

Acidity and Dentistry: Problems and Solutions

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Abstract

Dentists are often the first health care professionals to diagnose dental erosion in patients with gastro esophageal reflux disease (GERD). Early recognition of dental erosion is important to prevent serious irreversible damage to the dentition. This requires awareness of the clinical appearance of erosion compared to other forms of tooth wear. An understanding of the etiologies and risk factors for erosion is also important. These form the basis of a diagnostic protocol and management strategy that addresses the multifactorial nature of tooth wear. The primary dental care team has the expertise and the responsibility to provide this care for their Patient's with erosion. Treatment of dental erosion resulting from GERD involves a multidisciplinary approach among family physician, dentist, prosthodontist, orthodontist and gastroenterologist. When possible, dental erosion should be treated with minimal intervention, and such treatment should include control of microflora, remineralization, adhesive restorations and use of biomimetic materials.

Keywords: Tooth erosion, tooth wear, gastro esophageal reflux disease, diagnosis, prevention

Acidity and Dentistry: Problems and Solutions

Dentists are often the first health care professionals to diagnose a systemic disease through observation of its oral manifestations. Dental professionals

commonly review health histories listing medications that identify patients with a diagnosis of acid reflux. Most often, a specialized physician known as a gastroenterologist treats this condition. However, there are dental manifestations, so it is important that dental professionals identify these patients and recommend appropriate dental therapies to protect the long-term health of the dentition. Furthermore, dental professionals have the opportunity to recognize this condition in untreated patients and may need to refer those patients to a physician for further evaluation. Everyone talks about the effects of Acid Reflux Disease on digestion and other parts of the anatomy, but few people regard the teeth in the list of things affected by the acid. The truth is, the teeth can be very affected by acid reflux, and they are not something one should ignore. The gastroesophageal reflux disease (GERD), which may be evidenced by dental erosion.

The occurrence of this condition was reported as early as the 19th century (1) and since then the incidence and prevalence of dental erosion is increasingly being reported (2). Twenty decades ago, studies reported dental erosion occurred because of industrial hazards, specifically when workers were exposed to acidic aerosols. (3) In recent years, everyday foods and drinks such as lemons, pickles, sodas and sugary, starchy goods have been associated with tooth erosion. People now also need to be aware of another danger that causes permanent and severe loss of tooth structure, acid reflux-induced erosion, a condition that occurs when stomach contents reflux into the mouth.

Dental erosion is defined as irreversible loss of dental hard tissue by a chemical process that does not involve bacteria. (4), (5). Dissolution of mineralized tooth structure occurs upon contact with acids that are introduced into the oral cavity from intrinsic (e.g. gastro esophageal reflux, vomiting) or extrinsic sources (e.g. acidic beverages, citrus fruits). In addition to causing dental erosion, undiagnosed and untreated GERD may also result in esophagitis, Barrett's epithelium, esophageal adenocarcinoma and aspiration pneumonitis of various degrees. It is therefore important that dentists recognize GERD so that timely preventive and treatment measures can be instituted. This systemic review discusses the oral manifestation of GERD on teeth (dental erosion), on gums (burning red lesions), tongue, cheeks, lips and salivary PH studies and the prevalence and causes of

dental erosion, diagnostic approaches, preventive measures and treatment.

Prevalence:

In a 5-year longitudinal study, (6) 71% of children had erosive lesions of at least grade 1 affecting their primary dentition, and 26% had grade 2 erosions (**Table 1**). By 16 years of age, 12% had at least one permanent tooth with grade 1 erosion, and up to 0.2% of patients had at least one permanent tooth with grade 2 erosion. (6) Other studies have reported a similar prevalence of erosion in adults (between 5% and 16%). (3), (7) Different studies emphasize that the prevalence of GERD in India is likely to be between 8% and 19%, which is comparable to GERD prevalence rates published in western countries.²⁹ Dental erosion is the most common chronic disease of children ages 5–17. (8) It has been our observation, working in the dental department of a tertiary care facility with a catchment area of 10 million people, that many causes of dental erosion go unnoticed or undiagnosed in adolescence, and the problems are not identified until early adulthood, when the damage is much more severe and much more difficult to treat.

Causes:

Erosion begins as superficial demineralization of the enamel, which can cause dissolution of the subsurface layers and eventual loss of tooth structure. The teeth have a natural pH level of 5.5, which is relatively neutral in the pH scale. The acid in your stomach ranges around 2.0, which is much more acidic and can start to eat away at your tooth enamel. Any acid with a pH below the critical pH of dental enamel (5.5) can dissolve the hydroxyapatite crystals in enamel. In vitro experimental erosion has been shown to occur at an oral pH of less than 3.7.

Causes of dental erosion are classified as extrinsic or intrinsic.

Extrinsic causes include carbonated or acidic beverages, acidic foods, (9) citric lozenges, various medications, oral hygiene swab sticks, saliva substitutes,¹⁰ recreational exposure to water in gas-chlorinated swimming pools (10) and occupational exposure to corrosive agents such as battery acid fumes and industry aerosols (10). It can be seen that most fruits and fruit juices have a very low pH (high acidity). Carbonated drinks and sports drinks are also very acidic. Several studies have found that the frequency of consumption of acidic drinks was significantly higher in patients with erosion than without. (11), (12) This finding is of concern, particularly since children and adolescents are the primary consumers of these drinks. (11) (12)

Intrinsic causes of dental erosion include bulimia, rumination or voluntary reflux phenomenon, subclinical regurgitation due to chronic gastritis

associated with alcoholism, xerostomia, malabsorption syndrome, chronic vomiting during pregnancy and GERD. (10)

Saliva as a Modifying factor

Buffering capacity of saliva refers to its ability to resist a change in pH when an acid is added to it. This property is largely due to the bicarbonate content of the saliva which is in turn dependent on salivary flow rate. Bicarbonate concentration also regulates salivary pH. Therefore, there is a relationship between salivary pH, buffering capacity and flow rate, with pH and buffer capacity increasing as flow rate increases. (13)

Normally, when an acid enters the mouth, whether from an intrinsic or extrinsic source, salivary flow rate increases, along with pH and buffer capacity. Within minutes, the acid is neutralized and cleared from the oral cavity and the pH returns to normal. Patients with erosion were found to have lower salivary buffer capacity when compared with controls in several studies. (14) In other studies, low whole salivary flow rates in patients with erosion were determined to be the major difference. (15) Therefore, salivary function is an important factor in the etiology of erosion. Since many common medications and diseases can lower salivary flow rate, it is important to assess these salivary characteristics when evaluating a patient with erosion.

Clinical Presentation

A frequent finding is preservation of a cuff of enamel within the gingival crevice. The mandibular molars in both the primary and permanent dentitions are the teeth most commonly subject to erosion.⁵ Patients exposed to extrinsic acids suffer more damage to the labial or occlusal surfaces of the upper anterior teeth, (16) with severity decreasing posteriorly, whereas intrinsic acid causes more damage to the lingual surfaces of the teeth. The erosive effect tends to be localized on the palatal aspects of the maxillary teeth. The dental enamel erosion has been documented by profilometric scans, spectrophotometric analysis, and scanning electron microscopy (SEM).

The pattern of erosion caused by intrinsic acid may be modulated by the protective influence of the tongue, which forces regurgitated acid over the tongue, along the palate and into the buccal vestibule. (16) Thinning of the enamel imparts an unesthetic yellowish hue to the teeth (**Figs. 1 and 2**). Eroded teeth have the appearance of having been lightly prepared for full-coverage restorations with a chamfer margin (**Fig. 3**) and are more prone to wear. Once dentin is exposed, the loss of dentin progresses faster than the loss of enamel, such that “cupping” of

lesions on the occlusal surfaces occurs. (16) Amalgam restorations in eroded teeth appear highly polished and seem to “stand above” the tooth surface (Table 2).

Exposure of the dentinal tubules results in hypersensitivity to hot, cold, sweet and tactile stimuli. The pulp may eventually be exposed, with the attendant need for endodontic therapy. (16), (10) Additional sequelae of dental erosion include compensatory eruption of eroded teeth, tipping and drifting of teeth, formation of diastema, loss of vertical dimension, overclosure and bite collapse, all of which result in autorotation of the mandible and reduction of overjet toward or beyond an edge-to-edge incisal relationship. These sequelae can be exacerbated if attrition from bruxism is superimposed upon erosion, or if either the acidic oral environment or pre-existing or continuing erosion increases susceptibility to caries.

Table 1: Erosion grading scale of Ganss and Others (6)

Grade	Description
0	No visible erosion
1	Small pits and slightly rounded cusps, flattened fissures, moderate cupping, preservation of occlusal surface morphology
2	Depression of cusps with severe cupping and grooving, restoration margins raised above level of surrounding tooth, flattening of occlusal surface morphology

Table 2: Erosion grading scale of Eccles and Jenkins (17)

Grade	Description
0	No erosion
1	Loss of surface detail; change confined to enamel
2	Exposure of dentin affecting less than one-third of crown
3	Exposure of dentin affecting one-third or more of crown



Fig. 1: Dental erosion, facial view of lips and teeth.



Fig. 2: Facial erosion with smooth and shiny appearance.

Courtesy: Professor Adrian Lussi, Univ. Bern, Switzerland.



Fig.3: Dental erosion, palatal view showing chamfer margin

Guidelines for prevention and control

The following recommendations, if implemented in a preventive programme, might prevent occurrence, limit the damage, modify the habit or protect the remaining tooth tissue.

Early diagnosis and monitoring

Patients can barely detect early enamel erosion due to its smooth and shiny appearance (Fig. 1). Even when detected, they rarely seek treatment until it gets to an advanced stage when it either becomes symptomatic or affects the aesthetics of their teeth. The responsibility of early detection and initiation of treatment of dental erosion, therefore, falls on the dental professionals. In the light of this, the first and the most important step in a preventive strategy would be the development of and training of dental professionals on techniques for the early diagnosis and monitoring of the progress of dental erosion.

Preventive strategies

Following the diagnosis of an early lesion or patient's susceptibility, the following recommendations may be considered as a 'damage-limiting' as well as preventive policy.

Treatment of the underlying medical disorders and diseases

Some patients may not be aware of their underlying medical condition, but in search of treatment for the deteriorating condition of their teeth. Therefore the dentist may be the first healthcare professional to detect an underlying medical disorder. (18), Some patients may not recognize their condition as a disorder, especially the anorexia/bulimia patients, and hence would not seek medical attention until it starts affecting the aesthetics, function or 'comfort' of their teeth. Such patients should be referred to the appropriate specialist (doctor or clinical psychologist) for proper treatment of their condition.

Antacids

Use of antacids for time being. These are effective when taken one hour after meals and at bedtime because they neutralize acid already present.

Dietary Analysis

Record a minimum three-day diet history to include a weekend, times of food/drink consumption and bed time

Dietary Counseling

This must be tailored to the individual and is only possible after the diet has been thoroughly assessed. Specific points to emphasize are the limitation of acidic food and drinks to mealtimes. This is the time of maximum salivary flow and increased buffering capacity. Clear explanation of the difference between erosion and caries is often advisable as the public confuse these terms and believe them to be synonymous. This is especially relevant to artificially sweetened diet drinks, which can be as acidic as normal varieties. Chewing sugar free gum increases salivary flow and encourages tooth remineralization. (19) Finishing a meal with cheese or milk will neutralize intra-oral acid. (20)

Lifestyle Modification

Lifestyle modifications can relieve reflux symptoms. We should motivate the patient about living positive

lifestyle. The following steps, if followed, may reduce reflux significantly:

- Refraining from eating three hours prior to bedtime. This allows the stomach to empty. Without food stimulation, the stomach's hydrochloric acid production decreases.
- Avoiding lying down right after having eaten at any time of day. Elevation of the head six inches above the bed. Gravity helps to prevent reflux.
- Avoiding the ingestion of large meals. Eating a lot of food at one time increases the amount of acid needed to digest it. The alternative is to eat smaller, more frequent meals throughout the day.
- Avoiding fatty or greasy foods, chocolate, caffeine, mints or mint flavored foods, spicy foods, citrus, and tomato-based foods. These foods decrease the competence of the lower esophageal sphincter.
- Avoiding alcohol ingestion. Alcohol increases the likelihood of acid reflux.
- Smoking cessation. Smoking weakens the lower esophageal sphincter and increases reflux.
- Losing excess weight. Overweight and obese people are much more likely to have bothersome reflux than people of healthy weight.
- Standing upright or sitting up straight and maintaining good posture. This helps food and acid pass through the stomach instead of backing up into the esophagus.
- Discussing with health care providers the intake of certain medications such as over-the-counter pain relievers, including aspirin, ibuprofen or medicines for osteoporosis. These can aggravate reflux in some people.

Some of these changes may be difficult for people to make.

Use of a remineralizing agent:

It is a common practice among individuals to refresh their mouth by toothbrushing with dentifrice after vomiting or regurgitation, as the case with an eating disorder or chronic alcoholism. Bearing in mind that softening of tooth surface by acidic challenge decreases its wear-resistance, thus rendering it more susceptible to the effects of mechanical abrasion, (18) Although a softened enamel surface can be remineralized with exposure to saliva, (21), (22) it has been demonstrated that enamel surface softened by an erosive agent may be worn by abrasion from the surrounding oral soft tissues (23) and demastication, (23) before it can be remineralized by saliva, with consequent loss of tooth tissue softened by erosion.

It may be more acceptable, practicable and easier to gain patient's compliance, if, following an acidic challenge, a remineralizing agent could be administered immediately to enhance rapid remineralization of the softened tooth surface and also serve as a mouth refresher.

Use of fluoride mouthrinses: (24)

Fluoride tablets and fluoride lozenges, which have been demonstrated as effective remineralizing agent for dental caries, (25) could be useful for erosion with their dual functions of direct fluoride provision and stimulation of salivary flow. Stimulation of salivary flow could facilitate rapid remineralization of the softened tooth tissue as this has been shown to increase the potential of saliva for the remineralization of a carious lesion.

Periodic professional application of fluoride varnishes or gels can increase the resistance of the tissue to further erosive attack. (24) It has been demonstrated that etching of enamel increases the surface-reactive area, and topically applied fluoride has been shown to accumulate in demineralized lesions. (24)

Use of a neutralizing agent:

As an alternative to a remineralizing agent, sugar-free antacid tablets or a pinch of sodium bicarbonate or baking soda dissolved in some water may be used to neutralize the acidic oral fluid following exposure to acidic challenge.

Condition/method of drinking:

The temperature of an acidic drink influences its erosive potential. Taking the drink ice-cold reduces its erosive effect. (26) Acidic drinks should be consumed through a straw since this method of drinking has been reported to reduce the contact of the teeth with the erosive agent and enhance the rate of clearance of the agent from oral cavity. (27) The drink should be swallowed quickly and not sipped slowly or 'swished' around the mouth.

Use of protective devices:

It might be reasonable to use a close fitting occlusal guard at high risk times such as during sleeping (for GERD patients), swimming in poorly maintained swimming pool (for professional swimmers), voluntary vomiting (for anorexia/bulimia patients) or while on factory duty (for factory workers). An alkali, such as milk of magnesia or a neutral fluoride gel should be applied to the fitting surface of the guard to neutralize any acid pooling underneath the appliance and enhance the remineralization of the tooth surface.

Health education:

Dental professionals should be proactive in health education relating to prevention of dental erosion, as with dental caries. The public and patients should be informed of the dental implications of the predisposing factors discussed above. In addition, patients should be advised on how to prevent or minimize the problems and the importance of full compliance with the preventive policies. There is a need for the dental profession to work closely with medical colleagues to alert them of the dental consequences of certain medications and medical conditions, and how to minimize them. (28)

Dental school curricula should include training on the causes and consequences of dental erosion, and how to prevent or minimize it. The students/dentist should pass on this information to the patients and general public, as part of dental health education.

Other Preventive Measures

- Avoidance of toothbrushing after acid exposure of the teeth, whether by an intrinsic or extrinsic source
- Using toothpaste, preferably a low-abrasive formula
- Including modifications to reduce the extrinsic sources of acid, including reduction of dietary acids and/or careful rinsing of the mouth after acid exposure
- Use of a protective occlusal guard if attrition due to bruxism is present
- Use of a neutralizing agent such as sugar-free antacids held in the mouth after acid exposure
- Salivary flow stimulation by use of nonacidic sugarless candies.

Treatment:

The immediate goal in the treatment of dental erosion resulting from GERD is formulation of the correct differential diagnosis and prompt referral to a gastroenterologist. It is not unusual, particularly in medically underserved regions of the country, to encounter waits of up to 6 months or more to see a medical specialist. In the meantime, it is important to provide symptomatic relief and to discourage further progression of the erosion.

It has been known for many years that demineralized lesions can be remineralized and repaired. It is likely that the same factors controlling remineralization of carious lesions also control remineralization of areas of erosion. Chewing antacid tablets or rinsing with a solution of sodium bicarbonate can neutralize the demineralizing effect of acid on the dentition. (16)

Once the diagnosis of GERD has been established and the condition brought under control, some orthodontic treatment is usually necessary, unless wholesale crowning of one or both arches with an

attendant increase in vertical dimension of occlusion is indicated. The dentition may have to be realigned to compensate for overeruptions, drifting and loss of arch length.

Restorative Treatment

Depending on the degree of tooth wear, restorative treatment can range from placement of bonded composites in a few isolated areas of erosion, to full mouth reconstruction in the case of the devastated dentition. Description of the specific techniques of restoration is beyond the scope of this article. Regardless of the type of restorative therapy provided, prevention of the progression of erosion should be the basis of management of the patient with erosion. This will increase the likelihood of successful, long-term outcomes of the restorative treatment.

Because many patients treated for dental erosion caused by GERD are young or middle-aged adults, most dental restorations will require replacement over the patient's lifetime. The speed of deterioration of restorations is determined by many factors, not least the presence of residual reflux, which may contribute to demineralization of the hard dental tissues, particularly in the area of the restoration margins. In the absence of adequate control of GERD, the restoration margins are at risk for development of caries. The most serious consequence is that the restoration will be so deeply undermined that it cannot be replaced (which necessitates removal of the tooth), or it cannot be replaced without further adjunctive periodontal or endodontic procedures. Rigorous medical follow-up for recurrent GERD is imperative to avoid this scenario.

Conclusion

One way dental professionals can be proactive in preserving and protecting the dental health of their patients is to be aware of any factors that may affect the dentition. The patient's medical history can be reviewed to evaluate the potential for damage due to erosion from acid reflux. The listing of certain medications or the answering of specific questions are telltale signs that a patient may need continued monitoring and/or additional therapeutic recommendations. Furthermore, the presence of advanced erosion may require additional questioning of the patient with a possible physician referral. The primary dental care team is in the ideal position to provide this care for their patients with dental erosion and other forms of tooth wear.

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