Incisal Tooth Wear and Self-Reported TMD Pain in Children and Adolescents

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Purpose: Incisal tooth wear may be a sign of long-term bruxing behavior. Bruxism is purported to be a risk factor for temporomandibular disorders (TMD). The aim of this population-based cross-sectional study was to determine if anterior tooth wear is associated with the self-report of TMD pain in children and adolescents. ***Materials and Methods:*** In a population sample of 1,011 children and adolescents (mean age 13.1 years, range 10 to 18 years; female 52%; response rate 85%), TMD cases were defined as subjects reporting pain in the face, jaw muscles, and temporomandibular joint during the last month according to RDC/TMD. All other subjects were considered controls. Incisal tooth wear was assessed in the clinical examination using a 0 to 2 scale (no wear, enamel wear, dentin wear) for every anterior permanent tooth. The mean wear score for the individuals was categorized into 0, 0.01 to 0.20, 0.21 to 0.40, and 0.41+. A multiple logistic regression analysis, controlling for the effects of age and gender, analyzed the association between the categorized summary wear score and TMD. Specifically, the hypothesis of a trend between higher tooth wear scores and higher risk of TMD was tested. ***Results:*** An odds ratio of 1.1 indicated, after adjusting for gender and age, no statistically significantly higher risk of TMD pain with higher tooth wear scores. ***Conclusion:*** Incisal tooth wear was not associated with self-reported TMD pain in 10- to 18-year-old subjects. *Int J Prosthodont 2004;17:205–210.*

Pain from temporomandibular disorders (TMD) is a public health problem in children and adolescents.[1] Treatment demand is estimated to be between 2% and 5% in this age group.[2] Clenching and grinding are parafunctional habits implicated in TMD[3] based on the hypothesis that the increased muscle activity triggers pain in the masticatory muscles and temporomandibular joint.[4,5] Wear facets are suggested to be indicators of these parafunctional habits.[6,7] They are caused more by long-lasting, dynamic tooth-to-tooth contacts than by other factors (nutrition, salivary buffer)[8] and can be found mainly in the canine and incisor region.[9]

Wear facets from bruxing have been reported to be common in the primary dentition[10]; the reported prevalence varies from 5% to 81%.[6] Studies report a relationship between tooth wear and TMD symptoms in children as well as teenagers.[11–13] Other investigators have not been able to support these findings.[14–17]

At present, it is still unknown whether bruxism and TMD have a cause-effect relationship or represent coexisting phenomena.[18] The authors recently reported that incisal tooth wear is not associated with TMD risk in adults.[19] In that clinic-based case-control study, an odds ratio (OR) of 0.76 (95% confidence interval [CI] 0.51 to 1.15; $P = .20$) was found. Using a different study design (population-based cross-sectional), which reduces the potential of selection bias that clinical case-control studies may suffer from, offers the opportunity to confirm these findings. Performing such a study in children and adolescents should provide evidence for or against an incisal tooth wear–TMD relationship in this age group, but it should also contribute to knowledge about this association in general.

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Based on the hypothesis that long-lasting bruxing activity that becomes obvious in worn teeth increases the risk for TMD pain, this population-based, cross-sectional study aimed at investigating whether tooth wear of the anterior teeth, as assessed in a clinical examination, is linearly associated with self-reported TMD pain in children and adolescents.

Materials and Methods

Study Subjects

Children and adolescents (n = 1,011) came from a regional survey of 1,190 10- to 18-year-olds in Halle/Saale, Germany (85% response rate). They were sampled from a register containing all children and adolescents in Halle/Saale aged 10 to 18 years and required to attend school; a two-stage cluster technique was used. The sample was representative for 24,129 children and adolescents attending general schools in Halle/Saale in 1999. Schools with mentally retarded or learning-disabled children were not included in the sampling. Among the 189 nonresponding subjects, in 33% of cases (n = 62) parents did not give permission for school examination, 25% (n = 48) were absent because of illness, and 42% (n = 79) did not want to participate. Data were collected in an additional part of the regular dental school examination (yearly dental checkup). The study protocol was reviewed and approved by the Ethics Committee of Martin Luther University, Halle-Wittenberg, the local education authority, and the Parent's Council.

Variables

The outcome of the study was self-report of TMD pain asked using a question according to the *Research Diagnostic Criteria for Temporomandibular Disorders* (RDC/TMD)[20] (Have you had pain in the face, jaw, temple, in front of the ear, or in the ear in the past month?). Subjects with positive self-report of TMD pain were defined as cases; all other subjects were considered controls.

An intraclass correlation coefficient (ICC) that treated subjects and occasions as random factors was computed to determine test-retest reliability of the question in a group of 23 10- to 12-year-old children using an interval of 2 weeks. According to guidelines,[21] test-retest reliability was fair to good (ICC = .73).

The exposure variable, incisal tooth wear, was assessed for all anterior permanent teeth (ie, all maxillary and mandibular incisors and canines) in the clinical examination according to a modified scale described by Egermark-Eriksson.[22] This scale consisted of three grades of tooth wear: 0 = no tooth wear; 1 = enamel wear only; and 2 = dentin wear. The mean wear score for the individuals was categorized into four groups: 0, 0.01 to 0.20, 0.21 to 0.40, and 0.41+ (minimum 0 = no tooth wear, maximum 2 = all teeth worn into dentin). Three calibrated examiners took part in the study. The interexaminer reliability of tooth wear assessment was determined prior to the study using 10 subjects (10 to 16 years old). Test-retest reliability was excellent (ICC = .92) according to guidelines.[21]

Gender and age (two age groups: 10 to 13 years and 14 to 18 years) were considered confounding variables. Dental/facial trauma (Have you had dental or facial trauma? test-retest reliability: ICC = .77) and orthodontic treatment (Do you have or did you have an orthodontic appliance? ICC = .88) were considered influential variables, as were overbite and overjet. Overbite and overjet were measured with a millimeter ruler according to the manual of the RDC/TMD.[20] The interexaminer reliability was excellent for overbite (ICC = .92) and overjet (ICC = .94).

Statistical Analysis

The primary aim of the present study was to investigate whether tooth wear is linearly associated with (the log odds of) self-reported TMD pain. A secondary aim was to investigate whether differences exist in the distribution of tooth wear categories in cases and controls. First, the association between categorized tooth wear and TMD pain (not involving other factors) was investigated using a chi-square test with one degree of freedom (trend test), and a chi-square test with three degrees of freedom for differences among the tooth wear categories (test of independence). Second, stratified analyses were performed to control the influence of age and gender. Chi-square tests with one and three degrees of freedom were used to test for trend or any differences among the wear categories. Third, a multiple logistic regression analysis incorporated tooth wear, age, and gender. Tooth wear was modeled as a grouped linear variable to test for trend. To test for differences among the wear categories, tooth wear was modeled with indicator variables using the lowest wear category as the reference.

A sensitivity analysis was performed to check the robustness of the statistical model. Dental/facial trauma was included in the analysis, and age was modeled as a linear instead of dichotomous variable. Model fit was evaluated using the Hosmer-Lemeshow test.[23] No interactions between variables were included in the model because they were not expected a priori. To evaluate whether the sampling design had any effect on the results, the two-stage cluster structure of the sample and sampling weights was included in all regression models (design-based analysis). All analyses

Table 1 Sample Characteristics by TMD Status

Characteristic	TMD pain subjects (n = 156)	Control subjects (n = 855)
Age in y: mean (SD)	13.3 (2.0)	13.1 (2.0)
Female gender: % (n)	61 (95)	50 (430)
Dental/facial trauma: % (n)	49 (76)	37 (315)
Orthodontic treatment: % (n)	28 (43)	30 (253)
Overbite in mm: mean (SD)	3.3 (1.8)	3.3 (1.9)
Overjet in mm: mean (SD)	3.1 (1.9)	3.1 (1.9)
Tooth wear: mean (SD)	1.6 (2.6)	1.3 (2.3)
Mean wear categories: % (n)		
0.00	58 (91)	66 (560)
0.01–0.20	19 (29)	12 (106)
0.21–0.40	13 (20)	14 (116)
0.41+	10 (16)	8 (73)

SD = standard deviation.

Table 2 Tooth Wear and TMD Pain Association by Gender: % (n)

Mean wear category	Male* (n = 486)		Female† (n = 525)	
	TMD pain subjects	Control subjects	TMD pain subjects	Control subjects
0.00	64 (39)	64 (272)	55 (52)	67 (288)
0.01–0.20	15 (9)	12 (52)	21 (20)	13 (54)
0.21–0.40	10 (6)	15 (62)	15 (14)	13 (54)
0.41+	11 (7)	9 (39)	9 (9)	7 (34)

*Test for trend: $\chi^2(1) = 0.00$, $P = .99$; test of independence: $\chi^2(3) = 1.43$, $P = .70$.
†Test for trend: $\chi^2(1) = 2.44$, $P = .12$; test of independence: $\chi^2(3) = 6.29$, $P = .10$.

Table 3 Tooth Wear and TMD Pain Association by Age: % (n)

Mean wear category	10–13 y* (n = 556)		14–18 y† (n = 455)	
	TMD pain subjects	Control subjects	TMD pain subjects	Control subjects
0.00	72 (58)	75 (358)	43 (33)	53 (202)
0.01–0.20	14 (11)	11 (52)	24 (18)	14 (54)
0.21–0.40	8 (6)	8 (38)	18 (14)	21 (78)
0.41+	6 (5)	6 (28)	15 (11)	12 (45)

*Test for trend: $\chi^2(1) = 0.08$, $P = .78$; test of independence: $\chi^2(3) = 0.58$, $P = .90$.
†Test for trend: $\chi^2(1) = 0.87$, $P = .35$; test of independence: $\chi^2(3) = 5.24$, $P = .16$.

were carried out using the statistical software package STATA, release 7.0 (Stata Statistical Software), and with the probability of a type I error set at the .05 level.

Results

TMD pain was reported by 15% of the sample (n = 156). Compared to controls, subjects reporting TMD pain were more often female (cases 61% vs controls 50%) and more often had dental/facial trauma in their lives (cases 49% vs controls 37%) (Table 1). Age characteristics and orthodontic treatment were similar in cases and controls. Group means of overbite and overjet were nearly identical in both groups. Although cases presented a slightly larger mean tooth wear (1.6 vs 1.3), a trend for more frequent wear in cases across the wear categories was not observed (Table 1; trend test $\chi^2(1) = 1.26$; $P = .26$). The differences among wear categories were not statistically significant (independence test $\chi^2(3) = 5.33$; $P = .15$).

Association Between Tooth Wear and TMD Pain, Stratified by Gender or Age

A trend between higher mean tooth wear and higher proportion of TMD pain was not observed for either gender (Table 2). The lower percentage of female control subjects in the category 0.01 to 0.20 (13%) compared to female cases in this category (21%) was not statistically significant (Table 2). No substantial differences in the distribution of tooth wear categories among cases and controls were observed in male subjects.

The prevalence of any tooth wear increased from about 25% in 10- to 13-year-olds to almost 50% in 14- to 18-year-olds (Table 3). The distribution of cases and controls was very similar across mean tooth wear categories in the younger age group. In the older age group, the different proportions of cases and controls in the category 0.01 to 0.20 (24% vs 14%) were not statistically significant (Table 3).

Table 4 Multivariable Analysis of Tooth Wear and TMD Pain Association

Variable in the statistical model	Odds ratio	95% CI	P
Mean wear category			
0.00	Reference	–	–
0.01–0.20	1.6	1.0–2.6	.04
0.21–0.40	1.0	0.6–1.7	.94
0.41+	1.3	0.7–2.4	.36
Gender	1.6	1.1–2.2	.02
Age	1.2	0.8–1.7	.40

CI = confidence interval.

Multivariable Analysis

In the trend analysis, using mean tooth wear as a grouped linear variable, the odds of TMD pain increased by 9% for each tooth wear category, controlled for the influence of age and gender. This increase was clinically not meaningful and statistically not significant. A substantial linear association between tooth wear and TMD pain could be excluded by the narrow CI (OR 1.09; 95% CI 0.9 to 1.3).

Comparing single wear categories with the reference category "0," the OR for subjects with 0.01 to 0.20 tooth wear was 1.6, indicating a higher risk for TMD pain in this category compared to subjects without tooth wear. This effect was statistically significant ($P = .04$). In this model, gender (OR 1.6; 95% CI 1.1 to 2.2) was a statistically significant factor, but age (OR 1.2; 95% CI 0.8 to 1.7) was not (Table 4).

Sensitivity Analysis

Using tooth wear in its original continuous form resulted in an OR of 1.04 (95% CI 1.0 to 1.1) for the risk of TMD pain. When age was modeled as a linear instead of dichotomous variable, the results did not change. Neither the magnitude of the coefficients for mean tooth wear categories nor the standard errors changed notably compared with the base model in Table 4. The same analyses including the variable history of dental/facial trauma showed very similar results (all P values for mean tooth wear categories $> .05$).

Comparing the design-based analysis with the model-based analysis (the sampling design is not included in the analysis; Table 4) did not change the results, except for the mean tooth wear category 0.01 to 0.20, which was no longer statistically significant ($P > .05$). The previously observed gender effect became statistically nonsignificant ($P > .05$).

Discussion

The results of the present study support our previous findings that TMD pain and incisal tooth wear are not associated.[19] Together, this previous study in adults and the present study in children and adolescents present strong evidence for the absence of a substantial association between tooth wear and TMD. The primary hypothesis that higher tooth wear scores are linearly related to a higher risk for TMD pain could not be confirmed. However, we found a statistically significantly higher OR for TMD pain in the second wear category (0.01 to 0.20) compared to the reference category (0). This unexpected effect might be random. This assumption is supported by the fact that the effect could not be confirmed in the analysis including the sampling design.

The age and gender distribution also did not support the hypothesis of a tooth wear–TMD pain relationship. Both genders showed about the same prevalence of tooth wear. However, in most studies, TMD pain is more prevalent in female adolescents.[1,24] If tooth wear is a risk factor for TMD pain, it should occur notably more often in female subjects, which was not the case in our study.

Our results are supported by various bruxism-TMD studies in children and adolescents[15,17] that could not find a relationship between both phenomena. These studies, as well as our study, used tooth wear as a proxy for bruxism. Tooth wear can be regarded as a cumulative lifetime event: The higher the age, the larger the number of tooth wear facets.[25,26] A recently published longitudinal study confirmed that tooth wear is a chronic problem.[27] Thus, the parafunctional activity that caused tooth wear could have occurred several months or years previously. The assessment of worn teeth cannot differentiate between the different forms of bruxism (sleep-related or daytime bruxism, recent or past bruxism).[28] Thus, we are able to exclude an association between long-lasting (chronic) parafunctional activity and TMD pain, but not an association between recent parafunctional activity (recent grinding) and TMD pain, which has probably not yet led to detectable tooth wear.

A longitudinal study of 6- to 9-year-old children over 5 years, which could not find a relationship between bruxism and TMD symptoms, used a combination of tooth wear and self-reported clenching or grinding as exposure variables.[16] Although the exact approach of the combined analysis of tooth wear and self-reported bruxism using a chi-square-test was not described in that paper, multivariate methods would have been more appropriate for the TMD risk factor analyses.[29,30]

Another point is that, just around the age of 6 years, a mixture of primary and permanent teeth can be found in the subjects, as in a recent etiologic study of TMD in 6- to 8-year-old children.[30] This means that even in studies in which a tooth wear–TMD relationship was found in young children,[13,30] the presence of a mixture of primary and secondary dentition may complicate the analysis of such an association.

The credibility of our results regarding the nonexisting association between tooth wear as a proxy for long-lasting bruxing activity and TMD pain is supported by the fact that some important methodologic aspects were considered in the study design. First, we assessed the data from a large random sample. Second, the clinical assessment was performed using standard methods for TMD[20] as well as for incisal tooth wear.[9,31] Third, possible confounders of a TMD–tooth wear relationship, like age and gender, were considered in the multivariate analysis. Our analyses did not change notably when the sampling design was included in the statistical model. However, future research should consider that both tooth wear and TMD are complex and multifactorial phenomena with manifold possibilities of mutual influences that are largely unknown at present.

There is no universally accepted classification for TMD.[32] Therefore, we used self-report of TMD pain according to a question from the RDC/TMD as the study outcome, first because this question is well-accepted as part of a widely used TMD classification system, and second because self-report of TMD pain is part of RDC/TMD muscle as well as joint pain diagnoses.[20] Thus, a substantial correlation between self-report of TMD pain and disorders that are meaningful in terms of clinical effect can be assumed.

It seems to be of particular importance that two studies aiming to investigate the incisal tooth wear–TMD pain association from different angles came to the same conclusion. The first one was a clinic-based case-control study in adults, in which the outcome was treatment demand for TMD and exposure was incisal tooth wear assessed on casts.[19] The present study in children and adolescents was a population-based cross-sectional study with a TMD pain complaint in the last month as the outcome and a clinical wear assessment as exposure. The different approaches resulted in the same conclusion.

Incisal tooth wear, assessed on anterior teeth during a clinical examination, was not significantly associated with TMD pain in 10- to 18-year-olds after controlling for the influence of age and gender. Based on our findings, a clinically relevant increased risk for TMD from incisal tooth wear could be excluded. If incisal tooth wear can be regarded as a proxy for tooth grinding over longer periods, a clinically meaningful risk from that type of bruxism for TMD does not exist. Hence, therapy of bruxism in children and adolescents with the aim to prevent TMD pain is not supported by the present study. However, further studies are necessary to prove or exclude an association between recent parafunctional activity and TMD.

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Literature Abstract

In vitro cytotoxicity of traditional versus contemporary dental ceramics.

Five dental ceramic systems were investigated for their ability to affect cellular mitochondrial dehydrogenase activity (crucial for normal cell function). The systems tested included two feldspathic porcelains (Vita Omega and Duceragold), two lithium disilicate materials (Stylepress and Empress 2), and a pressable leucite-based material (Empress). Materials were tested for initial in vitro cellular response. Specimens were aged 1 week and tested again. Aging and cellular response steps were repeated at the end of the second week. Specimens were then polished with a diamond bur. Aging and cellular response measurements were repeated on the polished specimens. Polytetrafluoroethylene was used as a control. Regardless of aging and polishing, both feldspathic ceramics produced statistically insignificant mitochondrial suppression ($<$ 25% of controls). Insignificant mitochondrial activity stimulation was noted in the leucite-based material initially. Polishing the samples did not affect results. Initial suppression of mitochondrial activity was noted in both lithium disilicate materials. Empress 2 was cytotoxic initially ($<$ 20% of controls) and became more cytotoxic after polishing. Stylepress was less cytotoxic initially (85% of controls, insignificant) and did not become more cytotoxic after polishing. Conventional feldspathic ceramic materials have been accepted as biologically safe. However, this study showed that in vitro biologic effects of various dental ceramics are not identical. Based on the empiric biocompatibility standard used for dental alloy and composite evaluation, most ceramics tested produced a mild effect on cell function. One tested lithium disilicate material (Empress 2) demonstrated biologically unacceptable cytotoxicity. Cytotoxicity and biocompatibility of dental ceramics could be a significant factor in the long-term success of dental restorations. All dental ceramics should be tested for biologic safety; assumption of clinical safety should be avoided.

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