The craniofacial morphology of bruxers versus nonbruxers

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Abstract: The purpose of this investigation was to test for an association between the craniofacial morphologies of bruxers and nonbruxers. The sample for this retrospective descriptive comparative study consisted of 28 Caucasian dental school subjects. Sixteen were bruxers and 12 were nonbruxers. The determination of bruxism was based on a six-item questionnaire as well as objective measures of the severity of tooth wear as analyzed from dental casts. Craniofacial morphology was determined directly using anthropometric spreading calipers. Craniofacial measurements included glabella-opiscranion, euryon-euryon, nasion-gnathion, zygoma-zygoma, and gonion-gonion. From these measurements, the following indices were calculated: cephalic (Gla-Op/Eu-Eu), facial (Na-Gla/Zy-Zy), gonial (Zy-Zy/Go-Go), and gonial height (Na-Gla/Go-Go). This study found no differences in the craniofacial morphologies of bruxers and nonbruxers, nor was there a difference in overbite. There was, however, a statistically significant difference in the bizygomatic (Zy-Zy) and cranial (Eu-Eu) widths of bruxers compared with nonbruxers.

Key Words: Craniofacial morphology, Bruxers

Allusions to bruxism date back at least to passages in the Bible that mention the "gnashing and gnawing" of teeth. Although bruxism has been of particular interest to the dental profession for centuries, the dental literature provides no universally agreed-upon definition. Nevertheless, bruxism is generally defined as the activity of grinding or gnashing of the teeth at times other than during the mastication of food.[1] Furthermore, bruxism can be classified as nocturnal (i.e., while sleeping)[2,3] or diurnal (i.e., while awake),[4,5] and as centric or eccentric.[6] The type of bruxing can lead to different qualifying factors in diagnosis and treatment.

Pronounced attrition-related tooth wear is commonly associated with bruxism. Because the dentofacial morphology of some subjects with advanced dental attrition differs from that found in subjects without such wear,[7] it has been hypothesized that the craniofacial morphology of bruxers is different than that of nonbruxers. This notion is based on the theory that increases from the demand of function (i.e., bruxism) can result in larger and/or broader craniofacial features as dictated by the functional matrix theory.[8] Evidence to support this premise is indirect rather than direct. That is, indepentent variables closely related to bruxism—such as bite force,[9-15] tooth attrition,[7] number and thickness of muscle fibers,[7,9,16-25] and occlusion,[26-28]—have been studied vis-à-vis craniofacial form rather than bruxism per se. A more extensive literature review on these variables was presented in a previous publication;[29] some studies report a relationship between craniofacial morphology and factors related to, but not limited to, bruxism, while other studies do not. In our own recent study,[29] we found no difference in craniofacial morphology between 35 bruxers and 28 nonbruxers. The predominant craniofacial forms and dental occlusion of both the bruxers and nonbruxers were: dolichocephalic headform, euryprosopic facial type, and Class I dental occlusion.

The purpose of this study was to provide additional data relative to the dentofacial morphology of bruxers versus nonbruxers.

Materials and methods

Subjects

The sampling frame for this study included first-, second-, and third-year dental students from the University of Pittsburgh School of Dental Medicine and patients who were part of another study conducted by the

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University of Pittsburgh Department of Behavioral Sciences. Study casts were obtained from all available subjects (N=155). All subjects were Caucasian and ranged in age from 22 to 35 years. The initial inclusion criteria were that subjects (1) had a minimum of 27 teeth present, as determined from study casts, (2) reported being in good health for the past 5 years, and (3) were willing to participate in the study.

Subjects were classified as bruxers or nonbruxers on the basis of the percentage of teeth exhibiting wear facets and on their responses to a bruxism questionnaire. To be classified in the bruxer group, subjects had to demonstrate wear facets on at least 90% of their teeth. This limit was set to allow no more than three teeth without wear facets. This represents the number of teeth that could be out of occlusion and not have wear. Based on the inclusion criterion of a minimum of 27 teeth, subjects assigned to the bruxer group exhibited wear facets on a minimum of 24 teeth. Subjects assigned to the nonbruxer group could have wear facets on no more than 60% of the teeth present. Therefore, the maximum number of teeth exhibiting wear facets in the nonbruxer group was 19 (32 x .60). This upper limit of 19 teeth exhibiting wear facets in the nonbruxer group was established from a separate set of study models of bruxers.[30] Nineteen represented one standard deviation below the mean number of teeth (22) exhibiting wear facets in a previously diagnosed sample of bruxers.[30]

Craniofacial morphology was determined directly using anthropometric spreading calipers.[29]

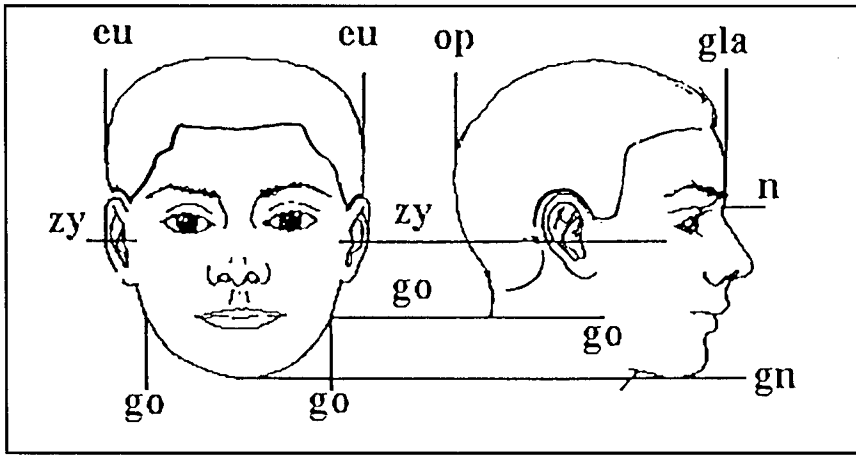

Figure 1
Craniofacial measurements

Table 1
Indices calculated

Cephalic index =	Maximum head breadth / Maximum head length	x 100 =	Eu-Eu / Gla-Op	x 100
Facial index =	Height of face / Width of upper face	x 100 =	Na-Gn / Zy-Zy	x 100
Gonial index =	Lower face width / Upper face width	x 100 =	Go-Go / Zy-Zy	x 100
Gonial height index=	Height of face / Width of lower face	x 100 =	Na-Gn / Go-Go	x 100

The questionnaire

All subjects who qualified for the high- or low-wear groups based on dental cast evaluation were asked to complete a six-item questionnaire. The questionnaire asked about (1) any history of bruxing activity, such as clinching or grinding, fatigue, or tenderness of the jaws or facial muscles; (2) headaches; (3) neck or shoulder pain; (4) loose or sensitive teeth; (5) trauma to the head or neck; and (6) prior orthodontic treatment. Subjects were classified as bruxers if they exhibited high wear facets and if they gave positive responses to items 1 and/or 2 and negative responses to items 3 through 6.

Extraoral craniofacial measurements

Extraoral head and facial measurements were recorded using anthropometric spreading calipers.[30] Head length, head width, facial width, bigonial width, and facial height were recorded. Craniofacial measurements included: glabella-opiscranion, euryon-euryon, nasion-gnathion, zygoma-zygoma, and gonion-gonion (Figure 1). Four indices were calculated (Table 1).

From the cephalic index, three headforms were descibed for bruxers versus nonbruxers: dolichocephalic (long head), mesocephalic (medium head), and brachycephalic (short head). In addition, the facial index was used to develop three facial types for bruxers versus nonbruxers: euryprosopic (short face) mesoprosopic (medium face), and leptoprosopic (long face).

Overbite

Each subject's dental overbite relationship was determined by examining his or her dental casts. Overbite was recorded in millimeters of incisor vertical overlap rather than in a defined rank (i.e., open, normal, or deep).

Reliability

Intrajudge reliability for the anthropometric measures was determined by having the principal investigator remeasure each subject after at least 30 minutes. The average of two recordings was used for data analysis. Interjudge reliability was determined by having two examiners repeat the measurements on a sample of ten subjects 1 week later.

Intrajudge reliability was tested via the paired two-tailed *t*-test, while interjudge reliability was tested with the correlation coefficient.

Statistical analyses

MANOVA and ANOVA were performed to test for differences between the independent (bruxism) and dependent (craniofacial morphology and overbite) measures.

Results

Reliability

Correlation coefficients and *t*-tests demonstrated this investigation's intra- and interjudge reliabilities. Intrajudge correlation coefficient values ranged from 0.953 (Na-Gn) to 0.995 (Gl-Op). As expected for high intrajudge reliability, *t*-tests were nonsignificant, with *p*-values ranging from 0.20 for Na-Gn to 1.00 for Zy-Zy. Similarly, interjudge reliability was also high. The correlation coefficient was 0.988 and the ANOVA test was nonsignificant (p=0.098)

General considerations

As expected by design, there was no difference in the total number of teeth present per subject between bruxers and nonbruxers, with both groups averaging 29 teeth per subject (SD=1.6). Also by design, bruxers had significantly more worn teeth than nonbruxers (p<0.0001). There was no difference in the dental overbite of bruxers versus nonbruxers ($\bar{x}$=2.7 mm, SD=1.6 mm, p=0.86).

Multivariate analysis (MANOVA) procedures were employed in comparing bruxers and nonbruxers for both the direct measures as well as the calculated indices. The multivariate F-ratio for the difference between bruxers and nonbruxers on the four

Table 2
Dependent indices versus independent variables

Indices	Nonbruxers	Bruxers	*F*-value DF (1,26)	Associated *p*-value
Cephalic index	$\bar{x}$=76.1% SD=3.8%	$\bar{x}$=77.4% SD=3.8%	0.73	0.40
Facial index	$\bar{x}$=89.8% SD=5.9%	$\bar{x}$=86.0% SD=4.9%	3.38	0.08
Gonial index	$\bar{x}$=76.3% SD=2.3%	$\bar{x}$=74.7% SD=4.2%	1.48	0.24
Gonial height index	$\bar{x}$=117.6% SD=6.4%	$\bar{x}$=115.0% SD=10.1%	0.37	0.55
Overbite	$\bar{x}$=2.5 mm SD=1.7 mm	$\bar{x}$=2.8 mm SD=1.6 mm	0.86	0.59

Table 3
Comparison of headform between groups

Cephalic index	Dolichocephalic (long head) ≤76.9	Mesocephalic (medium head) 77.0 - 81.9	Brachycephalic (short head) ≥82.0	Total
Nonbruxers	8 (66.7%)	3 (25%)	1 (8.3%)	12 (43%)
Bruxers	9 (56.3%)	6 (37.5%)	1 (6.2%)	16 (57%)
Total	17 (60.8%)	9 (32.1%)	2 (7.1%)	28 (100%)

Table 4
Comparison of facial types between groups

Facial index	Euryprosopic (short face) ≤83.9	Mesoprosopic (medium face) 84.0 - 89.9	Letoprosopic (long face) ≥90.0	Total
Nonbruxers	1 (8.3%)	7 (58.4%)	4 (33.3%)	12 (43%)
Bruxers	7 (43.8%)	4 (25%)	5 (31.2%)	16 (57%)
Total	8 (28.6%)	11 (39.3%)	9 (32.1%)	28 (100%)

Table 5
Dependent measures versus independent variables

Direct measurements	Nonbruxers	Bruxers	*F*-value DF (1,26)	Associated *p*-value
Glabella-opiscranion	$\bar{x}$=194 mm SD=7 mm	$\bar{x}$=198 mm SD=8 mm	1.09	0.31
Euryon-euryon	$\bar{x}$=148 mm SD=6 mm	$\bar{x}$=153 mm SD=6 mm	4.19	0.05
Nasion-gnathion	$\bar{x}$=118 mm SD=9 mm	$\bar{x}$=120 mm SD=8 mm	0.13	0.72
Zygoma-zygoma	$\bar{x}$=132 mm SD=5 mm	$\bar{x}$=139 mm SD=7 mm	9.83	0.004
Gonion-gonion	$\bar{x}$=101 mm SD=5 mm	$\bar{x}$=104 mm SD=6 mm	2.27	0.14

calculated indices was found to be statistically significant (F=4.08; df=1,22; p=.01). However, as described below, none of the individual indices were found to demonstrate significant differences between bruxers and nonbruxers. For the five direct measurements, the overall multivariate F-ratio did not achieve an acceptable level of statistical significance (F=2.10; df=1,22; p=0.10). Some of the direct measures, when analyzed separately, did exhibit statistically significant differences between bruxers and nonbruxers.

Indices

Cephalic index (headform)

The cephalic index is considered a measure of headform. As Table 2 shows, there was a 1.3% difference in the cephalic index between bruxers and nonbruxers, and this difference was not statistically significant (ANOVA, p=0.40). For both groups combined (bruxers and nonbruxers, Table 3) 17 subjects (60.8%, 9 bruxers and 8 nonbruxers) were dolichocephalic, 9 subjects (32.1%, 6 bruxers and 3 nonbruxers) were mesocephalic, and 2 (1 bruxer and 1 nonbruxer) were brachycephalic.

Facial index (facial type)

The facial index is a measure of facial type. There was no significant difference in facial type between bruxers and nonbruxers (Table 2, ANOVA; p=0.08). Table 4 shows that the 8 subjects (28.6%, 7 bruxers and 1 nonbruxer) were classified as euryprosopic, 11 subjects (4 bruxers and 7 nonbruxers) were classified as mesoprosopic, and 9 subjects (5 bruxers and 4 nonbruxers) were classified as leptoprosopic.

Gonial index

The average gonial index (Zy-Zy/Go-Go) for the entire sample was 74.7% (SD=3.6%); nonbruxers averaged 76.3% (SD=2.3%) and bruxers averaged 74.7% (SD=4.2%). There was no difference in the gonial index between bruxers and nonbruxers (ANOVA; p=0.24).

Gonial height index

The average gonial height index (Na-Gn/Go-Go) for the entire sample was 116.4% (SD =8.6%). Nonbruxers averaged 117.6% (SD=6.4%) and bruxers averaged 115.6% (SD=10.1%). There was no significant difference between bruxers and nonbruxers for gonial height index (ANOVA; p=0.55).

Direct measurements

Except for bizygomatic width (Zy-Zy) and cranial width (Eu-Eu), all individual direct measures were nonsignificant (Table 5). These two measures were significantly larger for bruxers than nonbruxers. Bizygomatic width (Zy-Zy) was 139.1 mm (SD=6.5 mm) in bruxers and 131.9 mm (SD=5.1 mm) in nonbruxers (ANOVA; F=9.83; df = 1,26; p=0.004). Cranial width (Eu-Eu) was 153 mm (SD=5.8 mm) in bruxers and 148 mm (SD=6.4 mm) in nonbruxers (ANOVA; F=4.19; df= 1,26; p=0.05).

Discussion

Craniofacial indices

The hypothesis that bruxers have shorter, broader craniofacial features than nonbruxers was not supported by this investigation. This study essentially found no difference in headform or facial type between bruxers and nonbruxers. This investigation's findings are in agreement with Crothers and Sandham,[31] Keeling et al.,[26] and Menapace et al.[29] However, these results differ from those supporting the concept of a functional matrix for craniofacial morphology and bite force. For instance, Braun et al.[13] demonstrated an association between craniofacial morpholgy and bite force. The difference in the findings between studies that demonstrate a difference and those that do not are possibly due to different independent variables, small sample sizes, and the lack of comparison groups for those finding a difference.

Interestingly, this study found a difference in the craniofacial morphology of bruxers versus nonbruxers only when all indices were considered together, as established by the multivariate *F*-test. No differences were found when individual indices for headform or facial type were compared between bruxers and nonbruxers. Perhaps there is a difference in headform and facial type between bruxers and nonbruxers that is not detectable by the indices used in this study or by the study design. Parenthetically, the use of dental casts as one of the criteria to distinguish bruxers from nonbruxers allowed a more detailed assessment of the occlusion and a greater level of facet and tooth wear identification over intraoral inspection, as in an earlier investigation.[29]

Direct measurements

This study found that mean bizygomatic (Zy-Zy) and cranial (Eu-Eu) widths were significantly larger in bruxers than in nonbruxers. These findings suggest a possible biologic association between craniofacial width and bruxism. Perhaps these findings indicate the greater functional effect of the masseter (Zy-Zy) and temporalis (Eu-Eu) muscles on craniofacial skeletal features for bruxers.

Although several uncontrolled studies have reported reduced vertical dimension related to tooth wear, this study failed to demonstrate a difference in anterior facial height (vertical dimension) between bruxers and nonbruxers. That is, there was no difference in the facial height dimension (Na-Gn). Crothers and Sandham[31] suggested that dentoalveolar development may compensate for tooth wear associated with bruxism and negate a possible effect to reduce anterior facial height in bruxers.

Dental overbite

This study found no difference in the degree of dental overbite between bruxers and nonbruxers. It is possible that while bruxers tend to shorten the clinical crown lengths of their incisors, eruption of the incisors tends to maintain the same degree of overbite.[31,32] Crothers and Sandham[30] demonstrated that maintenance of overbite, although reduced, occurs through dental compensation in subjects with severe tooth wear. Extrusion of the anterior teeth appears to keep pace with tooth attrition, and this may be nature's attempt at homeostasis—maintaining the anterior dental vertical dimension as the eruption of posterior teeth would maintain the facial vertical dimension. An observation of the subjects from this study supports the contention that in bruxers, gingival levels tend to be lower (more incisal) on the central incisors than on the lateral incisors. Parenthetically, normal gingival levels have a characteristic high-low-high (incisal-gingival-incisal) level from central to lateral to canine.[33]

Limitations

The sample size of 28 was smaller than intended. An á priori power analysis indicated a sample size of 40 (20 in each group). Nevertheless, the sample used in this study was adequate for the MANOVA test and also to find significant outcomes. Furthermore, the findings of this study generally support the results of other studies that also used comparison groups.

Implications and future studies

Future studies should investigate the association between bizygomatic (Zy-Zy) and cranial (Eu-Eu) width of bruxers versus nonbruxers. If this finding can be corroborated by other investigations, the use of these measures may lead to a more reliable and valid way to identify bruxers and/or study facial growth differences.

Conclusions

1. Zygoma-zygoma and euryon-euryon were significantly larger in bruxers than nonbruxers.

2. There was no statistically significant difference between bruxers and nonbruxers in the direct measures glabella-opiscranion, nasion-gnathion, and gonion-gonion.

3. There was no relationship between headform, facial type, and overbite between bruxers and nonbruxers.

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