bruxism event. We defined a bruxing event as any set of contiguous or consecutive "on" events. To distinguish between 2 bruxing events, we elected to use an arbitrary 1-second "off" period between 2 adjacent sets of "on" data points. For each recorded night, the first 15 minutes and the last 5 minutes of data were eliminated to avoid any nonsleep data. All positive, nonadjacent "on" counts throughout the whole night recording period were summed and divided by total hours asleep calculated from the total recording time (minus the first 15 minutes and the last 5 minutes). The resulting value was defined as the subject's bruxism score, which described the number of bruxing events per hour. All resulting sleep data, including the bruxism score, number of recorded nights, mean hours per night of recording, gender, and age, were tabulated for each subject.

The diary data (headache, anger, stress, sleep disturbance, and physical activity levels) were processed by first determining the mean plus 1 standard deviation for each variable recorded. The individual subject mean, the mean for each gender subgroup, and the overall mean for all subjects were tabulated and displayed. The bruxism score and each diary variable were compared to determine if there were any significant differences between the 2 gender subgroups (t test; $P < .05$). For each subject, correlation coefficients between each variable (headache, stress, physical activity, anger, sleep disturbance, and bruxism score) were calculated individually and across all subjects. Similarly, correlation coefficients between the bruxism score and difficulty falling asleep and the bruxism score and frequency of awakening during the night were calculated for each subject and then across all subjects. The resulting mean Pearson's and Spearman's correlation coefficients were examined to determine statistical significance at a $P < .05$ level.

Results

Subject Recordings. Six females (mean age 26.8, range 22 to 33 years) and 6 males (mean age 27.0, range 21 to 32 years) completed the experimental protocol. An additional 4 subjects (all female) were enrolled and occlusal appliances fabricated, but 3 of these subjects withdrew from the study before recordings were begun. One was unable to tolerate the occlusal appliance (it caused her to breathe with her mouth open at night), 1 experienced excessive salivation from the use of the occlusal appliance, and 1 received unrelated dental treatment, resulting in a poorly fitting appliance. All 3 subjects elected not to proceed with the recording phase of the study. One other subject did begin recordings, but dropped out of the study because she was unable to meet its time demands.

Bruxism Data. A representative graphic example of 1 week (7 consecutive days) of bruxism data taken from a single subject can be seen in Fig 4. These data are typical of the data collected and it can be seen that the bruxism patterns recorded varied substantially from night to night. Bruxism levels also varied, and subjects were both mild and strong bruxers (Table 1).

Table 1 shows the number of nights recorded, the mean time recorded per night, and the mean bruxism score per hour. These data demonstrate that both bruxism and sleep quality (ie, difficulty falling asleep and times awakened per night) are highly variable. The data in Table 1 also reveal that subjects exhibited a mean bruxism score (events per hour) varying from 1.78 ± 2.07 to 17.69 ± 14.90. Statistical testing was performed to compare the sleep data scores between the genders. Males and females did not differ with regard to nights of recording, mean recording time, or age, but their mean bruxism scores were different. Specifically, the mean bruxism score for the male subjects (12.4 ± 4.47) was significantly higher ($P = .02$; t test) than the mean score for the female subjects (5.61 ± 3.25).

While it was the goal to record 28 nights of data, the average number of recorded nights was 22. The lost nights were mostly due to subjects

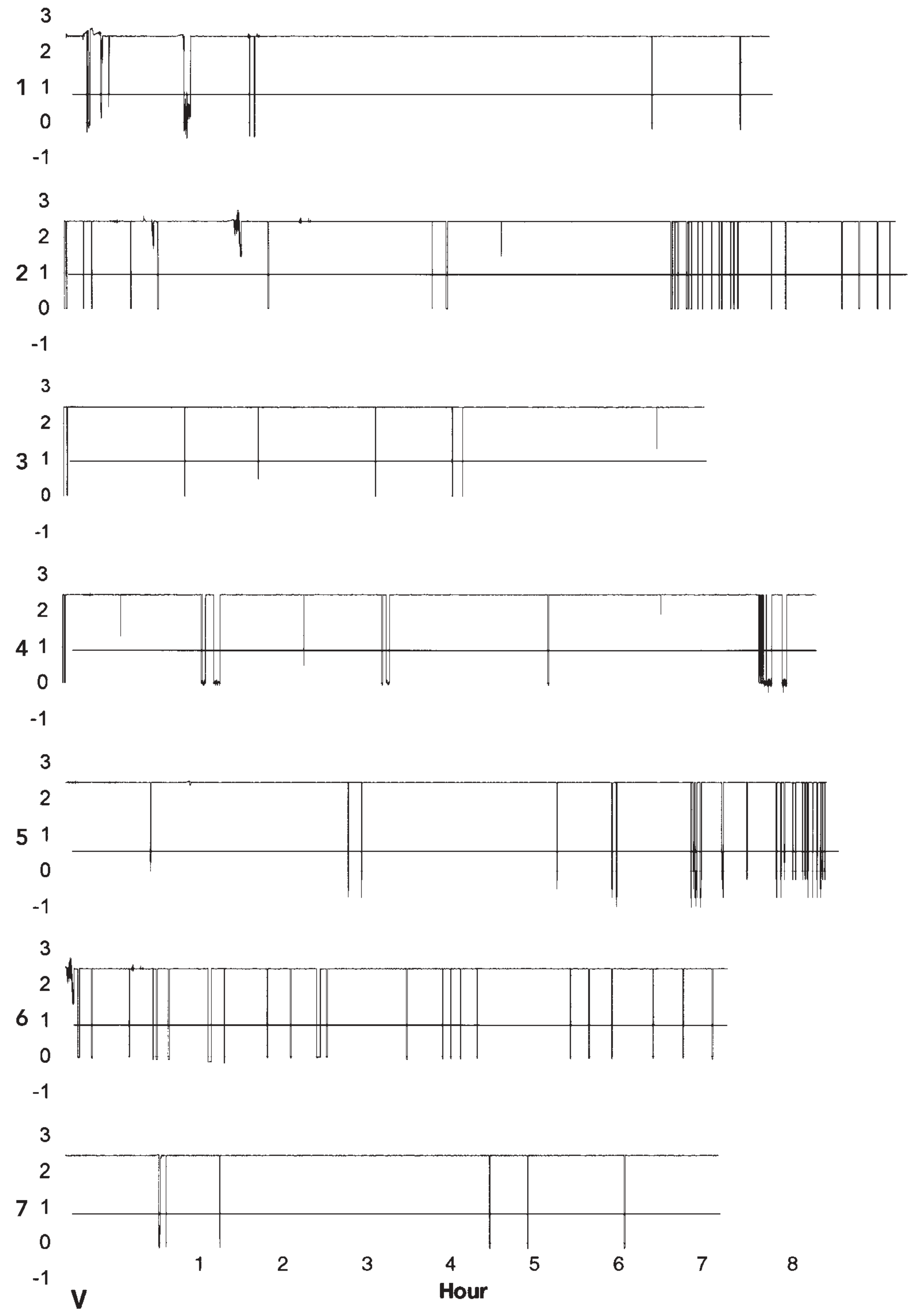

Fig 4 Seven consecutive nights of sleep recording in a single subject (no. 1). Each tracing (nos. 1–7) represents a single night's data. The baseline voltage level (approximately ± 2.5 V) can be seen at the top of these figures. The "on" events can be seen as multiple rapid and brief negative shifts in the voltage. The solid lines are 60% threshold level for considering a voltage shift a bruxism event.

Table 1 Gender, Age and Mean (± 1 SD) Sleep and Bruxism Data

	Sex	Age (years)	Total number of nights	Nightly mean time recorded	Difficulty falling asleep	Times awakened per night	Mean bruxism score/hour*
Subject 1	Female	25	24	7.77 ± 1.00	0.33 ± 0.48	1.17 ± 1.27	6.73 ± 5.60
Subject 2	Female	33	24	7.19 ± 1.13	0.20 ± 0.41	0.80 ± 1.15	10.35 ± 13.01
Subject 3	Female	28	25	6.54 ± 0.91	0.04 ± 0.20	0.08 ± 0.28	7.53 ± 9.01
Subject 4	Female	27	23	6.99 ± 1.46	0.00 ± 0.00	1.64 ± 1.09	4.85 ± 6.08
Subject 5	Female	26	27	7.29 ± 1.17	0.20 ± 0.41	0.80 ± 1.29	2.41 ± 4.43
Subject 6	Female	22	25	6.80 ± 1.36	0.29 ± 0.47	1.33 ± 0.72	1.78 ± 2.07
Female mean		26.8 ± 3.66	23.0 ± 3.79	7.09 ± 0.43	0.17 ± 0.13	0.97 ± 0.54	5.61 ± 3.25
Subject 7	Male	21	15	5.66 ± 1.45	0.00 ± 0.00	0.38 ± 0.65	14.99 ± 8.93
Subject 8	Male	27	24	7.16 ± 1.10	0.13 ± 0.34	2.83 ± 1.63	7.63 ± 7.44
Subject 9	Male	27	28	8.86 ± 1.32	0.00 ± 0.00	0.07 ± 0.38	5.65 ± 7.29
Subject 10	Male	29	18	4.91 ± 1.00	0.11 ± 0.32	0.83 ± 0.71	17.69 ± 14.90
Subject 11	Male	26	18	7.72 ± 1.43	0.12 ± 0.33	0.06 ± 0.24	12.91 ± 11.16
Subject 12	Male	32	26	8.02 ± 1.01	0.28 ± 0.46	1.24 ± 0.83	11.70 ± 19.69
Male mean		27 ± 5.46	21.3 ± 5.47	7.06 ± 1.49	0.11 ± 0.10	0.90 ± 1.05	12.4 ± 4.47
t test		*P* = .94	*P* = .51	*P* = .95	*P* = .29	*P* = .89	*P* = .02
Total mean		26.9 ± 6.5	22.2 ± 4.6	7.08 ± 1.05	0.14 ± 0.12	0.94 ± 0.80	8.61 ± 4.90

*Bruxism score is number of events per hour of sleep.

Table 2 Mean Data (± 1 SD) for Headache, Stress, Physical Activity, Anger, and Sleep Disturbance Frequencies

Subject	N	Headache	Stress	Physical activity	Anger	Sleep disturbance
1	24	8.8 ± 11.8	15.5 ± 19.3	4.5 ± 6.6	0.5 ± 0.6	27.3 ± 20.4
2	24	13.9 ± 13.4	28.8 ± 11.6	8.1 ± 3.8	12.6 ± 9.9	9.5 ± 5.3
3	25	1.5 ± 1.0	8.1 ± 4.8	1.6 ± 1.4	2.2 ± 2.2	1.6 ± 0.5
4	23	2.7 ± 3.0	2.0 ± 2.1	4.6 ± 8.3	1.5 ± 1.5	1.8 ± 1.7
5	27	1.8 ± 0.6	8.5 ± 11.6	11.2 ± 15.2	4.0 ± 6.4	8.1 ± 10.8
6	25	4.3 ± 8.4	20.2 ± 15.0	32.1 ± 15.3	6.3 ± 12.9	18.3 ± 23.7
Female mean		5.5 ± 4.9	13.9 ± 9.7	10.4 ± 11.2	4.5 ± 4.5	11.1 ± 10.0
7	15	13.1 ± 8.3	40.4 ± 14.7	31.5 ± 22.7	10.7 ± 3.5	13.9 ± 7.3
8	24	15.9 ± 8.9	25.5 ± 13.7	38.3 ± 18.3	19.8 ± 10.1	36.5 ± 10.0
9	28	1.5 ± 1.0	1.5 ± 0.9	1.4 ± 0.5	1.6 ± 0.6	1.8 ± 2.8
10	18	0.9 ± 0.6	12.2 ± 7.3	6.1 ± 3.6	1.0 ± 0.7	12.1 ± 6.1
11	18	3.0 ± 1.1	2.1 ± 0.8	10.9 ± 23.1	3.0 ± 1.4	13.3 ± 17.8
12	26	6.8 ± 8.2	11.7 ± 9.3	18.2 ± 12.2	1.6 ± 1.9	10.7 ± 12.0
Male mean		6.9 ± 6.3	15.6 ± 15.0	17.7 ± 14.6	6.3 ± 7.5	14.7 ± 11.5
P value		*P* = .68	*P* = .82	*P* = .35	*P* = .63	*P* = .58
Total mean		6.2 ± 5.4	14.7 ± 12.1	14.0 ± 13.0	5.4 ± 6.0	12.9 ± 10.5

N = total number of data points.

forgetting to record or being too tired to set up the system and turn it on before retiring. Only a few nights were lost due to equipment problems such as a battery problem, a loose wire, or failure to properly connect the recording system.

Diary Data. Table 2 presents the individual subject and the group means as recorded on each daily diary VAS for stress, anger, physical activity, headache, and sleep disturbance levels. Statistical testing was performed to compare the diary data scores between the genders. Male and female subjects were found not to differ significantly with regard to their self-reported diary data. Although not significant, sleep disturbance was one of the areas exhibiting considerable variability from night to night. The VAS data in Table 2 show that subjects exhibited a mean sleep disturbance which ranged from 1.6 ± 0.5 to 36.5 ± 10.0.

Correlation Analysis for Bruxism and Diary Data. The mean correlation coefficients between the various diary data and sleep data variables and the bruxism score are revealed in Table 3.

Table 3 Mean Correlation Coefficients Between Bruxism Score and Self-Reported Diary Data

Subject	HAL-BS	STL-BS	PAL-BS	ANG-BS	SDL-BS	DFS-BS	TAS-BS
1	0.378	0.121	–0.262	0.317	0.058	0.417	0.576
2	–0.079	–0.268	–0.351	0.155	–0.234	0.145	–0.177
3	0.399	0.239	–0.016	0.060	–0.153	0.249	0.490
4	–0.235	–0.098	–0.233	0.009	–0.98	0.502	0.428
5	–0.129	0.192	–0.019	0.023	0.132	0.136	0.210
6	–0.022	0.013	0.023	–0.145	0.238	0.199	0.220
7	0.379	0.141	0.132	*0.478	–0.068	0.268	0.431
8	0.435	0.468	–0.163	0.353	–0.326	0.500	0.538
9	–0.438	–0.329	–0.13	–0.124	0.228	0.500	0.119
10	–0.22	–0.163	–0.214	–0.168	–0.201	0.503	0.463
11	–0.247	0.332	–0.219	0.082	0.346	0.633*	0.302
12	–0.210	–0.085	–0.076	–0.001	–0.020	0.372	0.339
Analysis	Pearson	Pearson	Pearson	Pearson	Pearson	Spearman	Spearman

*Significant correlation ($P < .05$).
BS = bruxism score; HAL = headache level; STL = stress level; PAL = physical activity level; ANG = anger level; SDL = sleep disturbance level; DFS = difficulty falling to sleep; TAS = times awakened from sleep.

Only 2 correlations were found to be significantly different from a zero correlation. These were the anger and the bruxism score in subject no. 7, and difficulty falling asleep and the bruxism score in subject no. 11.

Discussion

The primary reason for undertaking this project was to explore the relationship between bruxism levels and self-reported behaviors such as sleep quality and daily stress, headache, anger, and physical activity levels. The device used in this experiment is able to detect any force-generating event above the threshold of 10% of the MVC. We cannot determine the type of jaw movement that produces this event (eg, tapping, grinding, or clenching). Nevertheless, the resulting data from this study provides information about the number and distribution of forceful jaw closures (above the 10% MVC level) during sleep in 12 self-proclaimed and clinically confirmed subjects with bruxism.[14] These data were collected over a substantially longer time period than has been previously reported (approximately 3 weeks on average). With the exception of a brief report on a single subject presented by Rugh and Harlan, these data represent the longest recordings of jaw motor events during sleep described in any study in the English literature.[15]

In the present study, a statistically significant difference in bruxism scores was found between male and female subjects. These data agree with the report by Ekfeldt et al, who described males presenting with significantly higher individual tooth wear indices than females.[16]

The effect of an occlusal appliance on bruxism activity was first documented over 25 years ago with a single-channel portable EMG device during sleep.[17,18] These articles reported on the short-term, muscle activity–modifying effect of occlusal appliances and suggested that after approximately 7 to 10 days this effect on bruxism behavior was likely to dissipate or diminish. Similarly, clinicians who have utilized occlusal appliances on multiple bruxism patients report that occlusal appliances quickly (within 1 to 2 weeks) show evidence of ongoing bruxism wear marks on the surface of the device. The current study incorporated a 1-week period for subjects to accommodate to splint use and it also extended the duration of the study to a 4-week period in an attempt to neutralize any short-term accommodative changes. It could be argued that there may be some individuals for whom an occlusal appliance may have a long-lasting modifying effect on the behavior of bruxism (whether increasing it or decreasing it). In such situations, since the presence of the appliance is a necessary component of the recording apparatus, this modifying effect will be present for all recordings, so it is a constant. Until there comes a time when a new method of detecting occlusal forces in any and all jaw positions is developed, the occlusal appliance is a necessary component of this technique. In our opinion, its presence will not diminish the potential use of this method for long-term recording of bruxism for the reasons offered above.

With regard to the recording itself, we cannot be absolutely assured that the forceful tooth contact patterns reported are only caused by classic rhythmical side-to-side bruxism, since classic short sliding-grinding motions cannot be distinguished from static short clenching with this device. Although this device is designed to record bruxism, the possibility that other orofacial activities during sleep could produce above-threshold forces on the appliance cannot be discounted. Moreover, the ability to distinguish forceful jaw closure on the splint during sleep from inadvertent or even deliberate forceful contact when the subject was awakened during the night is also impossible. For example, it is possible that some subjects carried the device (against the protocol instructions) with them to the bathroom and continued to record (assuming the transmitter could still receive the signal). These are potential confounding data artifacts that cannot be prevented other than by requesting cooperation and training the subject properly. We do not consider the likelihood of such artifacts or sabotage to be high and such uncertainty is inherent in all portable home-environment physiologic monitoring studies. Detecting such problems would not be possible unless electroencephalographic recordings and independent "visual or videotape-based" monitoring of the subjects during sleep were made. These measures would allow one to check if the patient was not following instructions. Essentially, it is impossible to know if or how often this might have happened, since the incorporation of such monitoring methods into the protocol would have exponentially increased the complexity and cost of data collection. This type of surveillance would make long-term monitoring impractical for the same cost-benefit reasons that data from several weeks of recording in a sleep laboratory is not widely performed. In spite of the aforementioned shortcomings, we strongly feel that our method of monitoring bruxism is both logical and practical, and the benefit clearly outweighs the possibility of inadvertent nonadherence to instructions, much less outright sabotage of the study.

In conclusion, these data are consistent with other reports in the literature[8,11,12] and they demonstrate that bruxism behaviors are not highly influenced by day-to-day variations in stress, anger, and even physical activity. Only in 2 subjects were there statistically significant correlations found (at a level of 1 correlation per subject) for any of the 84 possible correlations between bruxism and various sleep and waking behaviors. These correlations were most likely due to chance and were therefore discounted. Moreover, the subjects exhibited little headache pain or sleep disturbance, so it was not surprising that these variables were not found related to bruxism. The possibility cannot be discounted that for subjects with substantially higher levels of headache pain or jaw pain, or day-to-day variations in daily life, events might be more correlated with bruxism. Future research with such a population may answer this question.

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