Correlation Between Sleep-Time Masseter Muscle Activity and Tooth Wear: An Electromyographic Study

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Aims: To assess the correlation between tooth wear and sleep-time masseter muscle activity (sMMA) in a group of healthy young adults who underwent home electromyographic/electrocardiographic (EMG/ECG) recordings with a portable device. **Methods:** A total of 41 healthy volunteers (23 women, 18 men; mean age 28.8 years, range 25 to 40) with good natural dentition underwent a 2-night in-home evaluation with a portable device that allowed a simultaneous sleep-time recording of EMG signals from both masseter muscles and heart rate. The number of sleep bruxism (SB) episodes per sleep hour (SB index), the number of phasic, tonic, and mixed sMMA events per hour, and the total number of sMMA events per night were calculated. All individuals also underwent an assessment of tooth wear on digital casts with the adoption of a six-degree rating scale. Correlations between sMMA variables and tooth wear were assessed using Pearson test. The null hypothesis was that correlation between the two conditions would not be significant. **Results:** On average, the SB index was 4.5 ± 2.6, while the total number of sleep-time masseter contractions was 97.2 ± 55.2. Of those contractions, almost 60% were phasic. Average tooth wear was 1.5 ± 0.7, with the canines and mandibular incisors showing the highest wear scores. For all pairwise analyses, correlation values were not significant (*P* values .11 to .69), with *r* values ranging from 0.064 to 0.253. **Conclusion:** The null hypothesis of an absence of correlation between tooth wear and sMMA could not be rejected, implying that tooth wear cannot be used as an indicator of ongoing SB or sMMA. Future studies taking into account the multifaceted nature of tooth wear and the complex natural course of sleep phenomena are encouraged to investigate the issue further, at the individual level.
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Bruxism, either during sleep (indicated as sleep bruxism [SB]) or wakefulness (indicated as awake bruxism, [AB]), is a masticatory muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible and is not considered a disorder in otherwise healthy individuals.[1] There is now consensus that bruxism can be considered as a physiologic phenomenon when no complaints arise.[2] Notwithstanding, bruxism has often been linked to possible clinical signs and symptoms, including tooth wear, but the literature is inconclusive on this topic.[3]

A possible reason for this is the difficulty of comparing findings from studies that adopt different approaches to diagnosing bruxism. For instance, in the field of the bruxism–temporomandibular disorders (TMD) relationship, quite opposite results came from investigations measuring SB compared to studies that relied on its self-report.[4] This problem has been addressed with a recent proposal to adopt a diagnostic grading system of possible, probable, and definite SB or AB. For SB, a definite diagnosis requires a polysomnographic (PSG) or an electromyographic/electrocardiographic (EMG/ECG) recording.[1] In addition, as a strategy to try to understand the clinical correlates, it has also been suggested to expand the assessment to the full spectrum of masticatory muscle activity (MMA).[5]

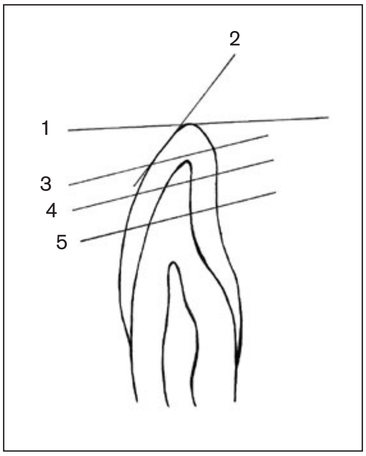

Fig 1 Degrees of tooth wear in the anterior and canine teeth.

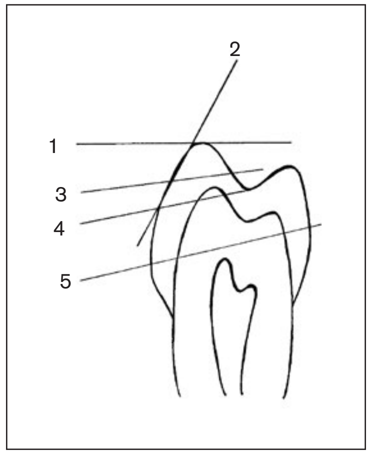

Fig 2 Degrees of tooth wear in the bicuspids and molar teeth.

Many practitioners still commonly believe that tooth wear indicates the presence of ongoing SB and consider it as a diagnostic tool for SB. Such belief is only partly backed up by the literature, as available data have relied on a dichotomous diagnosis of SB and showed a correlation of doubtful clinical relevance.[6] Thus, there is a need to investigate deeper the topic of the tooth wear–SB relationship within the framework of MMA and its possible clinical correlates. Such an approach has important implications in several dental fields, especially considering the issue of prosthodontic planning.[7]

Within the above premises, the present investigation aimed to assess the correlation between tooth wear and sleep-time MMA (sMMA) in a group of healthy young adults who underwent home EMG/ECG recordings with a portable device. The study design aimed to answer the clinical research question: Is there a correlation between tooth wear features and sMMA? The null hypothesis was that tooth wear would not be related to instrumentally measured sMMA.

Materials and Methods

This study was performed in 41 healthy volunteers (23 women, 18 men; mean age 28.8 years, range 25 to 40 years) with good natural dentition (ie, no missing teeth, other than third molars, and no prosthetic crowns) recruited from among the personnel and staff of the Postgraduate School of Orthodontics, University of Ferrara, Ferrara, Italy. Exclusion criteria were the presence of TMD, as diagnosed by a trained examiner based on the guidelines of the American Academy of Orofacial Pain (AAOP),[8] and/or a history of neurologic, mental, or sleep disorders (eg, periodic leg movements, insomnia). Participants could not be under medications or the effects of alcohol, nicotine, or caffeine at the time of recording. AAOP guidelines were used for the TMD screening because they already contained a partial update with respect to the Research Diagnostic Criteria for TMD (RDC/TMD). A trained examiner (D.M.) performed the assessment.

All subjects underwent an instrumental in-home evaluation with a portable device (Bruxoff, OT Bioelettronica) that allowed a simultaneous recording of EMG signals from both masseter muscles and heart rate. Each participant underwent 2 consecutive recording nights (at least 4 hours of sleep per night). The first night was an accommodation session to familiarize with the device; only data recorded during the second night were considered for statistical analyses. Technical details about the device and the recording procedure have been described elsewhere.[9,10] Previous studies showed that the portable device has high sensitivity (92.3%) and specificity (91.6%) for SB diagnosis when the diagnostic cut-off was set at four SB episodes per hour,[10] as suggested by PSG/SB criteria.[11,12] In addition, a reliability study showed good repeatability as far as the number of SB episodes per night, SB episodes per hour, and heart frequency are concerned.[9]

The portable EMG/ECG recorder was used to gather data on SB events (ie, masseter contractions exceeding 10% of the maximum voluntary contraction [MVC] amplitude and preceded by a 20% increase in heart rate). In addition, all suprathreshold masseter contractions that were not preceded by a heart rate increase were also scored (sMMA). For each recording night, the device automatically scored the number of SB episodes per hour of sleep (SB index), the number of phasic, tonic, and mixed sMMA events per hour, and the total number of sMMA events per night.

All individuals also underwent an assessment of tooth wear on digital casts. In short, an intraoral scanner (3Shape TRIOS, 3Shape) was used to acquire digital images of dental arches. For each tooth, the degree of wear was scored as follows, based on a possible 6-item rating: degree 0 = no tooth wear; 1 = slight wear on the top of the cusps or incisal tips; 2 = noticeable wear in the form of flattening with respect to the normal contour of the cusps or tips; 3 = marked flattening of the cusps or tips; 4 = total loss of cuspal or tips contour and moderate dentinal exposure;

Table 1 Descriptive Statistics of Sleep-Time Masseter Muscle Activity (sMMA) in the Study Sample (n = 41)

sMMA variables	Mean (SD)	Range
SB index	4.5 (2.6)	0.4–10.9
Total no. of sMMA events	97.2 (55.2)	21–201
No. of phasic sMMA events/h	9.4 (7.4)	0–32
No. of tonic sMMA events/h	5.0 (4.4)	0–16
No. of mixed sMMA events/h	1.6 (1.7)	0–7

SD = standard deviation; SB = sleep bruxism.

and 5 = severe tooth wear with marked dentinal exposure (Figs 1 and 2).[13] Digital casts were examined by two examiners, who scored wear by consensus and referred to a third examiner when failing to reach an agreement. For each patient, a mean tooth wear value was assessed.

The procedures were approved by the Ethics Committee of the Postgraduate School of Orthodontics, University of Ferrara. All individuals gave their informed consent in accordance with the Helsinki Declaration and understood that they were free to withdraw from the experiment at any time.

Descriptive statistics were calculated for all sMMA and tooth wear variables. Kolmogorov-Smirnov test for normal distribution was performed, and correlations between sMMA variables and tooth wear were assessed. Significance was set at $P < .01$.

Results

On average, the SB index was 4.5 ± 2.6, while the total number of sleep-time masseter contractions was 97.2 ± 55.2. Of those, almost 60% (9.4 ± 7.4 per hour) were phasic contractions (Table 1).

The mean degree of tooth wear was scored 1.5 ± 0.7. The canines and mandibular incisors were the teeth with the highest wear scores (Table 2).

Kolmogorov-Smirnov test showed normal distribution of variables. Thus, correlation analysis between tooth wear and sMMA variables was performed with Pearson test. For all pairwise analyses between patients' mean tooth wear and sMMA variables, correlation values were not significant (P = .11 to .69), with r values ranging from 0.064 to 0.253 (Table 3). Similarly, no significant correlations were found between mean wear values of single teeth and the different sMMA variables (Table 4).

Discussion

The relationship between bruxism and features of dental occlusion has always been a fascinating issue for the dental profession. For years, it has been hypothesized that occlusal factors (ie, interferences) could trigger bruxism as an attempt to remove a disturbing imperfection of the dentition. Such a theory clearly lacked enough biologic rationale and was challenged in a series of experimental studies.[14,15] Thus, in a review, it was concluded that neither occlusal interferences nor factors related to the anatomy of the orofacial skeleton

Table 2 Descriptive Statistics of Degree of Tooth Wear per Tooth and per Patient

Tooth	Mean (SD)	Range
17	0.7 (0.9)	0–3
16	1.1 (1.1)	0–4
15	0.8 (0.9)	0–3
14	0.9 (1.0)	0–3
13	2.0 (1.1)	0–4
12	1.3 (1.0)	0–4
11	1.4 (1.0)	0–4
21	1.4 (1.0)	0–4
22	1.4 (1.1)	0–4
23	1.9 (1.1)	0–4
24	0.9 (1.0)	0–4
25	0.7 (0.7)	0–3
26	1.1 (1.2)	0–4
27	0.8 (1.0)	0–4
37	1.6 (1.2)	0–4
36	1.8 (1.1)	0–4
35	1.5 (1.0)	0–4
34	1.3 (0.9)	0–3
33	2.4 (1.1)	0–4
32	1.8 (1.2)	0–5
31	2.0 (1.0)	0–5
41	1.9 (1.0)	0–5
42	2.0 (1.1)	0–5
43	2.2 (1.1)	0–4
44	1.2 (1.0)	0–4
45	1.2 (1.0)	0–4
46	1.8 (1.2)	0–4
47	1.5 (1.1)	0–4
Patients' mean	1.5 (0.7)	0.1–3.1

SD = standard deviation. Tooth numbers are based on the World Health Organization (WHO) system.

Table 3 Correlation Values Between Mean Tooth Wear and Sleep-Time Masseter Muscle Activity (sMMA) Variables

sMMA variables	r value	P value
SB index	.064	.692
Total no. of sMMA events	.253	.0110
No. of phasic sMMA events/h	.189	.237
No. of tonic sMMA events/h	.163	.308
No. of mixed sMMA events/h	.118	.463

SB = sleep bruxism.

Table 4 Correlation Values Between Mean Tooth Wear per Tooth and Sleep-Time Masseter Muscle Activity (sMMA) Variables

Tooth	SB index	Total no. of sMMA events	No. of phasic sMMA events/h	No. of tonic sMMA events/h	No. of mixed sMMA events/h
17	−0.039 (.811)	0.069 (.667)	−0.137 (.392)	−0.150 (.351)	−0.063 (.696)
16	−0.010 (.951)	0.181 (.259)	−0.058 (.717)	−0.012 (.942)	−0.066 (.683)
15	−0.056 (.733)	0.100 (.538)	−0.170 (.293)	−0.217 (.178)	−0.108 (.505)
14	−0.065 (.689)	0.084 (.605)	−0.026 (.872)	−0.119 (.465)	0.028 (.862)
13	−0.024 (.882)	−0.004 (.979)	−0.039 (.811)	0.052 (.745)	−0.008 (.959)
12	0.039 (.810)	0.381 (.014)	−0.021 (.895)	−0.049 (.762)	−0.017 (.915)
11	0.066 (.681)	0.264 (.095)	−0.088 (.585)	0.001 (.994)	−0.043 (.789)
21	−0.010 (.949)	0.223 (.160)	−0.144 (.369)	−0.065 (.688)	−0.121 (.453)
22	−0.176 (.270)	0.085 (.598)	−0.251 (.114)	−0.270 (.087)	−0.235 (.139)
23	−0.007 (.964)	0.180 (.260)	−0.035 (.830)	0.194 (.223)	0.035 (.826)
24	−0.026 (.873)	0.248 (.123)	−0.062 (.706)	0.080 (.623)	0.104 (.522)
25	−0.144 (.375)	0.106 (.515)	−0.131 (.420)	−0.177 (.275)	−0.107 (.511)
26	0.015 (.924)	0.351 (.024)	−0.002 (.991)	0.004 (.980)	0.006 (.972)
27	0.057 (.726)	0.236 (.138)	0.034 (.833)	−0.020 (.899)	−0.124 (.440)
37	−0.077 (.633)	0.178 (.264)	−0.268 (.090)	−0.148 (.355)	−0.213 (.181)
36	−0.106 (.517)	0.061 (.708)	−0.220 (.173)	−0.279 (.082)	−0.156 (.337)
35	−0.103 (.522)	0.052 (.745)	−0.191 (.233)	0.000 (.999)	0.090 (.574)
34	−0.195 (.222)	−0.054 (.737)	−0.311 (.048)	−0.093 (.564)	−0.109 (.497)
33	−0.197 (.217)	−0.058 (.717)	−0.358 (.022)	−0.094 (.558)	−0.243 (.126)
32	0.135 (.401)	0.282 (.074)	−0.044 (.786)	−0.261 (.099)	−0.119 (.457)
31	0.057 (.724)	0.204 (.201)	−0.132 (.410)	−0.220 (.166)	−0.044 (.783)
41	−0.003 (.987)	0.279 (.077)	−0.079 (.622)	−0.231 (.146)	−0.071 (.661)
42	0.102 (.526)	0.293 (.063)	−0.030 (.851)	−0.214 (.179)	−0.093 (.563)
43	−0.225 (.158)	0.023 (.888)	−0.174 (.277)	−0.216 (.174)	−0.204 (.201)
44	−0.146 (.363)	0.060 (.711)	−0.101 (.528)	−0.130 (.419)	−0.166 (.300)
45	−0.069 (.667)	0.077 (.633)	−0.223 (.160)	−0.221 (.164)	−0.018 (.911)
46	−0.110 (.495)	0.212 (.183)	−0.182 (.254)	−0.208 (.191)	−0.075 (.641)
47	0.108 (.501)	0.279 (.078)	−0.046 (.774)	−0.080 (.619)	0.057 (.722)

Data are reported as *r* (*P* value). SB = sleep bruxism.

had any evidence available to suggest their involvement in the etiology of bruxism.[16]

On the other hand, the hypothesis of bruxism being the main cause of tooth wear still remains much debated. Such an interaction would imply that tooth wear is a consequence of bruxism and, further, is a valid diagnostic tool for bruxism. The basic prerequisite for such a hypothesis is that the two conditions (ie, tooth wear and bruxism) are associated.

This investigation was designed to assess the correlation between tooth wear and sMMA. This could represent a step forward with respect to the available literature, which has focused on the presence/absence of SB and not on the number of muscle contractions. The rationale for this approach was that, even if SB events with teeth-grinding sounds are likely the main example of sMMA that may have effects on teeth, it cannot be excluded that such effects are also due to activities that do not fulfill the requirements for SB. The present findings do not support the existence of a correlation between tooth wear and SB or other sMMA.

These results are difficult to compare with other investigations, mainly due to the heterogenous study designs. Jonsgar et al performed an investigation in individuals with mechanical intrinsic tooth wear and did not find any increased EMG activity during sleep with respect to matched controls.[17] Similar findings were reported by Palinkas et al, who compared PSG-confirmed SB individuals to nonbruxing individuals and concluded that tooth wear cannot help discriminate SB individuals.[18] Likewise, Castroflorio et al reported that the presence of tooth wear was not related to SB diagnosis performed with a portable EMG/ECG recorder.[19] Abe et al partially supported those observations, finding that the presence of tooth wear discriminated EMG-diagnosed SB with a current history of tooth grinding from nonbruxers in a young adult population, but its diagnostic value was modest (ie, between-group differences were statistically, but not clinically, significant due to the very small wear differences, which are likely clinically negligible). Moreover, tooth wear does not help determine the severity of SB.[6] Only Yoshizawa et al found opposite results, describing a higher rhythmic masticatory muscle activity (RMMA) in subjects with intrinsic mechanical wear than in those without.[20] Thus, in general, the available literature tends to suggest that clinicians cannot consider the presence of tooth wear as a direct indication of active SB.[21]

This investigation can be considered the first to broaden the assessment of an SB–tooth wear relationship to a more comprehensive spectrum of MMA, but it still has limits. In particular, both phenomena (ie, tooth wear and MMA) are complex conditions that require the adoption of a best available approach, which is less than ideal. For instance, while digital casts have been proposed as a valid evaluation tool for the assessment of tooth wear,[22,23] it cannot be excluded that multimodal assessment could help refine the approaches to its rating and differential diagnosis.[21] As for SB, emerging evidence is pointing out that PSG/SB criteria for a definite diagnosis have a limited value for clinical purposes.[5,24] Thus, measuring the number of muscle contractions is only the first step toward the refinement of studies on the topic, which should take into account the total muscle activity levels (ie, muscle work).

Current evidence, supported by this investigation, suggests that even if tooth wear can be a consequence of bruxism, its assessment cannot be used as a diagnostic tool for ongoing SB or for sMMA. The multifactorial and irreversible nature of tooth wear itself, as well as the momentary assessment of SB not taking into account the possible time-related fluctuation of the phenomenon, make it difficult to correlate the two conditions. In addition, it is likely that, in the clinical setting, tooth wear is actually the result of combined mechanical and chemical wear, with different relative predominances on an individual basis. In theory, suggestions that bruxism activity can stimulate the production of saliva and acts as a protective mechanism against chemical tooth wear further complicate the issue.[25,26] Furthermore, clinicians should keep in mind that tooth wear is irreversible and its assessment only provides information on the presence, but not the timing, of tooth surface loss. The clinical implications of these findings are important, as they encourage clinicians to broaden their view on both tooth wear and SB and to stop assuming a linear relationship between the two phenomena. From the bruxism expert perspective, it is also important to remark that tonic and phasic activities might have different relationships with tooth wear, since the latter occur more frequently in combination with grinding sounds.[11] Thus, a thorough evaluation of tooth wear risk factors and measurement of current SB/MMA aiming to understand whether the process is ongoing or is a result from earlier loss could be particularly useful for those practitioners involved in the field of prosthodontics and restorative dentistry.

Conclusions

Within the limits of this investigation, the correlation between the phenomena tooth wear and ongoing sMMA was not significant; thus, the null hypothesis of an absence of correlation between tooth wear and sMMA could not be rejected. The clinical implication of these findings is that the presence of tooth wear cannot be assumed as an indicator of ongoing SB or sMMA.

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