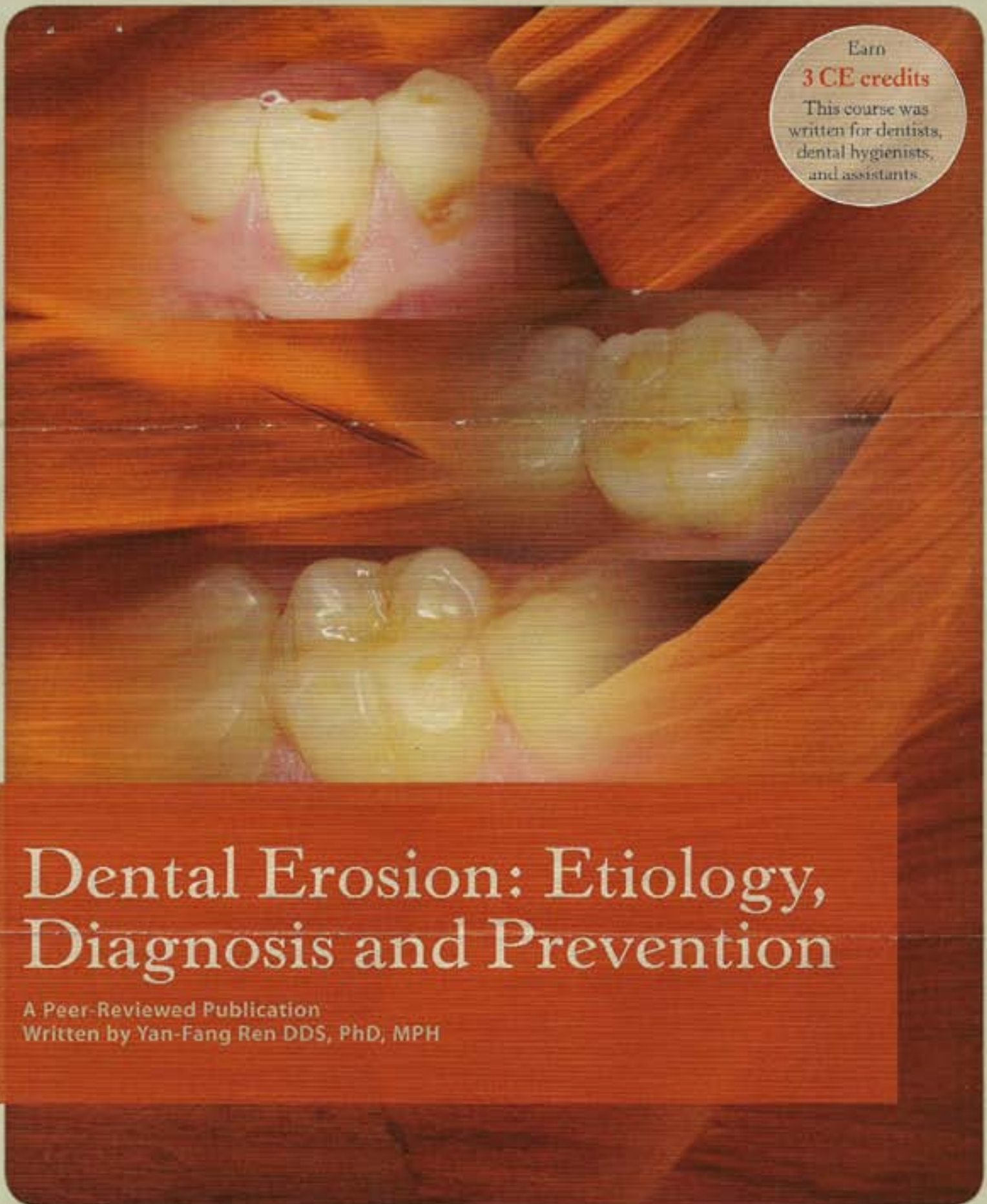

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# Dental Erosion: Etiology, Diagnosis and Prevention

**A Peer-Reviewed Publication**
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Publication date: April 2011
Expiry date: March 2014

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## Educational Objectives

The overall goals of this article are to provide an overview of the causes, risk factors, diagnosis and prevention of dental erosion. On completion of this course the reader will be able to:

1. List and describe the prevalence of dental erosion
2. List and describe the etiologies of dental erosion
3. List and describe the signs and symptoms of dental erosion and the complicating factors associated with dental erosion
4. List and describe methods for the management and prevention of dental erosion.


## Abstract

Dental erosion is a prevalent condition that occurs worldwide. It is the result of exposure of the enamel and dentin to nonbacterial acids of extrinsic and intrinsic origin, whereby mineral loss occurs from the surface of the tooth. The most frequently affected areas are the palatal surface of maxillary incisors and the occlusal surface of the mandibular first molars in adolescents. Characteristic early signs of dental erosion include smooth and flat facets on facial or palatal surfaces, and shallow and localized dimpling on occlusal surfaces. Early intervention is key to effectively preventing erosive tooth wear. Effective prevention of dental erosion includes measures that can avoid or reduce direct contact with acids, increase acid resistance of dental hard tissues and minimize toothbrushing abrasion.


## Introduction

Dental erosion is the loss of dental hard tissue, associated with extrinsic and/or intrinsic acid that is not produced by bacteria. Though the chemical process of dental erosion is similar to that of caries, i.e., dissolution of hydroxyapatite by acids, the clinical manifestations and management of dental erosion are fundamentally different from caries because the erosive process does not involve acid of bacterial origin. Dental erosion does not begin as a subsurface enamel lesion that is conducive to remineralization, as in the caries process, but rather as a surface-softening lesion that is susceptible to wear and resistant to remineralization by conventional therapies. It is often widespread and may involve the entire dentition. Dental hard tissue loss associated with erosion is almost always complicated by other forms of tooth wear such as attrition and abrasion. Dental erosion results in tooth surface softening, which inevitably accelerates tissue loss caused by tooth-to-tooth contact while chewing and grinding (attrition) or by abrasive wear while mechanically brushing or cleaning tooth surfaces (abrasion). If dental erosion is not managed through effective interventions, it may result in substantial loss of enamel and subsequent exposure of the underlying dentin, which can, in turn, lead to dentin sensitivity, loss of vertical height and esthetic problems.

Effective management of dental erosion is largely dependent on a thorough understanding of its etiology and early recognition of its signs and symptoms in clinical practice.

## Prevalence

Dental erosion is a common condition, and its prevalence seems to be trending higher in recent decades.[1] It is difficult to accurately assess the prevalence of dental erosion from published literature, for there is not a universally accepted standard for clinical evaluation of this condition. Dental erosion is almost always complicated by other forms of tooth wear. The reported prevalence of dental erosion varies greatly in the literature, which can be partially explained by age, country and different evaluation standards. The median prevalence of dental erosion is 34.1 percent of children (interquartile range 27.4) and 31.8 percent of adults (interquartile range 18.7). In studies that reported prevalence of dental erosion in different age groups, there is a clear trend of increasing prevalence with age in children and adults.[2-6] Dental erosion has been considered a common condition limited to developed countries.[1]

## Etiology

Dental erosion is caused by sustained direct contact between tooth surfaces and acidic substances. It has long been recognized that demineralization of dental enamel will occur once the oral environmental pH reaches the critical threshold of 5.5.[7] Acids in the mouth originate from three main sources: produced *in situ* by acidogenic bacteria, ingested extrinsic acids as dietary components and dislocated intrinsic acids through the backflow of gastric contents. Acids of bacterial origin cause caries, while extrinsic and intrinsic acids cause dental erosion. Clearance of acids from the oral cavity is, to a large extent, dependent on the saliva flow rate and the saliva buffering capacity. Low saliva flow rate and poor buffering capacity allow prolonged retention of extrinsic and intrinsic acids in the mouth, which will accelerate the erosive process.

### Extrinsic acids

#### *Acidic beverages*

Soft drinks, including carbonated beverages, fruit juices and sport drinks, are almost exclusively acidic (pH<4.0) in nature in order to maintain a fresh and fizzy mouthfeel (carbonated beverages) and to prevent rapid growth of bacteria. Table 1 lists the pH ranges of common beverages on the consumer market. These beverages, when in contact with the tooth, will reduce the pH at the tooth surface to a level below the critical value of 5.5 for enamel demineralization.

The effects of these beverages on dental hard tissues have been extensively studied in recent years. Numerous experimental and clinical investigations have shown that dental erosion in the form of enamel and dentin tissue loss can be caused by carbonated soft drinks[8-11], fruit juices[12-16], sport drinks[17-19] and wines.[20-22] Erosion starts with enamel surface softening in the early stage, and enamel tissue loss develops progressively with continued erosive challenges. Softened enamel is susceptible to abrasive wear. Brushing after erosive challenges will accelerate enamel tissue loss.[23-27]

Table 1. pH values of common beverages[28-30]

| Carbonated drinks | pH | Juice drinks | pH | Other drinks | pH |
|---|---|---|---|---|---|
| Coke | 2.7 | Orange juice | 3.4 | Iced tea | 3.0 |
| Pepsi | 2.7 | Grapefruit juice | 3.2 | Fanta orange | 2.9 |
| 7-Up | 3.2-3.5 | Cranberry juice | 2.3-2.5 | Red Bull | 3.4 |
| Sprite | 2.6 | Apple juice | 3.4 | Gatorade | 3.3 |
| Mountain Dew | 3.2 | Pineapple juice | 3.4 | Isostar | 2.4-3.8 |
| Dr. Pepper | 2.9 | Kiwi juice | 3.6 | Coffee | 2.4-3.3 |
| Lemon Nestea | 3.0 | Grape juice | 3.4 | Tea (black) | 4.2 |
| Root beer | 3.0-4.0 | Carrot juice | 4.2 | Beer | 4.0-5.0 |
| Ginger ale | 2.0-4.0 | Beetroot juice | 4.2 | Wine | 2.3-3.8 |

### *Acidic foods and dietary ingredients*

Besides acidic drinks, many solid and semisolid foodstuffs are also acidic in nature. Table 2 lists common foods and dietary ingredients that have low pH values. Though the potential erosive effects of acidic foodstuffs are not well understood, it is believed that frequent ingestion of these types of foods may also contribute to dental erosion.

Individual eating habits may be the most important factor affecting the erosive potential of acidic foods. Frequent consumption of citrus fruits could significantly increase the risk for dental erosion.[31] Persons with a diet with more fruits and acidic berries may also have higher frequencies of dental erosion.[32,33]

Table 2. pH values of common foodstuffs[28-30]

| Fruits | pH | Other foodstuffs | pH |
|---|---|---|---|
| Apples | 2.9-3.5 | Cranberry sauce | 2.3 |
| Apricots | 3.2-3.6 | Fruit jams/jellies | 3.0-4.0 |
| Blueberries | 3.2-3.5 | Italian salad dressing | 3.3 |
| Cherries | 3.2-4.7 | Ketchup | 3.7 |
| Grapes | 3.3-4.5 | Mayonnaise | 3.8-4.0 |
| Grapefruits | 3.0-3.5 | Mustard | 3.6 |
| Lemons/limes | 1.8-2.4 | Pickles | 2.5-3.0 |
| Oranges | 2.8-4.0 | Relish | 3.0 |
| Peaches | 3.1-4.2 | Rhubarb puree | 2.8 |
| Pears | 3.4-4.7 | Sauerkraut | 3.1-3.7 |
| Pineapples | 3.3-4.1 | Sour cream | 4.4 |
| Plums | 2.8-4.6 | Tomatoes | 3.7-4.7 |
| Raspberries | 2.9-3.7 | Fermented vegetables | 3.9-5.1 |
| Strawberries | 3.0-4.2 | Yogurt | 3.8-4.2 |

### *Other sources of extrinsic acids*

Acidic medications such as those containing vitamin C[34,35] and aspirin[36,37] may cause erosion when used in a manner resulting in sustained contact between tooth surfaces and the medication. Habitual use of mood-enhancing drugs such as ecstasy may also increase the risk for erosive tooth wear.[38,39] Environmental and occupational factors may contribute to dental erosion in selected populations, including swimmers[40-41], workers in an environment with acidic industrial vapors[42-44] and professional wine tasters[45,46].

### Intrinsic acids

The source of intrinsic acids in the oral cavity is mostly from the backflow of the gastric contents through the esophageal tract. Gastric juice consists mainly of hydrochloric acid, produced by the parietal cells in the stomach. The presence of the highly acidic gastric juice (pH 1.0-3.0) in the oral cavity may lead to dental erosion. Gastro-esophageal reflux disease (GERD), bulimia and rumination are the main conditions associated with the backflow of gastric juice to the mouth.

Voluntary reflux of gastric contents (rumination) has been reported in special populations as a potential cause of dental erosion.[47-49] Though it is rare in occurrence, rumination should be considered as one of the potential etiological factors in patients with unknown causes of erosive tooth wear. Patients suffering from bulimia may ruminate multiple times daily over a prolonged period of time, which may cause typical dental hard tissue loss on the palatal aspect of the maxillary teeth.[50] The prevalence of dental erosion is higher in bulimic patients than in non-bulimic controls.[50,51] Dental erosion in bulimic patients is most likely associated with oral retention of regurgitated gastric contents. The dietary habits of bulimic patients may include binging on high-energy foods and foods with high erosive potential, which may further exacerbate erosion.[51]

### Saliva flow and buffering capacity

When acidic substances enter the mouth, salivary glands will reflectively increase secretion and saliva flow will accelerate to clear the acids from the oral cavity. Since human saliva contains bicarbonates and urea, it rapidly neutralizes the acidic remnants and returns the oral pH to normal – which is known as the buffering capacity of saliva, an important mechanism for oral pH regulation. Many factors affect saliva flow rate and buffering capacity, including autoimmune diseases (e.g., Sjögren's syndrome), medications (e.g., antidepressants and antipsychotics) and aging. When saliva flow rate is reduced, its clearance and buffering capacity will be negatively impacted, resulting in abnormal acid retention in the mouth, which, in turn, may contribute to dental erosion. Saliva flow rate and buffering capacity are therefore important etiological factors for erosion.[52,53] Low saliva flow rate and poor buffering capacity are often found to be associated with the development of dental erosion.[31,54-56]

## Diagnosis

Accurate diagnosis of erosion and erosive tooth wear begins with an in-depth assessment of risk factors for erosion and of medical and dental histories. Visual inspection of tooth surfaces and wear patterns provides direct evidence of dental erosion. Since dental hard tissue loss associated with erosion is not reversible, and a severely worn dentition represents a great challenge to dentists and patients, it is imperative to recognize the risk factors early, preferably before any sign of erosive tooth wear is present, to facilitate early intervention.

### Risk factor assessment

As described earlier, extrinsic and intrinsic acids are the predominant etiological factors for dental erosion. Therefore, erosion risk assessment mainly involves identification of these factors in a specific patient and an evaluation of their roles in the development of dental erosion.

Risk factors for dental erosion include:

- Frequent use of acidic dietary products, especially soft drinks, fruit juices and acidic foods
- GERD, rumination, regurgitation and frequent involuntary vomiting
- Prolonged use of chewable acidic medications, especially vitamin C and aspirin
- People in occupations involving hazards that include direct contact with acidic substances, e.g., wine makers and tasters, swimmers, and battery workers
- Sustained use of recreational drugs such as ecstasy
- Low saliva flow rate and inadequate saliva buffering capacity

Patients with any of the above factors are at risk of developing dental erosion. Though the current paradigm is for dental practitioners to look for these risk factors after they see signs of erosion and erosive wear, identification of these factors before the existence of any sign of erosion may be more important. Early intervention for the prevention of dental erosion is a more effective therapeutic strategy than any attempt to restore lost dental hard tissue due to erosion. A thorough evaluation of dietary habits will be helpful in assessing the erosive potential of acidic foodstuffs. Patients should record all their dietary activities in a diary over a 4-day period, including the weekend.[57] The time of day and quantity of all food and beverage intakes should be included in the diary. Careful review of medical history and consultation with a patient's primary care physician may help to identify erosion from intrinsic acids (e.g., GERD) and the presence of salivary hypofunction. A review of current medications and their ingestion methods is also helpful in finding drugs that cause low saliva flow and that may cause erosion if ingested inappropriately. Both stimulated and non-stimulated saliva flow rates can be assessed in dental offices by simply measuring the amount of saliva collected in a 5- or 10-minute period. Patients with a non-stimulated saliva flow rate of less than 0.12 ml/min may be considered as having low saliva flow.[58]

### Clinical evaluation

Though dental erosion often coexists with attrition and abrasion, it has some distinctive characteristics in location, appearance and morphology. The most frequently affected areas are the palatal surface of maxillary incisors and the occlusal surface of the mandibular first molars in adolescents.[3] Lussi et al described that erosion of facial surfaces was commonly seen on maxillary and mandibular canines and premolars, occlusal erosion was seen on maxillary and mandibular premolars and molars, and palatal erosion was seen on maxillary incisors and canines.[5] Early signs of erosion often include smooth and flat facets on facial or palatal surfaces, and shallow and localized dimpling on occlusal surfaces (Figure 1). Without intervention, erosive wear will progress, leading to deep cupping lesions with exposed dentin and eventual loss of occlusal morphology (Figure 2).

Cervical and incisal grooves are typical erosive lesions in premolars, canines and incisors (Figure 3). Shallow defects with a broad base on facial surfaces above the cementum-enamel junction have been found to be associated with acidic dietary habits but not with abrasive diets.[59]

Figure 1: Mandibular premolar and molars with signs of early-stage of erosion

Note the smooth and flat facets on non-occluding surfaces and small, localized dimpling on occlusal surfaces.

Figure 2: Mandibular molars with advanced erosive wear

Note the rounding of cusps, deep cupping lesions with exposed dentin and loss of typical occlusal surface morphology.

Figure 3: Mandibular incisor, canine and premolar with moderate to advanced erosive wear

Note the grooving, cupping and broad-base cervical lesions that are typical signs of erosive wear in incisal, occlusal and cervical areas of these teeth.

Numerous classification and index systems have been developed to better quantify the severity of dental erosion and to differentiate erosion from attrition or abrasion. None of these classification systems has been universally accepted, and their validity has been challenged.[60] Nonetheless, the erosive tooth wear index or classification system represents a benchmark that allows direct comparison between clinical data from different centers or from different time points and will continue to be used in clinical studies until a golden standard is established. The index systems developed by Smith and Knight,[61] Eccles[62] and Lussi[63] are among the frequently used evaluation methods in clinical studies and practices.

## Prevention and management

If no effective intervention occurs at an early stage, the eventual outcome of dental erosion is severe loss of dental hard tissues that adversely affects function and esthetics. In patients with extensive dentin exposure, transient and persistent pain due to dentin sensitivity and pulp pathology may further reduce quality of life. Severe erosive tooth wear can be managed restoratively. Composite resins and ceramics can be used for partial and full coverage restorations to restore the esthetics and function of the teeth. However, if the restored teeth continue to be subjected to severe erosive challenges, the restorations may fail in due course following marginal deterioration and continued loss of surrounding dental hard tissues. Therefore, preventive measures for dental erosion are not only essential for early intervention and primary prevention of erosive tooth wear, but they are also important for secondary prevention of erosion around the restorations.

To better understand the effectiveness of common preventive measures for dental erosion, it is helpful to review the chemical process associated with erosion. Dental hard tissues are largely composed of mineral crystals of hydroxyapatite with the formula $Ca_{10}(PO_4)_6(OH)_2$. Dental hydroxyapatite is often described as "calcium deficient" and "carbonated" because some calcium ions may be substituted by sodium, magnesium and potassium, and some phosphates ($PO_4$) by carbonates ($CO_3$), which renders the minerals more susceptible to acid dissolution.[64] On the other hand, some hydroxyl groups ($OH^-$) can be replaced by fluoride ions ($F^-$) to form fluoro-hydroxyapatite, $Ca_{10}(PO_4)_6(F,OH)_2$, which has increased crystalline stability and decreased susceptibility to acid dissolution during acidic challenges, as compared to hydroxyapatite.[7]

Acid dissolution of dental hard tissues can be expressed in the following equation:

$$Ca_{10}(PO_4)_6(OH)_2 + 20\ H^+ = 10\ Ca^{+2} + 6H_3PO_4 + 2H_2O$$

From our knowledge, we know that hydroxyapatite is less likely to dissolve under the following conditions:

1. There is no direct contact with acid (no supply of $H^+$).
2. Hydroxyapatite is replaced with fluoro-hydroxyapatite.
3. The environment is saturated with calcium and phosphates (oversupply of $Ca^{+2}$ and $PO_4$).

Therefore, effective strategies for prevention of dental erosion may be formulated correspondingly as follows:

1. Avoid or reduce direct contact with acids through behavioral and clinical interventions.
2. Increase acid resistance of dental hard tissues through fluoride therapy.
3. Increase resistance to hydroxyapatite dissolution through the provision of calcium and phosphates.

In addition, there is adequate evidence to conclude that toothbrushing abrasion can potentially be a major contributing factor to erosive tooth wear.[25,65,66] Dental hard tissue loss associated with erosion can be viewed as a process of initial chemical softening followed by physical removal of the softened tissue. A fourth strategy therefore includes reducing mechanical abrasion of teeth through proper toothbrushing instructions.

## Strategy #1: Avoid or reduce direct contact with acids

### Behavioral interventions:

1. Reduce frequency of dietary intake of acidic beverages and foods: Frequency and duration of direct contact between teeth and acids are important factors for the development of erosive lesions.[67-69] Prolonged sipping of acidic drinks will increase the risk of erosion, while gulping will minimize the risk.
2. Adopt drinks habits that limit contact time with teeth: Using a straw will reduce contact time between teeth and acidic drinks. Rinsing with water or drinking milk immediately following the drinking of acidic beverages will accelerate the clearance of acids and help return the oral pH to neutral.
3. Avoid misuse of acidic medications, including vitamin C: Chewing this type of medication or using such pills as lozenges increases risk for dental erosion. Acidic medications should be swallowed, if possible.
4. Use proper protection to avoid occupational hazards: Masks, mouth guards and neutralizing agents should be used to reduce contact with acidic vapors and fluids.

### Clinical interventions:

1. Apply fluoride varnish to tooth surfaces susceptible to erosion: A protective film containing fluoride will reduce direct contact between tooth surfaces and acids and deliver fluoride to strengthen the enamel surfaces.
2. Treat underlying diseases associated with the presence of intrinsic acids intraorally: This includes GERD, bulimia, regurgitation and rumination. It is often necessary to establish close consultation with the patient's physicians when an intrinsic cause of erosion is suspected.
3. Treat conditions causing salivary hypofunction: When low saliva flow rate is established as a factor for erosion in a specific patient, measures should be taken to improve saliva flow, where possible. This may include consultation with the patient's physicians on adjustment of medications causing dry mouth, and referrals for evaluation and treatment of autoimmune diseases such as Sjögren's syndrome.

## Strategy #2: Increase acid resistance through fluoride therapy

It has been shown that fluoride could minimize the erosive effects of soft drinks when applied as a varnish[70-72] a mouthwash[73] a topical gel[74-75] or a dentifrice[76-77]. A dose-response effect has been observed when using fluoride dentifrices for treatment of enamel erosion in an *in situ* study.[77] Enamel samples treated by dentifrices with higher fluoride concentrations was significantly more resistant to erosive challenges than were those with lower fluoride concentrations. Frequent application of high concentrations of fluoride has been considered the regimen of choice for the prevention and treatment of dental erosion.[78] Recent laboratory and clinical studies have shown that toothpaste containing 5000 ppm fluoride was significantly more effective than one containing 1450 ppm fluoride in reducing enamel loss caused by orange juice.[79,80] Patients with risk factors for dental erosion should benefit from the application of 5000 ppm fluoride twice daily.

## Strategy #3: Increase resistance to acid dissolution using calcium and phosphate

The addition of calcium and phosphate to acidic beverages could significantly reduce their erosive potential.[81-84] It was shown that the addition of 40 mmol/l calcium and 30mmol/l phosphate could significantly diminish the erosive potential of orange juice.[85] Supplementation of soft drinks with calcium was more effective in reducing erosion than with phosphate and fluoride.[86] The addition of 0.5-1.5mmol/l calcium has been found to be effective in reducing the erosive potential of citric acid. Some *in vitro* and *in situ* studies have shown that toothpastes containing casein/calcium phosphate were useful in protecting enamel against erosive challenges[87-89] while another study did not find a protective effect[90].

## Strategy #4: Minimize toothbrushing abrasion of eroded enamel

It has been shown that the timing of brushing, toothbrush bristle stiffness and abrasivity of toothpastes can all affect erosive-abrasive tooth loss.[24,25,65] For patients at risk of dental erosion, toothpastes with low abrasivity should be used with a soft toothbrush. Toothbrushing should be performed before an erosive challenge and avoided after consumption of erosive drinks or an erosive episode such as vomiting. If toothbrushing needs to be done after erosive challenges, the waiting period should be as long as possible. Table 3 summarizes the above strategies as concise recommendations to patients at risk of dental erosion.

Table 3: Recommendations for prevention of dental erosion

| |
|---|
| Avoid or reduce frequent intake of acidic beverages, and use a straw when drinking to minimize acid contact with tooth surfaces. |
| Select beverages containing calcium, phosphate or fluoride, and rinse with water or drink milk after an acid exposure in order to lessen erosive attacks. |
| Use dentifrices with a high fluoride concentration to strengthen enamel surfaces. |
| Avoid toothbrushing immediately after an acid exposure and wait for at least 30 minutes to allow tooth surface recovery from acid attacks. |
| Have a dental visit for application of fluoride varnishes and treatment of salivary hypofunction. |

## Conclusions

Dental erosion is a common condition in children and adults in all regions of the world. Prolonged contact between extrinsic or intrinsic acids with tooth surfaces will result in softening and dissolution of surface minerals. If not recognized and treated early, erosive challenges may cause severe loss of dental hard tissues that adversely affects esthetics and function of the mouth. Early intervention is key to effective prevention of erosive tooth wear. Effective prevention of dental erosion includes measures that can avoid or reduce direct contact with acids, increase acid resistance of dental hard tissues and minimize toothbrushing abrasion.

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## Questions

1. Dental erosion begins as a _____.
   a. subsurface enamel lesion
   b. surface-hardened lesion
   c. surface-softening lesion
   d. none of the above

2. Dental erosion results in a lesion that is _____.
   a. susceptible to wear
   b. susceptible to remineralization
   c. resistant to remineralization
   d. a and c

3. Tissue loss is accelerated by _____ at sites where dental erosion has occurred.
   a. attrition
   b. abrasive wear
   c. bond failure
   d. a and b

4. Effective management of dental erosion is largely dependent on _____.
   a. a thorough understanding of its etiology
   b. recognition of its signs in clinical practice
   c. recognition of its symptoms in clinical practice
   d. all of the above

5. The prevalence of dental erosion seems to be trending _____ in recent decades.
   a. lower
   b. higher
   c. negligibly
   d. none of the above

6. The variability in the reported prevalence of dental erosion can be partially explained by _____.
   a. age
   b. country
   c. different evaluation standards
   d. all of the above

7. The median prevalence of dental erosion is _____ of children and _____ of adults.
   a. 24.1%; 29.8%
   b. 28.1%; 30.4%
   c. 34.1%; 31.8%
   d. 38.1%; 33.4%

8. Dental erosion is caused by _____ direct contact between tooth surfaces and acidic substances.
   a. occasional
   b. continual
   c. sustained
   d. any of the above

9. Demineralization of dental enamel will occur once the oral environmental pH reaches the critical threshold of _____.
   a. 5.5
   b. 4.5
   c. 4.0
   d. 3.5

10. Acids in the mouth originate from _____.
    a. acidogenic bacteria
    b. extrinsic acids
    c. intrinsic acids
    d. all of the above

11. Extrinsic and intrinsic acids cause _____.
    a. dental erosion
    b. caries
    c. abrasion
    d. a and b

12. _____ is related to the clearance of acids in the oral cavity.
    a. Saliva flow rate
    b. Creatinine
    c. Saliva buffering capacity
    d. a and c

13. Dental erosion can be caused by _____.
    a. carbonated soft drinks
    b. wines
    c. fruit juices
    d. all of the above

14. Brushing after erosive challenges _____.
    a. inhibits enamel tissue loss by removing acids
    b. inhibits dentin tissue loss by creating a uniform smear layer
    c. accelerates enamel tissue loss
    d. is essential to remove plaque

15. _____ has a pH of 4.2.
    a. Black tea
    b. Beetroot juice
    c. Carrot juice
    d. all of the above

16. _____ are acidic in nature.
    a. Many drinks
    b. Many solid foods
    c. Many semi-solid foods
    d. all of the above

17. _____ is a source of extrinsic acid that may cause dental erosion.
    a. Medications with vitamin C
    b. Aspirin
    c. Mood-enhancing drugs
    d. all of the above

18. _____ is an occupation that may lead to dental erosion.
    a. Professional wine tasting
    b. Swimming
    c. Music
    d. a and b