The diagnosis and control of extrinsic acid erosion of tooth substance

Kevin H-K. Yip, BDS, MEd, MMedSc, PhD  |  Roger J. Smales, MDS, DDSc  |  John A. Kaidonis, BDS, BScD, PhD

As modern societies increase their acidic food and beverage consumption, erosive tooth wear is an increasing cause of tooth destruction among young people.

The primary causes can be exacerbated by xerostomia, which can be induced by dehydration, several systemic diseases, or any of a number of drugs. Initial preventive treatments are directed at eliminating extrinsic acids, reducing xerostomia and other co-factors, and increasing teeth’s resistance to acid. Initial restorative treatments should be conservative, using adhesive materials. Treatment of advanced tooth tissue loss is difficult; preventive management is emphasized.

Received: April 8, 2002  Accepted: May 21, 2002

Dental erosion may be defined as tooth wear produced by chemical dissolution of teeth by acids other than those produced by bacteria, attrition from direct contact of occluding or proximal surfaces, and abrasion produced by exogenous material force over tooth surfaces. Tensile forces induced by occlusal loads also may lead to tooth wear from cervical enamel microfractures on facial and, occasionally, lingual surfaces. This process is known as abfraction.¹

A recent study of young adolescents in the United States and the United Kingdom found that both populations had a high prevalence of tooth erosion.² The findings did not support the assumption that dental erosion is less frequent in the U.S. Such an assumption may result from incorrect attribution regarding the causes of erosive tooth wear.²

Although the etiology of tooth wear often is multifactorial, recent studies indicate that tooth erosion is becoming a significant factor in all age groups.³,⁴,⁵ However, erosion is a particular concern among younger persons, where preserving the dentition depends on identifying and treating the causes correctly. All too often, young adults display advanced tooth tissue loss from erosion before the appropriate diagnosis is made and a treatment is undertaken. A review of dental erosion in children was published in 2001.⁶

Appearances
Eroded tooth surfaces that have lost detailed surface microanatomy appear rounded and glazed. Cupping becomes the predominant feature in those areas where the softer and less-mineralized dentin is exposed (Fig. 1). Active lesions show little if any staining, although the teeth may become hypersensitive, especially among younger persons. Extensive wear leads to tooth shortening, an unsightly appearance, and pulp problems. Erosion in older patients with exposed root surfaces may simulate the softened dentin seen with rapid root caries. Tooth attrition produces matching facets on opposing tooth contacts, while toothbrush abrasion lesions have more well-defined margins and often are wedge-shaped when they appear in cervical regions. Some tooth wear is a normal ongoing physiological process, of course, and its significance will vary depending on age, diet, and parafunctional habits.⁷ Tooth wear can be regarded as pathological if the teeth become so worn that they do not function effectively or seriously affect a patient’s appearance before they are lost through other causes, such as fracture, trauma, caries, and advanced periodontal diseases.⁸

Causes
Acids may reach the oral cavity from both external and internal sources in approximately equal instances.⁹ Individuals whose dental erosion is caused by extrinsic acids appear to be at risk through either their behavior and lifestyle or their occupations. Important co-factors include dehydration; several systemic diseases, including Sjögren’s syndrome; medicaments and drugs such as diuretics and antidepressives; and major salivary gland irradiation therapy, which adversely affects salivary production.¹⁰ Even without excessive exposure to extrinsic acids, xerostomia may induce dental erosion, as reduced salivary flow rates lead to a reduced buffering capacity, lowering the oral clearance of acids and the normal remineralization of tooth tissues.¹¹

Tooth grinding, abrasive diets, and incorrect tooth brushing also may exacerbate the effects of erosion; even brushing that took place two hours after the erosion of dentin in vitro did not reduce the loss of dentin.¹² A similar in situ study of enamel erosion failed to show a significantly reduced loss from brushing one hour after dentin erosion, although there was a 31% reduction in the loss of enamel.¹³ Recent in vivo studies have demonstrated an increased susceptibility to enamel erosion in primary teeth as compared to permanent teeth.¹⁴,¹⁵ Other studies have confirmed the important protective function of the salivary pellicle against enamel erosion.¹⁶,¹⁷

The most common external erosive causes are dietary (see table). The most frequently cited reason for erosion in children is acidic drinks, either pure fruit juices or carbonated soft drinks with added hydroxy organic and phosphoric acids.¹⁸ Consuming fruit juices at bedtime, when the salivary flow is decreased, can be very damaging.¹⁹ Frozen fruit juices, such as confections on a stick, may present a greater risk for tooth erosion than fruit drinks because the frozen juices are consumed slowly and take considerably longer to neutralize.²⁰ Citric acid is particularly damaging to teeth as it can chelate calcium in hydroxyapatite even after the pH rises, forming soluble citrates.²¹ Some beers and herbal teas with low pH values also have been shown to cause potential tooth erosion problems in vitro.²²,²³ Many pickled foods have both high titratable acidity and a pH of 3.0 or less; frequent consumption of
Primary causes of dental erosion.

Extrinsic factors
- Diet (for example, acidic citrus and other fruits, fruit juices, carbonated beverages, and sports drinks, beers, and herbal teas, vinegars, and pickles, and candies)
- Medicaments (for example, non-encapsulated HCl replacement, chewing ascorbic acid tablets (vitamin C) and acetylsalicylic acid tablets (aspirin), iron tonics, salivary stimulants)
- Occupation (for example, wine tasting or jobs that involve working around acidic industrial vapors)
- Sports (for example, swimming in improperly gas-chlorinated commercial pools)

Intrinsic factors
- Overt vomiting or regurgitation of gastric fluids into the mouth
- Consequences of anatomic defects, such as hiatus hernia, gastroesophageal reflux disease, and esophageal diverticulosis
- Psychological problems, such as bulimia nervosa, alcoholism, and stress rumination
- Drugs or foods that irritate the gastric mucosa, including spices and alcohol
- Medical conditions (for example, uraemia, peptic ulcer, and morning sickness during pregnancy)

Table. Primary causes of dental erosion.

<table>
<thead>
<tr>
<th>Extrinsic factors</th>
<th>Intrinsic factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet</td>
<td>Overt vomiting or regurgitation of gastric fluids into the mouth</td>
</tr>
<tr>
<td>Medicaments</td>
<td>Consequences of anatomic defects, such as hiatus hernia, gastroesophageal reflux disease, and esophageal diverticulosis</td>
</tr>
<tr>
<td>Occupation</td>
<td>Psychological problems, such as bulimia nervosa, alcoholism, and stress rumination</td>
</tr>
<tr>
<td>Sports</td>
<td>Drugs or foods that irritate the gastric mucosa, including spices and alcohol</td>
</tr>
<tr>
<td></td>
<td>Medical conditions (for example, uraemia, peptic ulcer, and morning sickness during pregnancy)</td>
</tr>
</tbody>
</table>

Fig. 1. Erosion caused by consumption of soft drinks and cordials, showing loss of enamel and dentin exposed at the cusp tips. The amalgam restoration protrudes above the adjacent molar surface.

Fig. 2. Erosion caused by consumption of soft drinks has exposed the dentin on the palatal surfaces of the maxillary anterior teeth. The resin composite restoration protrudes above the adjacent central incisor surface.

Fig. 3. Erosion caused by swishing soft drinks in the mouth, showing dentin of the molar teeth are exposed, apart from a buccal cervical rim of retained enamel. It is likely that the crevicular fluid has neutralized the acid in this region.

Fig. 4. Extensive tooth erosion in the mouth of a professional wine taster.

Sucking citrus fruits may predominantly affect the labial surfaces of the maxillary incisors. In the chemical and metal industries, workers in certain processes may work in acidic environments, although this is less of a problem in developed countries today. At rest or during speech, the soft tissues protect the incisal parts of the anterior or teeth from acid fumes. Professional wine tasters move acidic wines around their mouths for 30–60 seconds at a time; some taste up to 200 wines a day for up to four consecutive days and do so several times a year, which can result in extensive tooth erosion (Fig. 4). Cervical hypersensitivity may develop within two years and affect their ability to work.

Management
To manage tooth erosion properly, a dentist first must examine a patient’s occupational, medical, dental, and dietary histories and
follow that with a thorough dental examination. Certain affected tooth sites may suggest erosion caused by a specific source, although these relationships are not definitive.\textsuperscript{14} Occupation-related causes—particularly professional wine tasting and those occupations that involve industrial sources of acid fumes—could have dento-legal consequences which require careful documentation.\textsuperscript{13} Questioning younger persons regarding their dietary habits can be especially inaccurate.\textsuperscript{3} Treatment requires eliminating or substantially reducing the intake of acidic drinks and foods, taking care to avoid swishing and sucking habits. It may be difficult to identify tooth tissue loss caused predominantly by erosion because erosive wear may be exacerbated by xerostomia, tooth grinding, abrasive diets, and tooth brushing.\textsuperscript{10,12,13,15}

Many proposed indices and methods for assessing and monitoring tooth wear are impractical for a clinical practice or for individual patients. A practical method of monitoring for a general dentist involves comparing changes that occur over time in the normal morphological features. These features can be compared by using high-density die stone study casts poured from addition-cured silicone impressions. Changes may be identified more readily around the margins of metallic and resin composite restorations or fissure sealants when magnification is utilized. Markers for subsequent erosion progression can be made by using small amounts of resin composite bonded to non-occluding sites of erosion.

Efforts should be made to remove the primary causes of tooth erosion. The necessary actions will depend in part on the causes, the extent and severity of the lesions, and on the patient’s age and level of cooperation. Inadequate salivary flow and buffering capacity can increase the susceptibility of teeth to erosion. Xerostomia can result from dehydration; other causes include such systemic diseases as Sjögren’s syndrome, major salivary gland irradiation, and appetite suppressants, diuretics, antidepressants, or amphetamines.\textsuperscript{10,16} Xerostomic patients may consume citrus fruits and acidic drinks to stimulate salivary flow.

**Preventive treatment**

Eliminating acids, reducing the effects of xerostomia and other cofactors, and improving the resistance of the teeth to acidic attacks are essential. Using neutral or alkaline mouthwashes, using sugar-free chewing gum, and finishing a meal with milk or a small piece of cheese also are beneficial for increasing salivary flow.\textsuperscript{10,16} Fluoride dentifrices and topical fluoride mouthrinses or gels, fluoride varnishes, and filled resin bonding agents can be applied to reduce any tooth hypersensitivity and allow for remineralization.\textsuperscript{10} Fluoride gels also may be useful within a splint or mouthguard. APF gel is particularly effective among professional wine tasters for preventing demineralization and treating dentin hypersensitivity and erosion problems.\textsuperscript{32}

Advice on tooth brushing can be contentious, particularly when dentin is exposed.\textsuperscript{10,11} Gentle brushing only before bedtime, using a soft multiflushed toothbrush and a fluoride dentifrice, nay be advisable. Patients should be monitored intensively during the first few weeks for treatment compliance, then again after two and three months. Any softened dentin present should have hardened after three months. Continued dentin hypersensitivity indicates continued erosive activity. Follow-up visits at appropriate intervals, possibly over a long period of time, are required.\textsuperscript{5} For patients taking acidic medicaments and those who take drugs and suffer from systemic diseases that cause xerostomia, early contact with physicians may result in alternative drugs and general help.

**Restorative treatment**

Initial restorative treatments should be conservative, especially in younger persons. Adhesive resin materials should be utilized to protect susceptible tooth surfaces, relieve dentin hypersensitivity, and restore adequate appearance and function. Fine glass particle hybrid resin composites are satisfactory for these purposes when used with either hybrid-layer forming dentin bonding agents or resin-modified glass ionomer cement liners. In cases where fluoride-releasing materials are required in low-stress regions, newer composites should be satisfactory.\textsuperscript{37} Conventional glass ionomer cements are not recommended as permanent restorations because of their poor load-bearing and their susceptibility to erosion in acidic conditions.\textsuperscript{38} When the palatal surfaces of maxillary anterior teeth are affected by advanced erosion, the absence of interocclusal space requires placing either resin composite or metal individual palatal veneers as fixed Dahl-type appliances.\textsuperscript{39} Children’s primary molars are restored most easily with stainless steel crowns.\textsuperscript{6}

If the initial preventive and restorative treatments have been successful but extensive tooth tissue loss is present, occlusal reconstruction may be necessary, particularly for older patients. The potential for the materials to wear on opposing teeth must be taken into consideration; porcelain can be damaged by acidic fluoride gels used to control tooth erosion and hypersensitivity.\textsuperscript{40,41} Endodontic and periodontic surgery, surgical crown lengthening, placement of foundations, and orthodontic repositioning of the teeth may be required before crowns and other prostheses can be constructed. An acrylic full-arch maxillary splint or nightguard may be needed to limit the adverse effects of concomitant tooth grinding once restorative treatment is complete. An overdenture is a less expensive and extensive treatment option in severe cases of tooth tissue loss, provided that the periodontal tissue support is satisfactory.\textsuperscript{42}

**Summary**

Extrinsic acid erosion is an increasing cause of significant tooth wear. Erosion that results from the consumption of acidic foods and beverages can be exacerbated by xerostomia and incorrect tooth brushing. Eroded tooth surfaces appear rounded and glazed and the teeth may become hypersensitive and unsightly. The location of the affected teeth depends on how the erosive agent is consumed. A thorough history and oral examination must precede initial intensive preventive treatment and patient monitoring. Initial restorative treatments should be conservative; adhesive resin materials should be used to protect susceptible tooth surfaces and restore adequate appearance and function. More advanced oral rehabilitation may be required once the erosion is under control.

**Acknowledgment**

The authors gratefully acknowledge some financial assistance received from The University of Hong Kong (CERG 10202943).
Dr. Smales is a Visiting Research Fellow, Dental School, The University of Adelaide, South Australia, where Dr. Kaidonis is a Senior Lecturer.

References

33. McIntyre JM. Personal communication; November 1996.

Reprints of this article are available in quantities of 1,000 or more. E-mail your request to Jo-Ellen Fossett at AGDJournal@agd.org.