Dental erosion in a population of Swiss adults

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Abstract – The purpose of this study was to determine the prevalence of dental erosion in an adult population in Switzerland. 391 randomly selected persons from two age groups (26–30 and 46–50 yr) were examined for frequency and severity of erosion on all tooth surfaces. Information was gathered by interview about lifestyle, dietary and oral health habits. For facial surfaces 7.7% of the younger age group and 13.2% of the older age group showed at least one tooth affected with erosion with involvement of dentin (grade 2). 3.5 teeth per person in the younger and 2.8 teeth per person in the older age group were affected. Occlusally, at least one severe erosion was observed in 29.9% of the younger and 42.6% of the older sample with 3.2 and 3.9 erosion-affected teeth per person, respectively. 3.6% of the younger age group and 6.1% of the older age group showed slight lingual erosion on the maxillary anterior teeth. Severe lingual erosions were scarce. Data from interviews and multiple regression analyses revealed that acids from beverages are significantly associated with presence of erosion.

Key words: dental erosion; epidemiology; facial; lingual; occlusal

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In a time of declining caries prevalence, it appears that an increasing number of patients show dental erosion. Dental erosion is defined as a loss of tooth substance by chemical processes not involving bacteria (1). Typical for erosion is a disc-shaped and shallow appearance with intact enamel found cervical to the erosion (2). Erosion may be caused either by intrinsic or by extrinsic factors.

Extrinsic causes could be acidic foodstuffs, beverages, snacks or exposure to acidic contaminates in the working environment (3–6). Intrinsic causes may be chronic gastric disturbances such as regurgitation and anorexia nervosa with frequent vomiting (7).

In a sample of 10 000 extracted teeth the incidence of erosion-like lesions was reported to be about 18%. Cervical sites of incisors were the most common area for occurrence. Intraoral frictional forces were also discussed as a possible etiologic factor for erosion (8-10).

To our knowledge, there are no epidemiologic data about dental erosion for Switzerland or the rest of Europe. The aim of the present study was to evaluate the prevalence of dental erosion in an adult Swiss population belonging to two age groups. In addition, information was gathered to study the association between erosion and dietary and oral habits.

Material and methods

Using the central registry of four political communities in the cantons of Berne and Lucerne, 980 letters explaining the study were sent to randomly selected subjects. Three communities had less than 10 000 inhabitants while one community (Berne) had about 150 000 inhabitants. About 25% of the population in Switzerland lives in medium-sized towns (20 000–160 000 people) while about 40% inhabit villages and small towns. The aim of the study and the procedures for examination were explained in the letter. Out of 980 persons, 498 agreed to participate in the study. 107 had full dentures or did not attend the appointment. No further efforts were made to persuade subjects to participate. Examinations were conducted in the homes of participants with an explorer (Deppeler SE 4, Deppeler, Rolle, Switzerland) and a modified mirror with a built-in light source. This device allowed illumination of the teeth so that the severity of erosion could be assessed.

391 persons (40%) were examined. 204 lived in the city of Berne, while 187 lived in the three smaller communities in the canton of Lucerne. 197 persons were aged 26–30 yr and 194 persons from 46–50 yr of age.

Facial, lingual, and occlusal surfaces of all teeth except third molars were examined for dental erosion. The rating of the facial surfaces was done using a scoring system modified from that of Linkosalo & Markkanen (11).

Grading of severity for the facial surfaces

Grade 0: No erosion. Surface with a smooth, silky-glazed appearance and absence of developmental ridges possible.

Grade 1: Loss of surface enamel. Intact enamel found cervical to the erosion and concavity on enamel whose breadth clearly exceeds its depth, thus distinguishing them from toothbrush abrasion. Undulating borders of the lesions are possible. Dentin is *not* involved. (Fig. 1, left).

Grade 2: Involvement of dentin for *less*

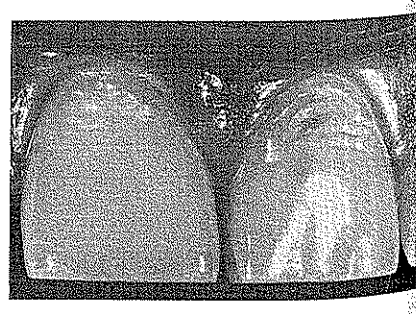


Fig. 1. Maxillary incisors showing facial erosion of grade 1 (left) and of grade 2 (right).

Table 1. Interexaminer agreement beyond chance (κ) between the two dentists

Erosion	grade	κ
facial	0	0.84
	1	0.95
	2	1
	3	–
occlusal	0	0.95
	1	0.92
	2	1
lingual	0	0.80
	1	0.80
	2	–

$0.75 < \kappa$: excellent agreement beyond chance.

than one half of the attacked area of the tooth surface. (Fig. 1, right).

Grade 3: Involvement of the dentin for *more than one half* of the attacked area of the tooth surface.

Grading for other than facial surfaces

Grade 0: No erosion. Surface with a smooth, silky-glazed appearance and absence of developmental ridges possible.

Grade 1: Slight erosion, rounded cusps, edges of restorations rising above the level of adjacent tooth surface, grooves on occlusal aspects. Loss of surface enamel. Dentin is *not* involved.

Grade 2: Severe erosion, more pronounced signs than in grade 1. Dentin *is* involved.

Since erosion, attrition and abrasion are difficult to distinguish in their initial stages, only those lesions that were considered definitely affected by erosion were classified above grade 0 so as to allow discrimination for study purposes. As defined above, localization and morphology are the clue for discrimination.

Before the clinical examination, all subjects were interviewed. This interview instrument containing 14 items was designed to gain information about: dietary habits including intake of acidic food (fruits, citrus fruits, fruit juice, apple juice, vegetables, yoghurt), preventive habits and aids (type of toothpaste, hardness of toothbrush bristles), drug usage (tranquillizers, other drugs, effervescent tablets), stomach problems (gastric regurgitation), possible X-ray irradiation, salivary gland disorders, environmental acid exposure, hypersensitivity of the teeth.

The examination was conducted by two dentists, calibrated together using 12 patients prior to the study. In order to assess interexaminer agreement 34 randomly selected subjects with 898 teeth were examined during the study by both dentists using identical procedures. The proportion of agreement and the Kappa-value (κ) (= the proportion of agreement beyond chance) were calculated (12).

The data were analyzed by descriptive and multivariate methods using the general linear model procedure (GLM) of SAS software for data analyses (SAS Institute, Cary NC, USA). The diagnosed facial, occlusal and lingual erosions were subjected to multiple regression analyses, in order to test whether lesions were associated with age, living area, lifestyle, dietary or oral habits. Significance of a variable was based on the significance of its partial (type III) sum of squares contribution. The type III sum of squares is the increase in the model sum of squares when adding a certain variable to an otherwise complete model.

Results

Table 1 gives an overview of agreement between the two dentists (34 subjects with 898 teeth examined). In all cases, it shows good to excellent agreement between the two examiners. Kappa-values ranged between 0.8 (lingual erosion; grades 0, 1) and 1 (facial erosion, grade 2). The number of persons with at least one tooth with erosion and the corresponding percents are shown in Table 2. For facial surfaces 11.9% in the younger age group and 9.6% in the older age group showed one or more erosive lesions of grade 1, whereas 7.7% in the younger and 13.2% in the older sample had erosions on facial surfaces with involvement of dentin (grade 2). Overall, 16.0% of the participants had at least one tooth with signs of facial erosion (grades 1, 2, 3). For occlusal surfaces, 35.6% of persons in the age group of 26–30 yr had one or more teeth with erosion of grade 1, whereas in the older age group (46–50 yr) this number was 40.1%. One or more severe occlusal erosions (grade 2) were observed in 29.9% of the younger and in 42.6% of the older sample, respectively (Table 2b). 3.6% of the younger age group and 6.1% of the older age group showed at least one tooth with lingual erosion of grade 1 (Table 2c). All lingual erosions were found on maxillary teeth only. Overall, a greater percentage of subjects in the older age group had at least one tooth with facial, occlusal or lingual erosion.

The means of the affected teeth per subject with a certain grade of facial, occlusal and lingual erosion are shown in Table 3.

Generally speaking, the older sample had more affected teeth per person than the younger sample. 4.1 teeth per person in the younger and 4.5 teeth per person in the older age group were affected with facial erosions of grade 1. Only one person in the older age group showed facial erosion of grade 3. Occlusally, 6.0 teeth per person in the younger age group and 6.7 in the older age group had grade 1, whereas 3.2 affected teeth per person involving dentin (grade 2) in the younger age group and 3.9 teeth per person in the older age group were involved (Table 3b).

Table 4 shows the results of the multiple regression analyses. All variables with a significant impact on buccal, occlusal and lingual erosion as well as the Type III sum of square and the *P*-values are listed. For facial erosion, consumption of fruits like apples, pears and plums were the predominant variables ($P < 0.001$), whereas chronic vomiting ($P < 0.001$) appeared to be most decisive for lingual erosion. Occlusally, age ($P < 0.001$) and consumption of other than citrus fruits ($P < 0.001$) as well as of fruit juices ($P < 0.001$) were the most dominant variables.

Table 2. Numbers of subjects with at least one tooth affected with erosion. Percentage given in parentheses

		a) Facial erosion			b) Occlusal erosion		c) Lingual erosion	
Age	grade	Score 1	Score 2	Score 3	Score 1	Score 2	Score 1	Score 2
26–30 yr	194	23 (11.9)	15 (7.7)	0 (0)	69 (35.6)	58 (29.9)	7 (3.6)	0 (0)
46–50 yr	197	19 (9.6)	26 (13.2)	1 (0.5)	79 (40.1)	84 (42.6)	12 (6.1)	4 (2.0)

Table 3. Teeth per subject of those affected with erosion

Age	grade	a) Facial erosion Score 1	Score 2	Score 3	b) Occlusal erosion Score 1	Score 2	c) Lingual erosion Score 1	Score 2	
26–30 yr	194	94	53	0	411	188	24	0	affected teeth
		23	15	0	69	58	7	0	affected subjects
		4.1	3.5	0	6.0	3.2	3.4	0	affected teeth per subject
46–50 yr	197	86	73	1	533	327	47	6	affected teeth
		19	26	1	79	84	12	4	affected subjects
		4.5	2.8	1.0	6.7	3.9	3.9	1.5	affected teeth per subject

Figs. 2 and 3 show the distribution of facial erosions of grades 1 and 2 within the dentition. In general, maxillary teeth showed more erosions of grade 1 (no dentin involved) than mandibular teeth. Of the maxillary anterior teeth between 2.8% and 5.9% in the younger and 3.1% and 6.1% in the older age group showed grade 1 erosions (Fig. 2). More pronounced erosions (grade 2; dentin involved), were distributed more equally between maxillary and mandibular teeth (Fig. 3). Canines and first premolars were most often attacked.

Fig. 4 shows the distribution of teeth with occlusal erosions of grade 1. Mandibular teeth had more signs of erosion than maxillary teeth. Lower first molars and lower second premolars showed the highest percentage of occlusal erosions. Severe occlusal erosions (grade 2) were most often found on mandibular first molars, with 16.0% and 18.4% affected teeth in the younger and 17.7% and 26.1% in the older age group (Fig. 5). Lingual erosions were found only in maxillary teeth. Central incisors were more often affected (3.5% in the younger and 7% in the older age group) than the lateral incisors or the canines (Fig. 6). Lingual erosions of grade 2 were scarce and were only found in the older age group (Fig. 7).

Discussion

In this investigation 391 randomly selected adults belonging to two groups were examined. In order to examine all persons under identical conditions, a mirror with a built-in light source was used. This device allowed illumination of the teeth in a manner that made a distinction of the several erosion indices possible. This is supported by good agreement between the two examiners (Table 1). The proportion of agreement beyond chance (Kappa) for all indices was always between 0.80 and 1.0. Kappa values above 0.75 may be taken to represent excellent agreement between the two dentists (12).

34.8% of all subjects suffered from hypersensitivity of teeth. However, only 16.9% of these had facial erosive lesions of grades 2 or 3 whereas 84.6% of the examinees with toothbrush abrasion complained of hypersensitivity of this area (13). This finding could be explained by the fact that hypersensitive areas often show open dentinal tubular orifices and that the latter are strongly correlated with toothbrush abrasion (14). It appears that mechanical stress irritates teeth more than chemical agents do.

7.7% of the younger and 13.2% of the older subjects had one or more erosive lesions on the facial surfaces with involvement of dentin (grade 2). Overall, 16.0% of the participants had at least one tooth with signs of facial erosion.

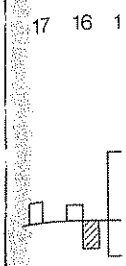
Due to different rating schemes comparison of the results reported here with those of other studies is somewhat difficult. BRADY & WOODY (15) found that 5.3% of 900 dentists examined had cervical erosions on their labial surfaces. These defects were probably not all erosions in our sense of the term, but rather cervical wedge-shaped defects associated primarily with toothbrushing. XHONGA & VAN HERLE (16) in 1973 examined 30 subjects with a median age of 33 yr and found 1.4 erosion-affected teeth per subject. It is not clear if the higher value found in the present study is due to different rating schemes or to different dietary habits in Switzerland today.

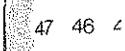
This epidemiologic study revealed that maxillary anterior teeth were the most often affected with facial erosion of grade 1, whereas it was the canines and premolars which were the most affected with grade 2 facial erosion (Figs. 2 and 3). SOGNNAES *et al.* (8) in their investigation of about 10 000 extracted teeth and XHONGA & VAN HERLE (16) found a rather similar distribution, although they did not distinguish between different tooth surfaces and the distribution of different grades or erosion was not reported. The

Table 4. Multiple regression analyses. *P*-values (*P*) and Type III sum of squares (SS) are listed for all variables with a significant impact on facial, occlusal, and lingual erosion

Dependent variable		Model	Citrus fruits	Other fruits	Fruit juice	Yoghurt	Toothbrush hardness	Vomiting	Age group	Living area
Facial erosion	*P*	<0.001	0.02	<0.001		0.03	0.007			
(r^2=0.10)	SS	1.93	0.11	0.33		0.10	0.16			
Occlusal erosion	*P*	<0.001		<0.001	0.001				<0.001	0.01
(r^2=0.12)	SS	44.8		2.04	1.54				3.58	0.56
Lingual erosion	*P*	<0.001			0.02			<0.001	0.02	
(r^2=0.07)	SS	2.03			0.21			0.78	0.21	

SS: Partial sum of squares: Increase in the model sum of squares when adding a certain variable to an otherwise complete model.





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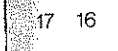

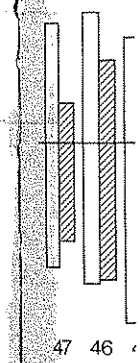

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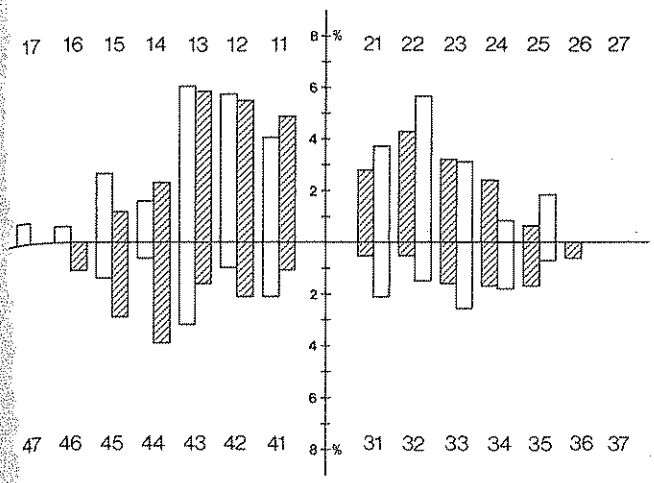

Fig. 2. Distribution of facial erosion of grade 1 within the dentitions of 2 age groups (▨ 26–30 yr, □ 46–50 yr). Missing teeth and crowns are not included in the calculations.

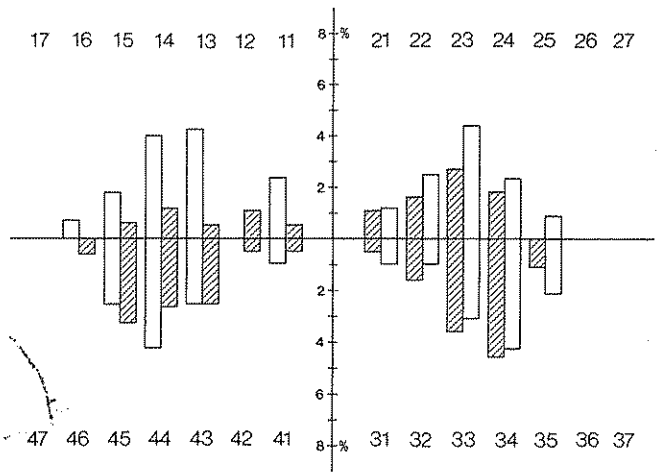

Fig. 3. Distribution of facial erosion of grade 2 within the dentitions of 2 age groups (▨ 26–30 yr, □ 46–50 yr). Missing teeth and crowns are not included in the calculations.

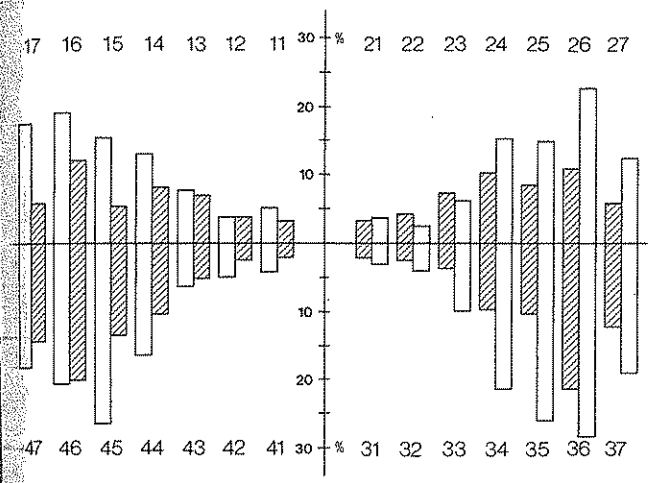

Fig. 4. Distribution of occlusal erosion of grade 1 within the dentitions of 2 age groups (▨ 26–30 yr, □ 46–50 yr). Missing teeth and crowns are not included in the calculations.

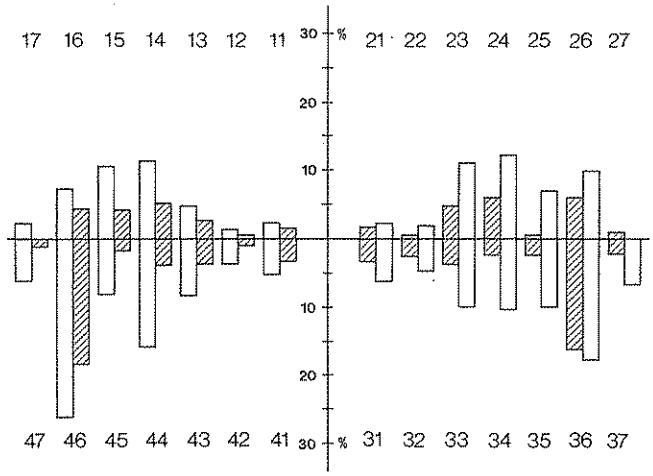

Fig. 5. Distribution of occlusal erosion of grade 2 within the dentitions of 2 age groups (▨ 26–30 yr, □ 46–50 yr). Missing teeth and crowns are not included in the calculations.

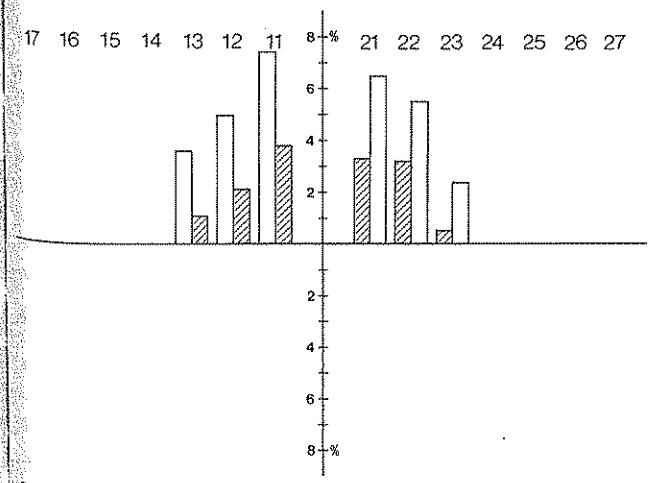

Fig. 6. Distribution of lingual erosion of grade 1 within the dentitions of 2 age groups (▨ 26–30 yr, □ 46–50 yr). Missing teeth and crowns are not included in the calculations.

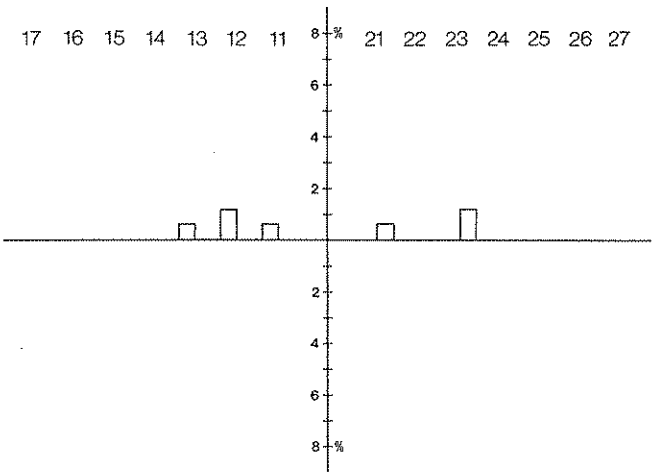

Fig. 7. Distribution of lingual erosion of grade 2 within the dentitions of 2 age groups (▨ 26–30 yr, □ 46–50 yr). Missing teeth and crowns are not included in the calculations.

prevalence and distribution of erosive lesions of the dentition could also be connected with the flow rate of saliva (17) and the buffer capacity, which were not considered in this study. However, statistical analyses of facial and occlusal erosion showed that consumption of fruits, fruit juices, citrus fruits and yoghurt were the dietary variables in multiple regression analyses with the most significant impact. Fruit juices with pH-values between 3.2 (grapefruit juice) and 3.9 (apple juice) are capable of softening enamel and dentin. The pH of yoghurt is around 4 depending on the brand and flavor. The buffer capacity, which is probably of greater importance for developing erosion of teeth (18), is also highest for grapefruit juice followed by orange and apple juice.

The older age group (46–50 yr) showed significantly more occlusal erosions than the younger age group (26–30 yr) which could be due to the fact that when erosion is present, abrasion and attrition can cause it to increase. LINKOSALO & MARKKANEN (11) examined facial, lingual and occlusal erosions on 26 lactovegetarians. They found 77% of the subjects with occlusal erosions. As expected, a smaller percentage of subjects in this study had occlusal erosion. However, even in this randomly selected population 29.9% of the younger and 42.6% of the older subjects had severe erosion (grade 2) on the occlusal surfaces with 3.2 and 3.9 teeth affected per affected person.

Lingual erosions were scarce. Only 2% of the older subjects showed severe lesions (grade 2). About 50% of these persons had a history of chronic vomiting. Multiple regression analysis showed the amount of chronic vomiting to have a highly significant impact ($P < 0.001$) on lingual erosion (Table 4). HELLSTRÖM (19) found lingual erosions in 23 of 27 examined persons with chronic vomiting. ROBERTS & LI (20) showed that 35% of patients with anorexia and 33% of patients with bulimia showed lingual erosions of the maxillary anterior teeth. Also with this study, maxillary anterior teeth were most often marked with lingual erosions. There were no lingual erosions on maxillary premolars and molars nor were there any on mandibular teeth.

This study shows that in Switzerland teeth affected with erosion are not uncommon and that there exists statistically an association between dietary habits like intake of fruit juices, citrus fruits or other fruits and the occurrence of erosion. However, even severe facial erosions with involvement of dentin does not cause significant hypersensitivity problems to the population under study.

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