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Dental erosion Clinical diagnosis and case history taking

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Dental erosion is not a very rare condition. Early correct diagnosis of this damage of dental hard tissue consequently is of clinical importance. The aim of this paper is to present an easy-to-learn rating scheme for the assessment of the severity of dental erosive lesions with high inter- and intra-examiner agreement. It differentiates between facial, occlusal and oral surfaces of a tooth and has already been used successfully in epidemiological studies. Further, anamnestic risk factors are discussed with respect to their relevance for the development of dental erosion. Guidelines are given for the clinician on how to elicit information from the patient about relevant risk factors.

Key words: anamnestic risk factors, case history; dental erosion; diagnosis

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Introduction

Dental erosion is defined as a loss of tooth substance by chemical processes not involving bacteria (1). Based on this definition the term "corrosion" was also proposed (2) for the condition. Erosion may be caused by intrinsic as well as by extrinsic factors. In a study (3), a total of 391 randomly selected Swiss individuals of two different age groups (26–30 yr, 46–50 yr) were examined and questioned. The questionnaire comprised some 50 questions and subquestions regarding dietary habits, lifestyle, oral hygiene, general illnesses perhaps related to erosion, ingestion of medication, and tooth sensitivity. Eight percent of the younger age group and 13% of the older age group had at least one tooth affected by facial erosion with involvement of dentin. Overall, 16% of all subjects showed at least one tooth with signs of facial erosion. Occlusally, at least one severe erosion was observed in 30% of the younger and in 43% of the older subjects, whereas only 2% of the older subjects showed severe lingual erosions. Using multiple regression analyses, this study revealed that the consumption of fruits and fruit juices and recurrent vomiting were the risk factors most significantly related to this dental hard tissue defect (3). A case-control study of 106 patients with dental erosion showed that the frequent consumption of citrus fruits, soft or sports drinks and apple vinegar as well as chronic vomiting were associated with erosion (4).

Erosive lesions have to be clearly distinguished from wedge-shaped defects (Fig. 1). Toothbrushing is certainly the most widely accepted means for maintaining the health of oral hard and soft tissues. On the other hand, there is also evidence that incorrect tootbrushing techniques may traumatize these tissues and lead to gingival recession with root surface exposure and cervical wedge-shaped defects often called toothbrush abrasions (5). In this context, it should be mentioned that physical loading during interocclusal activities has also been discussed as a possible factor contributing to the formation of toothbrush abrasion. While true erosion is mainly caused by the action of acids and assisted by abrasion or attrition, wedge-shaped defects are primarily caused by abrasion and only secondarily aggravated by acid softening of the hard tissue. Since the etiology as well as the prevention of wedge-shaped defects are different from those of erosive lesions, it is important that the dentist is able to distinguish these conditions.

The aim of this paper is to propose a rating scheme for the assessment of the severity of dental erosive lesions and to suggest ways in which an appropriate case history can be obtained from a patient with erosion.


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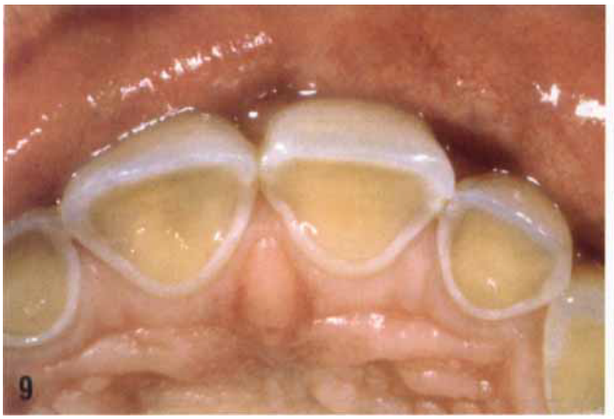

Fig. 9. Palatal erosion: Upper incisors, grade 2. (Patient's case history: chronic regurgitation)
Fig. 10. Palatal erosion visible from the labial side, grade 2. (Patient's case history: chronic vomiting)

Clinical diagnosis

An index for the clinical assessment of erosive lesions must fulfill the following requirements

- It should easily separate erosive lesions from other defects of dental hard tissue such as wedge-shaped defects
- It should clearly differentiate between various grades of severity
- It must be easy to learn
- It must exhibit good inter- and intra-examiner agreement
- It should be sensitive enough to monitor changes of severity over time in longitudinal investigations
- All tooth surfaces are to be assessed individually by visual inspection: 1 vestibular (buccal/labial), 1 oral (lingual/palatal) and 1 occlusal surface per tooth, i.e. a maximum of 84 (28×3) surfaces for a complete dentition.

  Due to varying distribution patterns and different prevalences in different age groups (3) it is at the present time recommended to assess the entire dentition rather than inspecting only a few selected, seemingly representative teeth. In the future the definition of certain "marker teeth" for any specific age group should be based on statistical analyses of epidemiological data.
- Surfaces with extensive restorations making clinical diagnosis impossible should be disregarded.

In the past, quite a number of indices for the grading of erosion have been formulated and applied, be it in animal (6–10) or in human studies (3, 4, 11–13)

The various indices describe morphological changes with up to seven grades of severity. Even though a fine-step grading scheme will pick up minute changes of the dental hard tissues, it will, at the same time, reduce inter- and intra-examiner agreement and thus complicate comparisons of various studies. Furthermore, the use of a very fine grading scale will prolong the decision process for every individual tooth and is thus more time consuming. Too fine a grading scale is consequently not ideal for an index aimed at gathering epidemiological data.

Fig. 1. Wedge-shape defect. Risk factor: horizontal toothbrushing technique.
Fig. 2. Facial erosion: Teeth 11 and 21 erosion of grade 1. (Patient's case history: low buffering capacity, low unstimulated saliva flow rate, 10–15 sugar-free acidic candies per day)
Fig. 3. Facial erosion: Tooth 21, grade 1; tooth 22, grade 2; tooth 23, grade 2. Note that only in tooth 22 the enamel cervical to the erosion is intact.
Fig. 4. Facial erosion: All teeth show involvement of dentin, grade 2. Tooth 21 and also the other teeth show signs of toothbrush abrasion. (Patient's case history: low buffering capacity, salad dressing, fruits)
Fig. 5. Facial erosion: grade 3. (Patient's case history: lemon slices during sports activities)
Fig. 6. Occlusal erosion: Tooth 35, grade 1; tooth 36, grade 2.
Note the amalgam filling rising above the occlusal surface. (Patient's case history: vinegar, fruit juices)
Fig. 7. Occlusal erosion: Tooth 46, grade 2. Note the filling rising above the buccal surface. (Patient's case history: orange juice, regurgitation)
Fig. 8. Occlusal erosion: Lower incisors, grade 2.
(Patient's case history: fruits, apple juice, orange juice, salad dressing)

For clinical investigations, the following index based on earlier published classifications is suggested (11–13):

Grading of facial surfaces

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

Grade 1: Loss of surface enamel. Intact enamel found cervical to the lesion. Concavity in enamel, the width of which clearly exceeds its depth, thus distinguishing it from toothbrush abrasion. Undulating borders of the lesions are possible. Dentin is *not* involved (Figs. 2, 3).

Grade 2: Involvement of dentin for *less* than *one-half* of the tooth surface. (Figs. 3, 4).

Grade 3: Involvement of dentin for *more* than *one-half* of the tooth surface (Fig. 5).

Grading of oral and occlusal surfaces

Grade 0: No erosion. Surface with a smooth, silky-shining appearance. 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 (Fig. 6).

Grade 2: Severe erosion, more pronounced signs than in grade 1. Dentin *is* involved (Figs. 6–10).

Since erosion, attrition and abrasion are difficult to distinguish from each other in their initial stages, only those lesions that are definitely considered to be the result of an acid challenge are classified above grade 0. As defined above and shown in the figures, localization and morphology are the clues for discrimination. Furthermore, for facial surfaces the limit between grades 2 and 3 is set at 50% dentin involvement, because this admittedly broad criterion can be assessed more easily and more reliably than more narrow scales. Grade 2 for oral and occlusal surfaces could be also further subdivided in the same way although, especially for occlusal surfaces, reliable assessements are difficult to achieve. Exact measurement of the size of the affected dentin area would certainly be more precise. However, it is not necessary for epidemiological purposes and too time consuming for the inspection of large cohorts.

This index proved to be easy to learn and to use. It also demonstrated excellent inter-examiner agreement (kappa=0.80–1), when used on 898 teeth (3) (Table 1). The proposed index is particularly suitable for epidemiological investigations. For the dental practitioner, however, it is more important to recognize erosive changes at an early stage in order to prescribe and supervise appropriate preventive measures. Typical signs of initial dental erosion, such as a silky-glazed appearance of enamel and relatively wide, shallow concavities on enamel (Figs. 2, 3) must not go unnoticed. In order to *precisely* monitor the progression of erosive lesions in an individual patient or a small group of patients (for example to judge the effectiveness of certain measures taken in the course of a preventive program), it may be advisable to record the degree of destruction of enamel and dentin using an even finer grading scheme than the one presented. By means of a periodontal probe, the maximum extention (diameter) of the affected area of the tooth surface can easily be measured. This is relatively easy if dentin is involved. It may be somewhat more difficult if only enamel is affected. Finally, a schematic drawing of the area indicating the extensions as well as the readings measured will be very helpful. Photographs and/or study models can also be used for documentation.

Table 1

Inter-examiner agreement beyond chance (kappa) assessed on 898 teeth (3)

Erosion	grade	kappa (κ)
Facial	0	0.84
	1	0.95
	2	1
	3	no case
Occlusal	0	0.95
	1	0.92
	2	1
Lingual	0	0.80
	1	0.80
	2	no case

0.75< k: excellent agreement beyond chance

Anamnestic considerations with dental erosion patients

Usually, only detailed discussion with patients suffering from erosive dental lesions may bring about clarification as to the etiological situation (Table 2). With patients at risk for dental erosion special consideration should be given to the following aspects of their case history:

- Dietary habits
- Gastric disturbances
- Drug influence, radiotherapy
- Salivary gland dysfunction
- Professional exposure to acidic environments
- Oral hygiene habits

Table 2

Items to be covered when recording the case history of a patient suffering from erosion (including frequency and duration)

Diet:	Citrus fruits, other fruits, citrus fruit juices, other fruit juices, pickled gherkin, salad dressing, vinegar, sports drinks, soft drinks, acidic beverages, fruit berries, acidic candies, herbal tea, other acidic food, alcohol, effervescent vitamin C tablets.
Gastric symptoms:	Vomiting, belching, acid taste in the mouth and gastric pain (especially on awakening), stomach ache, any sign of anorexia.
Drugs:	Tranquillizer, anti-emetics, anti-histamins, lemonade tablets.
Saliva:	Flow rate, buffering capacity, pH, X-ray therapy in the head and neck region, salivary gland disorders.
Professional exposure	to acidic environments.
Oral hygiene habits:	Toothbrush stiffness, technique, when, how often, how long.

Dietary habits

It has been known for a long time that acidic food and drinks may soften dental hard tissues (1, 8, 9, 14). In 1993, the consumption of soft drinks and fruit juices in Europe amounted to over 70 l *per capita* and year, representing on average more than 10% of the total individual fluid consumption. The erosive activity of citric, lactic, phosphoric and other acids was tested and demonstrated in many *in vitro* and *in vivo* studies dealing especially with single cases or small populations (13, 15–28). Excessive consumption of acidic beverages may produce dental hard tissue erosion. However, the erosive potential of an acidic drink is not exclusively dependent on its pH-value but is also strongly influenced by its buffering capacity, the chelation properties of the acid and by the frequency and duration of ingestion. The greater the buffering capacity of the drink, the longer it will take for saliva to restore the pH value. Also, the calcium, phosphate and fluoride content of the beverages and the pretreatment of the dental hard tissue seem to be important factors (6, 29–33). In this context, it should be kept in mind that the buffering capacity and the flow rate of saliva (34) have also to be taken into account, when estimating a patient's risk for the development or progression of erosive lesions (Figs. 2, 4).

Chairside interviews are mostly not sufficient to determine dietary habits leading to erosion because the patients may be unaware of their acid ingestion.

Table 3

Example of a patient's dietary history (to be recorded over 5 consecutive days including a weekend)

1st day		2nd day	
6.30	"Birchermuesli", yoghurt, 1 apple, honey, coffee with milk, toothbrushing immediately afterwards	6.30	"Birchermuesli", youghurt, 1 orange toothbrushing immediately afterwards
9.30	300 ml orange juice, sip-wise toothbrushing immediately afterwards	9.30	300 ml orange juice, sip-wise 1 coffee toothbrushing immediately afterwards
13.00	Cooked whole potatoes, cheese, salad with wine vinegar dressing, herbtea and 1 apple brushing immediately afterwards	10.30	300 ml orange juice, sip-wise
16.15	300 ml orange juice, sip-wise toothbrushing immediately afterwards	12.00	mixed salad with wine vinegar dressing and fish toothbrushing immediately afterwards
19.00	mixed salad with french dressing, bread and herbtea	15.00	coffee, 1 apple, 1 grapefruit
	20.00 2 oranges	18.00	"Birchermüesli", apple juice
		20.00	2 apples

5nd day (Sunday)		Frequency of acidic intakes			
9.00	300 ml orange juice, sip-wise		day 1	day 2....	day 5
9.30	"Birchermuesli", plain yoghurt, 1 apple, honey, coffee with milk	main meal duration	2 normal	3	3
12.30	salad with wine vinegar dressing, bread and tea toothbrushing immediately afterwards	between meals duration	3 long lasting	4	4
14.00	1 apple				
15.30	coffee with milk and 2 mandarins				
17.00	apple juice (sip-wise)				
18.15	rice-salad, 1 pear and herb tea toothbrushing immediately afterwards				
20.00	2 mandarins				
22.00	1 orange				

Therefore, it is advisable to have such patients monitor their complete dietary intake for at least five consecutive days including a weekend, recording in writing: time, quality and quantity of all ingestions, including diet supplements such as vitamin C tablets or solutions, or iron tonics and also acidic candies (Table 3). Excessive consumption of the latter combined with a low salivary buffering capacity may well either lead to or aggravate already existing erosive lesions (Fig. 2) (35). Both week days and weekend days should be included, as dietary habits during weekends may considerably differ from those during working days. This dietary record should be sent to the dentist prior to the next appointment. Besides estimating the erosive potential of the different foodstuffs and drinks and taking into account the various parameters mentioned above, the dentist should also analyse the frequency of ingestion of acidic (and of sugar-containing) foodstuffs with main meals and with in-between snacks and estimate the duration of the acid challenge (Table 3). In summary, it is important to know how, how often, how much and when what type of drink or foodstuff is ingested.

Based on such analyses, realistic preventive programs may be suggested. These aim primarily at reducing acid exposure by reducing the frequency of ingestion of potentially harmful drinks and foodstuffs, as well as at reducing contact time by rapid rather than sip-wise consumption or by using a straw. It is to be noted, however, that diet-related erosions cannot be fully explained with the ingestion of acidic foodstuffs and beverages. Additional factors such as various salivary parameters and oral hygiene habits may also be of importance.

Gastric disturbances

The possible influence on dental erosion of gastric disturbances, such as chronical regurgitation and frequent vomiting due to *anorexia nervosa* or *bulimia*, is well documented (36–41). Usually the palatal surfaces of the maxillary teeth are affected first. More advanced cases show involvement of occlusal surfaces of molars and premolars as well as of labial surfaces of maxillary incisors.

Patients with gastric disturbances including reflux may report an acidic taste in the mouth or gastric pain early in the morning. If there is substantial suspicion as to reflux being a causative factor, patients need to be questioned specifically, since they may have come to consider this phenomenon as "normal". However, such questions will have to be formulated very carefully and diligently because the patient under examination may be anorectic or perhaps pregnant.

It should be noted that gastric reflux can be asymptomatic and may even be observed in children.

Drug influence

Besides radiotherapy to the head and neck region and salivary gland disorders, a number of drugs, such as tranquillizers, anti-histamine, anti-emetics, anti-Parkinson medicaments and many others may lead to reduced salivary secretion which is often associated with a low buffering capacity. Therefore, erosion patients should always be questioned as to regular (chronic) intake of medication. In the affirmative, further clarification of possible side effects may be necessary. Individual susceptibility of salivary parameters to various drugs may make it desirable to have the patient's physician change a given medicament against one with less oral side effects. It should be noted that frequent and/or extended contact of teeth with low-pH medicine may also cause or at least accelerate the progression of exisiting erosive lesions. Therefore, patients should be asked about regular or frequent use of both prescription medicines and pharmacy products such as cough medicines.

Salivary gland dysfunction

As already mentioned patients with reduced salivary flow rate and/or reduced buffering capacity are particularly prone to accentuated acid-induced erosive lesions.

A first estimate of the salivary flow rate of a patient can be made in the course of a normal clinical appointment. However, in order to quantify correctly an objective test method will be needed. Assessing salivary parameters such as flow rate, pH and buffering capacity in the dental office is possible using commercially available diagnostic kits. The procedure for the collection of unstimulated saliva is as follows: The patient sitting in a upright position is asked to swallow his/her saliva. From then on the saliva is collected over a 5 min period. The patient is requested to resist swallowing and to spit periodically into a graduated beaker. If the saliva secretion rate is too small, it may be necessary to extend the collection period. When the collection time is over, the amount of saliva (ignoring the foam) is read and the secretion rate calculated and expressed in ml saliva per minute. For adults, normal secretion rates are in excess of 0.25 ml/min. Values below 0.1 ml/min should be considered as low. Values between 0.1 and 0.25 ml/min are borderline.

The buffering capacity and, if desired, the pH of the saliva are measured with the freshly collected saliva using indicator systems (Dentobuff®, Viva-

dent, Schaan, Liechtenstein). A drop of the saliva is placed on a test strip. The strip contains a weak acid and a pH-indicator. Saliva with a high buffering capacity will raise the pH, indicated by the colour change on the strip. After exactly 5 min the colour is read (compared to a standard) and a classification into low, medium and high saliva buffering capacity is possible.

Professional exposure to acidic environments

Previously quite frequently observed dental erosions due to professional exposure to acidic environments are hardly seen nowadays. Nevertheless, the possibility should not be disregarded completely. Also, frequent swimming in gas-chlorinated water may damage dental hard tissues (42).

Oral hygiene habits

Toothbrushing will abrade superficially softened dental hard tissue more easily than regular (unsoftened) surfaces. DAVIS & WINTER (43) reported a significantly enhanced enamel loss by toothbrushing from eroded compared to uneroded enamel. Information about the type of toothpaste and brushing method should be obtained. Also, as an excessive use of, for example, acidic mouthwashes could be a risk factor, patients should be asked about other oral hygiene habits. Since erosive processes may be enhanced by abrasive procedures toothbrushing immediately after definite acid contact should be avoided. Instead, patients at increased risk for dental erosion should rinse their teeth with a fluoride solution or, if not practical, at least with plain water immediately following every exposure to acid. They must be informed neither to brush their teeth immediately after an acid challenge, nor to use strongly abrasive toothpastes.

Conclusion

It may be stated that the index presented allows rapid gathering of reliable data regarding dental erosion. Furthermore, due to its high interexaminer agreement it enables the comparison of data collected from different sources by different examiners.

Effective preventive programs must be based on a thorough clinical examination and on a careful analysis of possible etiologic factors from the individual case history. Well aimed questions as well as a complete dietary record over a period of at least 5 d will help to provide the desired information. Further examinations may become necessary.

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