Occlusal wear

A follow-up study of 18 subjects with extensively worn dentitions

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Eighteen patients with moderate to severe dental wear were re-examined 6–10 years after a treatment period that included use of occlusal splints at night. The splints were used with various intensities for an average of 2 years. The methods of evaluation comprised a questionnaire, clinical examination, comparison of dental casts, salivary analysis, and bite force measurements. The changes in dental wear during the follow-up period were small, the typical finding being an increase of facets but no measurable reduction of tooth length. The results indicate that many variables apart from occlusal parafunctions, such as acid regurgitation and salivary and dietary factors, may contribute to loss of tooth substance diagnosed as dental wear. In most patients, the continuing wear process was slow after long-term treatment with occlusal splints. □ *Bruxism; mastication; saliva; tooth abrasion; tooth erosion*

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Gradual attrition of the occlusal surfaces of the teeth is a physiologic process, but there are many factors that can influence the type and rate of wear (1). In some populations, such as Australian aborigines, there is usually such a systematically progressive reduction of dental morphology that attrition can be used for age determination (2). Knowledge of the eruption sequence of the permanent teeth and comparisons of the wear of the occlusal surfaces provide a basis for age estimation often used in anthropological studies (3, 4). Most studies on tooth wear have been cross-sectional, and longitudinal investigations are rare. Molnar et al. (5) studied the rate of tooth wear (reduction of molar cusp height) on casts of 64 contemporary Australian aborigines, taken at intervals from the age of 7 to 18 years. They concluded that the tooth wear was greater than that in Europeans. By 18 years of age an average of 0.5 mm of cusp height was lost. Extensive occlusal wear is rarely seen in modern man, and when it occurs, it is considered to present great treatment problems in clinical dentistry (6–8). Few dentists have continuously seen more than occasional patients with severe attrition, and we have found no long-term studies of occlusal wear in modern man. There is thus a lack of knowledge of the progression and rate of tooth wear, and it is difficult for the dental practitioner to predict attrition in individual patients.

The purpose of this paper was to study the rate of occlusal wear in a group of patients with moderate to severe wear.

Materials and methods

Dental casts and photographs of teeth of patients examined 6–10 years previously were scrutinized to find cases of severe occlusal wear. The original strict criteria for selection had to be changed slightly to include a reasonable number of patients, and they finally comprised the following: a) extensive wear into dentin (grade 3, see below) on at least one group of teeth; b) ≥ 7 occluding pairs of teeth; and c) dental cast of good quality, enabling detailed evaluation of the degree of attrition.

On the basis of these criteria, 20 patients were selected. Their present addresses were traced, and they were invited for examination at the clinic. Eighteen of them, nine men and nine women, came for the survey,

whereas two could not come to the clinic during the time set up for the examination. The mean age of the subjects at first examination was 42 years (range, 31–61) for the men and 34 years (range, 16–45) for the women.

The examination comprised a questionnaire related to possible background factors of importance for dental attrition (dietary, environmental, working, and parafunctional factors), signs and symptoms of functional disturbances of the masticatory system and recurrent headache, and the patients' evaluation of their need of treatment for the tooth wear. The case records of the patients from the first treatment period were scrutinized for planned and given therapy.

The clinical examination included routine procedures used at the clinic (9, 10), alginate impressions for dental casts, intraoral photographs of the teeth, bite force measurements in accordance with methods described previously (11, 12), and collection of saliva for determination of secretion rate and analysis of pH, buffer capacity, and some ion contents by routine methods used at the Department of Cariology of the University of Gothenburg. The salivary tests were also performed in a control group of 13 subjects with little or no dental wear. The mean age of the controls was 30 years (range, 19–53). Bite force measurements were also performed in a control group of 12 subjects with only slight dental wear.

The following scale of original attrition was applied: 0 = no or little wear of enamel only; 1 = marked wear facets of enamel; 2 = wear into dentin; 3 = estensive wear into dentin (>2 mm^2); and 4 = wear into secondary dentin (verified by photographs).

The assessment was performed on casts, and, when available, intraoral photographs taken at the first examination. An index of original wear was calculated by adding the highest value for each group of teeth (molars, premolars, canines, and incisors) in each jaw. The theoretical maximal value was thus 32.

Continuation of occlusal wear was judged in accordance with the following scale by comparing and measuring casts and photographs from the first and the follow-up examination: 0 = no certain change; 1 = visible change, such as increase of facet areas, without measurable reduction of tooth length; 2 = measurable reduction of tooth length <1 mm; and 3 = marked reduction of tooth length ≥1 mm.

An index of continuing wear was calculated by adding the highest value for each group of teeth as described above for the original wear. The maximal value for this index was 24.

Statistical methods

Differences between groups were tested by means of Mann–Whitney's U-test (9). Interdependence between variables was tested by linear correlation, r. The level of statistical significance used was $p \leq 0.05$.

Results

At the first examination all patients had dental wear with facets in the dentin (grade 3) on at least one group of teeth, and four of them had wear into secondary dentin on one or more teeth (grade 4). The incisors were usually the teeth with most wear (Table 1). The index of original wear ranged from 11 to 28, with a median value of 16.

The number of occluding pairs of teeth varied between 7 and 14, with a median value of 9. The initial treatment varied depending on the signs and the symptoms accompanying the dental wear, but all patients had received an occlusal splint. The splints were worn at night for various periods of time and with various intensities, the average being 2 years, with gradually decreasing regularity. During the interval between the first and the follow-up visit, nine patients had received crown and bridge therapy (in two of them covering all maxillary teeth and in the other seven less extensive therapy ranging from five to one crown).

The change in dental wear during the follow-up period was on average small. The median value was 1 for all groups of teeth (Table 1)—that is, an increase of facet areas but without measurable reduction of tooth length. A marked shortening of the tooth

Table 1. Medians and range of gradings of initial dental wear and continuation of wear in a 7-year period in 18 patients (for scales, see Methods). Teeth treated with crowns during the follow-up period are excluded

	Maxilla				Mandible			
	Incisors	Canines	Premolars	Molars	Incisors	Canines	Premolars	Molars
Initial wear								
Median	3	2	1	1	3	2	1	1
Range	1–4	1–4	1–4	1–3	1–4	1–4	1–4	1–3
Continuation of wear								
Median	1	1	1	1	1	1	1	1
Range	0–3	0–3	0–3	0–3	0–3	0–3	0–3	0–3

length (≥1 mm) was seen only on single teeth in a few patients (Figs. 1 and 2). The index of continuing wear ranged from 3 to 21 (median, 8) in the nine patients who had received no crown and bridge therapy.

The correlation between the original degree of wear and the continued wear during the observation period was weak and statistically non-significant ($r = 0.33$; $p > 0.05$). It was of the same magnitude ($r = 0.3$;

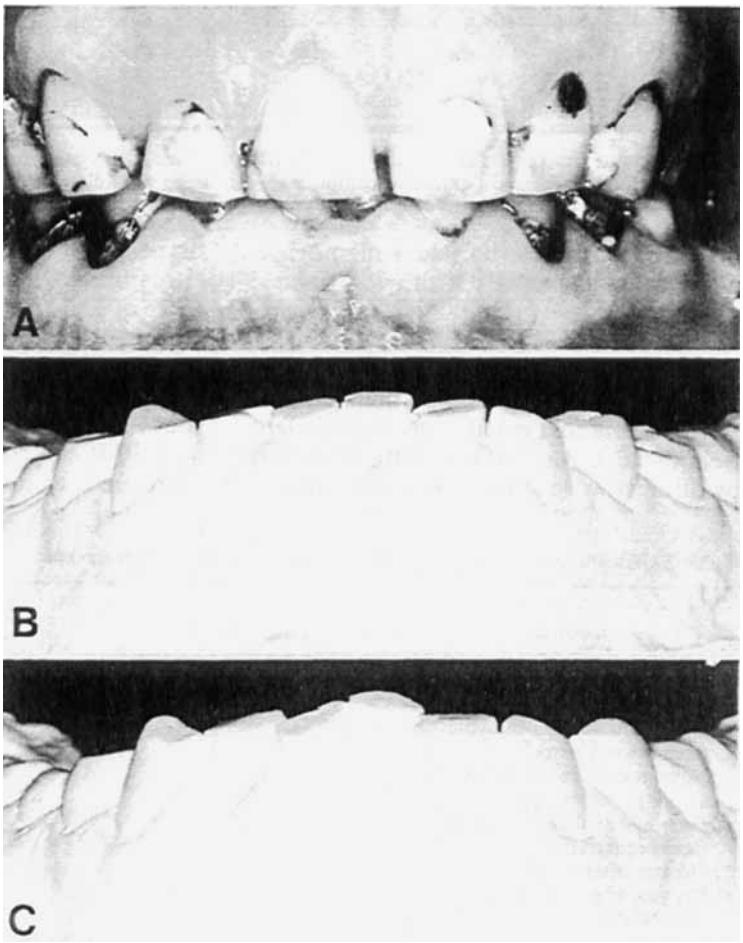

Fig. 1. The patient (a woman, 44 years old at the follow-up study) with the most extensive continuing wear (index value 21) during the follow-up period. A) Anterior view clinically. B) View of the cast of the lower jaw at the follow-up study. C) 7 years previously.

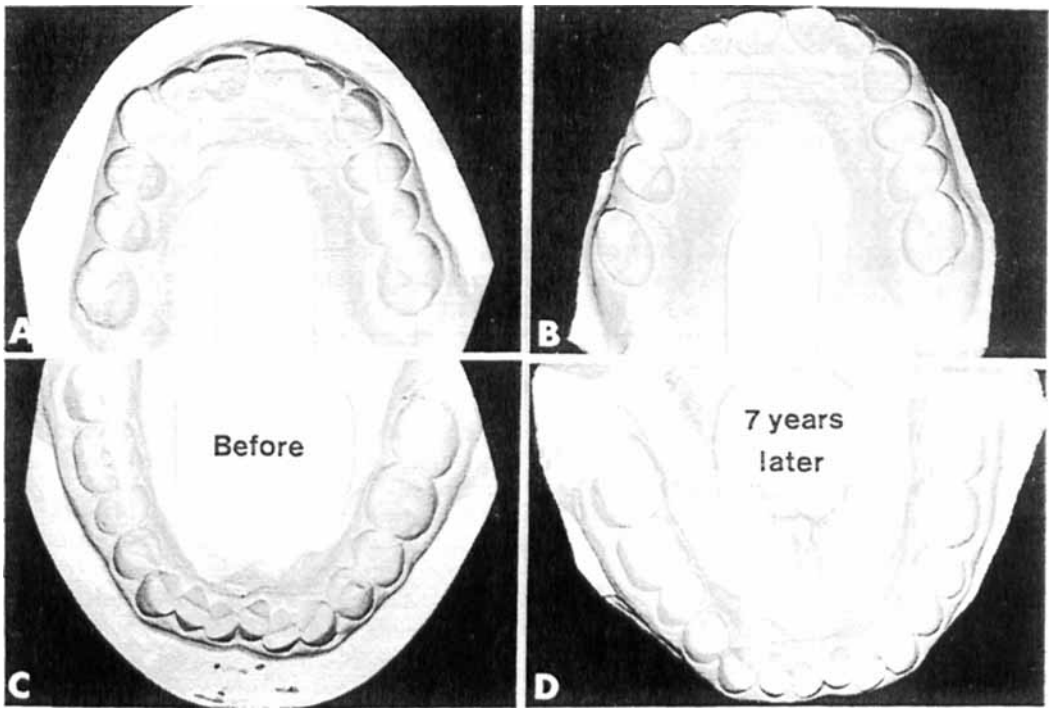

Fig. 2. Occlusal views of the casts of the upper (A,B) and lower (C,D) jaws, before (A,C) and 7 years later (B,D) of the patient with the most extensive continuing wear during the follow-up period.

$p > 0.05$) in those who had a high original index value as in those with a low value.

Questionnaire

The answers to the questions revealed many factors that could contribute to dental wear (Tables 2 and 3). Bruxism was reported by all but two patients. Acid regurgitation, dryness of the mouth, and daily intake of citrus fruits were also common. The prevalence of some symptoms of pain and discomfort reported by the patients is presented in Table 4. These symptoms were distributed among 12 patients; the other 6 patients said they had no such symptoms.

Half of the patients judged the wear of their teeth to be severe (five, very severe;

Table 2. Distribution of answers to some of the questions in 18 patients with extensive dental wear

Question	Yes, now	Yes, previously but not now	No
1. Do you spend much time in a dusty environment	4	2	12
2. Do you sometimes use your teeth in your work?	0	1	17
3. Have you had a dry mouth for a long period of time?	5	3	10
4. Do you often have 'heartburn' (acid regurgitation)?	3	5	10
5. Do you often vomit?	1	1	16
6. Do you often clench or grind your teeth?	10	6	2

Table 3. Dietary habits in 18 patients with extensive dental wear

Does your diet include	Never	1–2 times a month	1–2 times a week	Daily
Whole-meal bread	1	4	5	8
Raw root vegetables	—	6	9	3
Lemons	3	11	2	2
Oranges	—	7	7	4
Grapefruit	7	6	4	1
Tangerines/mandarins	—	2	10	6
Apples	2	2	9	5
Grapes	2	10	6	—
Coca-Cola or other soft drinks	4	11	2	1

four, rather severe), whereas five said it was moderate and four slight. Thirteen thought they did not need any treatment. Two of them, however, indicated that if the wear continued, something would have to be done. Five desired therapy immediately.

Bite force

The results of the bite force measurements are presented in Table 5. The individual variations were great, but there were clear differences between the levels tested both for individuals and with regard to the means for the whole group. The values were similar for the men and the women in the wear group. They had higher values in the anterior part of the mouth than the controls with slight wear, whereas the opposite was found for the most posterior location and maximal

Table 4. Distribution of some reported symptoms in 18 patients with extensive dental wear

Do you suffer from	Yes, now	Yes, previously but not now	No
Frequent headache	5	5	8
Pain in your jaws and/or face	6	—	12
Dizziness (vertigo)	5	—	13
Buzzing in your ears (tinnitus)	5	—	13
Tongue problems	1	—	17

Table 5. Bite force in N (means ($\bar{x}$) and standard deviations (SD)) in 18 patients with extensive dental wear (A) and in 12 controls with only slight wear (B). The measurements were performed at three force levels in five regions of the mouth and with maximal force in the 'best biting position'

		15/45		13/43		11,21/41,31		23/33		25/35	
Force level	Group	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Light biting	A	55	45	70	54	69	56	77	56	84	72
	B	70	38	53	21	54	22	53	27	84	56
Biting as when chewing	A	115	64	115	76	107	52	102	57	134	79
	B	105	34	81	36	72	26	76	25	110	32
Powerful biting	A	297	182	229	109	190	80	203	99	268	138
	B	336	117	202	64	149	27	173	36	285	77
Maximal biting (best biting position)	A			407	180						
	B			570	127						

Table 6. Means ($\bar{x}$), standard deviations (SD), and range for some salivary variables in 18 patients with extensive dental wear (A) and 13 controls with little or no wear (B). p denotes whether the difference between A and B is statistically significant (* = $p < 0.05$)

	A			B			
	$\bar{x}$	SD	Range	$\bar{x}$	SD	Range	p
pH	7.4	0.3	6.8–7.8	7.5	0.2	7.3–7.9	
Buffer capacity	5.4	1.6	3.0–7.7	6.4	1.5	3.7–8.0	*
Secretion, ml/min	2.3	1.4	0.3–6.0	2.3	0.9	0.8–4.0	
Protein, μg/ml	1746	776	672–3528	1578	587	756–3000	
Phosphate, mM	3.5	0.8	1.9–5.3	4.2	0.9	2.6–5.8	*
Ca, mval/l	2.9	0.8	1.8–5.3	2.3	0.4	1.8–3.3	*
Na, mval/l	19.7	6.6	10.0–30.8	29.3	15.2	9.0–53.5	*
K, mval/l	19.6	5.2	12.8–31.3	13.7	5.6	5.0–25.6	*

force, usually exerted between the first molars.

Salivary analyses

The rate of secretion of stimulated saliva and the pH did not differ significantly between the patients with extensive dental wear and the controls. The buffer capacity and contents of phosphate and sodium were significantly lower, whereas the calcium and potassium contents were higher, in the dental wear group than in the control group (Table 6).

When the patients were divided into two groups in accordance with the degree of wear at the first examination, the buffer capacity and the rate of secretion were lower in those with the most extensive wear. The other salivary variables examined did not differ significantly between these groups. A corresponding division of the patients by the degree of the continuing wear during the observation period gave only one significant difference: the calcium content was lower in those with the most extensive continuing wear.

When these subgroups were compared with regard to maximal bite force, no significant differences were found.

Discussion

Our initial intention was to select patients with extensive dental wear only, but the group became rather heterogeneous. This fact and the small number of patients studied give this investigation a pilot study character. The fact that the scrutiny comprised a large number of casts (about one thousand) and only resulted in 20 accepted cases verifies the clinical impression that extensive dental wear is uncommon in modern society, at any rate if severely reduced dentitions are excluded.

The most remarkable finding in this study was the relatively small changes that had occurred during the follow-up period of 6–10 years. We had expected that, in these patients with more than 'normal' dental wear in relation to their age, the rate of continuing wear would have been great. Only in a few patients, however, was a measurable reduction of tooth length found after an average of 7 years.

The treatment with occlusal splints certainly reduced some of the attrition due to bruxism but the splints were in general not used for more than a third of the follow-up period. Some of the patients ceased their parafunctions during that period. Others continued, as was evident from clinical observation and the answers to the questionnaire (Tables 2 and 4).

The bite force measurements showed rather high mean values, especially for the women, in comparison with previously reported results (11, 13). The control group also had high bite forces, even though they had lower values on the anterior teeth than the wear group (Table 5). The clinical impression that some of the patients with

extensive dental wear used high bite forces is thus verified. This can probably be explained as a training effect in subjects with parafunctions like tooth clenching and grinding, which had resulted in more wear of the incisors (Table 1).

It is not only parafunctions that are considered responsible for extensive dental wear. The multifactorial character of the phenomenon is obvious from the observations of contributing biochemical, salivary, and dietary variables (Tables 2, 3, and 5). This finding deserves to be studied further, among other reasons to determine the importance in humans of factors previously reported to influence dental wear in animal experiments (14, 15). Salivary factors do not seem to have been studied in humans in relation to dental wear (16). Saliva from patients with erosion, however, had an increased mucin content, whereby the deposition of calcium, which normally repairs small defects in enamel, is prevented (17). The calcium deposition might be a factor of importance also in these patients, as those with the most extensive continuing wear had lower content of calcium in saliva than the others. The recently demonstrated (18) influence of age and sex on the secretion rate and buffer effect of saliva has not been analyzed in this material because of the small number of subjects examined.

Erosion affecting especially the palatal surfaces of upper anterior teeth is a condition that appears to be commoner than was formerly believed (19). The most probably etiologic factor in such cases is gastric acid, but combinations with dietary acid, mechanical abrasion such as by the tongue, and attrition must also be considered, as in patients with extensive dental wear.

When treating a patient with extensive dental wear, it is essential to find the most important etiological factor to select the most effective therapy. The results of this study seem to indicate that continuing dental wear is in general a slow process, at any rate in patients who had received an occlusal splint. It thus corroborates the clinical recommendation (19) that patients seen for the first time with extensive dental wear should in general not be subjected to immediate restorative procedures. Dental wear is not an acute problem and due time should be allowed for careful analysis of etiological factors and therapy planning. Many of the patients do not even consider rehabilitation necessary, provided the progression is slow. And this was true for most of the patients in this study.

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