DENTAL EROSION

Protection From Dental Erosion: All Fluorides are Not Equal

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Abstract: All fluoride sources help strengthen teeth against bacterial acids that cause caries. However, excessive exposure to dietary acids, which can result in dental erosion, presents a more aggressive level of challenge compared to caries. Despite the fact that almost all toothpastes contain fluoride, both the incidence and prevalence of dental erosion appear to be on the rise. This article: (1) describes key differences between caries and dental erosion and the ability of different fluoride sources to help prevent erosion; (2) discusses the importance of the evaluation of patients for dental erosion at the earliest stages using the Basic Erosive Wear Examination scoring system to help assess and educate patients; and (3) provides evidence-based information for making specific recommendations to patients with dental erosion. The objective of this article is to assess the comparative ability of fluoride agents to protect against dental erosion. Though all fluorides are able to help strengthen teeth against cariogenic acids, not all available sources of fluoride provide the same level of erosion protection. Daily use of a stabilized stannous fluoride dentifrice has been shown to provide the most effective means of protecting teeth against the increasing risk of dental erosion and erosive tooth wear.

Thirty years ago caries was the primary concern of dentists when examining patients' teeth. Dietary counseling focused on reducing sugar intake. Since then, oral examinations have become more complex as tooth structure now faces multiple challenges. Such challenges are not only from cariogenic diets, but also from increased consumption of acidic foods and beverages,[1] greater incidence of gastroesophageal reflux disorder,[2] and hyposalivation associated with increased use of medications, particularly among older patients.[3,4] These newer threats have led to a heightened focus on problems related to dental erosion and erosive tooth wear. This article will describe key differences between caries and erosion, the evidence behind the benefits of fluoride use for erosion prevention, and recommendations for assessing the most effective products available for erosion prevention and counseling patients.

Dental Erosion Vs. Caries: What is the difference?

Dental erosion is the irreversible loss of tooth structure due to chemical dissolution by acids or chelators that are not of bacterial origin.[1] During erosive challenges, tooth minerals are directly and irreversibly removed from primarily plaque-free, smooth tooth surfaces (Figure 1 through Figure 3). Although dental erosion has been recognized as a problem for decades, it was not considered to be a major oral care issue until recently. A review of numerous public health surveys indicates that dental erosion is not only prevalent but also increasing in many developed nations.[1]

Dental erosion is often associated with modern diets, specifically the excessive ingestion of acid-containing drinks such as carbonated beverages, juices, and energy and sports drinks.[5] The consumption of acid-containing beverages in the United States alone has increased by approximately 500% over the past several decades.[1] Dental erosion can also be related to gastric (intrinsic) acids. Eating disorders such as anorexia and bulimia, as well as gastroesophageal reflux disorder (GERD), can all result in erosive challenges.[6]

Erosive acids cause a drop in the pH of saliva and penetrate through the acquired pellicle, the semi-permeable glycoprotein

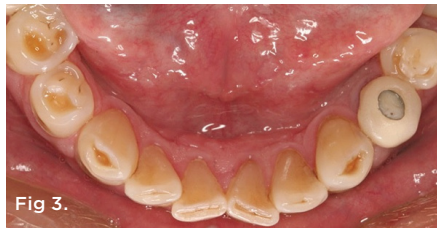


Fig 1 through Fig 3. Clinical examples of dental erosion in three different patients. Fig 1: retracted front view. Fig 2: occlusal view, upper arch. Fig 3: occlusal view, lower arch.

film covering teeth. As this occurs, the pH on the tooth surface lowers and initial softening can occur. If there is adequate saliva when the challenge occurs, the potential for tooth surface loss is minimized. If erosive acids are continually introduced, such as through repeatedly sipping acidic beverages, the potential for demineralization and surface softening increases. This softened surface becomes susceptible to erosion due to abrasive forces, such as hard foods, bruxing, and toothbrushing.[7]

The Caries Process

There are clear differences between dental erosion and caries, as listed in Table 1. Caries occurs after long-term exposure to low levels of bacterial acids in plaque biofilms that penetrate into subsurface regions of the tooth.[8] This results in the slow removal of minerals (demineralization) from these areas and, ultimately, cavitation. Remineralization may occur with increased saturation of calcium and phosphate ions from saliva and control of bacterial acids, in addition to use of fluoride, which helps increase resistance of the teeth to further demineralization.[9]

Fluoride has unquestionably been proven to be one of the best ways to help prevent caries. All fluoride sources enhance remineralization and inhibit demineralization of tooth enamel. In the presence of fluoride, demineralized hydroxyapatite is reformed as fluoridated apatite, which is more resistant to acid challenges. Both sodium fluoride (NaF) and stannous fluoride (SnF_2) dentifrices provide fluoride ions during this process, but only SnF_2 has the additional ability to inhibit acid production by acidogenic bacteria.[10]

The Effects of Fluoride on Erosion

A series of mechanism of action studies was conducted to help understand how different sources of fluoride work to prevent dental erosion. Initial studies were conducted using either NaF or SnF_2 solutions, and SnF_2 was found to be significantly more protective against an acid challenge.[11] Both in vitro (laboratory) and in situ (clinical) studies were repeated with marketed toothpaste formulations. This is important, because some formulation ingredients can cause deactivation of certain active agents. In the laboratory study, the SnF_2 toothpaste once again provided superior protection against acid challenge compared to the NaF control.[11]

Another study demonstrated that measureable levels of protective stannous were found on pellicle-coated enamel surfaces after a single treatment with stabilized SnF_2 toothpaste, and that as additional treatments were made, the level of stannous increased; it remained on the tooth surface as an invisible, protective barrier layer for several hours after product use.[12] The increasing strength, intensity, and duration of the barrier layer are all important factors to consider, as acid challenges like orange juice, soft drinks, wine, sports drinks, gastric acids, and so on, generally occur at least a few hours after teeth are brushed.

Further studies demonstrated that of the four most commonly used sources of fluoride found in toothpastes sold globally—SnF_2, NaF, sodium monofluorophosphate (SMFP), and amine fluoride (AmF)—SnF_2 provided the greatest erosion protection.[13] The protective nature of various fluoride sources against common dietary

TABLE 1

Key Differences Between Caries and Dental Erosion

	Caries	Dental Erosion
Cause	Bacterial acids	Dietary acids
Site of Activity	Under plaque	Usually on plaque-free surfaces
Conditions	Exposure to weak acids for prolonged periods of time, usually at a pH above 5.5	Repeated exposure to strong dietary acids, generally below pH 4.5, for short periods of time
Result	Subsurface phenomenon with intact outer layer of enamel	Surface softening leading to irreversible damage of enamel
Contributing factors	Buffering by saliva helps to neutralize bacterial acids	Saliva and pellicle are overwhelmed by dietary acids
Reversible?	Reversible in early stages	Irreversible surface damage
Preferred Therapeutic Approach	Prevention and reversal of early damage are both successful	Prevention is critical for management

TABLE 2

Common Sources of Erosive Dietary Acids

Acetic Acid	Citric Acid	Lactic Acid	Tartaric Acid
Salad dressing	Soft drinks	Cheese	Grapes
Vinegar	Energy drinks	Yogurt	Apricots
Pickled foods	Juices	Soy sauce	Avocados
Ketchup	Citrus fruits	Fruit juices	Bananas
Mayonnaise	Tomatoes	Bakery items	Wine

TABLE 3

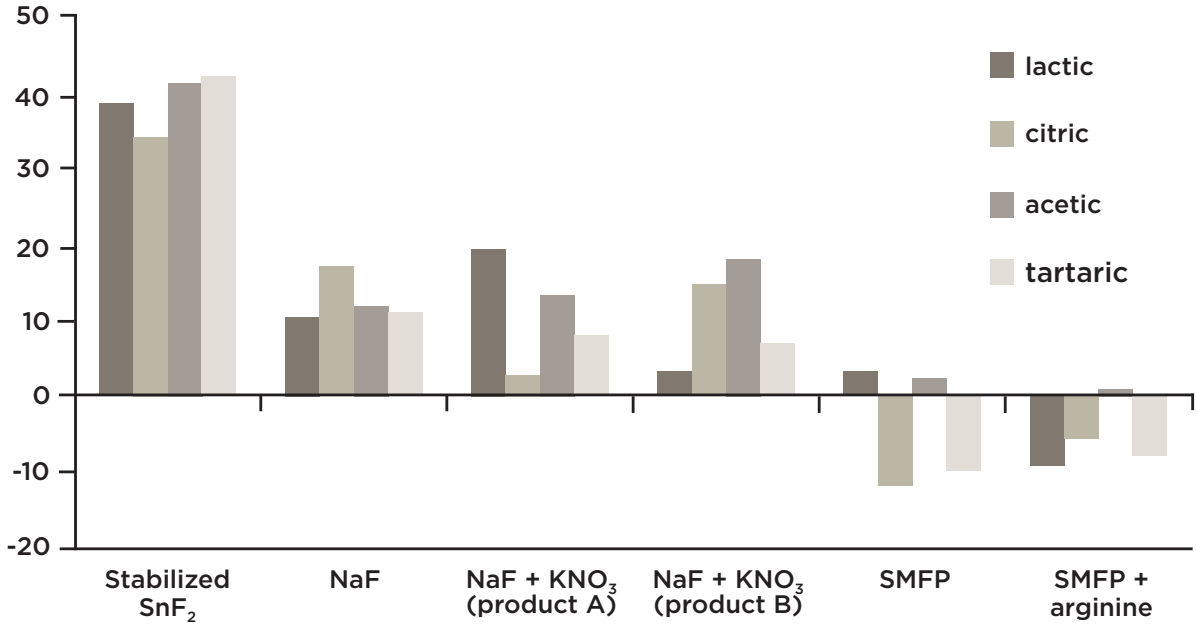
Criteria for Grading Erosive Wear

BEWE Score	Description
0	No surface loss
1	Initial loss of surface texture
2*	Distinct defect, hard-tissue loss of <50% of surface area
3*	Distinct defect, hard-tissue loss of ≥50% of surface area

*dentin is often involved in scores 2 and 3; BEWE = Basic Erosive Wear Examination
Adapted from Clin Oral Investig. 2008;12(suppl 1):65-68.[19]

FIGURE 4

% Protection Vs. Various Dietary Acids



KNO_3 = potassium nitrate; NaF = sodium fluoride; SMFP = sodium monofluorophosphate; SnF_2 = stannous fluoride;

Fig 4. In vitro protection against erosive acid study. The stabilized SnF2 dentifrice provided significantly greater protection against multiple dietary acids compared to other marketed products. Adapted from J Clin Dent. 2013;24(1):25-30.14

acids, including acetic, citric, tartaric, and lactic acids (Table 2), was also assessed. Again, the stabilized SnF2 dentifrice provided significantly greater levels of protection compared with other fluoride sources tested (Figure 4).[14]

The protective benefits of fluoride toothpastes have also been studied using human in situ clinical studies (Figure 5). These studies have consistently demonstrated that the protection provided by stabilized stannous-based fluoride dentifrices significantly exceeds the erosion protection of any of the other marketed dentifrices tested, including NaF,[15] NaF/potassium nitrate,[16] NaF/triclosan,[17] SMFP/arginine,[18] and SMFP/triclosan.[19] Although all of the commonly used fluoride dentifrices are effective against caries, SnF_2 has the unique ability to simultaneously protect against both cariogenic and erosive acids. In addition, stabilized SnF_2 dentifrices also provide clinically significant benefits in fighting plaque and gingivitis and reducing sensitivity and halitosis.[10]

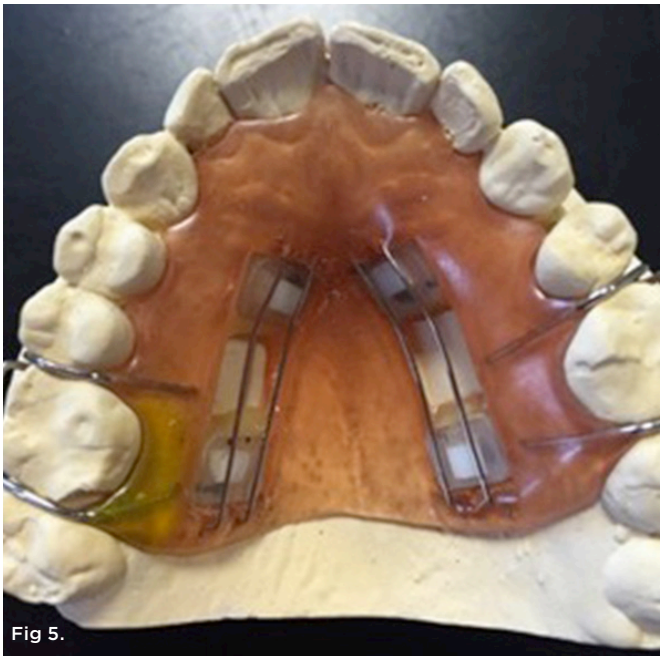


Fig 5.


Fig 6.

Fig 5. Example of the type of appliance used in human in situ erosion studies. The appliance is fitted with human enamel specimens and placed in the mouths of participants, challenged with erosive acids either in vivo or ex vivo, and then analyzed in the laboratory upon completion of the study.

Fig 6. Example of dental erosion that would be categorized as BEWE2. Note that dentin is showing on less than 50% of the occlusal surface.

Implications for Dental Professionals

Clinical management of erosion can be complex and time-consuming. Early recognition and ongoing monitoring is key to control. The Basic Erosive Wear Examination (BEWE) is helpful in identifying and quantitating erosive changes (Table 3).[20] Areas of erosion are charted in all six sextants of the mouth, and scores are used to identify and monitor changes in patients over time. The occlusal views in Figure 2 and Figure 3 show examples of BEWE3, while Figure 6 shows an example of BEWE2. Risk assessment, including dietary intakes and habits, saliva quality and quantity, medication use (polypharmacology), gastric reflux problems, and so on, is vital. Tracking changes and assessing risks helps facilitate giving patients guidance, treatment, and preventive options.

Early intervention with both preventive and minimally invasive restorative management of erosive tooth wear will help preclude the need for future extensive and costly reconstructive procedures.

Recommendations for Patients

Prevention of dental erosion begins with behavioral modifications. Patients should decrease intakes of acidic foods and drinks. Drinks should not be sipped or swished; using a straw will decrease the contact time between acids and teeth. Patients with gastric reflux problems should see their physicians for management strategies. Xerostomia is the most important biologic risk factor for dental erosion.[3] Staying well-hydrated is important, as dehydration can decrease salivary flow.

An effective way to protect tooth surfaces from acid challenges is to use a stabilized SnF_2 dentifrice, which provides a protective coating to guard against acidic challenges. Importantly, a recent consensus paper recognized the proven benefits of stannous-containing products for the prevention and management of dental erosion, noting data are sparse for other products.[21] In spite of the obvious preventive approaches, conservative restorative care using glass-ionomer cements and composite resins may be indicated.

Conclusion

Although all fluorides are able to help strengthen teeth against cariogenic acids, prevention against erosive acids requires a higher level of protection. Daily use of a stabilized SnF_2 dentifrice provides the most effective means of protecting teeth against the increasing risk of dental erosion and erosive tooth wear.

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