Erosion-Related Tooth Wear - Pathogenic Processes, Diagnosis, and Restorative Treatment

L0125-596 – 3 credits

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Certified Dental Assistants of BC
504-604 West Hastings Street
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Tel: 604.714.1766
TF: 1.800.579.4440
Fax: 604.714.1767
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COURSE OBJECTIVES

Upon successful completion of this course, the learner should be able to

1. differentiate between erosion, abrasion, and attrition.
2. explain the pathogenic processes of tooth erosion, including extrinsic and intrinsic causes.
3. discuss what should be included in the diagnostic protocol for erosion-related tooth wear.
4. describe prevention and restorative treatment approaches for erosion-related tooth wear.

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Primary Contributor
John Kross, DMD
Lincoln University, PA

Editor
Andrew Alden
Oakland, CA

INTRODUCTION

Tooth wear is defined as the loss of dental hard tissue by a chemical or mechanical process that does not involve bacteria. The mechanisms of tooth wear include erosion, attrition, abrasion, and abfraction. Dental erosion is due to chemical processes and is an important cause of tooth tissue loss in both children and adults. The damage caused by erosion can be accelerated when it occurs in combination with attrition or abrasion.

Unlike erosion, abrasion and attrition are the result of physical wear. Abrasion describes an abnormal wearing away of the tooth substance by causes other than mastication—such as tooth brushing or other oral habits—resulting in the physical removal of tooth structure. Attrition is defined as the mechanical wear resulting from mastication or parafunction, limited to contacting surfaces of the teeth.

Early recognition of tooth wear is important to successfully manage and prevent disease progression. The primary dental care team is in the ideal position to provide this care for patients with dental erosion and other forms of tooth wear.

PREVALENCE OF EROSION

Historically, tooth wear was generally believed to be caused by attrition and abrasion, and erosion was seldom considered or even examined. Today, dental erosion is widely considered a major cause of tooth wear (Bartlett, 2005). Estimates of the prevalence of tooth wear are complicated by studies that use different indices of measurement, many of which address tooth wear in general and not erosion specifically. Nevertheless, the results from several studies show that the prevalence of erosion-related tooth wear has increased in children and young adults over the past few decades (Jaeggi, 2006). Tooth wear is increasing in children and adolescents mainly as a result of dental erosion (Bartlett, 2005; Johansson, 2002; Jaeggi, 2006).

In the national children's dental health survey, the rate of erosion rose from 1993 to 1996/1997 in the United Kingdom. In another UK study of 1,308 children (age 12 years), deep-enamel or dentin lesions more than doubled in two years (Dugmore, 2003). Approximately 12% of initially erosion-free children developed erosion over two years, and new or more advanced lesions were seen in 27%.

In adults, a Swiss study (n = 391) found that 13.2% of the 46 to 50 year age group exhibited facial erosive lesions into dentin and 42.6% had occlusal erosion involving dentin (Lussi, 1991). Indeed, the progression of erosion has been found to be greater in older adults (52 to 56 years) compared to younger (32 to 36 years) and has a skewed distribution toward those with four or more

dietary acid intakes per day, a low buffering capacity of stimulated saliva, and use of a hard-bristle toothbrush (Lussi, 2000).

PATHOGENIC PROCESSES IN EROSION

The mechanisms by which teeth wear include attrition, erosion, and abrasion. These mechanisms seldom operate singly, and the overlap of two or more of them, often at different times, adds to the complexity of the phenomenon of tooth wear (Carlsson, 1985).

Erosion as Multifactorial Phenomenon

The three major types of tooth wear—erosion, attrition, and abrasion—rarely occur alone in a given individual. Recognizing and assessing all three conditions is important to prevent further loss of tooth structure. Abrasion and attrition in conjunction with erosion can accelerate damage and complicate diagnosis and treatment. These three entities may interact in the initiation and progression of lesions synchronously or sequentially, synergistically or additively.

Both enamel and dentin can be affected by erosion. It is more common for dentists to associate erosion with enamel loss; however, dentin exposed by gingival recession also can respond to low (acidic) pH levels in the oral environment. Enamel does not show structural damage when the pH is greater than 5.5; however, erosion of dentin has been reported with a pH level of 6.0.

(Neutral pH is 7.) When dentin and enamel are compared using the same time interval and pH value, more enamel than dentin is lost.

Interaction of chemical, biological, and behavioral factors is a major factor in determining the extent of erosion:

- Chemical factors such as pH, titratable acidity, mineral content, clearance on tooth surface, and calcium-chelation properties are determinants of the erosive potential of agents like acidic drinks or foodstuffs.
- Biological factors such as saliva, acquired pellicle, tooth structure, and positioning in relation to soft tissues and the tongue are also central to the pathogenesis of dental erosion.
- Behavioral factors like eating and drinking habits, excessive oral hygiene, and unhealthy lifestyle are predisposing factors for dental erosion.

Chemical Factors

Specific chemical factors that have been implicated as being etiological or associated with erosion include dietary acids and extrinsic factors such as occupational exposure to erosive chemicals (Johansson, 2008; Lussi, 2008). Examples are acidic beverages, foods, medications, or environmental acids. The most common of these are dietary acids. Most fruits and fruit juices have a very low pH, and carbonated drinks and sports drinks are also very acidic. For example, lemon/lime juices have a pH between 1.8 and 2.4.

The erosive potential of acidic beverages or foodstuffs does not depend on pH alone, but is also strongly influenced by its mineral content, its titratable acidity (the buffering capacity), and its calcium-chelation properties (Lussi, 2008). That is to say, other components of these agents, such as calcium, phosphate, and fluoride, may modify the erosive potential. Also, factors such as frequency and method of intake of acidic agents as well as proximity of toothbrushing after intake may influence susceptibility to erosion. Extrinsic erosion can also result from the use of particular drugs and exposure to certain fumes. Numerous case reports describe extensive erosion secondary to chewing vitamin C preparations or hydrochloric acid supplements.

The degree of saturation with respect to the tooth mineral, which is the driving force for dissolution, is determined by the pH value and mineral content (calcium, phosphate, and fluoride) of a drink or foodstuff (Lussi, 2008). Citric acid, for example, is a hydrous mixture of hydrogen ions, acid (citrate) anions, and undissociated acid molecules. In addition to the effect of the hydrogen ion, the citrate anion can complex with calcium and remove it from the tooth surface. Consequently, acids may attack the tooth surface by two processes, dissolution and complexation.

Calcium and phosphate components of foods or beverages are important determinants of erosive potential because they influence the concentration gradient within the local environment of the tooth surface. Several calcium-enriched orange juices and sports drinks are available, which hardly soften the enamel surface because the calcium enrichment makes the concentration

gradient small. Another example is yogurt, which has a low pH (about 4.0), but has no major erosive effect due to its high calcium and phosphate content. In sum, the erosive potential of food and drink is determined by pH and the titratable acidity as well as the mineral content and the ability of any of its components to complex calcium and to remove it from the mineral surface.

Increased soft drink consumption has been implicated as the most significant factor in tooth wear due to dental erosion, especially in younger individuals (Johansson, 2008). A prospective evaluation of dental erosion among young Saudi men and young children found that a quarter of maxillary anterior tooth surfaces had pronounced dental erosion and coincided with average soft drink consumption of 247 liters per year (Johansson, 2002). Significant correlates with dental erosion included high levels of soft drink consumption and long oral retention times before swallowing, excessive oral hygiene, and mouth breathing. The investigators concluded that factors related to erosion included consumption of soft drinks, amount of palatal plaque on maxillary anterior teeth, and salivary urea concentration. The drinking method also seemed to be an important factor in the risk of developing dental erosion.

Biological Factors

Biological factors possibly associated with the processes of erosion are numerous. They include functions and habits and patterns of mandibular movement, diseases, salivary factors, oral hygiene habits, and features of modern lifestyle (Johansson, 2008).

Saliva is an important biological parameter because it provides several protective mechanisms during an erosive challenge (Lussi, 2008). These include dilution and clearance of an erosive agent from the mouth, neutralization and buffering of acids, and slowing the rate of enamel dissolution by the presence of salivary calcium and phosphate (Zero, 2000). Conversely, erosion may be associated with low salivary flow and low buffering capacity (Jarvinen, 1991).

Among older individuals, regurgitation and dry mouth may result from lifestyle changes and medications and contribute to tooth wear (Johansson, 2008). Gastroesophageal reflux disease (GERD) is also a pervasive medical problem today (Moayyedi, 2005; Delaney, 2004). This term covers a spectrum of disease related to injury of the esophagus and adjacent organs secondary to the reflux of highly acidic gastric contents into the esophagus, oral cavity, or airways. Although heartburn and regurgitation are the most common manifestations of GERD, a wide spectrum of atypical symptoms and signs ranges from noncardiac chest pain to erosion of dental enamel (Katz, 2005).

Increased salivary output prior to regurgitation is not a feature of GERD because salivation is an involuntary response (Hara, 2006). Conversely, hypersalivation, which might minimize erosion, usually precedes vomiting as a response from the “vomiting center” of the brain (Lee, 1998). Typically, this response is seen in individuals with anorexia and bulimia nervosa, rumination, or chronic alcoholism.

Several studies have focused on the impact of mechanical factors in the pathogenesis of dental erosion. One well-designed study concluded that in patients with bruxism, dental erosion and not attrition was the more likely cause of the loss of tooth tissue (Khan, 1998). Although not restricted to dental erosion, a 2006 clinical study of noncarious cervical lesions showed a relationship between lateral excursive contact of teeth, bruxism, and formation of cervical lesions evidencing a correlation between occlusal and cervical pathology (Tomasik, 2006).

Behavioral Factors

Behavioral factors play a role in modifying the extent of tooth wear during and after an erosive challenge. How dietary acids are introduced into the mouth affects which teeth are contacted by the erosive challenge and possibly the clearance pattern. For example, high erosion is associated with a habit of drinking in which the drink is kept in the mouth for a prolonged period (Attin, 2006).

A recent review concluded that toothbrushing, with or without toothpaste, contributes only minimally to the development of enamel wear, but toothbrushing and an acidic diet may be linked to dentin wear and hypersensitivity (Addy, 2005).

Intrinsic erosion can result from vomiting (frequently associated with bulimia and alcoholism). Gastric acids, with pH levels that can be less than 1, reach the oral cavity and come in contact with the teeth in these conditions.

The etiology of tooth erosion includes chronic, excessive vomiting as exemplified in patients with eating disorders such as anorexia nervosa or bulimia. Vomiting-related erosion typically impacts the palatal surfaces of the maxillary teeth.

PATIENT ASSESSMENT

To prevent progression of erosion, it is important to detect this condition as early as possible. Dentists must be aware of the clinical appearance and possible signs of progression of erosive lesions and their causes to take timely preventive and, if necessary, therapeutic measures. The clinical examination has to be done systematically, and a comprehensive case history should be undertaken to ensure that all risk factors would be revealed. Given the multifactorial nature of dental erosion, a formal protocol for assessment of patients who present with tooth surface loss can facilitate diagnosis.

DIAGNOSIS OF EROSION

Because few signs and fewer if any symptoms accompany early forms of erosion, diagnosis may be difficult (Lussi, 2008). However, typical signs include smooth glazed, silky, or sometimes dull enamel surface without perikymata and intact enamel along the gingival margin. Attrition, abrasion, and abfraction also have features that might be used to differentiate these entities from erosion, although as noted earlier there is often interplay between them and erosion that complicates the diagnosis. Following are the principal features of these entities (Milosevic, 1998):

Erosion:

- smooth surface enamel and broad concavities
- dentin exposure due to cupping of occlusal surfaces
- increased translucency of incisal edges
- nonoccluding surfaces with worn appearance
- amalgam restorations that appear raised
- amalgams with nontarnished appearance
- enamel “cuff” in gingival crevice is preserved
- hypersensitivity
- pulp exposure in deciduous teeth

Attrition:

- occluding surfaces have matching wear patterns
- facets on amalgam contact surfaces are shiny
- wear rates for enamel and dentin are the same
- cusps or restorations are fractured

Abrasion:

- cervical areas are commonly involved
- lesions are wide rather than deep
- premolars and cuspids are most frequently involved

Abfraction:

- buccal/labial cervical areas of teeth are affected
- deep, narrow V-shaped notch

In the advanced stages of dental erosion, further changes in the morphology can be found (Lussi, 2008). These include developing a concavity in enamel, with the width exceeding its depth. Clinicians should distinguish between facial erosion and wedge-shaped defects located at or apical to the cemento-enamel junction. The depth of wedge-shaped defects usually exceeds its width. Progression of occlusal erosion results in rounding of the cusps and the appearance of "raised" restorations reflecting the loss of adjacent tooth surfaces. The entire occlusal morphology can be obliterated in severe cases.

To quantify the severity and progression of wear, different techniques are available ranging from sophisticated optical or laser scanning methods to relatively simple ordinal scales (Johansson, 2008). The latter can be adapted for clinical use. Besides the morphological variations of tooth wear, clinical symptoms may also appear, for example sensitivity or even pain initially, that can eventually affect eating, appearance, and the quality of life.

A simple ordinal scale has been developed that grades the severity of dental erosion on buccal and lingual surfaces of maxillary anterior teeth

ranging from 0 (no visible changes to enamel, developmental structures remain, macromorphology intact) to 4 (changes to enamel and exposure of dentin surface or pulp visible through the dentin) (Johansson, 2008).

History and Salivary Assessment

The clinical examination should begin with a thorough history with respect to general health, diet, and habits and by the assessment of saliva flow rates and buffer capacity.

- Dietary Questionnaire: As high intake of acidic foods and beverages is an identified risk factor for erosion, patients should complete a dietary questionnaire focused on acidic foods and beverages.
- Dental History: A history of jaw parafunction and bruxism may increase the possibility of attrition in addition to erosion. The patient should be asked about grinding noises during sleep and whether he or she experiences morning tenderness or fatigue in the jaw muscles. To determine the extent that toothbrushing habits may contribute to tooth wear, information about frequency and method of brushing, as well as the type of dentifrice used, should be obtained.
- Occupational/Recreational History: The character of the patient's work environment, or hobbies such as wine tasting, should be ascertained. People who swim frequently in chlorinated pools should obtain information about the pool water's acidity.

- Salivary Function: Salivary flow rate should be assessed in patients with erosion. However, the usefulness of measuring salivary pH and buffer capacity in these patients is not clear.

Head and Neck/Oral Examination

Signs of tenderness or hypertrophy of the masticatory muscles on head and neck exam may indicate a bruxism habit. Suspicion of Sjogren's syndrome, chronic alcoholism, or bulimia should be raised by enlarged parotid salivary glands. Inflammation, dryness, and the inability to express saliva from gland orifices may be signs of decreased salivary flow.

Erosion caused by GERD usually is seen in the posterior dentition and on the lingual surfaces of maxillary anterior teeth. The appearance of raised amalgam restorations is common. The loss of tooth structure eventually can lead to decreased vertical dimension and tooth sensitivity, while thinning enamel can cause both discoloration of teeth and chipping of the incisal edges.

Bulimics frequently hide their disease from family and friends; however, the pattern of erosion is so distinct that 28% of bulimia patients are identified first by dentists. Signs of erosion can appear in a bulimic's dentition within months of onset; the most common clinical appearance is severe erosion on the lingual surfaces of maxillary anterior teeth. Compared to the smooth and even wear that results from attrition, the incisal edges of a person who routinely induces vomiting are irregular and chipped. The lingual and occlusal surfaces

of maxillary premolars and molars tend to display moderate erosion, making raised restorations a possibility.

Occlusal surfaces may display scooped-out dentin or highly polished wear facets from a combination of chemical and mechanical wear. Gastric acids usually do not affect mandibular anterior teeth because they tend to be protected by the tongue, although erosion occasionally is evident in this area. Patients who have been bulimic for long periods of time commonly display generalized erosion and moderate to severe sensitivity. Long-term binging and purging can compromise the vertical dimension of occlusion.

In patients with erosion, caries is generally not common and plaque retention is rare. Conversely, preservation of a cuff of enamel within the gingival crevice is common.

Documenting Progression of Erosion

Comparison of clinical photographs of tooth surfaces may help in estimating loss of tooth structure due to erosion over time. Additional information can be gleaned by examination of study casts as well as radiographs, especially bitewings.

PREVENTION OF EROSION

The management of dental erosion consists of immediate, interim, and long-term phases. Immediate management consists of early diagnosis, baseline

measurements, and appropriate prophylactic approaches, including reducing acidic exposure and increasing resistance to tooth tissue loss due to erosion. Following is a summary (based on Gandara and Truelove, 1999) of seven approaches and their specifics:

1. Diminish the frequency and severity of the acid challenge: Reduce the amount and frequency of acidic foods or drinks; refer suspected GERD patients to a physician.
2. Enhance the defense: Stimulate salivary flow with sugarless lozenges, candy, or gum.
3. Improve acid resistance, remineralization, and rehardening of tooth surfaces: Apply topical fluoride at home daily and have office applications of fluoride (varnish) two to four times a year.
4. Enhance chemical protection: Neutralize oral acids with sugar-free antacid tablets, particularly after acid challenges; hold certain foods such as hard cheese in the mouth after acidic challenges.
5. Decrease abrasive forces: Use soft toothbrushes and low-abrasion dentifrices; avoid brushing teeth immediately after acid challenges; rinse with water after an acid challenge.
6. Provide mechanical protection: Consider composites and direct bonding to protect exposed dentin.
7. Monitor stability: Document wear using study casts or photos; implement regular recall examinations.

The chief philosophy underlying the management of erosion is implementing prophylactic measures, followed by restorative or prosthodontic intervention when required. However, eliminating causative factors, such as by preventing bruxism or managing GERD, may not be easy (Johansson, 2008). In addition, lifestyle changes may be needed for effective preventative strategies. In children, this may involve the entire family (Johansson, 2002). Nevertheless, even in very severe cases, control of progression of the tooth wear may be enhanced by information and prophylaxis.

Fluoride treatments have long been available to prevent dental caries, but fluoride's role in the erosion process is more limited (Meurman, 1996). Nevertheless, it appears that topical fluoride application can positively affect the tooth-wear process. In addition, theoretically, fluoride has some protective effect in a drink. The erosive potential of different beverages has been found to be inversely correlated with their fluoride content (Lussi, 1993).

Interim and long-term treatment options include temporary restorations for diagnostic purposes, monitoring of disease progression, definitive restorative work where appropriate, and modification and reinforcement of preventive advice (Mahoney and Kilpatrick, 2004). The treatment of teeth in each classification depends on identifying the factors associated with each etiology. Some cases may require specific restorative procedures, while others will not require treatment.

RESTORATIVE TREATMENT

The choice of restorative treatment depends on the degree of tooth wear and can range from isolated placement of bonded composites to full mouth reconstruction. Sealing of the tooth surfaces and small composite fillings are minimally invasive treatments for erosive lesions. Regardless of the type of restorative therapy provided, preventing the progression of erosion should be the basis of management. This will increase the likelihood of successful long-term outcomes.

The need for treatment should be established after considering the degree of wear relative to the age of the patient, the etiology, the symptoms, and the patient's wishes (Johansson, 2008). Definitive restorative procedures should not be performed before identifying the etiological factors, in conjunction with adequate preventive measures and advice. In bulimics, for example, definitive treatment cannot begin until the patient has ceased purging.

Restoration Material

A decision that is crucial to successful restoration is the choice of material. For example, selection of restoration can depend on whether there are natural teeth in the opposing arch or if the patient is a heavy bruxer. In cases of an opposing occlusion of tooth enamel, a metal occlusal surface and one of high noble content is preferred to minimize wear of the natural dentition. In cases of heavy occlusal load such as, for example, in bruxers, it is necessary to

consider not only the risk for wear of the restorative material itself and the opposing dentition, but also the demand for strength in all the components to withstand the applied load. In addition to mechanical failures under conditions of excessive load, biological failures are even more likely, including caries, marginal degradation, endodontic problems, and loss of retention.

Adhesive Strategies

Conventional fixed and removable prosthodontics are the foundation of rehabilitation of the extensively worn dentition. However, such treatment is also complex and generally highly invasive. In children, especially when wear affects permanent teeth in the mixed dentition, resin-based restorations are the restorative option of choice (Johansson, 2008). Adhesive technologies and materials also offer promise as a less invasive option for the older patient.

Systems available for restoring cervical erosive lesions include resin-modified glass ionomer cements, polyacid-modified resin-based composites, and resin-based composites. Most studies of these adhesive materials have focused on restoration of noncarious cervical lesions without identifying the underlying etiology. Nevertheless, recent studies demonstrate the effectiveness of adhesive strategies in this setting.

One small, five-year, double-blind, randomized clinical trial (Loguercio, 2003) evaluated a resin-modified glass ionomer (Vitremer, 3M) and a polyacid-modified resin (Dyract, Dentsply DeTrey). A total of 32 restorations were placed in patients with at least one pair of equal-sized noncarious cervical lesions

under occlusion. Results indicated no secondary caries with either material and no significant difference in retention rate for Vitremer (93%) and for Dyract (78.5%; $p > 0.05$). Vitremer had significantly better marginal adaptation with lower marginal discoloration and higher retention rate higher than Dyract after five years. Surface texture and color match in noncarious Class V restorations was better with Dyract after five years.

Similar findings were published from a study that evaluated the five-year clinical performance of a one-bottle adhesive and resin composite system versus resin-modified glass ionomer restorative in noncarious cervical lesions (Franco, 2006). The clinical performance of resin-modified glass ionomer restorations was better than that of resin composite restorations after five years of evaluation.

A two-year clinical performance of esthetic restorative materials including Vitremer, F2000 Compomer (3M), Dyract AP, and Valux Plus (3M) found that resin-modified glass ionomer cement, polyacid-modified resin-based composite, and resin-based composite behave differently in the restoration of noncarious cervical lesions (Onal, 2005). The study concluded that Vitremer is the "most appropriate material" for restoration of noncarious cervical lesions because of its high retention rate, although esthetics might be inferior to resin-based composites. Because these materials differ as restorative options in noncarious cervical lesions, clinicians should consider esthetic needs and localization in selecting them.

CONCLUSION

This course emphasized the importance of early diagnosis of dental erosion and of accurate detection of possible risk factors and their interplay. These facts are prerequisites to initiate adequate preventive (and therapeutic) measures.

REFERENCES

Addy, M. (2005). Tooth brushing, tooth wear and dentine hypersensitivity: Are they associated? *International Dental Journal, 55* (Suppl 1), 261–267.

Attin, T. (2006). Methods for assessment of dental erosion. *Monographs in Oral Science, 20*, 152–172.

Bartlett, D. W. (2005). The role of erosion in tooth wear: Aetiology, prevention and management. *International Dental Journal, 55*(Suppl 1), 277–284.

Carlsson, G. E., Johansson, A., & Lundqvist, S. (1985). Occlusal wear. A follow-up study of 18 subjects with extremely worn dentitions. *Acta Odontologica Scandinavica, 43*, 83–90.

Delaney, B. C. (2004). Review article: Prevalence and epidemiology of gastro-oesophageal reflux disease. *Alimentary Pharmacological Therapy, 20*, 2–4.

Dugmore, C. R., & Rock, W. P. (2003). The progression of tooth erosion in a cohort of adolescents of mixed ethnicity. International Journal of *Paediatric Dentistry, 13*, 295–303.

Franco, E. B., Benetti, A. R., Ishikiriama, S. K., Santiago, S. L., Lauris, J. R., Jorge, M. F., et al. (2006). 5-year clinical performance of resin composite versus resin modified glass ionomer restorative system in non-carious cervical lesions. *Operative Dentistry, 31*(4), 403–408.

Gandara, B. K., & Truelove, E. L. (1999). Diagnosis and management of dental erosion. *Journal of Contemporary Dental Practice, 1*(1), 16–23.

Hara, A. T., Lussi, A., & Zero, D. T. (2006). Extrinsic causes of erosion. Biological factors (pp. 88–99). In Whitford, G. M. (ed.), *Monographs in Oral Science. Dental erosion: from diagnosis to therapy*. Karger, Basel.

Jaeggi, T., & Lussi, A. (2006). Prevalence, incidence and distribution of erosion. *Monographs in Oral Science, 20*, 44–65.

Jarvinen, V. K., Rytomaa, I. I., & Heinonen, O. P. (1991). Risk factors in dental erosion. *Journal of Dental Research, 70*, 942–947.

Johansson, A., Johansson, A. K., Omar, R., & Carlsson, G. E. (2008). Rehabilitation of the worn dentition. *Journal of Oral Rehabilitation, 35*(7), 548–566.

Johansson, A. K. (2002). On dental erosion and associated factors. *Swedish Dental Journal, 156*, 1–77.

Katz, P. O. (2005). Gastroesophageal reflux disease and extraesophageal disease. *Reviews of Gastroenterological Disorders, 5*, 31–38.

Khan, F., Young, W. G., & Daley, T. J. (1998). Dental erosion and bruxism. A tooth wear analysis from south east Queensland. *Australian Dental Journal, 43*, 117–127.

Lee, M., & Feldman, M. (1998). Nausea and vomiting. In Feldman, M., Scharschmidt, B., & Sleisenger, M. (eds.), *Sleisenger and Fordstran's gastrointestinal and liver disease: Pathophysiology, diagnosis, management*, 6th ed. (pp 117–127). Philadelphia: Saunders.

Loguercio, A. D., Reis, A., Barbosa, A. N., & Roulet, J. F. (2003). Five-year double-blind randomized clinical evaluation of a resin-modified glass ionomer and a polyacid-modified resin in noncarious cervical lesions. *Journal of Adhesives in Dentistry, 5*(4), 323–332.

Lussi, A., Jaeggi, T., & Schärer, S. (1993). The influence of different factors on in vitro enamel erosion. *Caries Research, 27*, 387–393.

Lussi, A., & Jaeggi, T. (2008). Erosion—Diagnosis and risk factors. *Clinical Oral Investigations, 12*(Suppl 1), 5–13.

Lussi, A., Schaffner, M., Hotz, P., et al. (1991). Dental erosion in a population of Swiss adults. *Community Dentistry and Oral Epidemiology, 19*, 286–290.

Lussi, A., & Schaffner, M. (2000). Progression of and risk factors for dental erosion and wedge-shaped defects over a 6-year period. *Caries Research, 34*, 182–187.

Mahoney, E. K., & Kilpatrick, N. M. (2004). Dental erosion: Part 1. Aetiology and prevalence of dental erosion. *New Zealand Dental Journal, 99*(2), 33–41.

Meurman, J. H., & ten Cate, J. M. (1996). Pathogenesis and modifying factors of dental erosion. *European Journal of Oral Science, 104*, 199–206.

Milosevic, A. (1998). Toothwear: Aetiology and presentation. *Dental Update, 25,* 6–11.

Moayyedi, P., & Axon, A. T. (2005). Review article: Gastro-oesophageal reflux disease—The extent of the problem. *Alimentary and Pharmacological Therapy, 22*, 11–19.

Onal, B., & Pamir, T. (2005). The two-year clinical performance of esthetic restorative materials in noncarious cervical lesions. *Journal of the American Dental Association, 136*(11), 1547–1555.

Tomasik, M. (2006). Analysis of etiological factors involved in noncarious cervical lesions. *Annales Academiae Medicae Stetinensis, 52*(3), 125–136.

Zero, D. T., & Lussi, A. (2000). Etiology of enamel erosion—Intrinsic and extrinsic factors (pp. 121–139). In Addy, M., Embery, G., Edgar, W. M., & Orchardson, R. (eds.), *Tooth wear and sensitivity. Clinical Advances in Restorative Dentistry*. London: Martin Dunitz.

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L0125-596
Erosion-Related Tooth Wear:
Pathogenic Processes, Diagnosis, and Restorative Treatment
TEST

1. Dental erosion is caused by
a. behavioral processes.
b. biological processes.
c. chemical processes.
d. mechanical processes.

2. The pathogenic mechanisms of attrition, erosion, and abrasion
a. occur simultaneously.
b. function sequentially.
c. are preformed independently.
d. rarely operate singly.

3. Erosion of dentin has been reported with a pH level of
a. 6.0.
b. 8.0.
c. 9.0.
d. 10.0.

4. The pH value and mineral content of a drink or foodstuff determine the
a. separation of the enamel and dentin.
b. degree of saturation with respect to the tooth mineral.
c. separation of enamel from the pellicle.
d. erosive potential of the saliva.

5. Calcium and phosphate components of food or beverage are important determinants of erosive potential because they influence the
a. retention of residues in the oral cavity.
b. complexation activity within the local environment of the tooth surface.
c. anionic concentration in the tooth vicinity.
d. concentration gradient within the local environment of the tooth surface.

6. Erosion may be associated with
a. rapid salivary flow and high buffering capacity.
b. high salivary flow and low buffering capacity.
c. low salivary flow and low buffering capacity.
d. high salivary flow and high buffering capacity.

7. The loss of tooth tissue in patients with bruxism is more likely due to
a. attrition than to erosion.
b. erosion than to attrition.
c. abrasion than to attrition.
d. attrition than to abrasion.

8. High erosion is associated with a drinking habit in which the drink is a. expectorated.
b. sipped in small quantities.
c. held in the mouth.
d. swallowed rapidly.

9. Typical early signs of enamel erosion include
a. deep, narrow V-shaped notch.
b. shiny facets on amalgam contacts.
c. smooth enamel surface without perikymata.
d. chipped incisal edges.

10. Wear on nonoccluding tooth surfaces is typical of
a. erosion.
b. attrition.
c. abrasion.
d. abfraction.

11. Shiny facets on amalgam contact surfaces are typical of
a. abfraction.
b. abrasion.
c. attrition.
d. erosion.

12. Preservation of an enamel cuff in the gingival crevice is typical of
a. abfraction.
b. abrasion.
c. attrition.
d. erosion.

13. Involvement of premolars, cuspids, and cervical areas is typical of
a. abfraction.
b. abrasion.
c. attrition.
d. erosion.

14. Signs of advanced dental erosion include

a. wedge-shaped defects at or apical to the cemento-enamel junction.
b. preservation of the occlusal morphology.
c. raised restorations at the cemento-enamel junction.
d. Enlarged gingival tissue.

15. The dietary questionnaire should focus on intake of

a. acidic beverages.
b. fast foods.
c. abrasive foods.
d. acidic foods and beverages.

16. A history of bruxism may add to erosion the possibility of

a. attrition.
b. fatigue in the jaw muscles.
c. grinding noises during sleep.
d. abrasion.

17. The most common clinical appearance of erosion in a bulimic patient is

a. severe erosion in the posterior dentition.
b. severe erosion on the lingual surfaces of maxillary anterior teeth.
c. smooth and even wear on the incisal edges.
d. severe erosion of the mandibular anterior teeth.

18. The immediate phase of managing dental erosion includes early diagnosis, baseline measurements, and

a. restoration.
b. caries prevention.
c. modification.
d. prophylaxis.

19. Definitive restorative procedures should be preceded by

a. radiographic examination.
b. identification of the etiological factors.
c. a change in diet.
d. follow-up monitoring.

20. Resin-based restorations are the option of choice in

a. children.
b. older adults.
c. bulimics and anorexics.
d. cases of mixed erosion, abrasion, and attrition.