Tooth-wear patterns in adolescents with normal occlusion and Class II Division 2 malocclusion

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Introduction: In this study, we investigated tooth-wear patterns in adolescents with either normal occlusion or Class II Division 2 malocclusion. **Methods:** The sample consisted of dental casts from 165 subjects that were divided into 2 groups: 115 normal occlusion subjects (mean age, 14.3 years) and 50 complete Class II Division 2 subjects (mean age, 13.9 years). Dental wear was assessed by using a modified version of the tooth wear index. The 2 groups were compared with the Mann-Whitney test for the frequency and severity of wear on each surface of each group of teeth. The level of statistical significance was set at 5%. **Results:** The normal occlusion group statistically had greater tooth wear on the incisal surfaces of the maxillary lateral incisors and the incisal surfaces of the maxillary canines than did the Class II Division 2 malocclusion group. The malocclusion group showed statistically greater tooth wear on the labial surfaces of the mandibular lateral incisors, the occlusal surfaces of the maxillary premolars and first molars, the occlusal surfaces of the mandibular premolars, the palatal surfaces of the maxillary second premolars, and the buccal surfaces of the mandibular premolars and first molars than did the normal occlusion group. **Conclusions:** Subjects with normal occlusion and those with complete Class II Division 2 malocclusions have different tooth-wear patterns. Tooth wear on the malocclusion subjects should not be considered pathologic but, rather, the consequence of different interocclusal arrangements. (Am J Orthod Dentofacial Orthop 2010;137:730.e1-730.e5)

Tooth wear can be described as the loss of hard dental tissue resulting from physical or chemical attack; it is an all-embracing term used to describe the combined processes of abrasion, erosion, and attrition.[1,2] Abrasion and erosion must be distinguished from attrition, which is the regular, slow, and progressive loss of dental tissue as a consequence of tooth-to-tooth contact (as in mastication).[3-5]

It is not always possible to differentiate between erosion, abrasion, and attrition because these conditions are frequently combined.[6,7] However, if occlusal factors are involved in causing dental wear, they probably are related to attrition (tooth wear caused by opposing occlusal surfaces rubbing together), considered the most visible sign of functional wear.[8,9]

Attrition has specific characteristics. First, if attrition is the only cause of tooth wear, it will be located only in areas of occlusal contact. There will be no wear on the buccal or lingual surfaces of teeth unless mandibular movements can make the opposing teeth touch in these areas. Second, attrition creates wear facets with a specific appearance: shiny, flat, and sharp-edged. Third, attrition produces similar amounts of wear on opposing teeth. Tooth grinding cannot cause significant tooth wear on the maxillary anterior teeth but not on the mandibular anterior teeth. If attrition is the cause, the worn teeth must have occlusal contact during mandibular excursion.[9]

Some studies indicate that masticatory forces and malocclusion are primary etiologic factors for noncarious lesion development,[10-15] although other authors did not find this correlation.[1,8,16,17] Because of the high

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48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38

Primary Teeth	Permanent Teeth	CONDITIONS
a	0	No evidence of wear
b	1	Tooth wear into enamel
c	2	Tooth wear inte dentine
d	3	Tooth wear into pulp or secondary dentine
e	4	Tooth restored due to wear
-	9	Could not be assessed

Fig. Modified TWI.

prevalence of malocclusions in children as well as the controversies in the literature, it is relevant to verify the pattern of tooth wear of various occlusal relationships to help professionals to differentiate between physiologic and pathologic processes. The absence of previous studies of tooth wear with specific malocclusions encouraged us to compare the patterns of tooth wear in subjects with Class II Division 2 malocclusion with subjects with normal occlusal relationships.

MATERIAL AND METHODS

The study protocol was approved by the Ethics Committee on Human Research of Bauru Dental School, University of São Paulo, Brazil.

The sample consisted of dental casts from 165 untreated subjects from the files of the Department of Orthodontics at Bauru Dental School, University of São Paulo, and the Department of Orthodontics and Pediatric Dentistry, School of Dentistry, University of Michigan, Ann Arbor. The dental casts were divided into 2 groups. Group 1 consisted of 115 subjects with normal occlusion[18] (50 female, 65 male; mean age, 14.3 years; range, 11.0-17.5 years). Group 2 consisted of 50 complete Class II Division 2 subjects (23 female, 27 male; mean age, 13.9 years; range, 11.2-17.7 years). The dental casts were obtained only from subjects with permanent maxillary and mandibular teeth including the first molars. Additional inclusion criteria included no parafunctional habits, and no temporomandibular joint and airway problems, as noted in the subjects' charts.

We used a modified version of the tooth wear index (TWI),[19] described by de Carvalho Sales-Peres et al.[20] The modifications are consistent with the World Health

Organization standards, thus allowing application of the index in broad epidemiologic surveys for both deciduous and permanent dentitions.[21] In this study, the TWI for deciduous teeth was not used. The modifications made calibration easier and resulted in greater reproducibility, because the modified version of the TWI does not differentiate the depth of dentin involvement, as is the case for the original TWI. In addition, the modified version includes a code for teeth that have been restored because of wear (code 4), and another code for teeth that cannot be assessed (code 9). The form used to record the evaluations is shown in the Figure. The amount of permanent tooth wear is scored by numbers (Table I). A calibrated examiner (R.B.S.O.) performed the dental-cast evaluations.

A benchmark dental examiner (gold standard) (S.H.C.S.), skilled in epidemiologic surveys, trained and calibrated the examiner. The calibration process took 28 hours. Theoretical activities with discussions on diagnostic criteria of dental wear were performed.

Statistical analyses

To assess the reproducibility of the dental-cast analysis, 10% of the casts were reevaluated, with an intra-examiner kappa of 0.79 (Table II).[22]

Tooth surfaces were excluded from the statistical analysis if they were missing, or had extensive caries, large restorations, or fractures (code 9). The amount of tooth wear in the groups was compared with the Mann-Whitney test. The 2 groups were compared for the frequency and the severity of wear on each surface of each group of teeth (incisors, canines, premolars, and molars). The level of statistical significance was set at 5%.

Table I. Criteria used for tooth-wear evaluation, according to the modified TWI

Degree		Criteria	Description
Deciduous teeth	*Permanent teeth*		
A	0	Normal, no evidence of wear	No loss of surface features
B	1	Incipient, tooth wear into enamel	Loss of enamel giving smooth, glazed, shiny appearance; dentin not involved
C	2	Moderate, tooth wear into dentin	Extensive loss of enamel with dentin involvement; exposure of dentin
D	3	Severe, tooth wear into pulp	Extensive loss of enamel and dentin with secondary dentin or pulp exposure
E	4	Restored, tooth wear leading to restoration	Tooth received restorative treatment because of wear
-	9	Could not be assessed	Extensive caries, large restoration, fractured or missing tooth

Table II. Intraexaminer analysis (kappa statistics)

Tooth wear	Percentage of agreement (%)	Coefficient value	Strength of agreement
Dental casts	92.85	0.79	Almost perfect

RESULTS

In total, 11,880 dental surfaces were evaluated. Of these, 77.7% had no dental wear (code 0), 20.1% had incipient lesions (code 1), 0.4% had moderate lesions (code 2), and 1.8% were excluded (code 9). No severe lesions were found.

The normal occlusion group statistically had greater tooth wear on the incisal surfaces of the maxillary lateral incisors (Table III) and on the incisal surfaces of the maxillary canines (Table IV) than did the malocclusion group.

The Class II Division 2 malocclusion group showed statistically greater tooth wear on the labial surfaces of the mandibular lateral incisors (Table III), the occlusal surfaces of the maxillary premolars and first molars, the occlusal surfaces of the mandibular premolars, the palatal surfaces of the maxillary second premolars, and the buccal surfaces of the mandibular premolars and first molars than did the normal occlusion group (Table V).

DISCUSSION

We used a modified version of the universally used TWI, with a high degree of intraexaminer agreement (kappa >0.79).[19,23] The modified TWI does not differentiate the depth of dentin involvement, as is the case for the original TWI. Thus, the modified TWI achieves greater intra- and interexaminer agreement, even in field conditions.[20]

Some reports in the literature suggested an association between greater tooth wear and some occlusal factors,[11,12,14] although others did not corroborate this premise.[1,24,25] The results of this study showed that

Table III. Intergroup anterior tooth-wear comparisons (Mann-Whitney test)

Tooth	Normal occlusion		Complete Class II Division 2		P
	Mean	*SD*	*Mean*	*SD*	
Incisal surfaces					
Maxillary teeth					
12	0.40	0.53	0.21	0.41	0.0257*
11	0.58	0.51	0.48	0.58	0.2911
21	0.60	0.51	0.50	0.54	0.2763
22	0.40	0.51	0.15	0.41	0.0023*
Mandibular teeth					
42	0.67	0.47	0.78	0.51	0.1691
41	0.85	0.38	0.82	0.44	0.6141
31	0.83	0.40	0.90	0.36	0.2671
32	0.75	0.45	0.78	0.42	0.6700
Palatal surfaces					
Maxillary teeth					
12	0.25	0.46	0.31	0.47	0.4460
11	0.31	0.46	0.42	0.50	0.1612
21	0.40	0.49	0.38	0.49	0.7785
22	0.33	0.47	0.40	0.49	0.4500
Labial surfaces					
Mandibular teeth					
42	0.01	0.09	0.10	0.30	0.0040*
41	0.04	0.21	0.10	0.31	0.1577
31	0.03	0.18	0.08	0.27	0.2164
32	0.03	0.18	0.14	0.35	0.0126*

*Statistically significant at $P < 0.05$.

both the normal occlusion patients and those with complete Class II Division 2 malocclusion had some tooth wear. However, the groups had different tooth-wear patterns (Tables III-V).

In the normal occlusion group, tooth wear was greater on the incisal surfaces of the maxillary lateral incisors and the maxillary canines, compared with the corresponding surfaces of the malocclusion group (Tables III and IV). Less wear on the incisal surfaces of the maxillary lateral incisors in the Class II malocclusion group presumably is a consequence of the labial positioning of these teeth in this type of

Table IV. Intergroup canine tooth-wear comparisons (Mann-Whitney test)

Tooth	Normal occlusion		Complete Class II Division 2		
	Mean	SD	Mean	SD	P
Incisal surfaces					
Maxillary teeth					
13	0.68	0.58	0.13	0.34	0.0000*
23	0.69	0.59	0.14	0.35	0.0000*
Mandibular teeth					
43	0.73	0.52	0.64	0.48	0.3099
33	0.70	0.53	0.67	0.55	0.7365
Palatal surfaces					
Maxillary teeth					
13	0.11	0.31	0.10	0.31	0.9624
23	0.13	0.33	0.14	0.35	0.8105
Labial surfaces					
Mandibular teeth					
43	0.10	0.30	0.04	0.20	0.2201
33	0.08	0.27	0.14	0.41	0.2343

*Statistically significant at P <0.05.

Table V. Intergroup posterior tooth-wear comparisons (Mann-Whitney test)

Tooth	Normal occlusion		Complete Class II Division 2		
	Mean	SD	Mean	SD	P
Occlusal surfaces					
Maxillary teeth					
16	0.71	0.45	0.92	0.27	0.0032*
15	0.11	0.32	0.22	0.42	0.0884
14	0.27	0.45	0.27	0.45	0.9554
24	0.25	0.43	0.41	0.50	0.0370*
25	0.06	0.24	0.36	0.49	0.0000*
26	0.75	0.43	0.96	0.20	0.0021*
Mandibular teeth					
46	0.76	0.43	0.85	0.36	0.1984
45	0.09	0.28	0.45	0.50	0.0000*
44	0.19	0.40	0.52	0.50	0.0000*
34	0.22	0.42	0.53	0.50	0.0000*
35	0.12	0.33	0.38	0.49	0.0002*
36	0.85	0.36	0.92	0.28	0.2352
Palatal surfaces					
Maxillary teeth					
16	0.01	0.09	0.04	0.20	0.1686
15	0.00	0.00	0.04	0.21	0.0244*
14	0.00	0.00	0.02	0.14	0.1259
24	0.00	0.00	0.00	0.00	1.0000
25	0.00	0.00	0.00	0.00	1.0000
26	0.03	0.16	0.00	0.00	0.2593
Buccal surfaces					
Mandibular teeth					
46	0.19	0.39	0.30	0.46	0.1269
45	0.00	0.00	0.19	0.40	0.0000*
44	0.03	0.18	0.17	0.38	0.0031*
34	0.02	0.13	0.08	0.28	0.0467*
35	0.01	0.09	0.08	0.28	0.0120*
36	0.14	0.34	0.44	0.50	0.0000*

*Statistically significant at P <0.05.

malocclusion, which also is characterized by uprighted central incisors, deep overbite, and normal overjet.[26-29] With this interocclusal arrangement, disclusion on protrusion is carried out primarily by the maxillary central incisors with occasional contact of the lateral incisors.

Greater tooth wear on the incisal surfaces of the canines in the normal occlusion group (Table IV) probably occurred because of the normal anteroposterior relationship, establishing immediate lateral guidance during lateral mandibular excursions.[30-32] Since these teeth disclude the posterior teeth during lateral mandibular functional movements, it seems logical that they have greater wear. As a result of unfavorable anteroposterior positioning of the canines during lateral excursions in the Class II Division 2 malocclusion group, these teeth also do not disclude the posterior teeth as frequently as in normal occlusion, because of interferences of the posterior teeth.[30-32] Additionally, patients with Class II Division 2 malocclusions typically have a broad, square-shaped maxillary arch and a relatively normal mandibular arch.[26-29] This configuration positions the maxillary canines labially in relation to the mandibular teeth, impairing lateral disclusion by the canines. Thus, there is less wear on the incisal surfaces of the maxillary canines in the malocclusion group.

The deep overbite of a Class II Division 2 malocclusion also produces greater wear on the labial surface of the mandibular lateral incisors than the corresponding surfaces of the normal occlusion group (Table III). On the other hand, patients with Class II Division 2 malocclusion had greater wear on the posterior teeth, a differ-

ence that was statistically significant compared with that of the normal occlusion sample (Table V).

Because the canines are not in a favorable position to disclude the posterior teeth during lateral excursions in Class II Division 2 malocclusion, the posterior teeth assume this role and consequently have greater wear than observed in the normal occlusion group (Table V).

The greater wear on the palatal surfaces of the maxillary second premolars in Class II Division 2 malocclusion might be the result of a buccal crossbite (Brodie or scissors-bite) frequently found with this malocclusion (Table V). This occlusal configuration occurs because of the broad, square-shaped maxillary arch with a relatively normal mandibular arch, characteristics of this malocclusion.[26-29] These surfaces are worn during lateral movements of the mandible on the working side.

Even with some tooth wear in the normal occlusion and Class II Division 2 groups, the tooth wear cannot be

considered pathologic.[9,33,34] No severe lesions (eg, into the pulp or secondary dentin) were found on the dental casts, and only 0.4% had moderate dental wear (exposure of dentin). Most tooth wear was considered to be incipient lesions (20.1%), corroborating the findings of previous studies.[20,35]

Some controversies in the literature regarding the amounts of wear in malocclusions probably are a consequence of investigations evaluating unspecific malocclusion groups.[10-15] This study was performed specifically to investigate the differences in tooth wear between normal occlusion and Class II Division 2 malocclusion. Thus, it included a significant number of observations in each group. In addition, the groups had similar ages, essential when analyzing tooth wear that increases with age.[36]

CONCLUSIONS

Subjects with normal occlusion and those with Class II Division 2 malocclusions have different tooth-wear patterns. Tooth wear on the malocclusion subjects should not be considered pathologic but, rather, a consequence of a different interocclusal arrangement.

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