Predictors of Bruxism, Other Oral Parafunctions, and Tooth Wear over a 20-Year Follow-up Period

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Aims: *To analyze predictors of bruxism, other oral parafunctions, and tooth wear in a group of subjects who had been examined 20 years earlier.* ***Methods:*** *Originally, 402 randomly selected 7-, 11-, and 15-year-old subjects were examined clinically and by means of a questionnaire. Twenty years after the first examination, 94% of the original group could be traced, and 320 (85%) completed and returned the questionnaire. Of the oldest group, 100 (81%) also underwent a clinical examination focusing on occlusal factors and function and dysfunction of the masticatory system. For analyses of predictors of some oral parafunctions and tooth wear registered at the 20-year follow-up, logistic regression was used with recordings at the first examination as independent variables.* ***Results:*** *Subjective reports in childhood of bruxism (defined as tooth clenching during daytime and/or tooth grinding at night), clenching only, grinding at night only, nail biting, and/or other parafunctions were predictors of the same oral parafunctions 20 years later. There were different predictors of the 2 components of bruxism, daytime tooth clenching and tooth grinding at night. Postnormal occlusion (Angle Class II malocclusion) and tooth wear in childhood predicted increased tooth wear in adulthood. Subjects with nonworking-side interference had less anterior tooth wear than those without such interference.* ***Conclusion:*** *Oral parafunctions in childhood may be a persistent trait in many subjects. Postnormal occlusion and tooth wear in childhood predicted increased anterior tooth wear 20 years later, whereas nonworking-side interference reduced the risk for such wear in 35-year-old subjects.*
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Key words: dental occlusion, longitudinal study, nail biting, tooth clenching, tooth grinding

Bruxism, ie, clenching and grinding of the teeth, is a very common parafunction of the masticatory system. Although often described together, it has been acknowledged that 2 components of occlusal parafunction may be distinguished, viz diurnal and nocturnal bruxism, probably with different etiologies.[1] Milder forms of bruxism have rarely any severe consequences for the oral structures, whereas more extensive parafunctions may result in problems that are frustrating for both the patient and the dentist.[1–3] Examples of sequelae of bruxism often mentioned in the literature are tooth wear, muscular pain, temporomandibular joint pain, toothache, mobile teeth, headaches, and various problems with removable and fixed prostheses.

A positive relationship between bruxism and temporomandibular disorders (TMD) has been suggested by many clinicians and in many texts on TMD, but the evidence does not appear so strong

when critically scrutinized.[4–7] However, several recent studies both in children,[8–10] adolescents,[11] and adults[12–14] have demonstrated significant associations between various oral parafunctional habits and signs and symptoms of TMD. A few investigations have also found correlations between oral parafunctional activity and temporomandibular joint (TMJ) pathology.[15,16]

The etiology of TMD has long been a controversial issue and the knowledge of what causes TMD is still limited.[17] The etiology of bruxism has also been controversial and theories have invoked occlusal, psychological, genetic, and stress factors. The concept that bruxism is linked to occlusal disturbances has been abandoned. Currently, there is consensus about the multifactorial nature of its etiology, and bruxism is thought to be a central nervous system phenomenon related to stress and pain behavior more than to structural components.[4,7,18] Conflicting findings regarding the role of genetic factors have been presented in 2 extensive studies,[19,20] which may partly be explained by different objectives and populations of the 2 investigations. During the last few years much research on bruxism has focused on motor activities during sleep, whereas few studies have focused on daytime clenching.[21–25] Bruxism has lately been defined as a sleep disturbance and movement disorder.[18,24,25]

There are no conclusive results regarding the longitudinal development of bruxism in children. Some investigators have considered it a temporary phenomenon, others have described it as a fluctuating habit, and still others have observed many subjects who have retained their bruxing habit over long periods.[13,26,27] In a large questionnaire study of twins aged 33 to 60 years, it was found that current bruxism during sleep was highly correlated to retrospective reports of such bruxism in childhood.[19]

It is easy to find subjects who have increased tooth wear that most probably is caused by excessive bruxism. However, in the last few years, the multifactorial etiology of tooth wear has been emphasized. A combination of mechanical and chemical factors can often be verified, and parafunctions are only 1 of many risk factors.[28–32]

Some of the unanswered questions related to bruxism, tooth wear, and TMD might be investigated through a longitudinal approach. We have recently reported on a 20-year follow-up of subjects examined at 4 different occasions over 20 years.[13,33] The purpose of the present study was to analyze predictors of bruxism, other oral parafunctions, and anterior tooth wear by the use of logistic regression models with variables recorded at the first examination as independent variables. The hypothesis was that bruxism and other oral parafunctions in childhood would be identified as predictors of bruxism and other oral parafunctions and tooth wear 20 years later. Furthermore, an analysis was performed of the association between the dependent variable anterior tooth wear and variables recorded at the same occasion, at the 20-year follow-up.

Materials and Methods

Subjects

A detailed description of the subjects examined and the examination methods used has been presented recently.[13,33,34] Originally, 402 randomly selected 7-, 11-, and 15-year-old subjects were examined by means of a questionnaire on TMD symptoms, headaches, and oral parafunctions, and clinically regarding signs of TMD and occlusal factors. Follow-up examinations were performed after 5 and 10 years, the results of which have been presented previously.[35–37] Twenty years after the first examination, an attempt was made to find the addresses of the original participants, who at that time had reached the age of 27, 31, and 35 years, respectively. Three hundred seventy-eight individuals (94%) of the original group could be traced. The traced subjects were all sent a questionnaire. The response rate was high; 320 (80% of the original sample, 85% of the traced subjects) subjects comprising 167 women and 153 men completed and returned the questionnaire. The response rate varied somewhat between the 3 age groups: 74%, 80%, and 84% for the 27-, 31-, and 35-year-old subjects, respectively, calculated for the original samples.

The oldest group also received an invitation to participate in a clinical examination. Of the original 135 15-year-old subjects, 124 could be traced after 20 years, 114 completed and returned the questionnaire and 100 (81% of the traced subjects) also underwent a clinical examination focusing on function and dysfunction of the masticatory system.

Methods

The questionnaire included questions about the presence of symptoms from the masticatory system, including headaches, whether the subject often felt stress or was worried or depressed, oral parafunctions, previous trauma to the face, experience of TMD treatment during the observation period, and

current demand for TMD treatment. Questions about oral parafunctions comprised tooth clenching, tooth grinding at night, and other oral habits such as biting on nails, lip, cheek, and/or foreign objects. The variable bruxism was constructed by combining daytime tooth clenching and/or tooth grinding at night. The questions about stress, anxiety, and depression were not included in the first examination but added from the 10-year follow-up.

The standardized clinical examination[2,38] comprised measurements of range of movement of the mandible, presence of deflection during mouth opening, registration of TMJ sounds, locking or luxation, pain on movement of the mandible, TMJ or muscle pain on palpation, number of occluding tooth pairs, occlusal characteristics, and the degree of occlusal wear. All 3 authors have taken part in the follow-up examination after careful calibration, which was repeated at the start of each follow-up.[39]

Temporomandibular joint sounds were recorded as grade 1 (palpable clicking when the TMJs were palpated laterally) and grade 2 (audible clicking).

The muscles palpated were the origin and the insertion of the temporalis muscle, the lateral pterygoid muscle, the superficial portion of the masseter muscle, and the posterior belly of the digastric muscle. All muscles were palpated bilaterally.

Occlusal wear was classified according to a 5-point scale[38]; 1 = no or slight wear, 2 = wear of enamel only, 3 = wear into the dentin in single spots, 4 = exposure of dentin in an area of more than 2 mm^2, 5 = wear of more than one third of the clinical crown.

A Clinical Dysfunction Index (Di) according to Helkimo[40] was calculated from the 5 clinical parameters of mandibular mobility, TMJ function, pain on movement of the mandible, TMJ pain on palpation, and muscle pain on palpation.

Statistical Methods

Descriptive statistics were used to characterize the results of the questionnaire and clinical examinations that are presented elsewhere.[13,33] For analyses of predictors of some oral parafunctions and tooth wear, logistic regression was used. As these variables were categorical, dichotomies were constructed for use as dependent variables.

The following variables from the 20-year follow-up examination were selected as dependent variables: *(1)* bruxism (yes to 1 or both questions regarding daytime tooth clenching and tooth grinding at night); *(2)* daytime tooth clenching; *(3)* tooth grinding at night; *(4)* nail biting and/or other oral parafunction; and *(5)* anterior tooth wear (dichotomized wear scores 1 to 2 vs 3 to 5). For the original tooth wear recording used as the independent variable in the logistic regression analysis, the dichotomized scores were 1 to 2/3 to 5, because very few children had wear scores 4 or 5 (see below and Table 2). The first 4 variables were calculated for all participants who had answered the questionnaire at the 20-year follow-up (n = 320), whereas the fifth variable was based on the clinical examination that was performed only in the oldest group (n = 100, 35 years of age at the last follow-up). Because of missing data for some of the variables, the number of subjects in these analyses was slightly lower than the total number of participants. Associations between the dependent variable anterior tooth wear and variables recorded at the same occasion, the 20-year follow-up examination, were also analyzed by stepwise logistic regression.

The bivariate analyses between the dependent dichotomous variables at the 20-year follow-up and the independent variables were performed by Fisher non-parametric permutation test for ordered variables[41] and by Fisher-exact test for dichotomous variables. All significant variables from these bivariate analyses and some other variables considered to be of special interest were entered as independent variables into multivariate stepwise logistic regression models. The results from these analyses were given as odds ratios (OR) with 95% confidence intervals (CI) and adjusted *P* values. All significance tests were 2-tailed and conducted at the 5% significance level.

Results

The bivariate analyses between the dependent variable, reported bruxism at the 20-year follow-up, and selected variables from the first examination 20 years earlier resulted in 5 significant ($P < .05$) associations. These 5 variables (reported bruxism, bruxism and other oral parafunctions, headache, pain after heavy chewing, TMD symptoms including pain after chewing) plus 1 dental variable (anterior open bite) that was close to significance ($P = .06$) were included in the logistic regression model with reported bruxism at the 20-year follow-up as the dependent variable. Two variables (reported bruxism and TMD symptoms) turned out to be statistically significant predictors (Table 1). The OR of 3.1 suggests that there is approximately 3 times greater chance that a person who reported bruxism at the first examination would report bruxism 20 years later. The increased risk

Table 1 Significant Results of Stepwise Logistic Regression with 4 Variables Related to Oral Parafunction at the 20-Year Follow-up as Dependent Variables, and Variables from the First Examination as Independent Variables

Dependent variables	Independent variables	OR	95% CI	Adjusted *P*
Reported bruxism	Reported bruxism	3.1	1.6–6.3	.0003
	TMD symptoms	1.6	1.03–2.3	.034
Reported tooth clenching	Reported tooth clenching	6.8	1.6–28.3	.0004
	Dysfunction Index	1.7	1.1–2.8	.024
Reported tooth grinding at night	Tooth grinding at night	2.9	1.3–6.3	.0059
	Tooth Wear Index	12.5	1.5–100.0	.0030
Reported nail biting or other oral parafunctions	Nail biting/other oral parafunctions	2.4	1.6–3.6	< .0001
	Psychologically tense/10 yr	2.6	1.4–5.0	.0023

OR = odds ratio; CI = confidence interval.

for subjects who originally reported bruxism and TMD symptoms to report bruxism at the latest follow-up is illustrated in Table 2. Those who were aware of bruxism at the last follow-up comprised all (100%) who had reported frequent bruxism and 75% of those with occasional bruxism 20 years earlier.

In the bivariate analyses between variables from the first examination and the dependent variable tooth clenching at the 20-year follow-up, 8 significant ($P < .05$) associations were found (pain after heavy chewing, tooth clenching, tooth grinding at night, headache, muscle pain at palpation, dysfunction index, TMD symptoms including pain after chewing, bruxism). These variables were included as independent variables in a logistic regression model with tooth clenching at the 20-year follow-up as the dependent variable. Tooth clenching was the strongest and Clinical Dysfunction Index[40] was the other significant predictor found (Table 1).

The bivariate analyses between the dependent variable tooth grinding at night at the 20-year follow-up and variables recorded at the first examination resulted in 5 significant ($P < .05$) associations (tooth clenching at night, bruxism, tooth wear, headache, tooth wear index: 1 to 2/3 to 5). These variables were used as independent in a logistic regression analysis, which exhibited 2 significant predictors, the tooth wear index being the strongest (Table 1).

In the similar procedure with nail biting and/or other oral parafunctions at the 20-year follow-up as the dependent variable, 6 significant variables (jaw fatigue, oral parafunctions, bruxism and oral parafunctions, TMD symptoms excluding TMJ clicking, motorically uneasy, and psychologically tense at 10-year examination) were found to be significantly ($P < .05$) associated and included as

Table 2 Relationship Between the Significant Predictors from the First Examination (According to the Logistic Regression, Table 1) and the Dependent Variables at the 20-Year Follow-up

Predictors at start	n (%)	*P* value
Reported bruxism		
No	116 (52)	
Occasional	33 (75)	
Frequent	7 (100)	.0004
Reported TMD symptoms including pain during chewing		
No	53 (50)	
Occasional	88 (61)	
Frequent	15 (91)	.030
Reported tooth clenching		
No	102 (46)	
Occasional	16 (80)	
Frequent	5 (100)	.002
Dysfunction Index		
0	50 (41)	
I	58 (55)	
II	17 (74)	
III	1 (25)	.014
Reported tooth grinding at night		
No	63 (38)	
Occasional	15 (65)	
Frequent	3 (75)	.005
Tooth Wear Index		
1–2	78 (31)	
3–5	11 (73)	.005
Reported nail biting or other oral parafunctions		
No	21 (24)	
Occasional	52 (44)	
Frequent	39 (59)	< .0001
Psychologically tense		
No	69 (35)	
Yes, often tense	20 (67)	
Yes, often very tense	4 (57)	.003

Table 3 Significant Results of Stepwise Logistic Regression with Anterior Tooth Wear at the 20-Year Follow-up as Dependent Variable, and Variables from the First Examination as Independent Variables

Dependent variable	Independent variables	OR	95% CI	Adjusted *P*
Anterior Tooth Wear (score 1 to 3/4 to 5)	Anterior tooth wear	3.4	1.2–10.0	.019
	Postnormal occlusion	7.3	1.2–14.4	.0011
	Premolar tooth wear	4.1	1.2–14.4	.019

OR = odds ratio; CI = confidence interval.

Table 4 Relationship Between the Significant Predictors from the First Examination (According to the Logistic Regression, Table 3) and the Dependent Variable at the 20-Year Follow-up Anterior Tooth Wear (Incisors and Canines)

Predictors at start	n (%)	*P* value
Anterior tooth wear		
1	1 (10)	
2	15 (21)	
≥ 3	10 (59)	.0016
Premolar tooth wear		
1	0	
2	17 (20)	
≥ 3	9 (53)	.0057
Postnormal occlusion		
No	17 (20)	
Yes	9 (60)	.0012

Table 5 Relationship Between Nonworking-Side Interference and Severe Anterior Tooth Wear in 100 35-Year-Old Subjects (*P* = .031)

	Nonworking-side interference	
	No	Yes
Severe anterior tooth wear (score 4 or 5)		
No	49	25
Yes	23	3

independent variables in the regression model. Two significant predictors were found (nail biting and psychologically tense at 10-year follow-up), both with similar OR (Table 1).

The relationship between the predictors from the earlier examinations for occlusal and oral parafunctions reported at the 20-year follow-up is presented in Table 2. A majority of those who reported occlusal and oral parafunctions at the last follow-up had been aware of these parafunctions 20 years earlier.

The bivariate analyses between the dependent variable anterior tooth wear (wear on incisors and canines) at the 20-year follow-up, and variables recorded at the first examination resulted in 4 significant ($P < .05$) associations (anterior tooth wear, premolar tooth wear, scissors bite [also known as lingual crossbite], and postnormal occlusion [also known as Angle Class II malocclusion]). These were used as independent variables in a logistic regression analysis, which exhibited 3 significant predictors, postnormal occlusion being the strongest (Table 3). The relationship between these predictors recorded at the first examination and extensive anterior tooth wear 20 years later is shown in Table 4. The influence of a postnormal occlusion is also illustrated by the finding that those with more extensive anterior tooth wear (score 4 to 5) at the last examination (at age 35) had a greater horizontal overjet (4.1 mm) than the other subjects (2.9 mm for those with a score of 1 to 3) at age 15.

The bivariate analysis between wear of front teeth and other variables recorded at the 20-year follow-up (of the 100 clinically examined 35-year-old subjects) resulted in only 1 significant association ($P < .05$), viz with nonworking-side interference. To this variable 2 more were added (headache and bilateral crossbite, which were close to significance; both $P = .08$) and included in the regression model with wear of anterior teeth as the dependent variable. Only nonworking-side interference was significant with an OR of 0.26 (CI 0.07–0.93, $P = .030$), indicating that those with nonworking-side interference had an almost 4 times (1/0.26) reduced risk of exhibiting severe tooth wear on incisors and canines (Table 5).

Discussion

The significant predictors of bruxism and oral parafunctions in a 20-year perspective were bruxism and oral parafunctions, respectively, reported in the first questionnaire. The strong associations between the first report and the one 20 years later are evident in Table 2. The majority of those who

considered themselves bruxers as adults were aware of bruxism as children. This suggests that bruxism (including both daytime clenching and grinding at night) is a behavior that may persist for long periods in some individuals and contradicts the opinion that bruxing in childhood is a temporary phenomenon.[26,27] It corroborates the finding in a large group of Finnish twins that there was a strong correlation between bruxism in childhood and in adulthood.[19] Another interpretation may be that subjects who have become aware of bruxism, in one way or another, continue to report the habit.[42] It would be interesting to discuss the long-term experience of bruxism observed in the present study in relation to the recent opinion that nocturnal bruxism may be a sleep disorder.[24,25] No study published so far seems to have focused on the longitudinal aspects of sleep bruxism.

TMD symptoms in childhood were a predictor of bruxism 20 years later (Tables 1 and 2). As presented earlier, reported bruxism at the 20-year follow-up examination was moderately correlated ($r \approx 0.4$ to 0.5) to jaw fatigue and TMD symptoms reported at the same occasion.[13] These findings might suggest support for the prevalent opinion that bruxism is an etiologic factor in TMD patients.[3] It is prudent to be cautious with such a conclusion, since one of the problems in studying this relationship is the difficulty of quantifying bruxist activity. This study relied on self-report of bruxism, which has been considered to be methodologically questionable.[22,42] However, in epidemiologic studies, self-reporting by means of a questionnaire or an interview is one of the few methods available.

Since it has been suggested that tooth clenching during daytime and nocturnal sleep-related tooth grinding may be different parafunctional entities,[1,7] the variable bruxism was divided into the original components. The analyses showed that each of the originally reported occlusal parafunctions (as well as nail biting and/or other parafunctions) predicted an increased risk of reporting the same parafunction 20 years later (Table 1). The different second predictors of tooth clenching (Clinical Dysfunction Index) and tooth grinding (Tooth Wear Index) may be interpreted as support for the opinion that these 2 parafunctions can be separated in terms of, for example, their etiology and pathophysiology. Previous studies have also demonstrated some differences between tooth clenching and tooth grinding with respect to associated TMD symptoms.[20,43,44]

The frequently suggested (but far from clear) association between sleep bruxism and psychological factors[18] found some support by the statistically significant correlations previously presented for these subjects.[13] It must be emphasized, however, that these correlations were very weak ($r \approx 0.2$) and may explain less than 5% of the variance of bruxism. In the present analyses, the reporting of psychological tension at the 10-year follow-up (no such data were available at the first examination) turned out to be a significant predictor of nail biting and other oral parafunction at the 20-year follow-up but not to bruxism or its components (Table 1). The current consensus among most TMD experts that bruxism is not linked to occlusal characteristics[18,45] was supported by the results, which could not demonstrate any significant association between dental/occlusal factors and bruxism.

It is a trend in the current literature to emphasize the multifactorial etiology of tooth wear[28–32] and to maintain that bruxism is only one of many reasons for increased tooth wear. Factors that are now considered important, such as dietary habits and salivary flow rate, were not included in the analyses. The tooth wear index at the first examination was a strong predictor of tooth grinding at night 20 years later, which might suggest a long-term relationship. However, none of the other oral parafunctions was significantly associated with tooth wear (neither as long-term predictors nor as factors recorded at the same occasion, the 20-year follow-up), which indicates that bruxism may not be as strong as an etiologic factor in tooth wear as often suggested.

Anterior and premolar tooth wear indexes at the first examination were significant predictors of tooth wear of front teeth 20 years later. This seems logical, as tooth wear does not "heal" spontaneously. Wear of the canines was not significantly associated with the later front tooth wear, which probably is due to the fact that the canines had not been erupted long enough at age 15 to have acquired much tooth wear. The longitudinal increase of tooth wear in the examined group over the 20-year observation period has been described elsewhere.[33]

A dental factor, postnormal occlusion at age 15, was the strongest predictor of increased wear of anterior teeth at age 35. This finding was corroborated by the bivariate analyses demonstrating an originally greater horizontal overjet among those with increased tooth wear (score 4 to 5) in comparison with those with less tooth wear (score 1 to 3) at age 35. One explanation to the increased tooth wear in postnormal cases might be that both tooth grinding and tooth clenching are more common in subjects with postnormal occlusion, compared to

subjects with normal occlusion.[46] A hypothetical explanation for the increased wear of anterior teeth might be that subjects with postnormal occlusion consciously or unconsciously protrude the mandible to improve the profile of the face ("sunday-face position"), thereby creating more wear in the frontal region. This hypothesis is supported by the increased wear found in subjects with dual bite, in whom the posterior occlusal position often can be characterized as postnormal.[47]

Among variables recorded at the same occasion in the 35-year-old subjects, the only factor that was significantly associated with increased wear of anterior teeth was absence of nonworking-side interference (Table 5). The importance of nonworking-side interference has been described in controversial terms.[48] It has been considered both as detrimental to the health of the masticatory system and as a protection from developing TMJ clicking.[49] The present results indicate that nonworking-side interference may protect the dentition of extensive wear from the anterior teeth, probably by preventing the anterior teeth from extensive contacts during function. In the previous analyses of this material, there was no evidence that nonworking-side interference was correlated to TMD signs and symptoms.[33]

Conclusions

Based on the results of this study, the following conclusions may be drawn:

1. Reports in childhood of bruxism, tooth clenching, tooth grinding at night, and nail biting, and/or other parafunctions were predictors of the same oral parafunctions 20 years later. This suggests that oral parafunctions may be a persistent trait in many subjects.
2. Predictors of the 2 components of bruxism, tooth clenching during daytime and tooth grinding at night, were not the same, which supports the opinion that these 2 occlusal parafunctions may be different entities.
3. Postnormal occlusion and tooth wear in childhood predicted increased tooth wear in adulthood.
4. Nonworking-side interference reduced the risk for extensive tooth wear of the anterior teeth in 100 35-year-old subjects.

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