

# Dental erosion, summary

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Although reports on dental erosion have always appeared in the dental literature, there is currently a growing interest among researchers and clinicians. Potential risk factors for dental erosion are changed lifestyle and eating patterns, with increased consumption of acidic foods and beverages. Various gastro-intestinal and eating disorders expose the dentition to frequent contacts with very acidic gastric content, which may lead to erosion. Whether these factors indeed lead, on a population scale, to a higher prevalence and incidence of erosion is yet to be established. This article summarizes the different aspects of the prevalence, pathology, etiology, assessment, prevention and treatment of dental erosion, and concludes with recommendations for future research.

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## Introduction

Wear is a functional loss of dental hard tissue, existing since (pre)historic times when also men were using their dentitions more intensely than today to bite and grind abrasive foods. Modern standards of living have changed both food selection and eating habits. Carbohydrates became an important part of our diet, and as a result dental caries developed into being a major dental disease. Following the widespread usage of fluoride as a caries preventive agent, the prevalence, incidence and severity of caries declined, and the life expectancy of the average dentition was prolonged.

More emphasis is therefore given today to the prevention of non-carious causes of loss of dental tissue. The prevention of periodontal destruction is important, because the healthy state of the periodontium is a prerequisite for maintaining the functional dentition into old age. Attention is also paid to the loss of dental hard tissue resulting from frequent contact with acids that erode the tooth surface. A high consumption of acidic beverages, and an apparent increase in prevalence of various gastro-intestinal diseases, and especially eating disorders, which lead to frequent contact by the teeth with acid gastric contents, are seen to be risk factors for non-carious tooth destruction.

Although data are still lacking to substantiate the allegation that dental erosion is a growing problem, a comprehensive inventory of the state of the art of laboratory and clinical research on this topic is needed. This article summarizes the proceedings of an ILSI-Europe Workshop on Dental

Erosion held in Belgium in September 1995. The participants agreed that reliable and representative epidemiological surveys into the prevalence and incidence of erosion at the population level should have a high priority. The ten resulting articles cover the topic of erosion from fundamental issues such as etiology and pathology to the prevention and restoration of erosive defects.

A clinical index of erosion and methods for case history taking in patients with erosive lesions is proposed. Recommendations for further studies are given.

## Definition

The clinical term *dental erosion* is used to describe the physical results of a pathologic, chronic, localized loss of dental hard tissue that is chemically etched away from the tooth surface by acid and/or chelation without bacterial involvement. The acids responsible for erosion are not products of the intraoral flora; they stem from dietary, occupational or intrinsic sources.

In the literature, erosions are classified by different methodologies, mainly based on the etiology, on clinical severity, on the activity of progression, and on localization.

## Prevalence

Very few population-based surveys have been published. A complicating factor in many of the known reports is that the criteria for assessing erosions were not well defined. The reported lesions

were often combinations of erosion and other types of wear, the key etiological factor not being known. From random sample studies in adults, it was concluded that between 8 and 13% of the subjects had at least one facial surface lesion involving the dentin. A further 30 to 43% of the subjects had between 3.1 to 3.9 teeth affected by occlusal lesions extending into the dentin. Lingual erosions were found only in 2% of the subjects. These values applied to young (26–30) and middle-aged (46–50) groups, respectively. A prevalence study of 14 yr-old children disclosed that erosions involving the dentin were mainly on incisal (30%) and to a lesser extent on occlusal or lingual (8%) sites. A separate study on various age groups reported that in the primary dentition (5–6 yr-olds), half of the children had their maxillary incisors affected by erosion, with every other affected child showing erosions reaching the dentin. Loss of tissue was most severe on palatal surfaces.

### **Etiology**

Frequent contacts between acids and the tooth surface may cause dental erosion. These acids may originate from extrinsic or intrinsic sources. Extrinsic acids may stem from environmental sources, diet and medication. Also lifestyle factors may play a role in the development of erosions. Improved industrial safety regulations have gradually diminished the extent of environmental dental health hazards in the past decades. With respect to dietary acids, particular attention has been given to beverages and fruits. Many of these have been tested for their erosive potential in laboratory and animal experiments. A predictive model has been suggested by which the *in vitro* erosive potential is determined by the titratable acidity, the pH, the phosphate, and the fluoride content. Caution was, however, recommended in extrapolating findings of such assessments to the *in vivo* situation. In the oral environment, saliva is an important protective factor, inhibiting or diminishing erosion. Salivary flow is increased by acid-induced stimulation of the glands. The saliva then counteracts the acids in the oral cavity by its buffering capacity. The organic components form a pellicle on the tooth surfaces, which represents a diffusion barrier to the acids, preventing them from directly dissolving the tooth mineral.

Several reports have associated medicaments and oral health products (rinses) with erosion. Many such products exhibit a low pH and may be erosive when used frequently. In most cases, the risk associated with a product could be reduced by either product modification, such as encapsulation of acid medicaments, or by changes of consump-

tion habits, such as refraining from sucking vitamin tablets. Special attention should be given to saliva substitutes, aimed at patients with reduced salivary secretion or xerostomia. These substitutes often have a low pH and may be very detrimental to patients whose lack of saliva leads to prolonged clearance times.

Among lifestyle factors which could contribute to erosion, the increased consumption of sport drinks during heavy exercise, the excessive consumption of citrus fruits and fruit juices as part of dieting regimes, and excessively frequent consumption of acidic beverages throughout the day merit mentioning.

A growing number of people are suffering from some kind of regurgitation or reflux of gastric content, which periodically brings acidic fluids in direct contact with their dentition. It is estimated that 60% of the population suffer from this phenomenon at some stage of their lives. Regurgitation or gastroesophageal reflux may cause severe damage to the dentition in patients of all ages. Often the erosion is most severe on palatal tooth surfaces (sometimes extending almost to the pulp), but other surfaces may also be affected when the gastric contents are chewed or kept in the buccal sulci before reswallowing.

Patients suffering from psychosomatic eating disorders (*bulimia nervosa* and *anorexia nervosa*), particularly young women and estimated at a prevalence of about 8% in certain age groups, are also at high risk of erosion owing to gastric acid. A correlation has been recorded between the duration of the disease and dental erosion. Again, erosions are initially confined to palatal enamel, but after 3 or 4 yr of chronic vomiting, incisal edges and labial surfaces of the upper incisors are also affected. Eventually, further loss of dental hard tissue from the occlusal surfaces results in a loss of vertical dimension of the teeth.

### **Indexing erosion**

Because epidemiological data on erosion are so scarce, there is a great need for prevalence studies in well-defined age groups. For this purpose, the establishment of an index for the clinical assessment of erosive lesions is imperative. The participants of the Workshop on Dental Erosion concluded that two types of indices should be available. The first one, aimed at large-scale epidemiological surveys, should fulfil the following minimal requirements: it should be easy to learn, show good inter- and intra-examiner agreement, and allow the differentiation between various grades of severity and between different types of defects. A clinical index should, however, also be sensitive

enough to monitor progression over time. As this criterion, demanding a fine scale allowing small differences to be recorded, seems to conflict with a number of the other prerequisites, a second "research" index for longitudinal studies should be developed.

The index discussed at the Workshop is based on a severity score, with no (0), only enamel (1), half dentin (2) or extensive dentin (3) involvement for facial lesions, and a three-scale code for lingual and occlusal surfaces with no differentiation of severity of dentinal involvement.

A questionnaire for the case-history of patients suffering from erosion was proposed. The latter concentrates on the various risk factors for erosion, including the difficult area of how to elicit information from patients on a sensitive topic like eating disorders. Advice is included on individual (physiologic) parameters, such as salivary flow and buffer capacity, which could be assessed to help reveal the patient's potential susceptibility to erosive processes.

### Pathology

The pathogenesis of erosive lesions parallels, at a microscopic level, the pattern of mineral loss resulting from acid etching of enamel, as used prior to placing composite restorations. Due to the very acidic nature of the erosive agents and the immediate clearance of the dissolved minerals, enamel is lost layer by layer from the surface. This irreversible process differs fundamentally from that of a subsurface demineralisation occurring underneath a microbial plaque and leading to dental caries. In prismatic enamel, the surface loss leads to an anisotropic dissolution with either a preferential loss of the interprismatic regions or of the prism core region. Aprismatic enamel is eroded in a highly irregular way, and is probably not as prone to erosive destruction as prismatic enamel. In dentin, erosion starts in the peritubular dentin, which causes the dentinal tubuli to be widened. With progressive tissue loss, intertubular regions are also affected. Rapid erosive processes in dentin may cause hypersensitivity; presumably because the rate of tertiary dentin formation (or of tubuli obstruction) cannot keep up with the superficial (and tubular) tissue loss.

Electron microscopic *in vitro* studies have demonstrated differing erosive potentials of various organic acids, with citric acid and phosphoric acid producing more tissue loss than maleic acid. This pattern, however, is not persistent with prolonged immersion into the respective acids. In general, it was concluded that not only the pH value, but also the type of acid, the amount of titratable acid (buf-

fer capacity), and possibly chelating properties are factors determining the progression of erosion. The oral cavity has several protective mechanisms against dental erosion, the most prominent being saliva, as discussed above.

The role of fluoride in preventing erosions remains relatively unclear. The literature contains conflicting reports. Theoretically, it can be argued that the pH during an erosive challenge is so low that fluoride would only be effective at very high concentrations, that are neither practical nor toxicologically safe. Mixtures of saliva and acids (either from extrinsic or intrinsic origin) below pH 4 are undersaturated with respect to both hydroxyapatite and fluorapatite, which explains the surface rather than subsurface nature of the mineral loss. Concentrated fluoridated varnishes or lacquers are presumably the best methods of F<sup>-</sup> application aimed at preventing the progression of erosions.

### Methods of assessing erosion

Given the limitations of assessments of erosion *in vivo*, a number of methods have been developed to test the erosive potential of foods and beverages *in vitro* or in animals. They generally involve chemical, physical (electron microscopic) and histologic techniques. The extrapolation of such findings to predict a product's erosive action *in vivo* should be made with caution, because of possible protective factors and specific consumption patterns *in vivo*, which can hardly be simulated *in vitro*. However, methods available for assessment in man vary widely in sensitivity, and are generally not specific to damage of the teeth by erosion.

### Prevention

The prevention of erosion can be attempted in two ways, namely by weakening the erosive potential of acid challenges and by increasing the resistance of the dentition.

To reduce the frequency of contact with acidic foods and beverages or medicaments is the most logical and effective advice. Modification of products is theoretically possible, but generally not feasible because of food regulatory constraints, formulation problems and doubtful consumer acceptance. Thus, adding fluoride to foods and beverages is not currently permitted by food laws, as uncontrolled consumption could lead to overdosage. Changes in pH and/or the incorporation of large amounts of calcium and phosphate can affect the taste of many products and reduce their shelf-life. In some medicaments such modification might be possible. Various types of dietary advice can be given to try to enhance or increase protection from

saliva in neutralizing acids. The consumption pattern of potentially harmful foods is important. Examples are the drinking of acid beverages through a straw, the changing of the order of courses in a meal, and the consumption of products with high content of calcium, phosphate or lipids, or buffering substances. Milk and cheese may help to counteract the erosion resulting from acidic drinks. Other suggested measures are the use of urea- or bicarbonate-containing chewing gum, which should be formulated to be non-abrasive. Oral health instructions should be given to patients liable to erosion in order to prevent loss of dental hard tissue by abrasion.

In patients suffering from erosion caused by gastric acids, the dentist is often the first to notice the signs, as some of these diseases and disorders may be kept a secret by the respective patients. Referral to a general physician or psychiatrist is recommended to attempt to elicit the cause and to treat the underlying causes. The frequency of tooth contact with the gastric acids should be minimized, while anti-acid lozenges are advised to neutralize the acids in the mouth. Again patients should be advised to use non-abrasive dentifrices.

### Restoration

For the functional and aesthetic repair of dentitions affected by erosion, a variety of restorative approaches is available. The currently used glass-ionomer cements and composite resins bind both to dentin and enamel and enable aesthetically acceptable restorations at all sites of the dentition. In particular, as long as the causes of erosion cannot be eliminated, no restorative materials should be used, which are abrasive to the antagonistic

teeth. Sealants and varnishes containing fluoride can be used in their capacity of releasing fluoride and providing some mechanical protection.

### Recommendations for future research

Data on dental erosion are still fragmentary, and there is a definite need for thorough and comprehensive studies on most of the topics discussed in this Workshop.

- 1) It is recommended to validate the proposed erosion index for large-scale epidemiological surveys by way of a multicenter exploratory epidemiological study.
- 2) It is further recommended that an index for the clinical assessment of the progression of erosion to be used in longitudinal studies should be developed, aimed at determining both the physiological and pathological rates of tooth surface loss by erosion.
- 3) Further prevalence studies are required to quantify the longitudinal patterns of dental erosion, and to link such progression to the simultaneously assessed risk factors.
- 4) It is recommended that research be continued to establish and evaluate experimental models to assess the erosive potential of foods and beverages to elucidate their relevance to the pathology of erosion observed *in vivo*.
- 5) It is recommended to extend the study of intrinsic protective factors and to develop methods to enhance their effectiveness *in vivo*.
- 6) It is recommended that the search for extrinsic protective agents be intensified and that their functions in potentially erosive products and preventive strategies be studied in greater detail.