Caries Process and Prevention Strategies: Erosion

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Conflict of Interest Disclosure Statement

- The authors report no conflicts of interest associated with this course.

Introduction

This is part 7 of a 10-part series entitled *Caries Process and Prevention Strategies*. This course establishes the concept of dental erosion as a condition that is distinct from caries, and as an emerging public health issue with increasing prevalence in people of all ages. Although often generalized under the heading of "tooth wear," there are actually two distinct tooth surface loss processes that must be taken into account. Tooth surface loss can be the result of physical mechanisms, such as attrition and abrasion, or chemical mechanisms triggered by acid. Both of these mechanisms are discussed, as well as the chemical, biological, and behavioral factors that increase or reduce risk of tooth surface loss. In addition, diagnosis and prevention measures related to dental erosion are introduced.

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Overview

This course establishes the concept of dental erosion as a condition that is distinct from caries, and as an emerging public health issue with increasing prevalence in people of all ages. Although often generalized under the heading of "tooth wear," there are actually two distinct tooth surface loss processes that must be taken into account. Tooth surface loss can be the result of physical mechanisms, such as attrition and abrasion, or chemical mechanisms triggered by acid. Both of these mechanisms are discussed, as well as the chemical, biological, and behavioral factors that increase or reduce risk of tooth surface loss. For the purpose of this discussion, the impact of physical processes on tooth surface loss, such as attrition and abrasion, will be referred to as tooth wear. The process related to chemical acid attack resulting in tooth surface loss will be referred to as dental erosion. In addition, diagnosis and prevention measures related to dental erosion are introduced.

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- Describe why tooth wear poses a serious public health issue.
- Discuss the difference between physical and chemical wear on hard dental tissues.
- Identify the factors that cause each of the three types of physical tooth surface loss (tooth wear).
- Discuss the multiple factors that cause chemical tooth surface loss (dental erosion).
- Identify the chemical, biological and behavioral factors that influence dental erosion.
- Be familiar with how to diagnose dental erosion.
- Advise the patient on the diet, behavioral, and medical factors that can reduce dental erosion.

Glossary

buffering capacity – Saliva and the fluid in dental plaque possess the ability to buffer. Buffering adjusts the pH of any solution such as saliva or plaque fluid, and can resist changes in pH. Buffering capacity is the degree of buffering that can be brought about.

chelation – As it applies to the oral cavity, chelation is the process whereby citric acid has the ability to demineralize enamel to a much greater degree than its pH can explain. Through its chelating properties, citric acid removes calcium from the enamel surface, and through chelation forms a compound from which the calcium cannot be released. Therefore, the calcium is not available to diffuse back into the tooth. Citric acid also has the ability to chelate calcium in saliva, reducing the remineralizing effect.

demineralization – The chemical process by which minerals (mainly calcium) are removed from the dental hard tissues – enamel, dentin, and cementum. The chemical process occurs through dissolution by acids or by chelation, and the rate of demineralization will vary due to the degree of supersaturation of the immediate environment of the tooth and the presence of fluoride. In optimal circumstances, the minerals may be replaced through the process of remineralization.

dentin hypersensitivity – Tooth pain that is characterized by brief, sharp, well-localized pain in response to thermal, evaporative, tactile, osmotic, or chemical stimuli that cannot be ascribed to

any other dental disease or condition. Exposed dentin is a feature, and therefore the condition is associated with enamel wear (usually erosion) or gingival recession.

developed countries – A term not frequently used today in classifying countries, as no definitive definition exists. The term is used to describe countries with industrialized economies and higher levels of gross domestic product. Developed countries are able to spend more on health systems. These systems are typically treatment-oriented and focus services on the needs of the individual rather than the community.

erosion – Localized loss of dental hard tissue that is chemically etched away from the tooth surface by acids or chelating agents. Can be referred to as Acid Erosion or Acid Wear. Teeth exhibiting signs of erosion lose their surface texture (perichymata), may appear more yellow, and have an altered shape.

fluorapatite – A crystal structure in tooth mineral (Ca_{10} $(PO_4)_6$ F_2) resulting from the replacement of hydroxyl ions (OH-) in the hydroxyapatite structure with fluoride ions (F-). Fluorapatite (also commonly referred to as fluoroapatite, fluorhydroxyapatite or fluorohydroxyapatite) is stronger and more acid resistant than hydroxyapatite.

GERD – Gastroesophageal reflux disease; the reflux of hydrochloric acid generated in the stomach that travels to the mouth. Erosion will occur upon the acid's contact with enamel surfaces.

hydroxyapatite – Crystals of calcium phosphate – (Ca_{10} $(PO_4)_6$ OH_2) that form the mineral structure of teeth and bone. Enamel comprises approximately 98% hydroxyapatite (by weight). Much of the hydroxyapatite in enamel, however, is a calcium-deficient carbonated hydroxyapatite, the crystals of which are readily dissolved by acids. The addition of fluoride creates fluorapatite, which is less soluble and more acid-resistant.

ions - Atoms or molecules that carry either a positive or a negative electric charge in a solution. For example, sodium chloride (NaCl, common table salt) in water dissociates into Na+ and Cl– ions.

prevalent – Widespread; widely or commonly occurring.

remineralization – The chemical process by which minerals (mainly calcium) are replaced into the substance of the dental hard tissues – enamel, dentin and cementum. The process requires an ideal environment that includes supersaturation with calcium and phosphate ions, and adequate buffering. In the presence of fluoride, remineralization is enhanced.

tooth wear – The non-carious loss of tooth tissue through the processes of attrition, abfraction, abrasion, or erosion, occurring alone or combined (most typically abrasion and erosion).

xerostomia – A subjective assessment of mouth dryness, usually but not always associated with low levels of saliva production. Inadequate production of saliva occurs for many reasons, most commonly as an unwanted effect of many prescription and over-the-counter medicines. Saliva is necessary for maintaining a healthy mouth, and, in relation to dental caries, is essential for remineralization.

Video: Erosion

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Course Test Preview

To receive Continuing Education credit for this course, you must complete the online test. Please go to: *www.dentalcare.com/en-us/professional-education/ce-courses/ce374/test*

1. Which of the following statements about dental erosion is true?

A. Dental erosion is not a serious public health issue.
B. Dental erosion is caused by bacteria.
C. Dental erosion is non-bacterial chronic loss of dental tissues.
D. Dental erosion is only prevalent in less developed countries.

2. Why is dental erosion of particular concern to dentists?

A. When reparative processes can no longer protect teeth, complications can include pain, dentin hypersensitivity, and pulpal inflammation.
B. It can lead to oral cancer.
C. Dental erosion is not a serious concern for dentists.
D. It can be an indicator of future caries.

3. Which of the following is correct about attrition?

A. Attrition is only caused by pathological behavior, like tooth grinding.
B. Attrition can be physiological when it is due to normal wear or pathological when caused by certain habits of the patient, like tooth grinding.
C. Attrition only damages the premolars and molars.
D. Attrition is the wearing away of dental tissue by foreign objects in the mouth.

4. Which of the following is correct about abrasion?

A. Abrasion is the wearing away of dental tissue due to tooth-to-tooth contact.
B. Abrasion is only caused by pathological behavior.
C. Abrasion causes include oral habits like using toothpaste and brushing teeth in a way that may be too hard.
D. Abrasion only damages the premolars and molars.

5. Which of the following is correct about abfraction?

A. Abfraction is a mechanical process caused only by foreign objects in the mouth.
B. Abrasion only damages the premolars and molars.
C. Abfraction is caused by "bad bite."
D. Abfraction occurs as a result of shear stress that leads to tooth flexure that causes fractures in enamel and dentin.

6. What is the first step of tissue loss during the dental erosion process?

A. Enamel exposed to acid first undergoes softening, and as softening progresses over time, dissolution can remove portions of enamel or the whole enamel layer.
B. There is dissolution at the junction of the peritubular and intertubular dentin.
C. There is formation of a demineralized collagenous mix.
D. There is the widening of tubule lumina.

7. Which acidic products below are not a major cause of dental erosion?

A. Carbonated beverages
B. Acidic foods and beverages
C. Yogurt
D. Citrus fruits

8. Which of the following is not an extrinsic source of erosive acid?

A. Chewable vitamin C
B. Gastric acid
C. Mouth rinses that contain sodium chloride
D. Herbal teas

9. What percent of calcium in saliva can be complexed by citrate in fruit juices?

A. 12%
B. 47%
C. 32%
D. 81%

10. Which of the following is true about the calcium, phosphate, and fluoride concentration of a beverage?

A. Solutions oversaturated in calcium, phosphate, and fluoride with respect to dental tissue will protect against dental surface softening.
B. A low degree of undersaturation does not impact enamel at all.
C. A high degree of undersaturation will only cause an initial surface demineralization.
D. Supplementing a solution with calcium, phosphate, and fluoride does not affect its erosive potential.

11. What helps the salivary pellicle have a protective effect?

A. It is a source of remineralizing electrolytes.
B. It cannot be removed once fully formed.
C. It contains acid-neutralizing enzymes, like carbonic anhydrase VI.
D. A and C

12. On which teeth surfaces are the most serious dental erosions typically found?

A. Facial surfaces of the upper incisors
B. Lingual surfaces of the lower teeth
C. Palatal surfaces of the upper teeth
D. All tooth surfaces are equally impacted

13. What information is useful in assessing a patient's risk of dental erosion?

A. The patient's oral hygiene habits
B. The patient's regular use of ADA approved toothpastes
C. A record of the patient's dietary intake
D. A and C

14. What qualities describe the appearance of enamel in early erosion?

A. Smooth, silky, glazed
B. Bumpy, dull, yellow
C. There are no detectable changes in early erosion
D. Thick, bumpy

15. Which source of fluoride has been identified as particularly beneficial for its ability to help protect against dental erosion?

A. Sodium fluoride
B. Sodium monofluorophosphate
C. Stabilized stannous fluoride
D. All fluorides are equally protective against dental erosion.

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Additional Resources

- No Additional Resources Available.

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Dr. Higham has supervised more than 50 postgraduate students and has published widely with approximately 400 peer-reviewed papers and book chapters. Her main research interests have been in the use of in vitro and in situ models and clinical trials to study dental diseases, together with the development of optical technologies for the quantification of mineral loss/gain in vivo. She has been involved in University teaching at all undergraduate and postgraduate levels since 1983. Dr. Higham was a scientific advisor for the European organization for caries research (ORCA) for many years and was a dentistry panel member for the Research Excellence Framework (REF) in the UK.

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In 2005, Chris was appointed as Lecturer in Oral Biology at the University of Liverpool where his experience of biofilm modeling complimented the research group themes of caries and plaque-related disease. Chris developed a biological model of dental caries which acquired enamel lesions in less than two weeks and continued his interests in imaging by studying the natural fluorescence of dental plaque and the lethal photosensitization of periodontal pathogens by means of their intrinsic porphyrins.

Chris served two terms on the British Society for Oral and Dental Research (BSODR) Oral Microbiology and Immunology Group (OMIG) management committee and was elected onto the management board of the BSODR in 2017. He has also previously served on the editorial board of the Journal of Medical Microbiology. Chris left academia in 2018.

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Phil is currently Honorary Senior Research Fellow and formerly Senior Lecturer and Honorary Consultant in Restorative Dentistry at Liverpool University Dental Hospital and he has been an NHS Consultant since 1998. He has been actively involved in teaching, research and clinical service, and was lead clinician for restorative care of CLP patients in Liverpool and North West (West) Region. He has gained experience in managing clefts from time spent in Oslo. He has published widely including authoring/co-author of 3 textbooks and has been supervisor, mentor and advisor for a number of postgraduate students and trainees. He is a reviewer for Journal of Dental Research, Journal of Dentistry, British Dental Journal, Dental Materials, Journal of The European Journal of Prosthodontics and Restorative Dentistry, and Dental Update. He has acted as external examiner for Universities of Birmingham, Cork, Dundee, Glasgow, Manchester and Newcastle. He was also part of a team from Liverpool commended in the recent Medical Futures Innovation awards and was President of the British Society of Prosthodontics.

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Video Course Presenter

Robert V. Faller, BS

Robert Faller has in excess of 40 years in the Oral Care Research field. He retired from P&G after more than 31 years in Oral Care, where he focused on caries and enamel related research as P&G's chief cariologist. He is editor of *Volume 17 – Monographs in Oral Science: Assessment of Oral Health – Diagnostic Techniques and Validation Criteria*. He has written 3 book chapters, published 34 papers in peer-reviewed journals and has over 100 published abstracts on fluoride, caries, dental erosion, and various oral care technologies, along with 5 patents related to Oral Care and 6 Continuing Education courses. He currently resides in the UK and is a consultant to the Oral Care industry.

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