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Original Articles

The Expression of Bruxism during Nocturnal Sleep

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Recently, the incidence of bruxism has been rapidly increasing. However, the mechanism of its occurrence or pathology has not been clarified. In this study, bruxism-related events were evaluated to clarify the characteristics of bruxism and identify a simple method to control it.

Masseter electromyograms obtained from 2 bruxists and 1 non-bruxist on 3 nights at 1-night intervals were analyzed to evaluate the characteristics of bruxism during sleep.

The following results were obtained:

1. Bruxism events were suggested not to occur periodically with time after the onset of sleep.

2. The frequency of bruxism events was high at a low EMG level and decreased with increases in this level.

3. The duration of a bruxism event was most frequently within 1 second, and fewer events were observed with increases in the duration.

4. A relatively strong positive correlation was observed between the duration and EMG level of bruxism events.

Key words: Bruxism, EMG level, Masseter electromyogram

INTRODUCTION

Bruxism during nocturnal sleep (bruxism) is considered to exert a wide range of adverse effects on the stomatognathic system, but there is presently no measure to eliminate it, and it has been suggested to have the physiologic significance of venting stress[1)].

Presently, therefore, dentists can only alleviate unpleasant symptoms such as muscle fatigue and pain that appear in various stomatognathic organs or prevent the excessive loading of various organs and mechanical damage to dental prosthetics such as wear and breakage. Specifically, symptomatic treatments such as dental splinting, cognitive behavioral therapy, and drug therapy are widely performed, but their scientific evidence or validation is insufficient[2)].

Factors suggested to be involved in the occurrence of bruxism include local factors (malocclusion), mental and psychological factors (stress, anxiety, tension), physical factors (pain, disease), and personality. Particularly, its relationship with occlusion was once considered close but has recently been questioned, and the view that mental stress plays an important role has become prevalent. Thus, bruxism is now widely considered to be caused not by a single factor but by multiple factors involved in a complex manner.

The incidence of bruxism has recently increased markedly[3)], and it is considered to be a major factor inducing attrition, tooth breakage, hyperesthesia, masseter hypertrophy, and abnormal jaw functions (temporomandibular arthrosis), as mentioned above. Therefore, the control of bruxism is of marked clinical significance. However, the mechanism of its occurrence or pathology has not been clarified.

In this study, therefore, the characteristics of bruxism were evaluated as the first step to clarify its status and establish a simple method for its control.

MATERIALS AND METHODS

1. Subjects

Three graduate student (mean age: 28years) at Asahi University School of Dentistry of our university with no dental defects, prosthetics, restorations, or routine medications were selected as the subjects with consent after sufficient explanation of the objective and contents of this study. Two of the 3 subjects were aware that they had habitual bruxism (Subjects 1 and 2; mean age 28. 6 years; bruxists), but 1 did not perceive bruxism (Subject 3; age 27. 5 years; non-bruxist).

This study was approved by the Ethical Review Board, Asahi University School of Dentistry (Submission No. 20056).

2. Measuring devices and methods for data collection

Since bruxism is caused by the overactivity of the jaw-closing muscle, muscle activities of the bilateral masseters were recorded in each subject while he/she was asleep on 3 nights at 1-night intervals using the UAS-108S (Unique Medical) electromyographic measurement and data collection system (Fig. 1).

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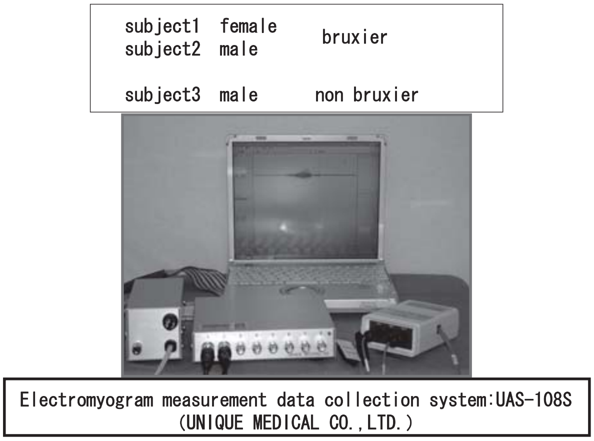

Fig. 1: Device for recording masseter muscle activities.

Signals output through surface electrodes (Delsys) placed at a distance of 10 mm at the center of the masseter were A/D converted using the UAS-A1 level control interface amplifier, transferred to a personal computer, and recorded. The UAS-1 measurement and analysis software (Unique Medical) was used for analysis. While RMS waveforms were employed for data analysis, the electromyographic source waveforms were simultaneously evaluated to eliminate artifacts clearly caused by body motion and noise.

Muscle activities were recorded by the subjects themselves at home. Prior to the recordings, each subject checked the sites of electrode placement and sufficiently practiced operating the recording device. Furthermore, the subjects were instructed not to change their usual living conditions or sleep environment and to sleep with the electrodes attached on 3 nights before the recording to become accustomed to sleeping with the electrodes on.

3. Analytical methods

The mean maximum amplitude (peak value) of the muscle action potentials (bursts) during 5 trials of maximum voluntary biting performed before the beginning of recording was regarded as the 100% maximum voluntary contraction (MVC), and bursts at 10% MVC or higher with a duration of 0. 25seconds or longer were regarded as bruxism events[4]. The 10% MVC was 120 μV in Subject 1, 230 μV in Subject2, and 90μV in Subject3.

Chronological changes in masseter activities observed during sleep in each subject were evaluated with regard to the number of bruxism events and amount and duration of muscle activities. The Friedman test, Kolmogorov and Smirnov test, and Spearman rank-correlation analysis were performed at the 99. 9% level of significance.

RESULTS

1. Distribution of bruxism events with time after going to bed

Fig. 2 shows the numbers of events (bursts) every30 minutes from immediately after going to bed to awakening in each subject.

The duration of sleep per night varied slightly among the subjects and nights. It was shortest at 3 hours and30 minutes in Subject 3 on Day 2 and longest at 6 hours and 35 minutes in Subject 2 on Day 1.

The total number of bruxism events was 51. 3 ± 20. 5 in Subject 1, 42. 3 ± 4. 7 in Subject 2, who were bruxists, and 17. 0 ± 5. 5 in Subject 3, who was a non-bruxist.

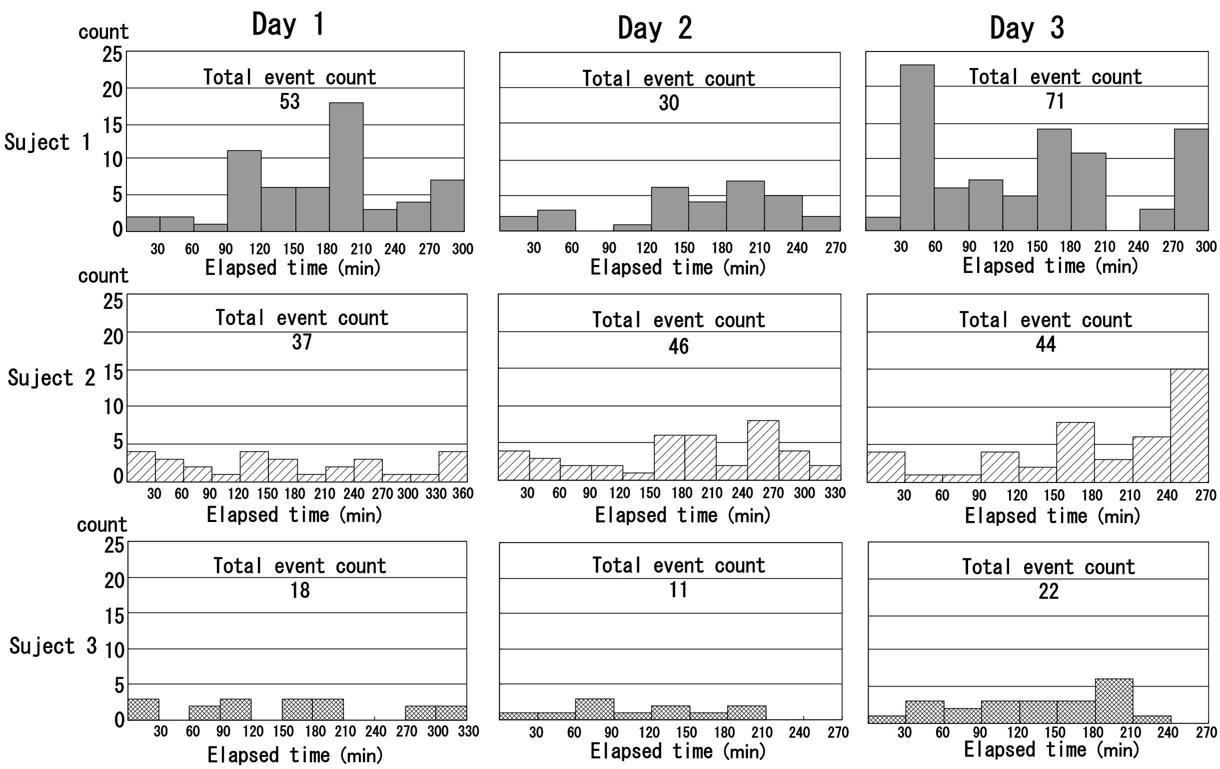

Fig. 2: Characteristics of bruxism events: Changes in their frequency with time after going to bed.

The numbers of events in 30-minute periods varied among the days of measurement in the same subject. They showed significant variation both within each subject and among the subjects on the Friedman test. Therefore, bruxism was shown to occur in a manner unrelated to the time after going to bed.

2. Distribution of muscle activities during events

Fig. 3 is a histogram showing the frequencies of events at various EMG levels categorized by 10% MVC.

The EMG level was distributed from 20-80% MVC in Subject 1, 10-80% MVC in Subject 2, and 30-100% MVC in Subject 3, not exceeding 100% MVC in any subject. Also, the frequency of bruxism events was high at a low EMG level and decreased with increases in this level in all 3 subjects.

The Kolmogorov-Smirnov test of the numbers of events at various EMG levels showed significant differences among the subjects but not within each subject.

3. Distribution of the duration of muscle activities during events

Fig. 4 is a histogram showing the distribution of the number of events with various durations categorized by seconds.

The duration of muscle activities was most frequently within 1 second, and the number of events decreased with increases in the duration in all 3 subjects.

The Kolmogorov-Smirnov test of the numbers of events in different duration categories showed no significant variation among days of measurement within each subject or among the subjects.

4. Relationship between the duration and EMG level of events

Fig. 5 shows the relationship between the duration and EMG level of events in each subject.

The Spearman rank correlation coefficient calculated for each subject was around 0. 65 in all subjects.

DISCUSSION

1. Significance of the study

Bruxism is classified into that occurring during the daytime and that during sleep. The former is considered to be acquired behavior (habit), and the latter to be a sleep disorder due to a central cause[5]. Bruxism during sleep is destructive, because, while sleeping, the cerebral cortex is suppressed and cannot control the occurrence of excessive muscle tension[6]. Many people exhibit bruxism, and, as it has been reported that most patients with TMD, which has been increasing recently, are bruxists, the significance of clarifying the pathology of bruxism and establishment of a method to control it are considered to be very great. We conducted this study, because it is considered necessary first to clarify the characteristics of bruxism.

2. Experimental procedure

Individuals who perceived bruxism and showed one of excessive tooth attrition, nocturnal noise of bruxism, and masticatory muscle discomfort were selected as the subjects according to the ICSD criteria[7] of the American Academy Sleep Medicine.

Bruxism was recorded on 3 nights but with 1-night intervals between the recordings, because there was a report that the frequency of bruxism increased on recording on consecutive nights[8]. Also, as bruxism is a habit sensitive to environmental changes, the recordings were performed at the subjects' homes to minimize the effects of such

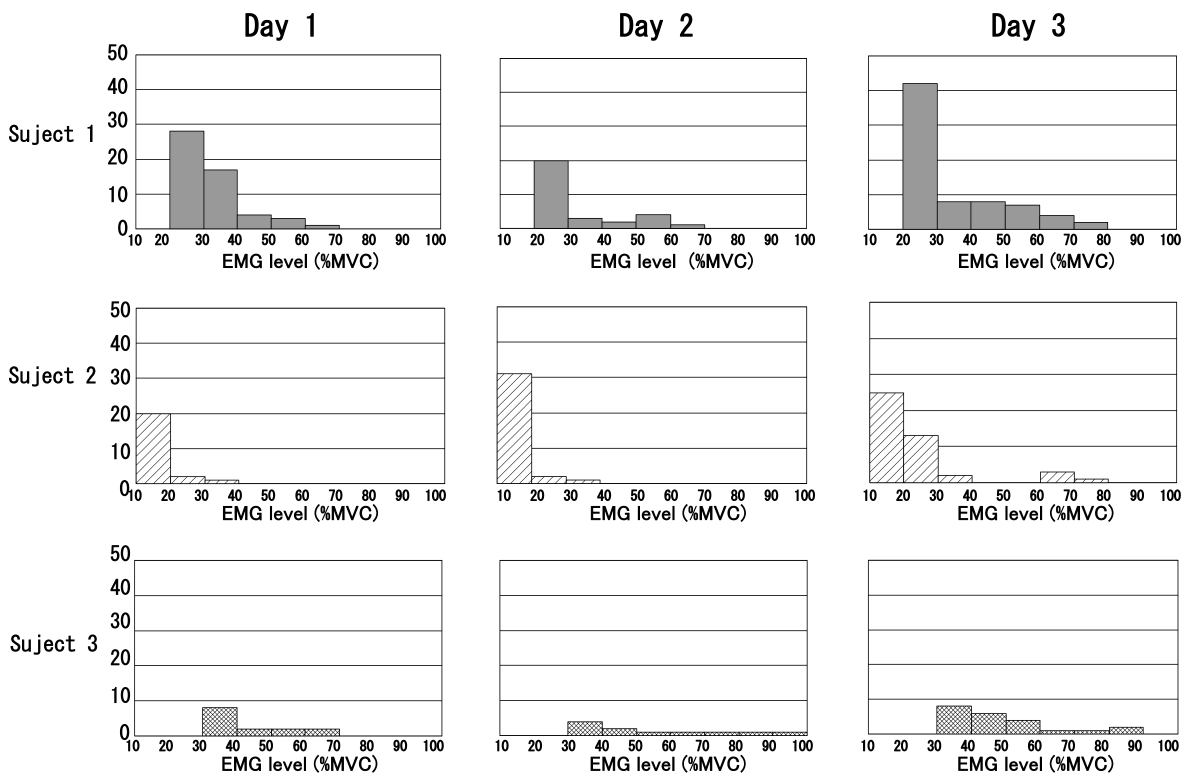

Fig. 3: Characteristics of bruxism events: Frequency of events at different EMG levels.

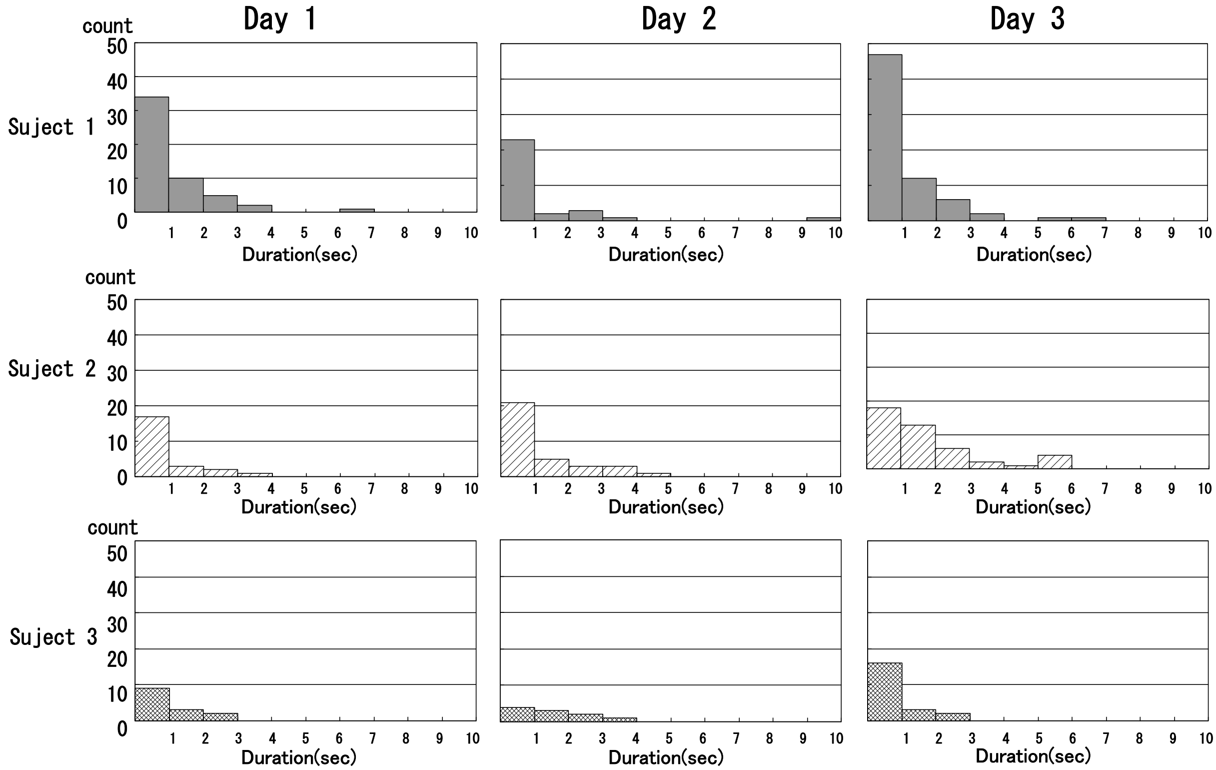

Fig. 4: Characteristics of bruxism events: Frequency of events with different durations.

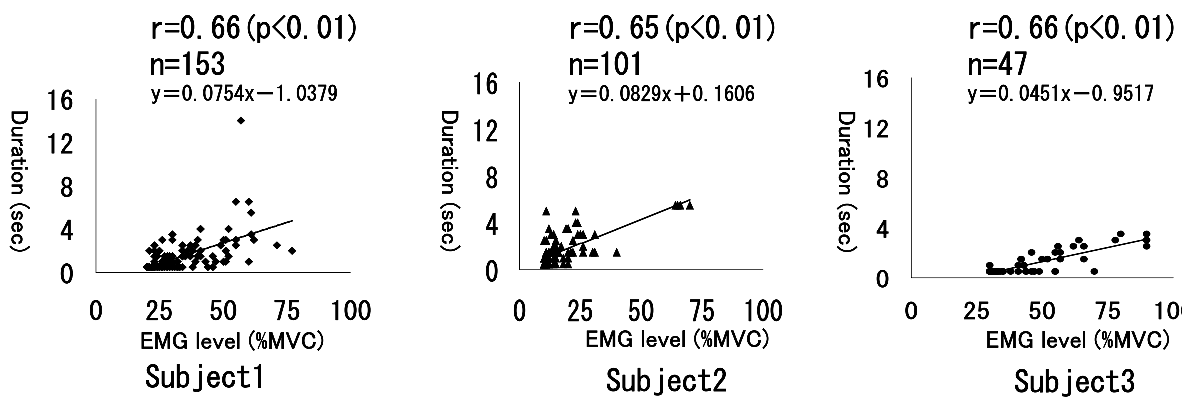

Fig. 5: Characteristics of bruxism events: Relationship between the duration and EMG level.

changes on the occurrence of events[9].

In previous studies on the electromyographic evaluation of bruxism, the criteria of bruxism were not standardized and varied among researchers. In this study, an event at 10% MVC or above was regarded as bruxism on the basis of the report by Okura et al[10]. that the mean muscle activity during bruxism events was 9. 3% MVC.

3. From the results

The results of the Friedman test indicated that bruxism does not appear periodically after going to bed.

There have been a number of reports that the occurrence of bruxism is related to the sleep stage. Reaing et al[11]. reported that bruxism occurred in all stages of sleep but more frequently in stage 2, a stage of shallow sleep, than in the REM period, and infrequently in stage 3 or 4. Nakamura[12] reported that bruxism occurs frequently during transitional periods from deep to shallow sleep in the first and second cycles, and Kobayashi et al[13]. reported that bruxism events occur in all sleep stages but less frequently in stages 3 and 4. Sleep is classified into non-REM sleep and REM sleep. Healthy individuals fall asleep in about 10 minutes after going to bed, reach stages 1-4 of non-REM sleep, but soon enter REM sleep by shallowing the sleep stage. This sleep cycle, which is about 90 minutes long, is repeated 3-5 times in 1 night. In this study, the sleep stage was not evaluated, but bruxism is considered to have occurred more frequently in relatively shallow stages of sleep but frequently also in all stages of sleep[14], and this probably accounts for the lack of periodicity in its appearance. The total number of bruxism events during sleep in Subjects 1 and 2 (who were aware that they were bruxists) was nearly equal to the numbers in TMD patients reported by Kobayashi et al[13]. Since bruxism is a pathogenic and exacerbating factor of TMD[6], these subjects are considered likely to develop TMD in the future.

The maximum occlusal force during a bruxism event is very high and may markedly exceed the voluntary occlusal force during the daytime[15]. Also, bruxism during REM sleep is known to be destructive[16]. However, the EMG level during bruxism events did not exceed 100% MVC in any subject of this study. In Subjects 1 and 2, bruxism was perceived, but the EMG level during events was relatively low, and there was no complaint of "heaviness" of "fatigue" in the masseter or temporal muscle region and little tenderness in the masticatory muscles on awakening, suggesting that these subjects had primarily grinding type bruxism. However, in Subject 3, in whom the total number of events during sleep was low, the EMG level during events was 30% MVC or higher, being higher than in Subjects 1 and 2, suggesting that even non-bruxists frequently perform clenching near the intercuspation position[17]. Our results may also indicate that bruxism occurs infrequently but at a high EMG level in non-bruxists, as reported by Ichiki et al[18].

Also, significant differences were observed in the occlusal force during bruxism among the subjects but not among the days of measurement within each subject. This may suggest that the distribution of the occlusal force during bruxism is intrinsic to each subject, but further discussion of this point should be reserved until data are obtained from a larger number of subjects in the future.

Next, the histogram of the duration of bruxism events at 1-second intervals showed that the duration was most frequently within 1 second and that the frequency of events decreased with increases in the duration in all 3 subjects.

Events with a duration of less than 1 second were the most frequent, probably because bursts were regarded as separate events of bruxism if they were separated by an interval of 0. 5 seconds or longer. This is also considered to have been the reason that the mean duration of events was much shorter than 9. 1 seconds, the value reported by Okura et al[10]. Furthermore, in this study, a relatively close correlation was noted between the duration of events and the EMG level during such events. Okura et al[19]. also reported a positive correlation between the duration of bruxism events and the peak % MVC of the muscle action potential. Therefore, an increase in events with a longer duration or at a higher EMG level is considered to exert more serious effects on the stomatognathic tissues due to interdependence between the duration and EMG level.

CONCLUSIONS

We evaluated the characteristics of bruxism during sleep in 2 bruxists and1non-bruxist by recording masseter electromyograms on 3 nights at 1-night intervals, and reached the following conclusions:

1. Bruxism events were suggested not to occur periodically after going to bed.
2. The frequency of bruxism events was highest at a low EMG level and decreased with increases in the EMG level.
3. The duration of bruxism events was most frequently within 1 second, and the frequency of events decreased with increases in the duration.
4. A relatively close positive correlation was observed between the duration and EMG level of bruxism events.

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夜間睡眠中におけるブラキシズムの発現様相

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ブラキシズムの発生率は近年になって急増している．しかしその発現メカニズムや病態については明らかとされていないのが現状である．そこで本研究は，ブラキシズムの本態の解明と簡便なブラキシズム制御法を見出すことを目的とし，その緒としてまずブラキシズムの発現様相を検討した．

ブラキシスト２名と非ブラキシスト１名の睡眠時ブラキシズムの発現様相を，隔日の３夜に測定した咬筋筋電図から検討した結果，以下の結論を得た．

１．ブラキシズムイベントは，就寝後の時間経過に依存して周期的に発現するものではないことが示唆された．
２．ブラキシズムイベントの発現回数は，低位の EMG レベルで多く，高位になるほど少なかった．
３．ブラキシズムイベントの持続時間は１秒以内が最も多く，持続時間が長くなるほど減少した．
４．ブラキシズムイベントの持続時間と EMG レベルとは，比較的高い正の相関を有することが認められた．

キーワード：ブラキシズム，EMG レベル，咬筋筋電図

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