Effect of an Adjustable Mandibular Advancement Appliance on Sleep Bruxism: A Crossover Sleep Laboratory Study

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Purpose: The objective of this experimental study was to assess the efficacy and safety of a reinforced adjustable mandibular advancement appliance (MAA) on sleep bruxism (SB) activity compared to baseline and to a mandibular occlusal splint (MOS) in order to offer an alternative to patients with both tooth grinding and respiratory disorders during sleep. ***Materials and Methods:*** Twelve subjects (mean age: 26.0 ± 1.5 years) with frequent SB participated in a short-term (three blocks of 2 weeks each) randomized crossover controlled study. Both brain and muscle activities were quantified based on polygraphic and audio/video recordings made over 5 nights in a sleep laboratory. After habituation and baseline nights, 3 more nights were spent with an MAA in either a slight (25%) or pronounced (75%) mandibular protrusion position or with an MOS (control). Analysis of variance and Friedman and Wilcoxon signed-rank tests were used for statistical analysis. ***Results:*** The mean number of SB episodes per hour was reduced by 39% and 47% from baseline with the MAA at a protrusion of 25% and 75%, respectively ($P < .04$). No difference between the two MAA positions was noted. The MOS slightly reduced the number of SB episodes per hour without reaching statistical significance (34%, $P = .07$). None of the SB subjects experienced any MAA breakage. ***Conclusion:*** Short-term use of an MAA is associated with a significant reduction in SB motor activity without any appliance breakage. A reinforced MAA design may be an alternative for patients with concomitant tooth grinding and snoring or apnea during sleep. *Int J Prosthodont 2009;22:251–259.*

The American Academy of Sleep Medicine recently reclassified sleep bruxism (SB) as a sleep-related movement disorder.[1] Bruxism occurring while awake must be differentiated from SB, which is mainly characterized by rhythmic masticatory muscle activity (RMMA) and occasional tooth-grinding sounds.[2–4] SB awareness in the general population is reported at 8%, and tooth-grinding noises are usually noted by the patient's bed partner or a family member.[4,5] The consequences of SB include excessive tooth wear, tooth or restoration fractures, tooth sensitivity, orofacial pain, and sleep-related headaches.[4,6–9]

The use of occlusal splint therapy is one of the standard management approaches to reducing the consequences of SB. However, it has been observed that while this kind of appliance initially reduces SB oromotor activity, the effects last no longer than a couple of weeks.[10–12]

Clinicians need to be aware that respiratory sleep disorders, such as snoring and sleep apnea and hypopnea syndrome (SAHS), may be observed concomitantly with SB.[4,13–16] Sleep apnea is characterized by a cessation of breathing for 10 or more seconds; sleep hypopnea is characterized by shallow breaths that reduce tidal volume. These respiratory disturbances may be associated with sleepiness, risk of vehicle accident, reduced work or familial productivity, cognitive dysfunction (ie, memory or concentration problems), hypertension, and vascular cerebral injury.[17–19] The gold standard treatments recommended by clinicians to treat sleep apnea include weight reduction and the use

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of a nasal continuous positive airway pressure device (CPAP). Other alternatives include mandibular advancement appliances (MAAs) or maxillomandibular and lingual surgeries.[20–24] The current literature tends to support the claim that a CPAP is superior to an MAA in reducing the apnea-hypopnea index and daytime sleepiness, although patients still prefer the MAA due to its ease of use (eg, travel) and in terms of compliance over time.[21–26] In the absence of reliable evidence, sleep medicine clinicians still find it a major challenge to identify the best option for patients suffering from both SB-related tooth grinding and respiratory sleep disorders.

The literature supporting the use of a CPAP in patients with SB-related tooth grinding is based on a single case report in which a reduction in both sleep apnea and SB was observed in one patient with severe apnea.[27] In the same sleep laboratory used for the current study, nasal CPAPs were used in four SB patients not suffering from any sleep breathing disorder. Over a 1-week period, only one subject was able to tolerate the CPAP for the full sleep period (unpublished observation). To our knowledge, only one study has reported a similar reduction related to the use of MAAs in patients with SB and without SAHS. A soft thermoplastic MAA, a cumbersome appliance, significantly reduced the SB motor index of frequent SB-related tooth grinding patients.[28] Clinicians should also be aware that the use of a maxillary occlusal splint may increase the severity of the respiratory disturbance index, as observed in half of the patients already suffering from apnea-hypopnea.[29] However, in a controlled study designed to test MAA efficacy, use of a mandibular occlusal splint (MOS) was not observed to aggravate the apnea-hypopnea index of apneic patients when compared to baseline.[30]

In the present study, an MOS, used as a control treatment, was compared with a reinforced MAA with two advancement positions in a population of patients without any respiratory disorders. The reinforced design was selected to prevent breakage of MAA parts and subsequent lung aspiration, a potential risk in SB-related tooth grinding patients.[31–33] The goal of this study was to offer an alternative to patients presenting with concomitant SB-related tooth grinding and a respiratory sleep disorder, such as snoring or obstructive sleep apnea and hypopnea. The specific aims of the present study were to test whether a robust MAA *(1)* reduces SB, *(2)* shows no breakage over a 4-week period, and *(3)* is as effective in a slightly advanced mandibular position (25%) as in a more advanced position (close to 75%, as commonly used in sleep apnea management). The specific null hypothesis used for this study was that a reinforced MAA design will not be associated with a decrease in SB frequency.

Materials and Methods

Subjects and Selection Criteria

The participants in this study were 12 moderate to severe SB subjects who were identified as frequent tooth grinders based on their sleep partner's report and subsequently confirmed by polygraphic recordings in a sleep laboratory. The subjects' mean age was 26.0 ± 1.5 (SEM) years. The gender distribution was three men and nine women. Sample size was based on previous studies that showed statistically significant differences in SB between baseline and nights spent with the oral appliances among a similar number of subjects.[10,28] All subjects gave informed consent to participate in the study by signing forms approved by the ethics board of the Université de Montré. Participants were recruited through advertisements placed on campus notice boards. Patients were selected using the following three steps: telephone interview, clinical examination, and sleep recording in the laboratory to exclude sleep disorders and confirm SB-related tooth grinding.

Subjects were screened by telephone to exclude those who did not grind their teeth on a regular basis (fewer than 3 nights a week as reported by the sleep partner), those who were not 18 to 45 years old, and those who were not willing to spend 5 nights at the sleep research laboratory (Hôpital du Sacré-Coeur de Montréal). Also excluded were patients presenting with a history of medical (eg, Parkinson's, tardive dyskinesia) or mental illness (eg, depression, anxiety), sleep disorders (eg, apnea, periodic limb movement disorder, nightmares, insomnia), or who were using any medications, drugs, or alcohol on a regular basis.[2] During the clinical examination, the presence of *(1)* a history of tooth grinding occurring at least 3 times a week in the past 6 months (as reported by the subject's sleep partner or family members); *(2)* tooth wear, probably related to tooth grinding, ranging from class 1 to class 4 based on criteria by Johansson et al[34]; or *(3)* hypertrophy of the masseter muscles in response to voluntary clenching and/or morning orofacial muscle fatigue, noted as a secondary finding, were recorded. None of the subjects invited to participate in the study presented orofacial pain or temporomandibular dysfunction or headache and all had a full dentition and a healthy periodontal condition.

The screening period at the sleep laboratory comprised the first 2 of the 5 total nights that the subjects spent there (Fig 1). The first night was for habituation and was not included in the statistical analysis. The second night served to establish the baseline for SB and to rule out other sleep disorders (as previously mentioned). To be considered an SB subject in this study, individuals had to meet the following diagnostic

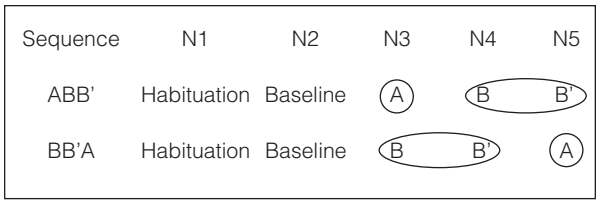

Fig 1 Study design: Short-term randomized crossover controlled experimental study. Two weeks of habituation in each condition were allowed before experimental nights (N3–N5). Subjects were randomized to either sequence ABB' or BB'A. A = MOS; B = MAA (25% advancement); B' = MOS (75% advancement).

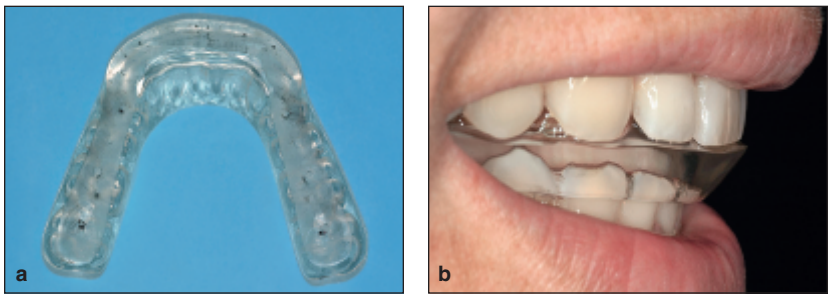

Fig 2 **(a)** Mandibular occlusal splint and **(b)** mandibular positioning.

criteria: *(1)* more than four RMMA episodes per hour of sleep consisting of three or more phasic or mixed contractions (phasic and tonic) of the masseter and temporal muscles at a frequency of 1 Hz and *(2)* at least two audible tooth-grinding events per night.[3,35–37] Baseline recordings were used to exclude subjects who showed signs of other sleep disorders such as periodic leg movements during sleep (> 10 events per hour of sleep), electroencephalographic epileptiform activity, sleep apnea (> 5 apnea or hypopnea events per hour of sleep), or snoring.

Oral Appliances Protocol

Two oral appliances, the MOS (labeled A) and the MAA (labeled B at the 25% and B' at the 75% advancement positions) were compared in a crossover study following an ABB' or BB'A sequence (Fig 1), similar to that used in the study by Mehta et al.[30] However, in the present study, subjects were given 2 weeks instead of 1 week to adapt to the appliance, and the BB' sequence was used for MAA adjustment in the two mandibular advancement positions (as described below). The MOS (A) was the control compared to the active arm, which consisted of an adjustable MAA (BB') modified for two jaw protrusion positions.

Two sets of irreversible hydrocolloid dental impressions were made of the maxillary and mandibular teeth. The impressions were then poured in artificial stone. The first set of casts was mounted on a semiadjustable articulator using a facebow and centric relation wax record. The MOS was fabricated on the mandibular arch and covered all of the mandibular teeth (Fig 2). It was made of hard acrylic resin (Lucitone 199, Dentsply) with a thickness of 1.5 mm at the molar region. Patients were placed in a dorsal decubitus position to mimic sleep and asked to relax their mandible so that the MOS could be adjusted. On the MOS, firm and equal contacts were established with the lingual maxillary cusps of the posterior teeth and light contacts with the anterior teeth. In addition, the MOS was adjusted with canine lateral guidance and anterior protrusive guidance in the absence of any interference from balancing sides.

The second set of casts was used to fabricate the MAA (Silencer Professional, Silencer Products International). The MAA was constructed of a shell of hard acrylic resin lined with a permanent elastic material (Fig 3). The entire occlusal surface was made of hard acrylic resin. The mounting of the reinforced titanium hinge (BH 1000 Hinge, Halstrom Hinge) was accomplished using a lost wax technique with the hinge being retained in hard acrylic resin. Casts were mounted according to the Gothic arch tracing record (Gothic Arch Tracer GAT). The hinge, with a pin 6 mm in length, was set in the second hole of the mandibular positioning plate, corresponding to 50% of the anteroposterior range of motion (ROM) from centric relation. Bilateral contacts on the posterior stops were adjusted. At first, the adjustable MAA was set at 25% of ROM (first hole of the mandibular positioning plate; mean: 3.6 mm) and later, it was set close to 75% of the advancement position (third hole of the mandibular positioning plate; mean: 9.6 mm).

Both devices were adjusted for patient comfort and function. Patients were given 2 weeks to get used to each appliance (MOS, MAA at 25% or 75% position). To reduce patient bias in assessing appliance preference, subjects were told that both devices provided tooth protection and were being tested for efficiency

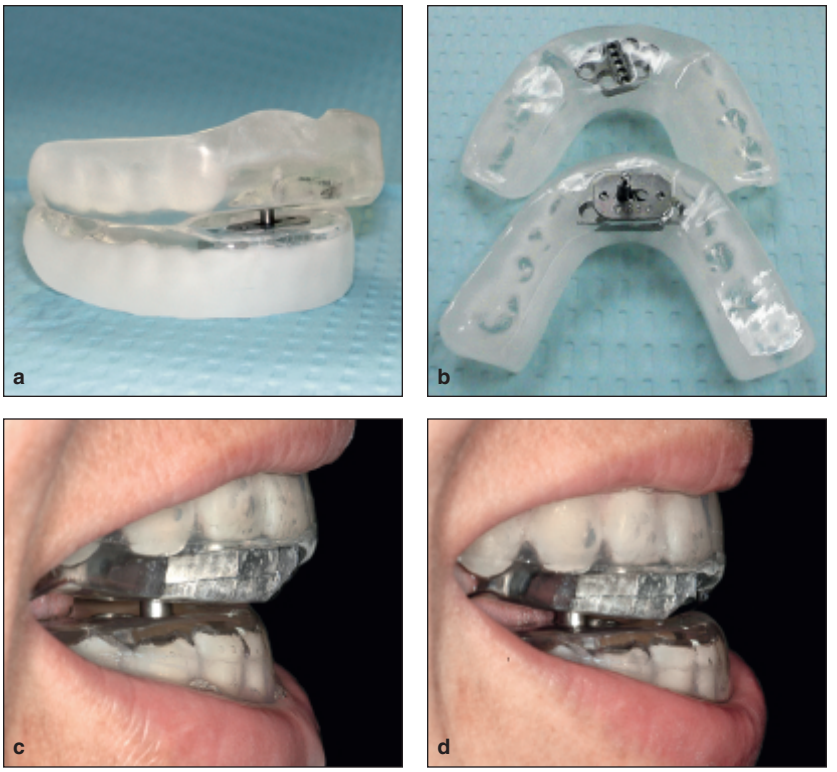

Fig 3 Mandibular advancement appliance and mandibular positioning. **(a and b)** MAA general view; **(c)** MAA at 25% advancement; **(d)** MAA at 75% advancement.

and comfort. The MOS was fully funded by the research grant obtained for this study and was made by a local laboratory (Laboratoire dentaire Marie-Claude Meloche), whereas the MAA was provided free of charge regardless of results or publication (Silencer Products International).

Study Design

During the third, fourth, and fifth nights of recording, polygraphic data were collected from subjects wearing the oral appliances (see Fig 1). A computer-generated list assigned the subjects randomly to either sequence ABB' (n = 7) or BB'A (n = 5). After each 2-week habituation period, patients spent another night at the sleep laboratory according to a prearranged schedule in order to avoid delay between conditions. The MAA was first worn in the 25% protrusion position (B) and then in the 75% protrusion position (B').

Patient compliance was verified through random phone calls to ensure that subjects were using the oral device as requested. At the end of each night spent in the sleep laboratory, subjects filled out questionnaires to ascertain comfort and preferences using a 100-mm visual analogue scale (VAS). Subjects made a vertical mark on the scale with the length of the mark (in millimeters) indicating the subject's degree of response (none to extremely) to each question.

Polygraphic Recordings and Scored Variables

Sleep recordings were made from approximately 10:30 pm to 7:00 am every night (30 min range). Recording settings have been described elsewhere.[10,35,38] The following surface electrodes were used to collect data: two electroencephalograms (C3A2, O2A1); bilateral electro-oculograms; one electrocardiogram; electromyograms for the masseter, sternocleidomastoid, and anterior tibialis muscles; and one site for chin/suprahyoid muscle activity. The collected data were amplified and sampled at a rate of 128 Hz using commercially available software (Harmonie, Stellate Systems). Sleep architecture and variables were scored offline according to standard criteria[39] and SB data were also scored offline using parallel and continuous audio/video monitoring to identify tooth-grinding episodes during sleep. A nasal cannula (Oral & Nasal Luer Lock Cannula, Breadon Medical Corporation) and thoracic and abdominal belts were used to evaluate respiratory function. Oxygen saturation was monitored by standard pulsoxymetry. All sleep scoring was performed by the same sleep technician, and SB episodes were scored by a highly trained research technician using research criteria previously developed in that laboratory.[3,35–37] All masseter electromyogram potentials associated with SB activity on audio/video recordings and with amplitudes of at least

Table 1 Effect of MOS and MAA in Two Advanced Positions on Sleep Variable Data (n = 12)

Sleep variables	Baseline	MOS	MAA 25%	MAA 75%
Sleep latency (min)†	5.8 (1.7–19.3)	5.2 (1.0–94.7)	4.2 (0.3–25.7)	3.0 (0.3–33.3)
Total sleep time (min)	424 ± 10	438 ± 16	451 ± 11*[1]	444 ± 11
Sleep efficiency (%)	95.8 ± 0.8	97.7 ± 0.4*[2]	96.9 ± 0.7	97.4 ± 0.4
% stage 1†	3.7 (2.7–11.5)	3.5 (2.3–6.4)	3.9 (1.8–10.7)	3.5 (2.5–6.7)
% stage 2	59.5 ± 2.3	61.7 ± 1.6	60.8 ± 2.3	60.2 ± 1.9
% stage 3+4	14.3 ± 2.4	13.5 ± 1.7	13.9 ± 2.3	13.7 ± 2.1
% REM	21.8 ± 0.9	21.0 ± 1.2	20.7 ± 1.3	22.1 ± 1.0
Awakenings	23.1 ± 2.3	17.5 ± 2.1*[3]	22.3 ± 3.5	18.5 ± 2.5
Arousals/h†	5.9 (3.3–15.5)	4.6 (0.0–10.4)	5.5 (1.7–15.7)	3.9 (2.5–13.6)*[4]
O_2 sat (%)†	96.9 (93.1–99.0)	96.6 (94.2–98.7)	96.9 (96.2–97.7)	97.0 (89.7–98.1)
Apnea/hypopnea/h	1.4 ± 0.3	1.6 ± 0.5	1.4 ± 0.3	1.5 ± 0.3

*Statistically significant.
† Median (min–max) is shown when data distribution was not normal. Otherwise, Mean ± SEM is shown.
[1]MAA 25% > Baseline, $P = .04$.
[2]MOS > Baseline, $P = .02$.
[3]Baseline > MOS, $P = .04$.
[4]Baseline > MAA 75%, $P = .04$.
REM = rapid eye movement.

20% of the maximum voluntary contraction were marked as SB bursts. SB episodes were classified as phasic (three bursts or more, each lasting 0.25 to 2.0 seconds), tonic (one burst > 2.0 seconds), or mixed (both burst types). Episodes were separated by intervals of more than 3 seconds. Variables scored during sleep included latency, total duration, sleep efficiency (percent of time asleep/time in bed), percentages of stage duration, number of arousals per hour, and number of awakenings per hour. SB events were quantified from the right masseter electromyogram into an index per hour of sleep for number of episodes and number of bruxism bursts. Number of episodes with tooth-grinding sounds was estimated using the audio/video signal.

Respiratory apnea and hypopnea events per hour of sleep were calculated as a combined index. Apnea was considered to have occurred when complete cessation of airflow lasted for more than 10 seconds. Hypopnea was considered to have occurred in three situations: when airflow was reduced by 50% for more than 10 seconds, when less than 50% airflow reduction occurred in the presence of an arousal, and in the presence of 4% oxygen desaturation.[39–41]

Statistical Analysis

Normality of data distribution was assessed using the Shapiro-Wilk test. When necessary, data distribution was normalized using a square root. Repeated measures analysis of variance (ANOVA) was used to evaluate the effect of the two oral devices on sleep and SB. Baseline data (night 2) were compared to the MOS and MAA in the different positions using paired comparisons. Freidman two-way ANOVA followed by Wilcoxon signed-rank tests for paired comparisons were used for the VAS scales and the number of episodes with tooth-grinding noises, since normalization was not achieved. The Fisher exact test was used to compare the groups for presence of morning pain.

Results

Eleven of the 12 subjects completed the 5 nights of the study protocol. One subject withdrew before the last night of recording, during which the MAA was to be set at the 75% protrusion position. The subject had experienced too much jaw pain and bite discomfort at such an advanced position; symptoms ceased as soon as the subject stopped wearing the MAA. The analysis includes the data from the subject who dropped out, in accordance with the concept of intention to treat.[42] For this subject, values recorded at baseline were used for the night with the MAA set at the 75% position.

The sequence effect (ABB' or BB'A) on SB variables was not statistically significant ($P \geq .40$). It was therefore removed from further analysis.

Analysis of sleep variables revealed that sleep architecture and quality were not influenced by use of the MOS or MAA in the two advanced positions (Table 1). However, statistically significant differences were observed for some sleep variables compared to baseline: a slightly longer total sleep time with the MAA at 25% advancement, slightly higher sleep efficiency with the MOS, and fewer awakenings with the MOS. It should be noted that all of these differences are marginal and that the means are well within the range of normal sleep values. One surprising finding is the significant reduction in number of arousals per hour of sleep with the MAA at 75% advancement compared to baseline; it remains to be proven whether this is a benefit of the MAA for SB patients. Again, this index is also within normal range.[43] All respiratory variables (apnea

Table 2 Effect of MOS and MAA in Two Advanced Positions on SB Variables (n = 12)

	Baseline	MOS	MAA 25%	MAA 75%
Episodes/h	5.9 ± 0.5	3.9 ± 0.8[1]	3.6 ± 1.0*[2]	3.1 ± 0.8*[3]
% Reduction vs baseline		34	39	47
Burst/h†	36.4 (21.8–77.0)	25.3 (1.1–64.6)*[4]	12.3 (1.0–89.6)*[5]	10.4 (0.9–57.5)*[6]
Episodes with noise†	8.5 (0–24)	0 (0–32)*[7]	0 (0–13)*[8]	0 (0–9)*[9]

*Statistically significant.
†Median (min–max) is shown when data distribution was not normal. Otherwise, Mean ± SEM is shown.
[1]B > MOS, $P = .07$.
[2]B > MAA 25%, $P = .03$.
[3]B > MAA 75%, $P = .002$.
[4]B > MOS, $P = .01$.
[5]B > MAA 25%, $P = .004$.
[6]B > MAA 75%, $P = .0007$.
[7]B > MOS, $P = .03$.
[8]B > MAA 25%, $P = .003$.
[9]B > MAA 75%, $P = .005$.

and hypopnea index, oxygen saturation) are well below and above their respective pathological levels (eg, five episodes per hour of sleep[1]) (Table 1).

Both oral appliances, the MOS and the MAA in both positions, showed a significant effect on all SB variables. As seen in Table 2, a comparison between baseline and the MOS and MAA showed a reduction in the number of episodes per hour, number of bursts per hour, and number of SB episodes with tooth-grinding noises. To more readily grasp the relevance of the reduction in SB episodes per hour with the MAA, the value is expressed as a percentage. The MAA set at 25% and 75% advancement reduced the number of SB episodes per hour by 39% and 47%, respectively (Fig 4). A comparison between MAA advancement positions showed no statistically significant difference ($P = .29$). The MOS reduced the number of SB episodes per hour by 34% compared to baseline, which also does not reach statistical significance ($P = .07$). No statistically significant differences were observed in the number of episodes per hour between nights with the MOS and the MAA at either advancement position ($P > .35$). Figure 5 depicts the distribution of subjects' variability over the various treatment arms. A decrease in the number of SB episodes per hour was observed in nine of the 12 patients with the MAA set at 75% compared to 25%. For the other subjects, the number of episodes per hour of sleep either remained the same or increased. The number of muscle contractions (bursts per hour of sleep) was also significantly lower for the MOS and the two MAA positions compared to the baseline night (Table 2). A similar observation was made for episodes with tooth-grinding noises (Table 2).

The subject who dropped out when the MAA was set at the 75% condition was included by using the subject's baseline values in the statistical analysis. This does not affect the results because the data calculated without these values showed exactly the same trend (results not shown).

Self-reports of comfort and pain revealed that six of the 12 subjects complained of tooth sensitivity to bite pressure after removing both devices in the morning. This discomfort disappeared within a few hours of awakening. When subjects reported perceived pain in the morning, no significant difference was observed between all experimental conditions and baseline ($P = .32$). The MOS was reported to be significantly more comfortable (median: 78.5 mm) than the MAA (median: 20 mm, $P = .004$ and 19 mm, $P = .005$ at 25% and 75% advancement, respectively). All 12 subjects preferred the MOS to the MAA. The subjects' complaints about the MAA concerned its size (eg, too bulky, uncomfortable), difficulty in closing the lips and therefore a tendency to drool, and fear of permanent changes to the teeth and/or arch. When asked about their perception of the devices' efficiency, five of the 12 subjects thought that the MOS was more effective in reducing SB. One and three subjects rated the MAA at 25% and at 75% as being the most efficient, respectively. Three subjects did not answer this question.

Discussion

This short-term crossover randomized controlled study was conducted to assess the potential of an adjusted, robust MAA to manage SB in patients who may also suffer from respiratory sleep disorders, such as snoring or obstructive sleep apnea and hypopnea. The results confirm the main research hypothesis that a decrease in SB frequency with the MAA would be observed. Consistent with the three specific aims, it was observed that the MAA *(1)* significantly reduced SB frequency (number of episodes per hour, number of bursts per hour, and number of episodes with tooth grinding) compared to baseline for both advancement settings; *(2)* did not break; and *(3)* was equally effective in both advancement positions, since no statistically significant difference was observed between the

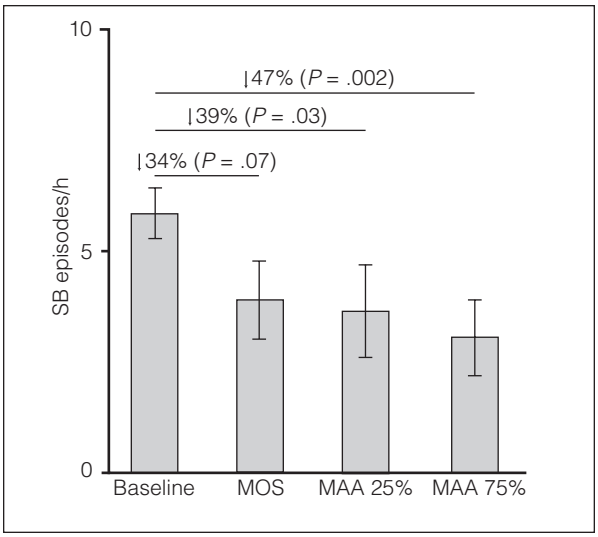

Fig 4 Comparison among baseline and experimental nights in each condition for SB episodes per hour of sleep. Means ± SEM are shown (12 subjects, calculated with values at baseline for the subject who dropped out in condition MAA 75%).

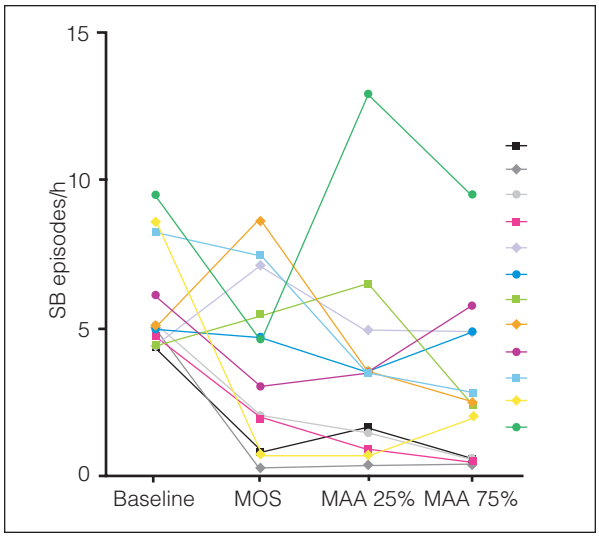

Fig 5 Individual data distribution across 4 nights for the number of SB episodes per hour of sleep for baseline and all experimental conditions. In one subject (upper left side) the SB index clearly worsens with the MAA; two others presented a slight increase in the SB index at the 75% position.

two positions. The subjects perceived the use of the MAA as limited due to its size and the discomfort it caused; the MOS was the preferred appliance. Appliance design seems to be a critical issue when it comes to patient choice.

To the authors' knowledge, only one other short-term study, conducted in the same laboratory, has demonstrated that SB can be reduced by a thermoplastic (boil and bite) MAA compared to a maxillary occlusal splint. In that study, patients also preferred the occlusal splint to the MAA.[28] The present study, which examines a well-fitted custom-made appliance compared to an MOS, supports the preliminary findings of that study. One of the main advantages of the custom-made MAA used in this report, compared to a thermoplastic MAA with lateral mandibular movement, is that the hinge gives subjects freedom of anteroposterior movement. However, this advantage was probably insufficient to change patient preference, which remained in favor of the MOS. Note that both studies allowed 2 weeks of acclimation between sleep laboratory recordings.

Over a short-term period, the MAA seems to be as effective as an MOS in decreasing SB motor activity. Caution must be used when using an occlusal splint to treat SB, however, because some individual variations have been observed.[10–12,28] In the present study, such variations were indeed observed; three of the 12 subjects showed increased SB motor activity during the night spent wearing the MOS (Fig 5). Nevertheless, even with no reduction in SB motor indexes, the MOS may provide tooth protection, as previously suggested.[10,28] Several studies have also reported that the influence of oral devices on SB might not persist over time. In fact, van der Zaag et al[11] reported no decrease in SB after 4 weeks of using an occlusal splint. Harada et al[12] reported a decrease in SB events within 3 nights, but a return to baseline levels after 2 weeks of wearing an occlusal splint. Oral devices seem to have a short-term effect on SB-related oromotor activities. Clinicians should keep this in mind when assessing the clinical efficacy of oral devices in the treatment of SB.

In previous studies, oromotor activities have been reported to decrease in the presence of muscle pain.[44,45] Pain and discomfort could have possibly prevented the occurrence of SB episodes when subjects were wearing the MAA at the 25% and 75% advancement positions. As the subjects in both Landry et al's study[28] and the present one reported pain with the MAA, it is difficult to discriminate between advancement and pain as the main factor in SB reduction. Subjects had more tolerance for the minimal protrusion (25%). This finding indicates a potential advantage in that it appears to reduce SB without creating discomfort, as well as reducing the apnea index in SAHS patients.[46,47] It remains to be proven whether simply preventing the mandible from retruding is sufficient to reduce SB motor events.

In this experimental study, the effect of two MAA protrusion positions was tested. No wash-out period was allowed between conditions and no reassessment of oromotor activity was made to ensure a return to baseline level. This could have influenced the results.

Data normalization using square root was performed when necessary to present repeated measures ANOVA for all numeric variables (except number of episodes with tooth-grinding noises). However, the use of nonparametric tests (Wilcoxon signed-rank test) would have led to the same conclusions (not shown).

A larger sample size would have been necessary to show a statistically significant difference between MOS and MAA nights. For example, 100 subjects would be needed to reach a power of 80% to detect a difference between the MOS and MAA in the 75% protrusion position with a significance level of $\alpha = .05$. However, the sample size of the present study was large enough to show a significant difference between baseline and MAA nights, in accordance with the first aim of the study.

The relevance of this study could also be improved by replicating it in a larger sample of patients presenting comorbidities. The population of intense bruxers examined in this study was young and healthy and without any pain or temporomandibular disorder. However, in patients with both snoring or sleep apnea and tooth grinding, appliances may break due to the intense force generated and the strain on appliance parts; a clinician would be well advised to report any breakage to the company that manufactured the MAA, as the aspiration of broken MAA parts has been previously reported.[31–33]

Another issue worth investigating in future studies is whether the so-called dentomorphologic changes observed over time with the MAA are more prevalent with certain appliance designs or whether they are due to the arch's reaction to the forward position alone.[22,48–51] It would be beneficial to develop a patient database that could be used to provide the best appliance for the patient based on sound evidence. Patient compliance, a well-known problem, also needs to be improved.[52,53]

Gold et al[13] reported that about 50% of a population suffering from upper airway resistance syndrome (UARS) also reported SB. Furthermore, Yoshida[54] reported that respiratory function and sleep quality variables could be improved by using an MAA in patients suffering from UARS. Since light bruxers often complain of headaches,[55] it would be interesting to investigate whether an MAA reduces orofacial pain and headaches in this population. A relationship between airway resistance and SB remains to be established. Future studies should be oriented toward UARS and SB.

Conclusions

In a small sample of SB-related tooth grinding patients, it was found that the short-term use of a robust MAA is associated with a significant reduction in SB motor activity without any appliance breakage. A reinforced MAA may therefore be a potential therapeutic alternative for patients with concomitant tooth grinding and respiratory disorders during sleep. The regular use of MAAs in SB patients without respiratory sleep disorders needs to be replicated by other investigations in different patient populations, especially in patients with comorbid conditions such as temporomandibular disorders or xerostomia.

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