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Factors related to the formation of buccal mucosa ridging in university students

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Abstract

Objective. Buccal mucosa ridging (BMR) is known as a clinical sign of clenching, which is one of the major manifestations of bruxism. However, there are few reports about the formation of BMR and no data regarding the association between BMR and factors such as malocclusion. The purpose of the current study was to investigate the relationship between BMR and factors such as the number of teeth present, gender, body mass index (BMI), occlusion and clenching habit in university students. ***Materials and methods.*** A total of 2101 students (1164 males, 937 females), aged 18–29 years old, were included in the study. BMR and the number of teeth present were recorded and malocclusion was defined using a modified version of the Index of Orthodontic Treatment Need. Additional information regarding gender, clenching habit and BMI was collected via a questionnaire. ***Results.*** Forty-six per cent of the subjects had BMR and the prevalence of BMR in females was significantly higher than that of males (chi square test, $p < 0.001$). According to logistic regression analysis, the probability of BMR was significantly associated with female gender (OR = 1.501, 95% CI = 1.259–1.790, $p < 0.001$), crowding (OR = 2.102, 95% CI = 1.706–2.590, $p < 0.001$) and overjet (OR = 0.585, 95% CI = 0.418–0.818, $p = 0.002$). On the other hand, BMR was not associated with awareness of clenching habit and BMI. ***Conclusions.*** Gender, crowding and overjet were related to the formation of BMR in university students. When evaluating BMR as a clinical sign of clenching, one might have to take factors such as gender and crowding into consideration.

Key Words: *buccal mucosa ridging, clenching, malocclusion, cross-sectional studies, epidemiology*

Introduction

Buccal mucosa ridging (BMR), which is also referred to as an occlusal line or linea alba, is an indentation of posterior teeth on the buccal mucosa at the level where the teeth occlude [1]. Histologically, BMR is regarded as compression and thickening of the mucosal epithelium in response to mechanical stimuli, and is not a pathological change [2]. Clinically, BMR observed along the occlusal plane has been described as a reliable indicator of clenching, which is one characteristic of bruxism [3]. However, Piquero et al. [4] found no correlation between the occurrence of BMR and awareness of clenching and grinding. In addition, other studies have reported that the presence of BMR is not conclusive evidence for the presence of bruxism [5] and the occurrence of BMR is related to oral habits such as cheek sucking and biting [6]. These contradictory reports indicate that the relationship between BMR and bruxism remains unclear.

There is little information regarding the prevalence of BMR because epidemiological data are not available. Only one study reported that the prevalence of BMR was 61.5% among bank employees aged 20–59 years old (n = 244) and the group aged 20–29 years old showed the highest incidence (79.7%) [4]. In that study, a higher percentage of BMR was seen in females than in males, although it was pointed out that the distribution of samples was very imbalanced (e.g. the percentage of male subjects was 95.1% in the group aged 50–59 years old and more than 60% of females were 20–29 years old).

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On the other hand, the reported prevalence of sleep bruxism (SB) varied. A most-representative large-scale epidemiological study conducted by telephone survey estimated an approximate SB prevalence of 8% in the general population [7]. Other epidemiological and clinical studies reported that the prevalence of SB is 14–20% in children, 13% in young persons aged 18–29 years old, 9% in adults and 3% in persons aged over 65 years old [8,9]. Although it is difficult to detect bruxism with a self-reported questionnaire [10], there is a remarkable disparity between the SB prevalence in these studies and relatively higher BMR prevalence in the previous reports [4]. Therefore, it is possible that other factors besides bruxism could affect the occurrence of BMR.

A clinical study suggested that both physiological factors, including movement of the stomatognathic system such as swallowing and tension in the buccinator muscle, and anatomical factors, such as the mechanical properties of the mucosa and the form of the dentition, affect the formation of BMR [11]. Takagi and Sakurai [12] measured the buccal mucosa pressure exerted on the buccal surface of the posterior teeth at rest, and while clenching, swallowing and retracting the angulus oris laterally. They found that buccal mucosa pressure on the buccal surface of the posterior teeth during swallowing was significantly higher in the subjects with BMR than in those without it. Gould and Picton [13] reported a difference in the pressure exerted by cheeks and lips on the teeth between subjects having normal occlusion and malocclusion. Thus, malocclusion would play a role on the formation of BMR due to pressure on teeth from buccal mucosa. However, there are no available data on the relationship between the formation of BMR and malocclusion. In the present study, we hypothesized that malocclusion affects the formation of BMR in young people. The aim of the present study was to assess the prevalence of BMR in university students and investigate the related factors.

Materials and methods

Study population

Of 2323 first-year students who underwent a general health examination at the Health Service Center of Okayama University in April 2012, 2297 students volunteered to undergo an oral examination and answer the questionnaire described below. We excluded 196 subjects due to the following reasons: (1) students who smoke and/or drink alcohol (n = 168); this exclusion was to avoid the influence of alcohol or smoking on mucosa [14]; (2) subjects who had provided incomplete data in their questionnaires (n = 25); and (3) subjects who were ≥30 years old (n = 3) [4]. As a result, data from 2101 students (1164 males, 937 females) aged 18–29 years old were analyzed. The study was approved by the Ethics Committee of Okayama University. Verbal consent was obtained from all subjects.

Table I. Questionnaire about clenching habits.

Awareness of clenching habit while sleeping
Is your jaw ever fatigued or sore on awakening in the morning?
Are your teeth or gums ever sore on awakening in the morning?
Do you ever experience temporal headache on awakening in the morning?
Awareness of clenching habit in the daytime
Are you ever aware of clenching your teeth during the day?

Questionnaire

A questionnaire was mailed to the participants before the health examination. Participants were asked about their gender, age and general condition. The questionnaire included the following items: Awareness of clenching habit: Various criteria which help to diagnose bruxism subjectively based on the patient's self-assessment, a bed partner's indication, intra-oral and extra-oral symptoms and so on have been advocated [15,16]. However, it is difficult to diagnose bruxism, especially in an epidemiological study. In this study, to examine the prevalence of habitual clenching, we included four items in the questionnaire (Table I) [17,18]. If a student responded positively to any of these categories (while sleeping or in the daytime), they were considered to have a clenching habit.

Oral examination

Four dentists (S.M., D.E., K.I. and T.A.) examined the oral health status of the study subjects. The number of teeth present was recorded. Malocclusion was defined using a modified version of the Index of Orthodontic Treatment Need (IOTN) (Table II). A previous study suggested that the modified IOTN is useful for the screening of malocclusion by non-specialists in oral health surveys [19]. The diagnosis criterion of BMR was defined as a linear thickening at the level where the teeth occlude on the buccal mucosa (Figure 1) [8].

Assessment of body mass index (BMI)

In the general health examination, the height and body weight of subjects were measured by public health nurses. BMI was computed as weight in kilograms divided by square height in meters [20].

Statistical analyses

The subjects were then divided into two groups (with BMR group; without BMR group). The independent

Table II. Modified dental health components of Index of Orthodontic Treatment Need.

Missing teeth	Hypodontia requiring pre-restorative orthodontic or orthodontic space closure to obviate the need of a prosthesis
	Impeded eruption of teeth. Presence of supernumerary teeth and retained deciduous teeth
Overjet	Increased overjet greater than 6 mm
	Reverse overjet greater than 3.5 mm with no masticatory or speech difficulties
	Reverse overjet greater than 1 mm but less than 3.5 mm with recorded masticatory and speech difficulties
Crossbites	Anterior or posterior crossbites with greater than 2 mm discrepancy between retruded contact position and intercuspal position
Displacement of contact points (crowding)	Contact point displacements greater than 4 mm
Overbite	Lateral or anterior open bites greater than 4 mm
	Deep overbite with gingival or palatal trauma

t-test or chi-square test was used to compare parameters between them. All possible associations of BMR experience were examined in a series of logistic regression models and the odds ratios and 95% confidence intervals (CI) were calculated. The logistic regression models were reviewed for goodness-of-fit and validated using the Hosmer-Lemeshow statistic [21]. BMR experience was considered as the dependent variable and gender and malocclusion (overjet and crowding) were added as independent variables. 'Missing teeth' of the IOTN was excluded from the logistic regression analysis because there were no subjects in the 'Without BMR' group with 'Missing teeth'. $p < 0.05$ was considered to be significant. A statistical program (SPSS version 20.0; IBM, Tokyo, Japan) was used for data analyses.

Results

The percentage of subjects with BMR was 46.0% and the prevalence of females who had BMR (51.3%) was significantly higher than that of males (41.3%) ($p < 0.001$). Table III shows the results of the questionnaire and oral status. A significant difference was observed between males and females in the number of teeth present ($p < 0.001$), BMI ($p < 0.001$), awareness of clenching habit while sleeping and in daytime ($p < 0.05$), overjet ($p < 0.05$) and reverse overjet ($p < 0.05$).

Significant differences were also observed in gender ($p < 0.001$), missing teeth ($p < 0.01$), overjet ($p < 0.05$) and crowding ($p < 0.001$) between the groups with and without BMR (Table IV). On the other hand, no significant difference was seen in age, number of teeth present, BMI or awareness of clenching habit between the two groups.

The results of multivariate analyses including gender and malocclusion (overjet and crowding) as explanatory variables are shown in Table V. Females, overjet and crowding were significantly related to the formation of BMR.

Discussion

Clinical findings such as tooth attrition, abnormal tooth wear and tooth movement are known as indicators of either current or past bruxism [22]. BMR has been reported to be a reliable indicator of bruxism activity and considered to be an important clinical oral finding of current bruxism [3]. However, another study found no correlation between the occurrence of BMR and awareness of clenching [4], so this association remains unclear. In fact, although there are many studies about bruxism, the literature available with regard to BMR is limited. This study appears to be the first epidemiological study to investigate the relationship between BMR and factors such as gender, BMI and malocclusion. Due to the fact that a higher prevalence of both BMR and bruxism was observed in teenagers or patients in their 20s than in other age groups [4,8,9], we focused particularly on

Figure 1. Representative photograph of buccal mucosa ridging (BMR). The diagnosis criterion of BMR was defined as a linear thickening on the buccal mucosa at the level where the teeth occlude.

Table III. Characteristics of the study participants.

		Males (n = 1164)	Females (n = 937)	Total (n = 2101)
Age		18.25 ± 0.65*	18.21 ± 0.71	18.23 ± 0.68
Number of teeth present[a]		28.62 ± 1.38	28.22 ± 1.32	28.44 ± 1.37
Body mass index[a]		21.29 ± 3.22	20.41 ± 2.47	20.90 ± 2.94
Awareness of clenching habit while sleeping[b]	No	1033 (88.7)**	797 (85.1)	1830 (87.1)
	Yes	131 (11.3)	140 (14.9)	271 (12.9)
Awareness of clenching habit in the daytime[b]	No	1092 (93.8)	841 (89.8)	1933 (92.0)
	Yes	72 (6.2)	96 (10.2)	168 (8.0)
Malocclusion				
Missing teeth	No	1161 (99.7)	934 (99.7)	2095 (99.7)
	Yes	3 (0.3)	3 (0.3)	6 (0.3)
Overjet[b]	No	1085 (93.2)	849 (90.6)	1934 (92.1)
	Yes	79 (6.8)	88 (9.4)	167 (7.9)
Reverse overjet[b]	No	1148 (98.6)	935 (99.8)	2083 (99.1)
	Yes	16 (1.4)	2 (0.2)	18 (0.9)
Crossbites	No	1147 (98.5)	927 (98.9)	2074 (98.7)
	Yes	17 (1.5)	10 (1.1)	27 (1.3)
Displacement of contact points (crowding)	No	899 (77.2)	718 (76.6)	1617 (77.0)
	Yes	265 (22.8)	219 (23.4)	484 (23.0)
Overbite	No	1151 (98.9)	923 (98.5)	2074 (98.7)
	Yes	13 (1.1)	14 (1.5)	27 (1.3)

*Mean ± SD.
**Number (%).
[a]Significant difference between males and females (t-test; $p < 0.001$).
[b]Significant difference between males and females (chi-square test; $p < 0.05$).
BMR, buccal mucosa ridging.

the factors related to the formation of BMR in university students.

The present results reveal that BMR was related to malocclusion, which is a new finding. The prevalence of subjects having crowding in the BMR group (29.9%) was significantly higher than that of crowding-positive subjects in the group without BMR (17.2%). However, the prevalence of subjects having overjet in the BMR group was significantly lower than that in the group without BMR. Takagi and Sakurai [12] reported that the buccal mucosa pressure exerted on the buccal aspect of teeth plays an important role in the formation of BMR. It was also reported that the upper labial resting forces, the lower labial resting forces and swallowing pressures from both the lips and the tongue in normal occlusion and class III malocclusion were significantly different [23]. Furthermore, Gould and Picton [13] found a difference in the pressure exerted by cheeks and lips on the teeth between subjects having normal occlusion and malocclusion. The present and previous evidence suggest that malocclusion may change the mucosal pressure on the buccal aspect of teeth and crowding contributes to the formation of BMR. Further studies are needed to investigate the mechanisms by which the change in mucosal pressure following malocclusion has an influence on BMR.

Other anatomical factors such as thickness of mucosa might be related to BMR formation [12]. Since it is known that BMI is related to palatal mucosal thickness [24], we examined the relationship between BMR and BMI in this study. The present result suggests no significant relationship between BMR and BMI. Furthermore, no significant difference in the thickness of buccal mucosa was observed between subjects with and without BMR in a previous study [12]. Although further studies are needed, these findings suggest that mucosal thickness has little effect on the formation of BMR.

No relationship was observed between BMR and awareness of clenching habit while sleeping and in the daytime and these results are in agreement with a previous study [4]. However, there may be some clenching of which subjects are unaware. To evaluate the presence of bruxism more precisely, diagnosis should be further confirmed by the use of diagnostic testing devices (polysomnography device, electromyography device or electroencephalogram) [22,25].

Table IV. Differences in questionnaire and oral status between with and without BMR groups.

		With BMR (n = 967)	Without BMR (n = 1134)	p-value
Age		18.26 ± 0.84*	18.21 ± 0.50	0.09
Gender	Male	486 (50.3)**	678 (59.8)	< 0.001[a]
	Female	481 (49.7)	456 (40.2)	
Number of teeth present		28.45 ± 1.30	28.43 ± 1.42	0.65
Body mass index		20.76 ± 2.91	21.01 ± 2.96	0.06
Awareness of clenching habit while sleeping	No	835 (86.3)	995 (87.7)	0.38
	Yes	132 (13.7)	139 (12.3)	
Awareness of clenching habit in the daytime	No	879 (90.9)	1054 (92.9)	0.10
	Yes	88 (9.1)	80 (7.1)	
Malocclusion				
Missing teeth	No	961 (99.4)	1134 (100)	< 0.01[a]
	Yes	6 (0.6)	0 (0)	
Overjet	No	906 (93.7)	1028 (90.7)	< 0.05[a]
	Yes	61 (6.3)	106 (9.3)	
Reverse overjet	No	959 (99.2)	1124 (99.1)	1.00
	Yes	8 (0.8)	10 (0.9)	
Crossbites	No	957 (99.0)	1117 (98.5)	0.45
	Yes	10 (1.0)	17 (1.5)	
Displacement of contact points (crowding)	No	678 (70.1)	939 (82.8)	< 0.001[a]
	Yes	289 (29.9)	195 (17.2)	
Overbite	No	955 (98.8)	1119 (98.7)	1.00
	Yes	12 (1.2)	15 (1.3)	

*Mean ± SD.
**Number (%).
[a]Significant difference between with BMR group and without BMR group (chi-square test).
BMR, buccal mucosa ridging.

A previous study reported that the prevalence of BMR was the highest in the 20–29-year-old population (79.7%) [4]. In our study, 56.1% of the 20–29-year-old students had BMR, which was lower than the previous study. The male-to-female ratio in the previous study was 1:2, while that in the present study was roughly 1:1. The prevalence of BMR in young adults may differ according to the male-to-female ratio in the study population. In fact, both the present and previous results showed that the prevalence of females who had BMR was significantly higher than that of males.

Because the diagnosis of bruxism is difficult, general dentists in their clinics usually suspect the prevalence of bruxism based on oral conditions such as tooth wear, as well as patient symptoms including muscle pain and temporomandibular joint disorder. BMR has also been used as a clinical sign of bruxism. Our results provide new insight into BMR-related factors and suggest that we need to take gender and malocclusion (overjet and crowding) into consideration.

In the present study, 30% of subjects had malocclusion according to the modified IOTN. Other studies showed a wide range of prevalence (21–50%) [26–28] in adolescent or young adult subjects and the prevalence of malocclusion in this study was within the range. Even though the sample size, age and race in our study differed from other studies, the prevalence of malocclusion was similar. Thus, our

Table V. Results of the multiple logistic regression estimating the correlation of BMR with gender and occlusion.

		Odds ratios	95% CI	p-value
Gender	Male	1	1.259–1.790	< 0.001
	Female	1.501		
Overjet	No	1	0.418–0.818	0.002
	Yes	0.585		
Displacement of contact points (crowding)	No	1	1.706–2.590	< 0.001
	Yes	2.102		

The logistic regression analysis with existence of BMR (with/without BMR) as a dependent variable.
BMR, buccal mucosa ridging.

findings can be applicable to adolescent and young adults in other populations. However, our results should be extrapolated to the older population with caution, because age is an important factor in the prevalence of BMR [4,7–9].

Our study has some limitations. First, we did not evaluate the buccal mucosa pressure exerted on teeth [12] or mucosal viscoelastic behavior [11], because the subjects had the dental examination as part of a routine general health examination and we did not have adequate time to examine these factors. Second, since this study was cross-sectional, it is still uncertain as to whether gender and malocclusion are causes of BMR. Prospective cohort studies would provide information beyond what we have presented here. Finally, all subjects were recruited from among Okayama University students, which may limit the ability to extrapolate these findings to the general population.

In conclusion, this study revealed that the prevalence of BMR was 46.0% among 18–29-year-old university students and that gender, crowding and overjet were significantly related to the formation of BMR. Crowding might be a new factor related to the formation of BMR. When evaluating BMR as a clinical sign of clenching, we might have to take factors such as gender and crowding into consideration.

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