

Bite force and sleep quality in patients with bruxism before and after using a mandibular advancement device

Força de mordida e qualidade do sono em pacientes bruxômanos antes e após o uso de placa de avanço mandibular

Abstract

Purpose: This study aimed to compare bite force and sleep quality in patients with bruxism before and after using a soft mandibular advancement device.

Methods: Eighteen patients with bruxism attending the Occlusion Clinics of the PUCRS Dental School were selected according to the study eligibility criteria, examined according to the RDC/DTM protocol, and treated with a soft mandibular advancement device. Before the treatment and after 30 days the subjects were tested for: maximal bite force with a cross-arch force transducer placed in the first molar region, sleep quality assessed by means of the University of Toronto Sleep Assessment Questionnaire (SAQ), and number of masseter muscle contractions during sleep measured with the adhesive BiteStrip®. Data were analyzed by Student t tests, Wilcoxon tests, and McNemar tests at a significance level of 0.05.

Results: After 30 days using the mandibular advancement device there was a significant decrease in some bruxism parameters, bite force, and total SAQ score ($P < 0.05$).

Conclusions: The results suggest that the use of a soft mandibular advancement device for one month reduced bite force and bruxism and improved sleep quality in this sample.

Key words: Bite force; bruxism; mandibular advancement device

Resumo

Objetivo: Comparar a força de mordida e a qualidade do sono em pacientes com bruxismo antes e depois do uso de uma placa de avanço mandibular resiliente.

Metodologia: Dezoito pacientes com bruxismo em atendimento na Clínica de Oclusão da Faculdade de Odontologia da PUCRS foram selecionados de acordo com os critérios de elegibilidade do estudo, examinados segundo o protocolo RDC/DTM e tratados com uma placa de avanço mandibular resiliente. Antes e após 30 dias de uso da placa de avanço mandibular os sujeitos foram submetidos a testes de força máxima de mordida com um transdutor de força compressiva de arco cruzado posicionado na região de primeiro molar; de qualidade do sono, de acordo com o questionário QAS da Universidade de Toronto; e de contagem do número de contrações do músculo masseter durante o sono usando-se o adesivo BiteStrip®. Os dados foram analisados por teste t de Student, teste de Wilcoxon e teste de McNemar ao nível de significância de 0,05.

Resultados: Houve diminuição significativa ($P < 0,05$) dos parâmetros de bruxismo, de força de mordida e do escore total do QAS após o uso da placa de avanço mandibular por 30 dias.

Conclusão: Os resultados sugerem que o uso da placa de avanço mandibular resiliente por um mês reduziu a força de mordida e o bruxismo e melhorou a qualidade do sono nesta amostra.

Palavras-chave: Força de mordida; bruxismo; placa de avanço mandibular.

Vivian Chiada Mainieri^{a,c}
Aline Cristina Saueressig^a
Simone Chaves Fagundes^b
Ézio Teseo Mainieri^c
Rosemary Arai Sadami Shinkai^a
Márcio Lima Grossi^a

^a Graduate Program in Dentistry, Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, RS, Brazil

^b Medical School, Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil

^c Dental School, Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil

Correspondence:

Vivian Chiada Mainieri
Rua Mostardeiro 910/401
Porto Alegre, RS – Brasil
90430-000
E-mail: vivianmainieri@hotmail.com

Received: January 17, 2008
Accepted: June 11, 2008

Introduction

Bruxism has been traditionally defined as a nocturnal or diurnal parafunctional oral activity, which may include dental clenching, grinding, and wear as proposed by the American Academy of Orofacial Pain in 1996. However, in 1997 the American Association of Sleep Disorders classified bruxism as a parasomnia, *i.e.*, an undesirable physical phenomenon that occurs parallel to sleep and characterized by stereotyped and periodical movements of the masticatory system during sleep (dental clenching or grinding), thus excluding diurnal parafunctional activities. Polysomnography is considered the gold standard exam for bruxism and sleep quality diagnosis because provides an objective method to monitor sleep manifestations (1-3). Polysomnographic studies showed that bruxism may occur during all sleep phases, but is more frequent in stage II of NREM sleep. Bruxism is related to sleep quality, because it causes micro-awakenings, which directly interferes with sleep. Bruxism patients often complain of difficulties to fall asleep and extreme fatigue. Sleep quality can be evaluated by the Sleep Assessment Questionnaire (SAQ) developed at the University of Toronto, Canada, which has 17 items to determine primary sleep disorders and sleep abnormalities in epidemiological studies (4). Nevertheless, several other methods have been used in Dentistry to diagnose bruxism, such as clinical exam and self-report or report of a roommate about nocturnal noises due to dental grinding. Electromyography and BiteStrip® (5-7) are used by the patient at home to measure muscle activity during sleep. BiteStrip® is an adhesive portable device with two electrodes that register the number of bruxism episodes (defined as the number of masseter muscle contractions above a cut-off point) per minute (5-7). Besides muscle activity, previous studies have suggested that bruxers exercise their masticatory muscles beyond normal limits, and may present muscular hypertrophy and increased bite force (8-10). Maximum bite force is defined as the resulting force of the mandibular teeth against maxillary teeth when masticatory elevator muscles exert maximum effort in physiological conditions (11).

The treatment of bruxism includes different approaches: occlusal treatment with occlusal adjustment and splints, medication, and psychotherapy. Several modalities aim to prevent dental wear, provide symptoms relief, and improve sleep and quality of life (1,3), yet none has been able to completely eliminate bruxism signs and symptoms. One treatment with good clinical results is the use of occlusal splints, which aim to protect teeth, provide muscle relaxation, redistribute forces, and reduce bruxism, thus improving sleep quality. There are several designs of occlusal splints, and the mandibular advancement device is a splint mainly used to treat apnea (12-15). This device also seems to be effective for the treatment of bruxism (16), but its mechanism of action still is unknown.

Therefore, this study aimed to evaluate bite force and sleep quality in bruxers before and after the use of a mandibular advancement device for thirty days. Furthermore, it was

investigated if the mandibular advancement device is efficient for the treatment of bruxism and reduction of nocturnal muscular contractions of the masseter muscle.

Methodology

The research protocol was approved by the local institutional review board and registered in SISNEP (117916). Eighteen patients seeking treatment at the Occlusion Clinics of the Pontifical Catholic University of Rio Grande do Sul (PUCRS) Dental School were selected according to the following eligibility criteria (3): a) Inclusion criteria – patients with history of bruxism (report of a minimum of three episodes of dental grinding per week), absence of a maximum of one tooth per hemi-arch, no restriction of mandibular opening, age range between 21 and 65 years old, no temporomandibular disorders (TMD); and b) Exclusion criteria – pregnancy, severe facial and skeletal alterations, orthodontic treatment in the previous two years, active periodontal disease and/or teeth with mobility, use of any medication that may interfere with the outcome measures, *e.g.*, drugs for anxiety. The sample comprised eighteen patients clinically diagnosed as bruxers. Sample clinical characteristics are shown in Table 1.

Table 1. Sample characteristics (n=18)

Variable	Mean (SD)
Weight (kg)	74.5 (15.6)
Height (cm)	169.2 (9.7)
Body Mass Index (kg/m ²)	25.3 (4.2)
Age (years)	38.8 (10.2)

Each patient signed an informed consent form and was subjected to standardized procedures in the following sequence: anamnesis, oral clinical exam, anthropometrical measurements (height, weight, body mass index – BMI), bite force recording (17), baseline application of SAQ (4), and baseline use of Bite Strip® (5). The patient was clinically examined according to the RDC/TMD protocol, which was described and validated previously to evaluate presence of pain after muscle palpation and TMJ noise (18). After fabrication of the mandibular advancement device (16) and its use for 30 days, patients were subjected to final clinical exam, bite force recording, application of SAQ, and home use of Bite Strip®.

Bite force recording

Bilateral maximum bite force was measured with a cross-arch compressive transducer (Sensotec 13/2445-02, Columbus, OH, USA) at the first molar region (17). The bite pad was covered with extra-hard rubber for dental protection, and the set was wrapped with disposable plastic film for biological safety control. The patient was asked to bite as hard as possible for two to three seconds. The

measurements were performed in triplicate with a 5-min rest interval, and the mean value was considered the subject's maximum bite force value.

Use of Bite Strip®

Each patient received the adhesive device Bite Strip® to be used at home during sleep for a minimum of five hours. Bite Strip® was applied over the skin previously cleaned according to standardized instructions and training given by the researchers at the dental school. The presence and number of masseter muscle contractions were measured according to an individual cut-off value, which was established during the first clinical session (5).

Mandibular advancement device

For each patient a soft mandibular advancement device was fabricated aiming to treat bruxism. Maxillary and mandibular casts were mounted in a semi-adjustable articulator using a occlusal record made of addition silicon impression material (Express®, 3M, Saint Paul, MN, USA) (Fig. 1A). Maxillary and mandibular soft splints were fabricated with 3mm-thick EVA plates (Bio-Art Equipamentos Odontológicos Ltda, São Paulo, SP, Brazil) over duplicated casts, using a vacuum plasticizer equipment (Plastvac P7, Bio-Art Equipamentos

Odontológicos Ltda, São Paulo, SP, Brazil). Both splints were positioned over the casts mounted in the articulator to be joined with heated silicon glue (Fig. 1B) at a 50% to 75% mandibular advancement position in relation to the patient's maximum protrusion (12-16). The mandibular advancement device was used for 30 consecutive days.

Statistical analysis

The normality of the continuous numerical variables was tested with Kolmogorov-Smirnov test before data analysis using paired Student t tests. Ordinal variables were analyzed by Wilcoxon tests, and nominal variables were tested with McNemar tests. A significance level of 0.05 was adopted for all tests.

Results

After 30 days using the mandibular advancement device, maximum bite force and total SAQ score decreased (Table 2). The ordinal variables (TMJ noises, grinding and/or clenching habits, etc) scores decreased or did not change after using the soft splint (Table 3). In relation to the nominal variables, such as sensitivity after muscle palpation, no significant change was detected after 30 days (Table 4).

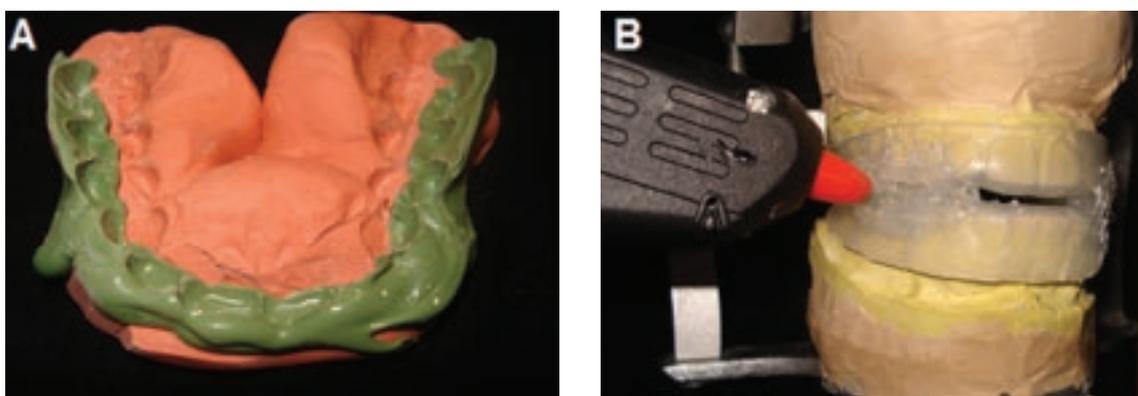


Fig. 1. (A) Occlusal record using addition silicon impression material. (B) Union of the maxillary and mandibular soft splints at the protrusive position determined by the occlusal record and casts mounted in semi-adjustable articulator.

Table 2. Comparison of the numerical continuous variables in this sample of patients with bruxism (n=18) before and after the use of a mandibular advancement device for 30 days.

Variable	Before mean (SD)	After mean (SD)	Paired Student t test
Maximum bite force (N)	794.7 (381.9)	614.4 (298.9)	P=0.018
Sleep Assessment Questionnaire (SAQ) – 0 to 68	30 (7)	23 (6)	P<0.001
Mouth opening (mm)	55.8 (4.4)	55.2 (4.6)	NS
Protrusion (mm)	5.4 (2.4)	5.1 (2.1)	NS
Right lateral movement (mm)	4.2 (3.3)	4.2 (3.3)	NS
Left lateral movement (mm)	4.7 (3.8)	4.5 (3.6)	NS
Overbite (mm)	1.9 (1.4)	1.8 (1.5)	NS
Overjet (mm)	2.3 (1.4)	2.3 (1.5)	NS

Table 3. Comparison of the ordinal variables in this sample of patients with bruxism (n=18) before and after the use of a mandibular advancement device for 30 days.

Variable	Number of subjects (n =18) with increased, reduced or equal scores	Wilcoxon test
BiteStrip©		
0 - No bruxism: 39 episodes	Reduced = 17	$P < 0.001$
1 - Mild: 40-74 episodes	Increased = 0	
2 - Moderate:75-124 episodes	No change = 1	
3 - Severe: above 125 episodes		
Occlusal wear		
1 - None or mild	Reduced = 0	NS
2 - Enamel wear	Increased = 1	
3 - Dentin wear in isolated points	No change = 17	
4 - Dentin exposure area >2mm ²		
5 - Wear greater than 1/3 crown		
Type of noise		
1 - Crepitation	Reduced = 7	$P = 0.04$
2 - Clicking	Increased = 2	
3 - Popping	No change = 9	
Dental grinding/clenching		
1 - Never	Reduced = 14	$P < 0.001$
2 - Rarely	Increased = 0	
3 - Sometimes	No change = 4	
4 - Often		
5 - Always		

Table 4. Comparison of the nominal variables in this sample of patients with bruxism (n=18) before and after the use of a mandibular advancement device for 30 days.

Variable	Before mean (SD)	After mean (SD)	McNemar test
Right TMJ noise			
Absent = 0	10	13	NS
Present = 1	8	5	
Left TMJ noise			
Absent = 0	8	14	$P = 0.03$
Present = 1	10	4	
Muscle sensitivity to palpation			
Masseter			
Absent = 0	4	9	NS
Present = 1	14	9	
Temporal			
Absent = 0	6	11	NS
Present = 1	12	7	
Sternocleidomastoid			
Absent = 0	9	12	NS
Present = 1	9	6	
Trapezius			
Absent = 0	7	9	NS
Present = 1	11	9	

Discussion

This study showed that the use of a soft mandibular advancement device for 30 days had a beneficial effect on bruxism treatment in this sample. There was a reduction of bite force and number of nocturnal masseter muscle contractions, as well as improvement of general sleep quality and some clinical variables, such as dental grinding. Although other clinical variables did not have significant improvement, *e.g.*, muscle sensitivity to palpation, no negative effect was observed after using the soft mandibular advancement device. The outcomes of this study were similar to the results reported by Landry et al. (16), who achieved significant reduction of bruxism with mandibular advancement devices.

Landry et al. (16) used polysomnography to diagnose bruxism in their study, and the mandibular advancement devices were fabricated according to the treatment protocol for obstructive sleep apnea and hypopnea with three different designs: individual maxillary and mandibular splints, joined splints with 40% mandibular advancement, and splints with 75% mandibular protrusion. In the present study, the maxillary and mandibular soft splints were joined at a protrusion position customized for each patient. During occlusal recording in protrusion, some patients reported pain at 75% protrusion, and the mandibular advancement was reduced to 50% to prevent discomfort and limitation of movements. Therefore, the use of soft mandibular advancement devices with 50% protrusion was effective in some patients with no detectable harm.

In the present study, the higher values of bite force before splint use may be explained by dental clenching and grinding, which would result in stronger and more fatigue-resistant masticatory muscles (9-11). After using the mandibular advancement device the masticatory muscles should have relaxed, and bite force decreased. Previous studies have related bite force levels to bruxism (8-10,19) and TMJ disorders (20,21). However, the literature still is controversial regarding the association between high levels of bite force and bruxism, and one recent study showed negative results in young dentate subjects with no TMJ disorders (22).

In this sample, most patients reported reduction of dental grinding and/or clenching after 30 days using the mandibular advancement device. Huynh et al. (23) also found that the mandibular advancement device provided the best results for reduction of nocturnal bruxism in comparison with conventional occlusal splints and medication. In the present study, TMJ noises decreased in seven patients but did not change in nine subjects. Also, no significant improvement was seen for sensitivity after palpation of masticatory muscles. For these outcomes, the use of mandibular advancement device for 30 days may have been insufficient to provide significant clinical improvement. On the other hand, no deleterious effect occurred. Therefore, a longer prospective evaluation might provide definite information on the efficacy of soft mandibular advancement devices for the treatment of bruxism and muscle sensitivity.

In summary, this short-term prospective study showed improvement of some clinical variables related to bruxism and sleep quality, such as reduction of maximum bite force, number of masseter muscle contractions as measured by the BiteStrip® device, and SAQ total scores. Schochat et al. (5) validated the BiteStrip® device as a diagnostic instrument to identify nocturnal electromyographic events related to bruxism. They found a positive association between polysomnography and BiteStrip® data, with satisfactory sensitivity and positive predictive value. Further research should use polysomnography to assess in detail the specific domains of sleep improvement after using the mandibular advancement device. In the present study, the BiteStrip® device was used as an auxiliary procedure to diagnose bruxism, but additional comparison with polysomnography still is necessary. If a simpler and less

expensive method than polysomnography can accurately diagnose bruxism, epidemiological and clinical research on this topic may be accessible to more subjects.

Conclusions

Within the limitations of this study, the results suggest that the use of a soft mandibular advancement device for 30 days reduced bruxism and bite force and improved sleep quality in this sample.

Acknowledgments

To CAPES for the scholarship during the Graduate Program in Dentistry of FO-PUCRS. To the volunteers who accepted to participate in this study.

References

- Okeson JP, Phillips BA, Berry DT, Cook YR, Cabelka JF. Nocturnal bruxing events in subjects with sleep-disordered breathing and control subjects. *J Craniomandib Disord* 1991;5:258-64.
- Ikeda T, Nishigawa K, Kondo K, Takeuchi H, Clark GT. Criteria for the detection of sleep-associated bruxism in humans. *J Orofac Pain* 1996;10:270-82.
- Lavigne GJ, Kato T, Kolta A, Sessle BJ. Neurobiological mechanisms involved in sleep bruxism. *Crit Rev Oral Biol Med* 2003;14:30-46.
- Cesta A, Moldofsky H, Sammut C. The University of Toronto Sleep Assessment Questionnaire (SAQ). *Sleep Res* 1996;25:486.
- Shochat T, Gavish A, Arons E, Hadas N, Molotsky A, Lavie P et al. Validation of the BiteStrip screener for sleep bruxism. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2007;104:32-9.
- Bite Strip. [access in 2006 Aug. 10]. Available in: www.bitestrip.com
- Quietsleep. [access in 2006 Aug. 20]. Available in: www.quietsleep.com/Snoringsleepapnéia/sleepstrip.htm.
- Ahlgren J, Omnell KA, Sonesson B, Toremalin NG. Bruxism and hypertrophy of the masseter muscle: a clinical, morphological and functional investigation. *Pract Otorhinolaryngol* 1969;31:22-9.
- Lyons M, Baxendale RH. A preliminary electromyographic study of bite force and jaw-closing muscle fatigue in human subjects with advanced tooth wear. *J Oral Rehabil* 1990;17:311-8.
- Nishigawa K, Bando E, Nakano M. Quantitative study of bite force during sleep associated bruxism. *J Oral Rehabil* 2001;28:485-91.
- Pellizzer E, Muench A. Forças de mordida relacionadas a próteses parciais removíveis, inferiores. *Rev Odontol Univ São Paulo* 1998;12:401-7.
- Liu Y, Zeng X, Fu M, Huang X, Lowe AA. Effects of a mandibular repositioner on obstructive sleep apnea. *Am J Orthod Dentofacial Orthop* 2000;118:248-56.
- Prathibha BN, Jagger RG, Saunders M, Smith AP. Use of a mandibular advancement device in obstructive sleep apnoea. *J Oral Rehabil* 2003;30:507-9.
- Cervo JJ. Avaliação do uso de um aparelho intra-oral no tratamento de pacientes obesos mórbidos portadores da síndrome das apnéias/hipoapnéias obstrutivas do sono grave [dissertation]. Porto Alegre (RS): Faculdade de Odontologia da Pontícia Universidade Católica do Rio Grande do Sul; 2006.
- Clark GT, Sohn JW, Hong CN. Treating obstructive sleep apnea and snoring: assessment of an anterior mandibular positioning device. *J Am Dent Assoc* 2000;131:765-71.
- Landry ML, Rompré PH, Manzini C, Guitard F, de Grandmont P, Lavigne GJ. Reduction of sleep bruxism using a mandibular advancement device: an experimental controlled study. *Int J Prosthodont* 2006;19:549-56.
- Hatch JP, Shinkai RS, Sakai S, Rugh JD, Paunovich ED. Determinants of masticatory performance in dentate adults. *Arch Oral Biol* 2001;46:641-8.
- Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders. *J Craniomand Disord Fac Oral Pain* 1992;6:301-55.
- Gibbs CH, Mahan PE, Mauderli A, Lundeen HC, Walsh EK. Limits of human bite strength. *J Prosthet Dent* 1986;56:226-9.
- Kogawa EM, Calderon PS, Lauris JR, Araujo CR, Conti PC. Evaluation of maximal bite force in temporomandibular disorders patients. *J Oral Rehabil* 2006;33:559-65.
- Pereira LJ, Pastore MG, Bonjardim LR, Castelo PM, Gavião MB. Molar bite force and its correlation with signs of temporomandibular dysfunction in mixed and permanent dentition. *J Oral Rehabil* 2007;34:759-66.
- Cosme DC, Baldisserotto SM, Canabarro Sde A, Shinkai RS. Bruxism and voluntary maximal bite force in young dentate adults. *Int J Prosthodont* 2005;18:328-32.
- Huynh NT, Rompré PH, Montplaisir JY, Manzini C, Okura K, Lavigne GJ. Comparison of various treatments for sleep bruxism using determinants of number needed to treat and effect size. *Int J Prosthodont* 2006;19:435-41.