Occlusal Tooth Wear in Patients of a Dental School's Prosthodontic Department in Xi'an, China

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Purpose: To assess the relationships between occlusal tooth wear and occlusal conditions, chewing side preference, and occlusal guidance scheme. ***Materials and Methods:*** A total of 257 Chinese adult dental school patients were categorized according to a hierarchical functional classification system. Occlusal tooth wear was assessed using a modified Smith and Knight index. Occlusal tooth wear index (OTWI) scores were analyzed using multivariate regression models, including four specific occlusal conditions (≥ 10 teeth in each arch, complete anterior regions, sufficient premolar regions, and sufficient molar regions) adjusted for age and sex. ***Results:*** Occlusal tooth wear was observed in all participants; older participants and men had significantly higher mean OTWI scores. The occlusal condition of having fewer than 10 teeth in each arch was significantly associated with occlusal tooth wear; participants with fewer than 10 teeth in each arch had higher mean OTWI scores in anterior and premolar teeth. OTWI scores for the different tooth types were highly correlated with chewing side preference. OTWI scores for the molar region (including third molars) were significantly higher at the preferred chewing side. The same effect was seen for OTWI scores of all teeth combined. OTWI scores were not associated with occlusal guidance scheme. ***Conclusions:*** The occlusal condition of having fewer than 10 teeth in each arch appears to be a risk factor for increased occlusal tooth wear. Occlusal wear was more severe at the chewing side. Occlusal tooth wear was significantly associated with the nondental factors of age and sex. *Int J Prosthodont 2014;27:54–60. doi: 10.11607/ijp.3642*

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Wear can be defined as the progressive loss of material from contacting surfaces of a body, caused by motion and pressure at the surface. Tooth wear is a complex phenomenon in which biologic, mechanical, chemical, and tribologic factors interact.[1,2] Occlusal tooth wear may lead to decreased masticatory function, with a concomitant negative impact on quality of life and possible deterioration of systemic health.[3] There is abundant evidence that tooth wear and tooth loss are age-related, but there is little evidence supporting a direct interrelationship between those two.[4–7]

Etiologically, tooth wear may be caused by attrition (tooth-to-tooth contact), abrasion (mechanical friction from foreign elements), or erosion (chemical dissolution from acidic diets) occurring together or separately. Of these processes, attrition is the most closely related to the occlusal status of the dentition. As number and location of teeth define occlusal status and attrition affects mainly the occlusal or incisal surfaces of the teeth, a mutual relationship between occlusal status and attrition might be expected. Evidence of such a relationship is only available from a Saudi Arabian

study that showed a relationship between number of teeth and tooth wear severity in 400 tooth wear patients from 20 clinics.[8] Data from general populations are needed to suggest evidence-based management of reduced dentitions, eg, splints for protection of the occlusal surfaces of the teeth or tooth replacements to compensate for the presence of fewer teeth. Recently, different occlusal conditions (referring to number and location of teeth) have been included in a hierarchical functional classification system that reflects oral function in relation to occlusal status.[9–12] In this classification system, based on conclusions of a comprehensive systematic review,[13] oral functionality is related with specific occlusal conditions in different dental regions: *(1)* the number of teeth in the maxilla and mandible, *(2)* completeness of the anterior region, *(3)* number of premolar occluding pairs, and *(4)* number of molar occluding pairs. This classification system has been used to study masticatory ability and oral health–related quality of life in China, Vietnam, and Bulgaria, but not to evaluate occlusal tooth wear.

Besides attrition, abrasion must also be considered in studying tooth wear in reduced dentitions. Chewing tests indicate that in reduced dentitions, fewer teeth may be at risk for higher levels of wear.[14] For example, chewing tests with subjects with shortened dental arches showed comparable occlusal forces; however, more masticatory cycles and higher masticatory frequencies were needed to pulverize test food to similar particle sizes than subjects with complete dentitions.[14,15] Occlusal tooth wear might also be related to unilateral chewing. A recent study reported that 74% and 58% of subjects had a chewing side preference for hard food and soft food, respectively; therefore, such a relation might exist.[16] Evidence for unilateral chewing effects on tooth wear severity stems from a single study that investigated a select population of patients that presented with tooth wear.[8]

Another suggested possible relevant factor in occlusal wear is the dynamic contact relationship between the occlusal surfaces of the teeth during function, eg, anterior protected articulation versus group function. Evidence for such an effect is limited to one study that demonstrated a relationship between canine wear and total posterior tooth wear for subjects younger than 50 years, while such a relationship was not found for subjects aged 50 years and older.[17,18]

The aim of this study was to assess the relationship between occlusal tooth wear and occlusal status in a patient population attending the prosthodontic department of a dental school in China. It was hypothesized that occlusal tooth wear was associated with occlusal status, chewing side preference, and occlusal guidance.

Materials and Methods

Individuals with at least one tooth in each arch were selected from patients attending a prosthodontic clinic and assessed for occlusal tooth wear, occlusal conditions, occlusal guidance scheme, and chewing pattern. The study was conducted at the School of Stomatology of the Fourth Military Medical University in Xi'an, China, approved by the local ethical committee (IRB-REV-2012013), and carried out in compliance with the Helsinki Declaration. Data were collected between January and July 2012.

Sampling Method

Participants were patients that were either referred to or asked for prosthodontic treatment in the Department of Prosthodontics. Each second patient that newly attended the department and was free of pain in the orofacial region was asked whether he or she was willing to participate in the study. If a patient did not wish to enter the study, the next patient was asked to participate. No further inclusion criteria were applied. During the 7-month recruitment period, a total of 257 patients (110 men and 147 women, mean age 45.4 years [SD, 16.1 years]) entered the study. Participants were divided into groups using a previously published hierarchical functional classifcation system,[9] within which data were analyzed. Observations were then made on the relationships between occlusal tooth wear and the significance of the occlusal status and masticatory habits within and between groups.

Clinical Examination

After obtaining verbal consent from the participants, a clinical examination was conducted by a calibrated examiner following the procedures and diagnostic criteria recommended by the World Health Organization.[19]

In this study, the presence of teeth (including third molars), tooth type, number and location of natural posterior occluding pairs (POPs), and occlusal tooth wear were considered. Occlusal tooth wear was assessed after drying the teeth using the index described by Smith and Knight, ie, the occlusal tooth wear index (OTWI): score 0 = no loss of occlusal enamel surface characteristics; score 1 = loss of occlusal enamel surface characteristics; score 2 = loss of occlusal enamel, exposing dentin for less than one-third of the surface/incisal loss of enamel and minimal dentin exposure; score 3 = loss of occlusal enamel, exposing dentin for more than one-third of

Table 1 Levels and Criteria for Dichotomization of Occlusal Conditions of the Step-by-Step Branching Hierarchy in the Hierarchical Functional Classification System

	Meeting occlusal condition		
Level	Yes	No	Dichotomy
Dentition level (1)	≥ 1 tooth present in each arch	No teeth	≥ 1 tooth vs no teeth
Arch level (2)	≥ 10 teeth in both the maxilla and mandible	< 10 teeth in maxilla or mandible	≥ 10 teeth vs < 10 teeth
Anterior teeth level (3)	All 12 anterior teeth present	< 12 anterior teeth	Complete vs incomplete
Premolar level (4)	3 or 4 occluding pairs of premolars	≤ 2 occluding pairs of premolars	Sufficient vs impaired
Molar level (5)	≥ 1 occluding pair of molars at both left and right sides of the dentition	No occluding pairs of molars at left or right side of the dentition	Sufficient vs impaired

the surface/incisal loss of enamel and substantial loss of dentin; score 4 = complete loss of occlusal/incisal enamel, pulp exposure, or exposure of secondary dentin; score 5 = occlusal surface restoration that prevents assessment of tooth substance loss.[20]

Retained roots were considered nonfunctional teeth and recorded as missing teeth. A POP was considered a posterior occluding pair of natural teeth. A distinction was made between teeth replaced by fixed dental prostheses (FDPs) and those replaced by removable dental prostheses (RDPs). Teeth replaced by FPDs were considered present teeth. Interobserver agreements between the principal investigator and an experienced researcher for clinical scores were good (kappa's ≥ 0.67).

Occlusal guidance was recorded as *(1)* anterior protected guidance in which anterior teeth disengage the posterior teeth in mandibular lateral movements, *(2)* a group function in which contact relations exist between posterior maxillary and mandibular teeth in lateral movements on the working side, or *(3)* unclear (not measurable).

After clinical examination, subjects were asked to indicate their chewing side preference (left side, right side, no preference, or not aware of having a chewing side preference/do not know).

Classification System

In the classification system,[9] dentitions were classified on the basis of a dichotomized five-level branching hierarchy in which the criteria applied on the levels are based on occlusal conditions that reflect functionality (Table 1). With regard to each level in the branching hierarchy, the number of natural teeth, the tooth types present, and the number of natural POPs were calculated. Subjects were classified on the basis of their configuration of natural teeth and fixed replacements only.

Data Analyses

Two approaches were used to analyze OTWI scores in relation to occlusal status. In the first approach, overall OTWI scores were related to the hierarchical functional classification system, in which the occlusal conditions are considered in the context of the dentition as a whole. Multivariate regression models were constructed to assess the effect of meeting versus not meeting criteria for specific occlusal conditions on OTWI for all relevant locations in the hierarchical functional classification system (for instance, the effect of having a complete anterior region was analyzed separately for those having 10 teeth and for those who had fewer than 10 teeth in each arch). For each analysis, regression models were used that included the background variables age and sex.

In the second approach, the relationship between occlusal tooth wear and occlusal conditions in separate dental regions were analyzed with multivariate linear regression models. In these models, occlusal tooth wear was the dependent variable; the occlusal conditions at the levels 2 to 5 (≥ 10 teeth in each arch; anterior region complete; premolar region sufficient; and molar region sufficient) were the independent variables. Possible associations between separate occlusal conditions and occlusal tooth wear were adjusted for the background variables age and sex. The performance of the multivariate models was expressed as R2.

Associations among OTWI scores with different tooth types and chewing side preference were analyzed using paired sample *t* tests. Associations between OTWI scores and occlusal guidance schemes (anterior protected guidance versus group function) were also assessed. SPSS software version 20 (IBM) was used for the statistical analyses.

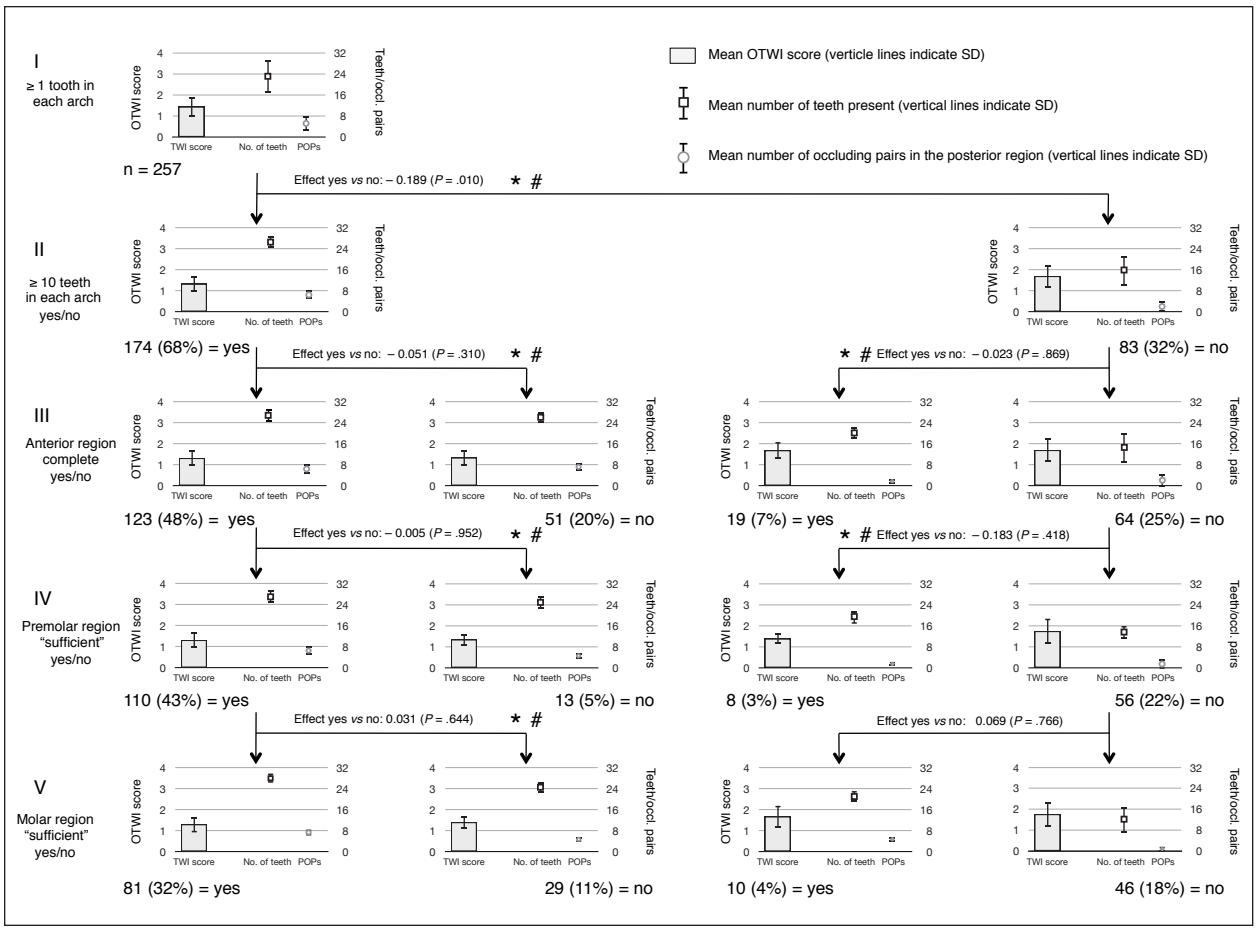

Fig 1 Distribution of subjects according to the step-by-step branching hierarchy with respective mean occlusal tooth wear (OTWI) score, mean number of teeth, and mean number of posterior occluding pairs (POPs). Vertical lines indicate SD. *Significant age effect; †significant sex effect.

Results

Occlusal tooth wear was observed in all subjects with a mean OTWI score of 1.44 ± 0.46. The highest OTWI scores were found for molars in men (1.57 ± 0.57) and the lowest were for premolars in women (1.32 ± 0.47). At level 1, subjects (n = 257) had a mean number of 23.1 ± 6.4 teeth and 5.1 ± 2.9 POPs (Fig 1). The branching hierarchy describes 73% of all subjects in this sample up to level 4 (premolar region) and 65% up to level 5. Because of the low number of subjects in categories not meeting the occlusal conditions in the ≥ 10 teeth in each arch branch and in categories meeting the occlusal conditions in the < 10 teeth in each arch branch, these categories were not further dichotomized to the next level. Mean overall OTWI scores were highest in the < 10 teeth in each arch branch, ranging from 1.38 ± 0.26 (subjects with sufficient premolar region, level 4) to 1.76 ± 0.61 (subjects meeting none of the criteria, level 5). The lowest mean overall OTWI scores were found for subjects meeting all criteria for the occlusal conditions up to level 5 (1.29 ± 0.39). In general, subjects meeting the criteria of the hierarchical classification system had lower mean OTWI scores compared with those not meeting the criteria; however, differences were relatively small and statistically nonsignificant, with the exception of the criterion ≥ 10 teeth in each arch (effect: –0.189: $P = .001$). A significant positive age effect was found at each level in both branches, except at level 5 in the < 10 teeth in each arch branch. Men had significantly higher OTWI scores at each level except at level 5 in the < 10 teeth in each arch branch.

The multivariate linear regression analyses demonstrated that the separate occlusal conditions did not affect mean OTWI scores, with one exception for teeth in the mandible not meeting the occlusal condition of ≥ 10 teeth in each arch ($P = .05$, Table 2). OTWI

Table 2 Effects, *P* values, and 95% CIs for Each Occlusal Condition and Background Variable on OTWI in the Maxilla, Mandible, and Entire Dentition (n = 257)

	Maxilla			Mandible			Overall		
Occlusal condition	Effect	*P*	95% CI	Effect	*P*	95% CI	Effect	*P*	95% CI
≥ 10 teeth in each arch	−0.07	.38	−0.23 to 0.09	−0.19	.05	−0.39 to 0.00	−0.15	.07	−0.32 to 0.02
Anterior region complete	−0.03	.61	−0.13 to 0.08	−0.05	.43	−0.18 to 0.08	−0.04	.43	−0.15 to 0.07
Premolar region sufficient	−0.02	.80	−0.16 to 0.12	0.00	.98	−0.17 to 0.18	−0.01	.87	−0.16 to 0.14
Molar region sufficient	−0.02	.78	−0.14 to 0.10	−0.02	.79	−0.16 to 0.12	−0.01	.85	−0.14 to 0.11
Age	0.011	<.001	0.008 to 0.015	0.015	.0001	0.011 to 0.019	0.013	<.001	0.010 to 0.016
Male sex	0.10	.03	0.01 to 0.20	0.14	.01	0.03 to 0.26	0.13	.01	0.03 to 0.23
R^2		0.271			0.331			0.337	

CI = confidence interval.

Table 3 Effects, *P* values, and 95% CIs for Each Occlusal Condition and Background Variable on OTWI in the Different Dental Regions (n = 257)

	Anterior teeth			Premolars			Molars		
Occlusal condition	Effect	*P*	95% CI	Effect	*P*	95% CI	Effect	*P*	95% CI
≥ 10 teeth in each arch	−0.26	.01	−0.47 to −0.06	−0.21	.03	−0.40 to −0.02	−0.02	.85	−0.25 to 0.20
Anterior region complete	−0.06	.40	−0.19 to 0.07	−0.04	.51	−0.17 to 0.08	0.02	.78	−0.13 to 0.17
Premolar region sufficient	0.06	.51	−0.12 to 0.24	0.01	.92	−0.16 to 0.18	−0.10	.31	−0.30 to 0.10
Molar region sufficient	0.02	.79	−0.13 to 0.17	−0.06	.40	−0.20 to 0.08	0.05	.53	−0.11 to 0.22
Age	0.011	< .001	0.007 to 0.015	0.012	< .001	0.008 to 0.016	0.017	< .001	0.012 to 0.022
Male sex	0.13	.03	0.02 to 0.25	0.12	.03	0.01 to 0.23	0.13	.05	−0.00 to 0.26
R^2		0.244			0.290			0.253	

OTWI = occlusal tooth wear index; CI = confidence interval.

Table 4 Correlation Coefficient Between Chewing Side Preference and OTWI and Mean Difference Between OTWI Score for the Preferred Chewing Side and Nonpreferred Chewing Side (n = 257)

	Correlation coefficient	*P*	OTWI score preferred chewing side minus OTWI score nonpreferred chewing side (SD)	*P*	95% CI
Anterior teeth	0.943	< .001	0.0207 (0.016)	.21	−0.012 to 0.053
Premolars	0.893	< .001	0.0378 (0.023)	.10	−0.007 to 0.083
First and second molars	0.847	< .001	0.0576 (0.033)	.08	−0.007 to 0.122
Molars, including third molars	0.823	< .001	0.0687 (0.033)	.04	0.004 to 0.133
All teeth	0.943	< .001	0.0423 (0.015)	.005	0.013 to 0.071

OTWI = occlusal tooth wear index; CI = confidence interval.

scores were significantly associated with age and sex (Tables 2 and 3). Mean OTWI scores increased from 0.011 to 0.017 points per year; men had higher scores than women. Meeting the separate occlusal conditions or not was not associated with OTWI scores for different tooth types, except for the occlusal condition ≥ 10 teeth in each arch: subjects with more than 10 teeth in each arch had significantly lower OTWI scores than those with fewer than 10 teeth in each arch (Table 3).

One hundred thirty-three subjects (52%) reported a chewing side preference: 77 (30%) for the right side and 56 (22%) for the left side. Six subjects reported that they were not aware of a preference. Chewing side preference was significantly correlated with OTWI scores (wear on the preferred side vs wear on the other side) for all teeth and tooth types: (all *P* values < .0001, Table 4). When taking all teeth into account, teeth at the preferred chewing side had significantly higher OTWI scores (*P* = .005). However, if

analyzed for the different dental regions separately, the significant difference of OTWI score only existed in the molar region (including third molars; $P = .04$).

Of all subjects, 23 (8.9%) had anterior protected guidance at the left and 22 (8.6%) at the right side. Subjects with group function had higher mean OTWI scores compared with those with anterior protected guidance; however, differences were relatively small and statistically nonsignificant for all teeth and for the tooth types seperately (all P values > .15)

Discussion

Occlusal tooth wear in this population of patients was associated with the occlusal condition of having fewer than 10 teeth in each arch and was independent from the other occlusal conditions investigated. When looking at the occlusal conditions separately, the data showed higher levels of occlusal tooth wear for anterior and premolar teeth in subjects with fewer than 10 teeth in each arch compared with subjects having at least 10 teeth in each arch, but not for molar teeth. The relationship between reduced numbers of teeth and increased severity of tooth wear was previously studied in a systematic review.[18] This review reported that only one study[21] found a correlation between fewer teeth and increased occlusal tooth wear. The other studies neither confirmed nor denied such a correlation.[18]

In the present study, the number of POPs, as reflected by the occlusal conditions "premolar region sufficient" and "molar region sufficient," did not affect severity of occlusal tooth wear. Such a relationship was not seen in the hierarchical classification analysis nor when considering the occlusal conditions seperately. Also, the scheme of occlusal guidance—anterior protected versus group function—did not affect occlusal tooth wear in any dental region. In contrast, chewing side preference was highly correlated with occlusal tooth wear for all tooth types, resulting in significantly higher OTWI scores for all teeth at the chewing side indicated by the subjects as preferred. Therefore, the hypotheses can be accepted only partially.

As in many other studies, occlusal tooth wear in this study was significantly associated with the nondental factors age and sex.[7,22,23]

Given the significant effect of the condition of having at least 10 teeth in each arch on occlusal tooth wear in this population, one would have expected that the occlusal conditions "premolar sufficient" and "molar sufficient" (associated with number of teeth in each arch) would also affect occlusal tooth wear because these conditions reflect large areas of contacts between maxillary and mandibular teeth, which would result in a decreased chance for attrition. On the other hand, it has been demonstrated in another study that fewer teeth result in a higher number of masticatory cycles before swallowing, thus increasingly exposing the teeth to abrasive agents.[14]

An explanation for the contradictive observations in the present study might be found in the complex etiology of tooth wear. In most cases, the eventual symptom of tooth wear at higher ages results from a combination of attrition, abrasion, and erosion. Of these causes, attrition and abrasion can be considered related to anatomical structures, more specifically to occlusal conditions. Dental erosion can be considered independent from occlusal conditions; however, signs and symptoms from erosion may bias tooth wear outcomes resulting from attrition and abrasion. Dental erosion is strongly correlated with dietary behavior. Nutritional data were not aviable in this study; therefore, it is impossible to assess the effects of erosion on the occlusal tooth wear observed. However, although nutritional data are not avialable, it can be argued that abrasion was playing a significant role in occlusal tooth wear by considering the chewing side preference of the participants. It can be argued that in participants with a predominant chewing side, the teeth on that side were more exposed to abrasive agents than teeth on the opposing, not used side. Moreover, another study reported that especially hard foods are chewed at the preferred side.[16] In the present study, chewing side preference was highly correlated with occlusal tooth wear of teeth in all dental regions. This finding indicates that chewing side preference was relatively stable, which is in accordance with another study that suggested that chewing side preference is centrally controlled and independent from the occlusal status.[24]

The present findings that the number of POPs as well as the occlusal guidance scheme did not affect severity of occlusal tooth wear, combined with the finding of a chewing side effect, give reason to suppose that abrasion plays a more important role in tooth wear than attrition. It is worth mentioning that the Chinese diet contains few hard fibrous foods and most foods frequently eaten by Chinese people are steamed, fried, or boiled. However, it should be recognized that regional cultural differences vary greatly in China, giving rise to different styles of food and different methods of food preparation.[25] Also, there are indications that food selection and preparation differs among urban and rural people, giving rise to the thought that more abrasive components are included in the diet of the latter. With the recent massive migration from country sites to urban cities such as Xi'an, this might have had some influence on the data resulting from this "urban" population.

Anthropologic reports support the abrasion hypothesis; however, it has also been suggested that the classical abrasive physiologic wear model is less appropriate to describe tooth wear in modern humanity and that a tribochemical pathologic model, including attrition, abrasion, and erosion, would be more appropriate.[26,27] The complexity of the tooth wear process prevents a straightforward diagnosis of the exact cause(s). Future analyses, combining occlusal functional status, musculoskeletal variables such as occlusal guidance schemes, and dietary data with tooth wear are needed to provide more clarity in this matter.

Conclusions

The occlusal condition of having fewer than 10 teeth in each arch seems to be a risk factor for increased occlusal tooth wear. Occlusal wear was more severe at the preferred chewing side. Occlusal tooth wear was significantly associated with the nondental factors age and sex.

Acknowledgment

The authors reported no conflicts of interest related to this study.

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