Does Tooth Wear Status Predict Ongoing Sleep Bruxism in 30-Year-Old Japanese Subjects?

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Purpose: This study investigated whether tooth wear status can predict bruxism level. **Materials and Methods:** Sixteen Japanese subjects (eight bruxers and eight age- and gender-matched controls; mean age 30 years) participated in this study. From dental casts of these subjects, the tooth wear was scored by Murphy's method. Bruxism level in these subjects was also recorded for 5 consecutive nights in the subject's home environment using a force-based bruxism detecting system. The relationship between the tooth wear score and bruxism data was evaluated statistically. **Results:** Correlation analysis between the Murphy's scores of maxillary and mandibular dental arch and bruxism event duration score revealed no significant relationship between tooth wear and current bruxism. **Conclusion:** Tooth wear status is not predictive of ongoing bruxism level as measured by the force-based bruxism detection system in 30-year-old Japanese subjects. *Int J Prosthodont 2004;17:39–44.*

Tooth wear is commonly considered to be an analogue of bruxism.[1,2] This belief is so strong that several researchers have used tooth wear to predict the patient's bruxism level in an effort to investigate the relationship between bruxism and temporomandibular disorders (TMD).[3–8] The use of tooth wear in this fashion is controversial; while tooth wear clearly provides information about a history of forceful tooth-to-tooth contact, it does not prove current ongoing bruxism, nor can it indicate if the subject has static clenching activity. For example, minimal wear has been reported in patients identified as active bruxers using electromyography (EMG) of the jaw closers during sleep.[9] Considering these observations, tooth wear may not be sensitive or specific enough as a marker to capture current bruxism. Moreover, the relationship between tooth wear and TMD symptoms is interesting but controversial. On one side of the controversy, several studies have reported a positive relationship between these variables.[3,4,6] Others have not been able to support these findings.[5,7,9]

Proof of any relationship between bruxism and tooth wear requires that both phenomena be reliably and accurately measured. Unfortunately, none of the prior studies have combined reliable quantitative measures of both tooth wear and bruxism during sleep. While accurate tooth wear measurement is relatively easily achieved with commonly available methods, bruxism measurement involves more technologic challenge and is harder to achieve.

To better identify who actually has bruxism, fully instrumented laboratory-based nocturnal polysomnographic (NPSG) studies have been performed.[10–12] One major limitation with these NPSG studies is that the behavior of sleep bruxism varies considerably

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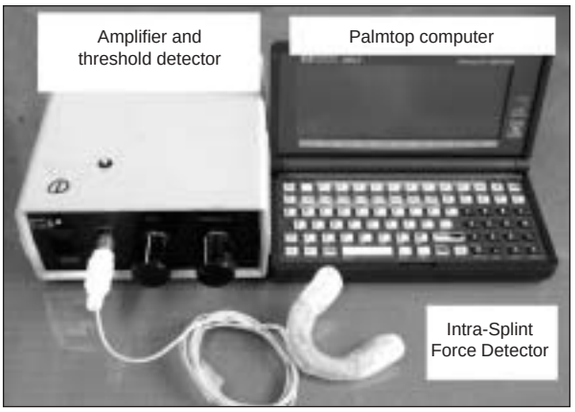

Fig 1 Bruxism recording system uses 100-µm-thick deformation-sensitive piezoelectric film embedded 1 mm below occlusal surface of modified complete-arch maxillary stabilization appliance.

from night to night, and it is difficult and very expensive to have a subject sleep in a sleep center with full physiologic instrumentation for multiple nights. To overcome this problem, multiple nights of jaw-closer muscle (usually masseter) activity recordings have been performed in the patient's home environment using portable EMG recording devices.[13–15] One problem with portable home EMG-based recording systems is that signal fluctuation may occur from variations in the nightly electrode placement on the subject,[16] especially if the subject is asked to apply the electrodes him or herself each night.

Considering the limitations of these bruxism recording systems, an easy-to-operate, reliable recording device for sleep bruxism has recently been developed; it uses a piezoelectric film within an occlusal appliance to measure the force being produced at the teeth. This method has been shown to be reliable and does not appear to be prone to any positioning variability artifacts, as are seen with repeated-night EMG methods.[17–19] The only critical assumption being made for this recording method is that the occlusal appliance itself does not stop the bruxism behavior. While this is possible, most researchers and clinicians have reported that subjects quickly exhibit signs of bruxism-type wear patterns on an occlusal appliance once they begin wearing it, often within days.[20]

The aim of the present study was to investigate if tooth wear can predict bruxism level as measured by the occlusal force–based recording system. The null hypothesis of the study was that there would be no association between tooth wear and bruxism levels in the subject population.

Materials and Methods

Subjects

Eight suspected Japanese adult bruxers (four men and four women, mean age 30.6 years, standard deviation 3.5) and eight gender- and age-matched Japanese adult controls (four men and four women, mean age 29.4 years, standard deviation 3.1) volunteered to participate in this research project after informed consent was obtained. This project was approved by the Institutional Review Board for Human Subjects Protection at Tokyo Medical and Dental University.

To be included in the bruxer group, an individual subject had to: *(1)* be in good health; *(2)* be between the ages of 25 and 35 years; and *(3)* have exhibited tooth grinding–type sounds during sleep in the last 6 months, as noted by his or her bed partner. Moreover, at least one of the following subjective criteria was required: morning masticatory muscle fatigue or pain, morning tooth soreness, or awakening during sleep because of clenching-induced jaw pain. Exclusion criteria for these subjects were: *(1)* more than two missing teeth per quadrant (excluding third molars) and presence of gross malocclusion; *(2)* use of any prescription medication or daily alcohol; *(3)* any history or signs of active TMD; and *(4)* compromised mental or physical ability. For the controls, the inclusion and exclusion criteria were the same as for the bruxism subjects, with two exceptions. First, inclusion criterion 3 was switched to be an exclusion criterion. The additional exclusion criterion was worded as follows: *(5)* any signs or symptoms suggesting the presence of bruxism, including tooth wear levels producing dentin exposure of the occluding surfaces of teeth, tooth grinding–type sounds during sleep in the last 6 months (as noted by his or her bed partner), morning masticatory muscle fatigue or jaw pain, morning tooth soreness, or awakening during sleep from clenching-induced jaw pain.

Bruxism Measurement

The bruxism recording system used a 100-µm-thick deformation-sensitive piezoelectric film, which was embedded 1 mm below the occlusal surface of a modified complete-arch maxillary stabilization appliance (Fig 1). With deformation, as would occur with any substantial occlusal force, the piezoelectric film generates an electric signal, which varies in accordance to the force applied to the film. This device was developed and described as an Intra-Splint Force Detector (ISFD) in prior research reports.[17–19] The ISFD was connected directly to a battery-powered portable amplifier and then to a threshold detection circuit (Micro Dynamics). This amplifier-

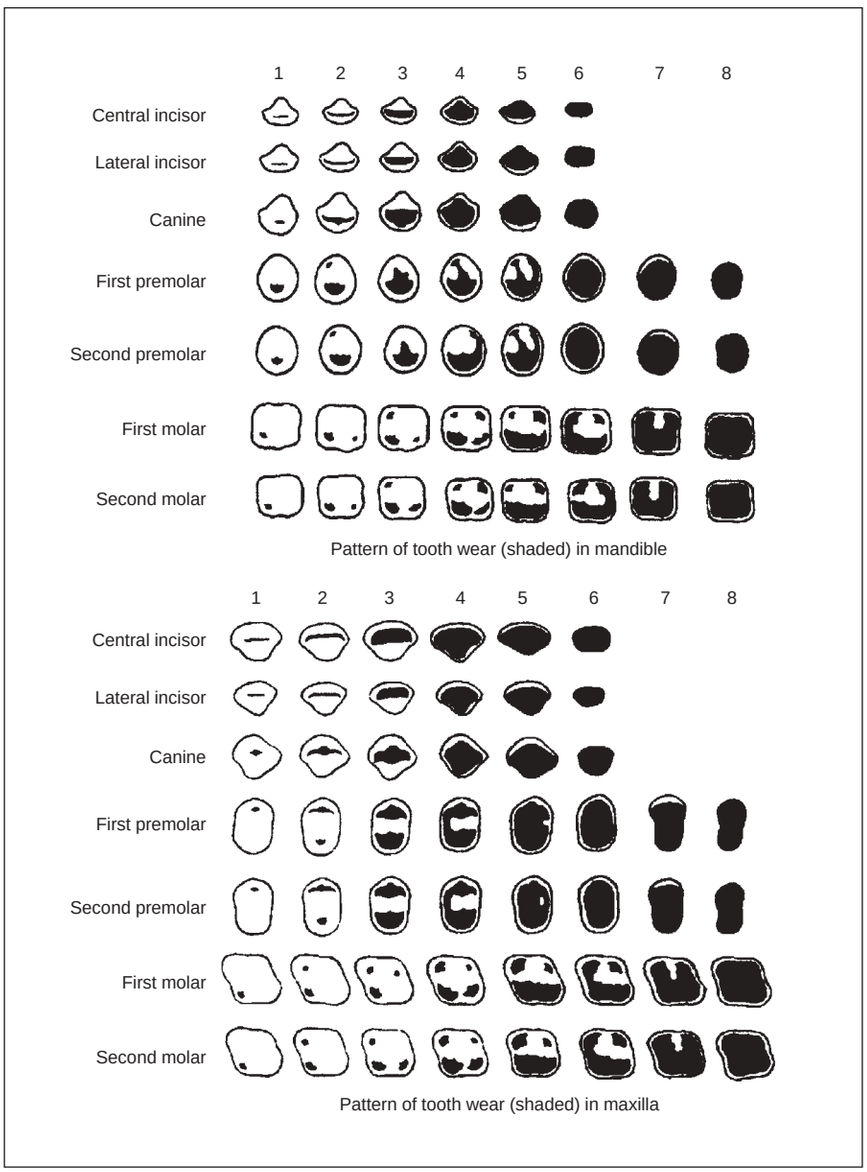

Fig 2 Standard set of tooth wear patterns against which each tooth's wear facet pattern was matched (0 to 6 scales for anterior teeth, *top*, and 0 to 8 scales for posterior teeth, *bottom*).

detector generated a fixed amplitude output signal when the preset threshold was surpassed. The amplifier and threshold detection device had a light-emitting diode (LED) that was turned on if the threshold was exceeded. This LED allowed the experimenters and subjects to check if the appliance was working correctly. The output signal was sent to a palmtop computer (HP 200LX, Hewlett-Packard), which was programmed to record and store data at a 1-second resolution in a text file.

At first, subjects were instructed how to use the device until they became familiar with its handling. The threshold level for the bruxism detection was set at 15% of each subject's maximum voluntary contraction ability to exclude any recording during swallowing and light (nonclenching) tooth contact on the appliance.[17] Prior to the actual recording, the subjects used the appliances for 5 days to adapt to sleeping with the occlusal appliance, which was connected to the amplifier with the wire. After this habituation period, ISFD measurements were performed in the subject's home for 5 nights. At the end of the fifth night, the subject returned the palmtop computer so that the data could be downloaded

into the laboratory computer. To more accurately determine the actual time asleep, the subjects were asked to record the time from when they turned on the recorder until they actually went to sleep and the time from when they woke up until they turned off the recorder in the morning. They were also asked to record the number and duration of and reason for any awakenings during the recording period.

Tooth Wear Measurement

Tooth wear was measured on dental casts using a method described by Murphy[21] and modified by Richards and Brown.[22] This method involved matching each tooth's wear facet pattern against a standard set of tooth wear patterns (0 to 6 scales for anterior teeth and 0 to 8 scales for posterior teeth; Fig 2). If the examiner could not decide clearly which of the tooth wear illustrations was closest to the outlined pattern, they were instructed to always use the lower score. As the maximum score for the anterior teeth was 6 while the posterior teeth had a maximum score of 8, the score of each tooth was then normalized to have a maximum value of 1.0. Finally, the mean score for each dental arch was calculated (tooth wear score).

In preparation for this study, the accuracy and precision of the method were determined through the correlation coefficient using 10 dental casts. Accuracy was established by first asking three expert examiners to score each tooth on these dental casts. Discussion of differences was resolved by consensus among the examiners. The mean tooth wear score was then calculated for each cast, and this score served as the gold standard against which two new trained and calibrated examiners were tested for accuracy. The training and calibrating of the two examiners involved teaching them to carefully outline the edge of the wear facets on each tooth with a sharp pencil and then match the outlined areas against the tooth wear diagrams. This training was performed on three sets of training casts before calibration testing was performed. Testing of each examiner's performance was done using a new cast. After duplicating, the original cast was given to one of the expert examiners and the two duplicate test casts were given to the two examiners for marking and tooth wear scoring. Each examiner was judged to be fully trained when their scores were the same as the score given to the original test cast or the difference of these tooth scores was no more than 1 Murphy score value on no more than half of the teeth in each cast. Each examiner passed this test on the first attempt. After successfully passing the calibration, the two examiners were asked to independently score the previously described 10 sets of dental casts two times with an interval of 1 week. The examiners were blind to the expert score and to the other examiner's score. The intraclass correlation coefficient between each examiner's score and the gold standard score was .86 and .93, respectively. Intraexaminer rate between the first and second scores was .92. Interexaminer rate was .86.

Data Reduction and Analysis

Based on the sleep diary, the sleeping period was determined, and only the tooth-to-splint contacts that occurred during sleep were analyzed. The second-by-second recorded ISFD signal was first conditioned by interval criteria, ie, any two events with less than a 3-second interval were combined and considered a single event. After this conditioning, the total bruxism event duration per hour was determined for each night. This variable was averaged over the 5 nights. The tooth wear status measurement involved fabricating stone casts of the maxillary and mandibular teeth of the 16 subjects; these casts were scored by one of the two calibrated examiners as described above. A tooth wear score was then calculated for each mandibular and maxillary cast, respectively. Using these two tooth wear variables and one bruxism variable, correlation analyses (Pearson's correlation) were performed if there was a significant positive association between bruxism duration and tooth wear of the mandibular and maxillary dental arch, respectively. A significance level of $P < .05$ was chosen to test for statistical differences.

Results

Statistical analysis revealed that total bruxism event duration per hour and tooth wear score of the mandible were significantly larger in the bruxer than the control group (Table 1). No significant gender difference for the three variables was found in our study subjects. Correlation analyses between bruxism and tooth wear scores for the maxillary and mandibular casts revealed no statistically significant correlation ($r = .24$, $P = .365$ for maxilla and $r = .46$, $P = .073$ for mandible).

Discussion

Our study results prevent us from rejecting the null hypothesis that there would be no association between tooth wear and bruxism levels. Specifically, the analysis of correlation between the tooth wear score measured on dental casts and ongoing bruxism level measured for multiple nights demonstrated no significant relationship. Given these findings, we suggest that studies focusing on the relationship between TMD symptoms and bruxism, which have

Table 1 Means and Standard Deviations (SD) of Total Bruxism Event Duration per Hour and Tooth Wear Score for Bruxer and Control Groups

Parameter	Bruxer group (n = 8) Mean	Bruxer group (n = 8) SD	Control group (n = 8) Mean	Control group (n = 8) SD	*P* value
Total bruxism event duration/hour (s)	27.63	10.7	9.74	7.90	.002*
Tooth wear score (maxilla)	0.46	0.1	0.38	0.01	.107
Tooth wear score (mandible)	0.50	0.1	0.33	0.10	.006*

*Statistically significant difference (Bonferroni-adjusted probability levels; $P < .013$).

used accumulated tooth wear as an analogue of bruxism level, cannot state categorically whether the subject has current bruxism or strong clenching. Therefore, any conclusions about the relationship between bruxism and TMD symptoms based on tooth wear may be misleading. In contrast to this finding, it is interesting to note that the inclusion/exclusion criteria we used did produce two subject groups that demonstrated a substantially (threefold difference) as well as significantly different bruxism score. This difference would reflect a subject selection bias of the study, and repeat analysis with a much larger sample or with probability sampling is recommended to see if these criteria might be successfully used as an analogue for bruxism. Moreover, for the mandible, but not the maxilla, the two groups did have a statistically significantly different tooth wear score. However, the correlation analysis performed on matched bruxism–tooth wear scores showed the level of tooth wear not to be predictive of the level of bruxism within a subject.

The advantage of the present study is that, for the first time, quantitative data were collected and analysis performed on both accumulated tooth wear levels and current bruxism levels during sleep. Prior to this study, only limited data on these phenomena were available. One prior study that examined bruxism and tooth wear used NPSG as a method to quantify bruxism but reported on only five subjects and recorded bruxism for only 2 nights.[23] It reported no significant relationships between these two variables. Two other studies that have looked at tooth wear and bruxism present sample sizes larger than ours.[2,24] Unfortunately, these studies used self-reports of bruxism; while this method is good for some study questions, it cannot be considered a highly reliable or quantitative assessment.[25] One study reports that bruxers exhibit more tooth wear than nonbruxers,[2] while another failed to find the association.[24]

Our speculation on the poor association between current bruxism activity and tooth wear can be explained in the following manner. First, it is highly likely that tooth wear results primarily from tooth-grinding activity and not clenching. Unfortunately, our recording system does not allow us to distinguish between side-to-side bruxism and sustained clenching, so some of the "bruxism events" we report on might be clenching rather than grinding. Subjects with predominant clenching behavior will be confounders to our analysis.[26] Second, tooth scores might be partially dependent upon the location and shape of the canine or other occlusal contact relationships.[7] Third, with the present study design, it was not possible to completely elucidate a cause-effect relationship between tooth wear and bruxism, since the subjects were of a relatively narrow age band (25 to 35 years). This relationship might differ by age and for different populations. We have no reason to speculate that one genetic grouping of the world's population has more or less tooth wear with the same level of bruxism; nevertheless, our data and any generalization from it are limited at this time to Japanese adults. Fourth, another potential confounder that was not measured is whether some other nonspecific factors may have influenced the level of tooth wear (eg, dietary practices,[27,28] digestive disturbances,[29] environmental factors,[30] buffering capacity of the saliva[31]). Fifth, it is also possible that our detection system may have produced a short-term alteration of the bruxism behavior being measured. To minimize this possibility, subjects were habituated to the force-detecting appliance by using it for 5 nights before any measurements were performed. In our experience, this is an adequate time for the bruxism behavior to reestablish itself if it is influenced at all. In defense of our detection system, we wish to point out that surface EMG is subject to baseline drift problems across the night as the electrode paste dries and skin resistance changes, as well as nightly electrode placement problems. The multiple-night piezoelectric force-based recording system we used has been assessed in three prior studies with success, and we have confidence in this system as a bruxism detection method.[17–19]

Clearly, an ideal bruxism detection system would be one that can distinguish side-to-side grinding from clenching, can be reliably placed each night by the subject (eg, on the teeth), does not interfere with sleep or complete closure of the teeth or in any excursive jaw position, and can detect any force produced between the teeth in a quantitative fashion. Unfortunately, such a recording system does not yet exist.

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