Bruxism and Voluntary Maximal Bite Force in Young Dentate Adults

Dúcia Caldas Cosme, DDS[1]/Simone Michielon Baldisserotto, DDS[1]/
Simone de Andrade Canabarro, DDS, MSc[2]/Rosemary Sadami Shinkai, DDS, MSc, PhD[3]

Purpose: Bruxism may increase the activity and volume of the masticatory muscles, yet its resulting effect on bite force is controversial. This study evaluated the relationship between voluntary maximal bite force (MBF) and presence of bruxism in 80 dentate young adults (40 men, 40 women, 20 to 38 years old), controlling for sex, body mass index (BMI), and presence of orofacial muscular pain during the MBF measurement. ***Materials and Methods:*** MBF was measured with a compressive load transducer at the first molar region. Information about the presence of bruxism was collected by means of self-report of centric or eccentric bruxism during the day or night and/or presence of tooth wear. Data on MBF were analyzed by analysis of covariance, with bruxism and sex as fixed factors, and BMI and orofacial muscular pain as covariates (.05 level of significance). ***Results:*** The mean ± standard deviation values of MBF were 859 ± 304 N for nonbruxers (n = 49) and 806 ± 282 N for bruxers (n = 31), with no significant difference between groups (P = .842). BMI was not a significant covariate for MBF (P = .237), and neither was the presence of orofacial muscular pain (P = .560). Sex was statistically significant for MBF (P < .001), and men (1,009 ± 290 N) had higher MBF than women (668 ± 179), but there was no interaction between sex and bruxism in relation to the MBF (P = .861). ***Conclusion:*** These results suggest that bruxers and nonbruxers did not have different voluntary MBF in this sample of young dentate adults. *Int J Prosthodont 2005;18:328–332.*

Bruxism is an involuntary activity of the masticatory muscles that is characterized by clenching and/or grinding of the teeth.[1,2] Dental clenching occurs in most episodes of diurnal bruxism, while in nocturnal bruxism, both clenching and grinding are observed.[3] Bruxism is classified as a parafunction because it does not have a functional objective such as mastication, phonation, or deglutition.[4] It has been associated with occlusal problems, stress, alterations of the central nervous system, sleep disorders, and use of specific medications.[3,5]

[1]*Graduate Student in Prosthodontics, Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, RS, Brazil.*

[2]*Masters in Prosthodontics, Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, RS, Brazil.*

[3]*Associate Professor, Department of Prosthodontics, Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, RS, Brazil.*

Correspondence to: *Dúcia Caldas Cosme, Department of Prosthodontics, Pontifical Catholic University of Rio Grande do Sul (PUCRS), Av. José Aluísio Filho 889, Casa 97, Humaitá, Porto Alegre/RS, Brazil 90250-180. Fax: +5551 33203626. E-mail: duciacaldas@terra.com.br*

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In bruxers, the distribution of muscle forces to the teeth and the temporomandibular joints may result in tooth wear and orofacial pain, as well as hyperactivity and hypertrophy of the masticatory muscles, especially the masseter muscle.[6–8] Severe bruxism may even lead to high risk for fractures of teeth, direct restorations, and dental prostheses. Some authors question the role of bruxism as a causal agent of tooth wear,[9] while others suggest that increased tooth wear is related to bite force[10] and parafunctional habits.[11]

The maximal bite force (MBF) is the effort exerted between the maxillary and mandibular teeth when the

Table 1 Characteristics of the Sample (n = 80)

Variable	Frequency (%)	Mean (SEM)	Range
Sex			
Female	40 (50)		
Male	40 (50)		
Age (y)			
Overall		25.30 (0.46)	20–38
Women		24.80 (0.64)	20–37
Men		25.80 (0.67)	20–38
Weight (kg)			
Overall		66.48 (1.59)	46.00–123.50
Women		56.07 (0.90)	46.00–70.10
Men		76.88 (1.96)	61.00–123.50
Height (m)			
Overall		1.71 (0.11)	1.52–1.92
Women		1.64 (0.01)	1.52–1.79
Men		1.78 (0.01)	1.63–1.92
BMI (kg/m^2)			
Overall		22.45 (0.34)	16.72–36.24
Women		20.76 (0.27)	16.72–25.26
Men		21.45 (0.49)	20.19–36.24

mandible is elevated by the masticatory muscles. Its magnitude varies between subjects and depends on the methods used to measure the force.[12] Previous studies report that MBF may be influenced by sex, size, and direction of the masseter muscle, craniofacial morphology, dental occlusal status, periodontal sensitivity, and psychologic factors.[7,12–15]

The relation between high levels of bite force and the presence of bruxism is controversial in the literature. It has been suggested that subjects with bruxism have overtrained masticatory muscles leading to hypertrophy and higher bite force.[16] Some authors reported that subjects with bruxism use a significantly higher bite force for a submaximal load,[14] but another other study did not find higher levels of bite force during episodes of sleep bruxism.[17]

Therefore, this study aimed to evaluate the relationship between voluntary MBF and presence of bruxism in a sample of dentate adults, controlling for potential confounders such as sex, body mass index (BMI), and presence of orofacial pain of muscular origin during the MBF measurements. The a priori hypothesis was that bruxers have higher MBF values than nonbruxers.

Materials and Methods

Subjects

A convenience sample of 80 dentate adults (40 men and 40 women, mean age 25.3 years old, range 20 to 38 years old) was recruited and selected from faculty and students of the Dental School of the Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, Brazil. All subjects participated voluntarily in the study and provided written informed consent, according to the research protocol approved by the institutional review board. Inclusion criteria were the presence of complete dentition, age between 20 and 40 years old, and dental occlusion with bilateral simultaneous contact. Exclusion criteria were: *(1)* history of oral and maxillofacial surgery, orofacial trauma, or orthodontic treatment in the previous 2 years; *(2)* presence of active phase of periodontal disease (eg, bone resorption, attachment loss, or acute inflammation) with tooth mobility; *(3)* presence of local or systemic osseous or neuromuscular disease; *(4)* presence of spontaneous orofacial muscular pain or pain in 1 or both temporomandibular joints; *(5)* large facial skeletal alterations (typical Class II and Class III individuals, categorized by cephalometric analysis); and *(6)* pregnancy.

Anthropometric measures were obtained for each volunteer. Each subject's height was measured in centimeters with the subject in erect position without shoes, and weight was recorded in kilograms by means of a mechanical anthropometric scale (Welmy, model R110). BMI was calculated using the formula weight/height^2. Table 1 displays the characteristics of the subjects in this sample.

Bruxism

The recognition of clinical complaints of bruxism was performed by means of self-reported bruxism and/or presence of tooth wear. Self-reports of bruxism included diurnal or nocturnal bruxism (tooth clenching or grinding) by the study subjects or their relatives or bedroom mates. Rare episodes of clenching or grinding (less than 1 per week) were excluded. Tooth wear was observed during clinical examination by one calibrated examiner (S.A.C.). Occurrence of bruxism was recorded in the presence of general wear of incisal and/or occlusal surfaces or dentin exposure of at least 1 tooth.[2,3] The bruxers group was composed of 31 subjects and the nonbruxers group included 49 subjects.

Maximal Bite Force Measurement

To measure the voluntary MBF, a compressive load transducer (Sensotec 13/2445-02) was placed in the first molar region.[18] A bite pad with the load transducer on it was covered with hard rubber to protect the teeth and ensure equal distribution of bite force, and the set was covered with disposable plastic film for infection control. The interocclusal distance of the bite pad at the insertion point was 14 mm. The subjects received detailed experimental instructions and tested biting the equipment several times before the actual recordings to build confidence in the test procedure. Then each subject was asked to bite the equipment 5 times with maximal effort for 1 to 2 seconds, with rest intervals between trials. The bite force was recorded in pounds and converted to newtons (by multiplying the recorded force values by 4.44822). The 3 highest measures were averaged and considered the subject's MBF value.[18]

Statistical Analysis

The outcome measure was MBF (in N), which presented normal distribution and homogeneity of variances (Levene test, $P = .218$). MBF data were analyzed by analysis of covariance (ANCOVA) at the .05 level of significance. The fixed factors were bruxism (bruxers versus nonbruxers) and sex (male versus female); the covariates were BMI (in kg/m^2) and presence of muscular orofacial pain only during the MBF measurement (yes versus no). The residues generated after the application of the statistical model followed normal distribution. All statistical tests were two-tailed, and a P value of .05 was considered statistically significant for rejection of the null hypothesis.

Table 2 Maximal Bite Force (N) of Bruxers and Nonbruxers as a Function of Sex

	Maximal bite force (N)		
	Mean	SD	n
Men			
Bruxism			
No	1019[a]	298	26
Yes	991[a]	284	14
Overall	1009[a]	290	40
Women			
Bruxism			
No	678[b]	189	23
Yes	653[b]	168	17
Overall	668[b]	179	40
All subjects			
Bruxism			
No	859[a]	304	49
Yes	806[a]	282	31
Overall	838[a]	295	80

Means followed by different letters (a, b) are statistically different at the .05 level of significance.

Results

Table 2 displays the means and standard deviations of MBF as a function of the fixed factors bruxism and sex. In the tested ANCOVA model ($r^2 = .36$ and adjusted $r^2 = .31$), there was no significant difference in MBF between bruxers and nonbruxers ($P = .842$). Sex was a statistically significant factor for MBF ($P < .001$), and men had higher MBF than women, but there was no interaction between bruxism and sex ($P = .861$).

In relation to the covariates of the model, BMI was not statistically significant for MBF ($P = .237$). Similarly, presence of orofacial muscular pain was not significant in 12 subjects during the bite force measurement ($P = .560$).

The a posteriori power analysis for a total of 80 cases, alpha = .05, two-tailed, and an elected effect size of 0.40 (Cohen's conventions for research in the social sciences: small = 0.10, medium = 0.25, large = 0.40) yielded a power of 0.94.

Discussion

Previous studies have reported a number of distinct anthropometric, orofacial, and systemic variables that may affect MBF, but the association of MBF with bruxism is still unclear. In contrast to our hypothesis, the results from this sample of young dentate adults showed that voluntary MBF was no different between bruxers and nonbruxers when controlling for some potential confounders. One possible explanation may be that the voluntary MBF is different from the MBF exerted during bruxism. One study has shown that the MBF exerted during sleep bruxism episodes can exceed the maximum voluntary clenching force in 54.5% of subjects.[17] This may be part of a protective reflex when the subject is awake, because excessive muscular contraction is usually inhibited by the central nervous system.[19] During sleep, however, this inhibitory system would not be active and, therefore, a stronger contraction may be exerted by the masticatory muscles compared to a voluntary contraction carried out during the day.[17]

The gold-standard diagnostic method for bruxism is the use of polysomnographic recordings in a specialized sleep laboratory.[20] Home monitoring with portable equipment to record muscle activity during sleep is also available.[21–23] Some clinical signs used for diagnosis of bruxism include muscular pain and fatigue, headaches, tooth wear, muscular hypertrophy, and tongue indentations.[24] The self-report of the habit of grinding or clenching the teeth combined with the clinical observation of tooth wear are considered valuable means to diagnose bruxism, although tooth wear is less reliable.[3] Lavigne et al[2] compared these clinical outcomes with the results of polysomnography to diagnose bruxism and found that the clinical criteria had a reliability of 83% in patients with bruxism and 81% in asymptomatic control subjects. One recent study did not find any association between tooth wear status and ongoing bruxism in 8 bruxers and 8 controls,[9] but some data from epidemiologic studies suggest that self-reported clenching/grinding are related to occlusal wear.[11] The subjects in our sample were recruited from among the faculty and students of a dental school, which suggest that the self-report of bruxism would be more accurate than self-reports obtained from the general population. On the other hand, our subjects may not be representative of the general population, and extrapolation of results must be conservative.

In our model, of the variables that could affect MBF (sex, BMI, and presence of orofacial muscular pain during the bite force test), only sex was a significant factor for MBF, explaining 36% of the variability in this sample. The MBF values for men were one third higher than for women. Previous studies also found significant differences in MBF between men and women of different ages and occlusal conditions.[11,12,14,18,25–29] This sex-related difference in MBF may be a result of anatomic differences. Tuxen et al[30] used electromyography and biopsy to further explore why MBF is higher in men than in women. The men's masseter muscles had type II fibers with larger diameter and sectional area than those of the women, and the authors suggested that hormonal differences might contribute to the composition of the muscle fibers.

In our study, the difference in MBF in men and women was not explained by the anthropometric variable (BMI) we controlled for in our analysis. We chose BMI because it is a composite of weight and height and represents a summary measure of distribution of corporal mass. Our sample was composed of young adults in good general health, and the BMI values were not extreme. Most studies have analyzed the association between MBF and weight or height separately, but the results are contradictory. A positive association of MBF and height has been reported only in women over 25 years old, and occlusal stability, age, and sex accounted for 30% to 60% of the variability in MBF.[25,26]

Our other cofactor—the presence of orofacial pain of muscular origin during the bite force test—was also not significantly related to MBF. Spontaneous muscular pain or pain of joint origin was an exclusion criterion, but subjects who reported muscular pain during the bite force tests were not excluded from the final analysis. Most studies do not distinguish between articular and muscular pain and consider both as orofacial pain in temporomandibular disorders (TMD). The association between presence of TMD and reduced MBF is also contradictory in the literature and may be dependent on the severity of the TMD in the given sample.[12,18,31,32]

The exact relationship between bite force and tooth wear is unclear. Anterior teeth present a higher degree of tooth wear (incisal/occlusal morphology altered) than posterior teeth,[11] but bite force values in anterior teeth are lower than the bite force recorded in premolars and molars.[31,33,34] Pigno et al[11] explained the greater anterior tooth wear by the increased tooth contact during jaw movements, the nondietary use of anterior teeth, and thin incisal edges compared to the occlusal surfaces of the posterior teeth. The higher bite force in the posterior region may be explained by the lever effect of the mandible and the larger area of periodontal ligament around the molars.[33] Also, the position of the force transducer (unilateral, bilateral, single tooth recording) and the interocclusal distance at the measuring point may account for variations in bite force recordings.

One possible limitation of this study is the sample size and low power to test the null hypothesis, if we aim to detect a medium effect size between groups, because subjects were selected from a homogeneous population. For instance, for an expected effect size of 0.25, a sample size of 80 subjects within this experimental design yields power of 0.59. Although we did not find any relationship between MBF and bruxism, it should be noted that the bruxers in our study had mild to moderate tooth wear in the occlusal and incisal surfaces of the teeth, and there were no cases of masseter hypertrophy with extreme facial asymmetry. Further studies are warranted to evaluate voluntary MBF in heavy bruxers with more pronounced clinical characteristics and more frequent episodes of clenching and/or grinding.

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