Effects of Orthodontic Appliances on Sleep Bruxism Episodes

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KEYWORDS

Sleep bruxism; Orthodontic appliance; Portable electromyogram device; Occlusal contact area; Electromyogram

ABSTRACT

Purpose

The main aim of this study was to investigate the effect of wearing an orthodontic appliance (OA) on masticatory electromyogram (EMG) activities associated with sleep bruxism by a portable EMG device.

MATERIALS and METHODS

Eight individuals needing orthodontic treatment using a multi-bracket OA participated in this study. All participants used a portable EMG device during sleep for 7 consecutive nights before orthodontic treatment and 7 consecutive nights immediately after wearing OA. The portable EMG device monitored EMG activity to detect temporalis muscle activities during clenching or grinding. Seven individuals compared the occlusal contact condition during tooth clenching between with and without OA.

Results

Sleep bruxism episodes on Day 2, Day 3, and Day 4 immediately after wearing OA were significantly lower than before wearing OA ($P < 0.05$). There were no significant differences in the coefficients of variation of sleep bruxism episodes between before and immediately after wearing OA. Negative correlation were found between the number of sleep bruxism events and NRS scores ($R^2 = 0.42$). There were no significant differences

in the occlusal contact condition during tooth clenching between with and without OA.

Conclusions

The present findings suggests that pain caused by multi-bracket OA affects to reduce masticatory EMG activities associated with sleep bruxism only short term.

INTRODUCTION

Definition of Sleep bruxism is that masticatory muscle activity occurs during sleep, and is characterized as rhythmic or non-rhythmic (1). To identify the expression mechanisms of sleep bruxism, our previous human study investigated the effect of sleep bruxism for the central and peripheral nervous system (2, 3). These studies suggested that sleep bruxism is associated with significant changes not only in the central nervous system as neuroplastic change, but also in the peripheral nervous system as motor learning (2, 3). However, to identify the expression mechanism of sleep bruxism in human, it is essential to investigate the peripheral nervous system (e.g. orofacial area) related to sleep bruxism using several methodological experimental protocol. Harada et al. investigated the effects of wearing a stabilization splint and a palatal splint without occlusal contact for sleep bruxism by a portable electromyographic (EMG) device, and they suggested that although both splints reduced the masticatory EMG activities associated with sleep bruxism, the effect of both splints for sleep bruxism was transient (4). Other studies also demonstrated that some kinds of splint reduce the masticatory EMG activities associated with sleep bruxism (5-7). These results suggest that orthodontic devices may also affect the masticatory EMG activities associated with sleep bruxism. Although Castroflorio et al. showed that clear aligners affected EMG signals during sleep (8), no studies have investigated the effect of multi-bracket orthodontic appliances. If wearing an multi-bracket orthodontic appliance also affects to sleep bruxism, the attachment of all oral appliances (e.g. stabilization splints, palatal splints without occlusal contact, clear aligners, and orthodontic appliances, etc.) regardless occlusal contact can be potentially affected the sleep bruxism episodes.

The purpose of the study 1 was to investigate the effect of wearing an orthodontic appliance on the occlusal contact condition and the masticatory EMG activities during tooth clenching. The purpose of the study 2 was to investigate the effect of wearing an orthodontic appliance on the masticatory EMG activities associated with sleep bruxism using a portable EMG device.

MATERIALS and METHODS

Study 1

Seven participants (2 men; 5 women; mean age 27.5 ± 2.1 years) with no history of medical or psychological disorders and without abnormality in stomatognathic function participated to evaluate the effect of wearing an orthodontic appliance on the occlusal condition. The Ethics Committee of the Faculty of Dentistry, Nihon University Matsudo (EC19-031), based on the guidelines set forth in the Declaration of Helsinki had given prior approval for the study.

To prepare the sham orthodontic appliance, a dentition model of each participant was created. The sham orthodontic appliance according to multi-bracket orthodontic appliance (bracket; Standard Edgewise Bracket, TOMY International Inc., Tokyo, Japan, wire; Stainless Straight wire .018inches, TOMY International Inc., Tokyo, Japan) was attached with temporary sealing material (PRG Protect Seal, Shofu Co., Ltd., Kyoto, Japan) (Figure 1). The wire was bending along the dentition without the orthodontic force from the wire.

Each muscle EMG during maximum voluntary tooth clenching (MVC) for 3 s was measured three times with and without the sham orthodontic appliance from all participants. Bilateral EMG activities from the masseter muscles and the temporalis muscles were measured from disposable surface EMG electrodes (NM31; Nihon Kohden, Tokyo, Japan). Bandpass-filter of EMG signals was set from 20 Hz to 1 kHz. Filtered EMG signals were recorded by PowerLab for offline analysis (Power Lab, Bio Research

Center, Nagoya, Japan). To quantify the muscle activities, the root mean square (RMS) EMG amplitude in each 3-s period were calculated from filtered EMG signals on each channel.

The occlusal contact area and point was synchronously recorded during 3 s of MVC by a silicone bite registration material (Blue Silicone, GC, Tokyo, Japan), according to our previous studies (9, 10). To proceed the occlusal analysis, the silicone bite registration material were trimmed according to our previous studies (9, 10). The occlusal contact area and contact points was calculated from trimmed silicone bite registration material by an occlusal analysis device (BITEEYE BE-I, GC, Tokyo, Japan).

Study 2

Eight malocclusion patients (4 men; 4 women; mean age 23.6 ± 1.5 years) needs orthodontic treatment with an orthodontic appliance were recruited as participants in this study. Exclusion criteria of this experiment were defined as any medical or psychological disorders. The Ethics Committee of the Faculty of Dentistry, Nihon University Matsudo (EC18-007), based on the guidelines set forth in the Declaration of Helsinki had given prior approval for the study. Eight participants used a portable EMG device to measure temporal muscle activities during sleep for 7 consecutive nights before orthodontic treatment and 7 consecutive nights immediately after wearing an orthodontic appliance. The time between before and immediately after wearing an orthodontic appliance was set as more than a month. The orthodontic appliance was attached with adhesives (Trancebond XT, 3M ESPE, St. Paul, MN).

Temporalis EMG activities were recorded by a portable EMG device (BUTLER GrindCare, Sunstar Suisse SA, Etoy, Switzerland) during sleep at home on 7 consecutive nights before and immediately after wearing the orthodontic appliance (Figure 2A). The single-channel portable EMG device monitored EMG activity to detect temporalis muscle activities during clenching or grinding. The EMG signal was bandpass-filtered after sampling at 2 kHz. Baseline EMG amplitudes were calculated from the 80 filtered signal points immediately before a preset point. When the EMG amplitude was greater than 3 times the standard deviation calculated from the baseline the EMG amplitudes, the portable EMG device defined it as a sleep bruxism episode. Sleep bruxism episodes per hour in each night was counted by the portable EMG device and stored on application (Figure 2B). To evaluate the variability of sleep bruxism episodes in each night, the coefficient of variation (CV) about sleep bruxism episodes in each night was calculated from the sleep bruxism episodes measured by the portable EMG device from Day 1 to Day 7. In each day, participants scored the perceived pain intensity caused by the attachment of multi-bracket orthodontic appliance on numerical rating scale (NRS) (Figure 3). Immediately after wearing the orthodontic appliance. The coefficient of determination between the number of sleep bruxism events and NRS scores was calculated in each day from all participants.

Statistical analysis

All experimental data are described as the median and interquartile range. To check normality and homoscedasticity, the Shapiro-Wilk test and Levene's test applied, respectively. Since variables of the Shapiro-Wilk test and Levene's test were non-normality ($P = 0.04$) and heteroscedasticity ($P = 0.03$), non-parametric analyses were applied. RMS EMG amplitude, occlusal contact area, and occlusal contact point during MVC with and without sham orthodontic appliance were analyzed using Wilcoxon's rank-sum test. Wilcoxon signed-rank test was used to compare sleep bruxism episodes and the CVs of sleep bruxism episodes in each night before and immediately after orthodontic appliance use. Pearson's regression analysis was used to analyze the correlation between pain scores and the number of sleep bruxism episodes. Significant defined as P values less than 0.05.

RESULTS

Study 1

Table 1 shows the comparison of EMG activities on bilateral masseter and temporal muscles during MVC between with and without the sham orthodontic appliance. There were no significant differences in RMS-EMG amplitudes on each muscle during MVC between with and without the sham orthodontic appliance. Table 2 shows a comparison of the occlusal contact area and the occlusal contact point during MVC with and without the sham orthodontic appliance. There were no significant differences in occlusal contact area and occlusal contact point during MVC between with and without the sham orthodontic appliance ($P = 0.73$, $P = 0.98$, respectively).

Study 2

Figure 4 shows the comparison of sleep bruxism episodes per hours between before and immediately after wearing the orthodontic appliance on the same participant in each day. Sleep bruxism episodes on Day 2, Day 3, and Day 4 immediately after wearing the orthodontic appliance were significantly lower than before wearing the orthodontic appliance ($P < 0.05$). Figure 5 shows the comparison of the CVs of bruxism episodes between before and immediately after the orthodontic appliance for each day. There were no significant differences in the CVs of bruxism episodes between before and immediately after wearing the orthodontic appliance ($P = 0.65$). Figure 6 shows correlation between pain score and number of sleep bruxism episodes. Negative correlation were found between the number of sleep bruxism episodes and NRS scores

($R^2 = 0.42$).

DISCUSSION

The present study indicated for the first time that wearing an orthodontic appliance does not reduce occlusal contact area and the occlusal contact point but reduces the masticatory EMG activities associated with sleep bruxism episodes within 48 hours.

Study1 demonstrated that wearing an orthodontic appliance does not affect masticatory EMG activities, occlusal contact area, and occlusal contact points during MVC. Although past studies investigated the effects of oral appliances on sleep bruxism episodes (4, 5), the oral appliances in these studies changed the occlusal condition. However, according to the study by Harada et al., use of a palatal splint without occlusal contact reduced the masticatory EMG activities associated with sleep bruxism (4). The present results suggest that the main factor reducing sleep bruxism episodes is not the changes in occlusal contact, but the use of an oral appliance.

Harada et al. suggested that use of stabilization splints and a palatal splint without occlusal contact reduced the masticatory EMG activities associated with sleep bruxism (4). However, this study compared the sleep bruxism episodes for each week. The present results showed that sleep bruxism episodes on Day 2, Day 3, and Day 4 with an orthodontic appliance were significantly less than without an orthodontic appliance, and may suggest that all oral appliances (e.g. stabilization splints, palatal splints without occlusal contact, clear aligners, and orthodontic appliances, etc.) reduce the masticatory EMG activities associated with sleep bruxism within 48 hours. However, use of an orthodontic appliance device can induce pain (11-13). Our present study demonstrated that negative correlation were found between pain score and number of sleep bruxism events. Our present study suggests that pain due to orthodontic appliances affect to reduce the masticatory EMG activities associated with sleep bruxism. In addition, although there were no significant differences in bruxism episodes between each day before wearing the orthodontic appliance, frequency of bruxism episodes on each day before wearing the orthodontic appliance was not suitable due to a daily variation. Further studies are needed to estimate the validity of daily variation about bruxism episodes using same portable EMG device in healthy participants.

A limitation of this study is that the participants may not have been pure sleep bruxers. Some studies have demonstrated that the threshold of sleep bruxism episodes was 20 times / hour (14, 15). Although our present study did not make the criteria about the threshold of sleep bruxism episodes to recruit the participants, the mean rate of sleep bruxism episodes in the present study was fortunately more than that. Since participants needed to apply orthodontic appliances in portable EMG recording during night, the sample size was relatively small and subjects could not be grouped as bruxers and non-bruxers in this study. Further studies are needed to investigate the effect of a multi-bracket orthodontic appliance for sleep bruxism in patients with patho-bruxism (16). Second, although portable EMG device have high validity as the measurement of sleep bruxism episodes comparing polysomnography (14, 17), this experimental data could not diagnose tonic or phasic episodes of sleep bruxism. To clarify the details of the effect of orthodontic appliance for sleep bruxism episodes, further studies are needed to investigate to use not only portable EMG device but also polysomnography for participants with orthodontic appliance.

In conclusion, the present findings suggests that pain caused by multi-bracket orthodontic appliance affects to reduce the masticatory EMG activities associated with sleep bruxism only short term.

Conflicts of interest

The authors have no potential conflicts of interest to declare.

Acknowledgments

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Figure and figure legends

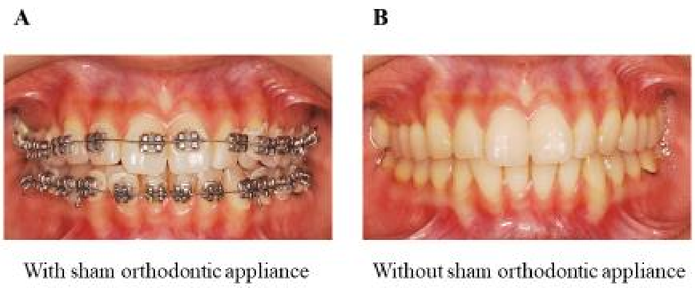

Fig. 1. Intraoral photograph with (A) and without the sham orthodontic appliance (B)

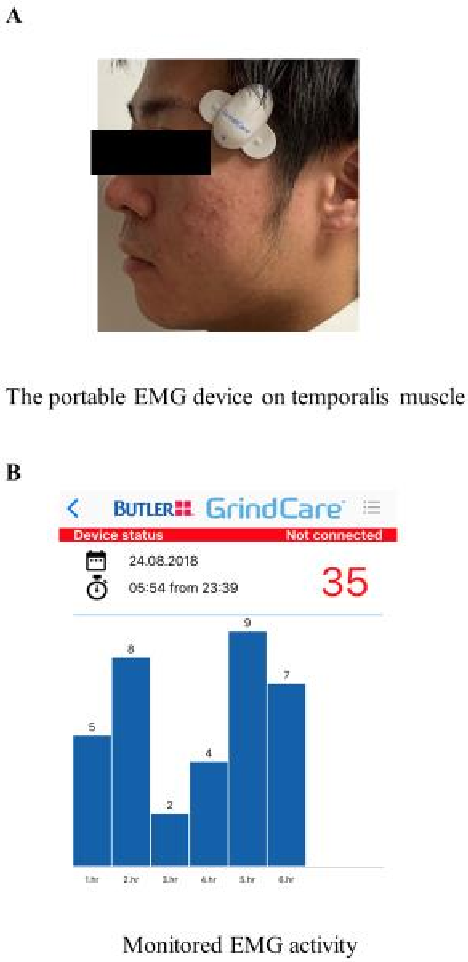

Fig. 2. Portable EMG device on temporalis muscle (A) and calculation of sleep bruxism episodes on application (B)

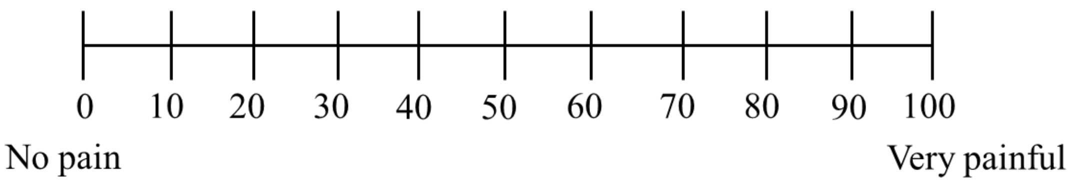

Fig. 3. Scoring the perceived pain caused by the installation of multi-bracket orthodontics on the Numeric Rating Scale (NRS)

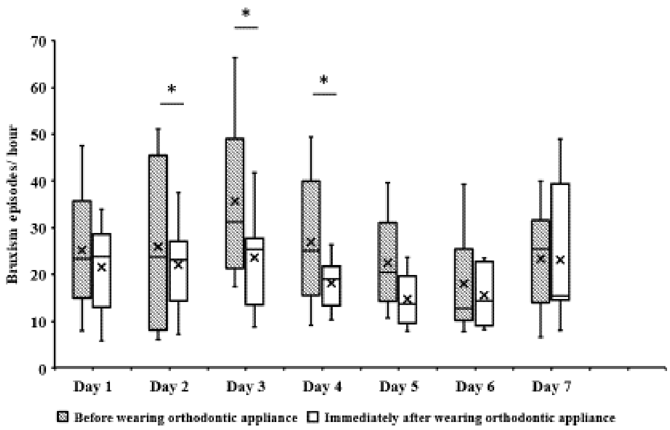

Fig. 4. Comparison of sleep bruxism episodes between before and immediately after wearing the orthodontic appliance in each day (median and interquartile range).

The horizontal line in the box plot is the median.

* $P < 0.05$

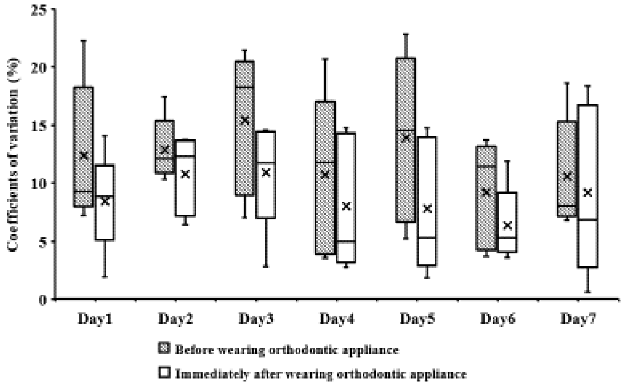

Fig. 5. Comparison of coefficient of variations of sleep bruxism episodes between before and immediately after the orthodontic appliance in each day (median and interquartile range).

The horizontal line in the box plot is median.

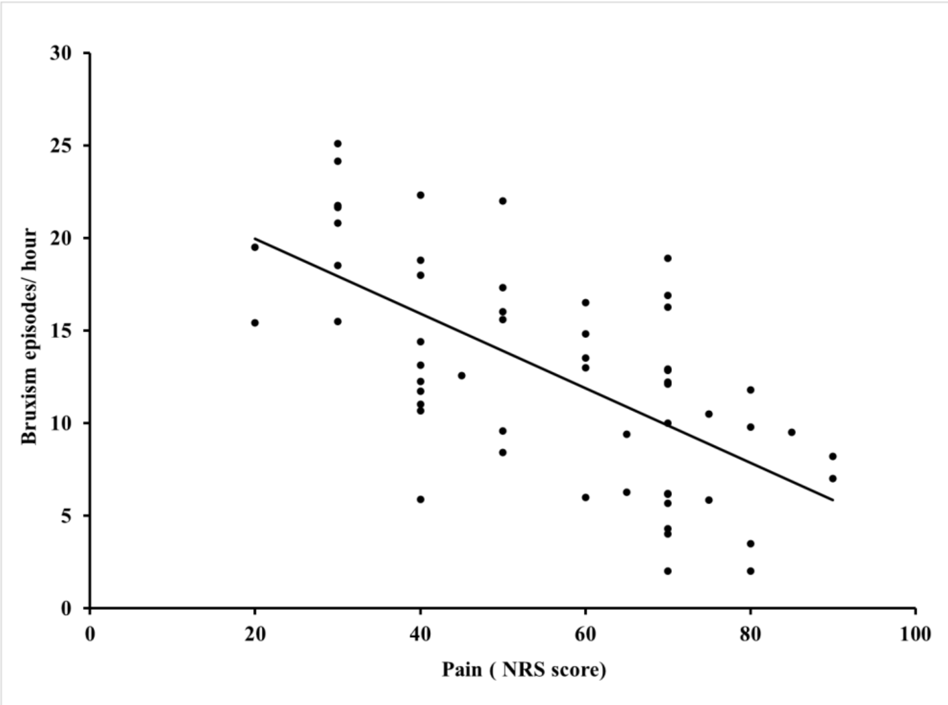

Fig. 6 Correlation between pain score and number of sleep bruxism episodes.

Table 1 Comparison of electromyogram (EMG) activities of bilateral masseter and temporal muscles during maximum voluntary tooth clenching between with and without the sham orthodontic appliance

Abbreviations: RMS, root mean square.

	Without sham orthodontic appliance	With sham orthodontic appliance
RMS EMG amplitude		
Left masseter muscles	0.010 (0.016 - 0.007)	0.008 (0.017 - 0.007)
Right masseter muscles	0.010 (0.043 - 0.007)	0.006 (0.022 - 0.005)
Left temporalis muscles	0.009 (0.022 - 0.007)	0.008 (0.026 - 0.006)
Right temporalis muscles	0.015 (0.042 - 0.005)	0.012 (0.037 - 0.006)

Table 2

Comparison of occlusal contact area and occlusal contact point during maximum voluntary tooth clenching with and without the sham orthodontic appliance.

	Without sham orthodontic appliance	With sham orthodontic appliance
Occlusal contact area (㎟)		
Left side	16.5 (20.6 - 12.2)	20.0 (25.9 - 16.0)
Right side	20.4 (22.4 - 14.3)	19.0 (25.4 - 16.0)
Both side	35.0 (45.9 - 26.7)	38.0 (52.0 - 32.5)
Occlusal contact point (number)		
Left side	26.0 (28.0 - 23.0)	24.0 (33.0 - 22.0)
Right side	27.0 (30.0 - 21.5)	28.0 (37.0 - 22.5)
Both side	51.0 (53.0 - 48.0)	49.0 (71.5 - 42.5)

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