Caries Process and Prevention Strategies: Erosion

Video Transcript

Hello, and welcome to dentalcare.com Cariology series. This session focuses on dental erosion. This is part 7 of the 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.

For the purpose of this discussion, the impact of physical processes on tooth surface loss, such as attrition and abrasion, what will be referred to as tooth wear. The process related to chemical asset 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.

First, I would like to discuss a couple of clinical significant snapshots, things that may come up in terms of questions that you may be faced within your practice. The first is, is dental erosion really a concern for me and my patients? Erosion is more frequently found in healthy patients, and this is where the greatest number of cases now occur. Although people adopting healthier diets and caring more for their oral health improve their overall wellbeing, they're also putting themselves at increased risk of dental erosion. Healthier diets include more fruits and vegetables as well as their juices, many of which are acidic. In addition, increased consumption of carbonated beverages with sugar or sugar-free and a concurrent decrease in milk consumption has led to increased acid intake and reduced calcium intake.

Taking all of the above into account, patients today have many more perfect unrestored teeth, all of which are susceptible to acid attack, more acid exposures through changes in diet and lifestyle and an increased frequency of toothbrushing with mildly abrasive toothpastes. A consequence of all of these factors is erosive tooth wear. Also, the teeth our patients have must work harder and last longer as life expectancy increases, wear and tear is only natural. The teeth today have more work to do over a longer period than previous generations that had teeth extracted and more dentures. Saliva is one of our main defenses against acid attack, yet more patients are taking an increased number of prescription and over the counter medications, more than 400 of which have the ability to reduce saliva flow and thus decrease this line of defense.

Minor erosion can be found in nearly every mouth and should be regarded as a normal response to a healthy lifestyle. If minor, erosion has no noticeable signs or symptoms for the patient, however, minor dental erosion is an

indicator of more significant signs, yellowing and loss of whiteness, dullness and loss of bluster, changes in shape. And symptoms, dental hypersensitivity and loss of occlusal contact and or occlusal height when advanced in relation to the patient's age.

Another question that comes up is, is erosion the most common form of tooth wear? Evidence of erosion can be found in almost every mouth and may co-exist with the other physical forms of tooth wear. Erosive tooth wear may be exacerbated by physical wear from inappropriate use of toothpaste, particularly if used immediately after an acid attack when the surface of the enamel is soft and vulnerable to wear. In this case, the clinical signs often lead to an incorrect diagnosis of toothbrush abrasion. Incidentally, nylon toothbrush bristles will not wear away enamel, they are too soft.

However, the action of aggressive brushing places greater pressure on the abrasive cleaning or on the abrasive cleaning particles in toothpaste that could wear enamel, especially if already softened by the dietary acids. Soft brushes hold more abrasives against the surface of the tooth and are thus more harmful to the hard tissues than a hard brush. It's imperative to assess erosive risk factors in all patients demonstrating signs or symptoms of tooth wear, no matter how obvious the diagnosis may be. Seldom does any one element of tooth wear occur alone.

Another question is, how is dental erosion linked to my patient's overall oral hygiene? After any acid, dietary or stomach, has softened the surface layers of an enamel, that an enamel is vulnerable to physical loss until the natural forces of saliva have, have remineralized and thus rehardened it. If oral hygiene is conducted while the enamel is still softened, the oral hygiene procedure may lead to physical removal of some of this softened material, which leads to irreversible loss. Used as directed, most toothpaste are safe. However, if used aggressively or abusively, too much force, too much paste, too frequently, the detergents and abrasive particles essential for cleaning under normal circumstances have the potential to increase physical loss of the softened enamel.

Now, our expectations upon completion of this course for the dental professional are that you will be able to describe why tooth wear poses a serious public health issue. To be able to discuss the difference between physical and chemical wear on hard dental tissues. To identify the factors that cause each of the three types of physical tooth surface loss or tooth wear. To be able to discuss the multiple factors that cause chemical tooth surface loss, this is dental erosion. To identify the chemical, biological, and behavioral factors that influence dental erosion. To be familiar with how to diagnose dental erosion. To be able to advise the patient on the diet, behavioral, and medical factors that can be used to reduce dental erosion.

Although erosive tooth surface loss was described as a different condition to caries as early as the 18th century, it was not considered with much importance until the 1990s. In 1996, the European Journal of Oral Science stated "dental erosion is an area of research and clinical practice that will undoubtably experience expansion in the next decade". Yet, many dental professionals today are unable to correctly identify signs and symptoms. Considering the increasing longevity of teeth as dental advances have reduced tooth loss, the damaging effects of dental erosion, the non-bacterial chronic loss of dental tissues, is emerging as a serious public health issue. In fact, erosive tooth surface loss is highly prevalent in developed countries, including the United States, Canada, Great Britain, and Sweden. Studies suggest a prevalence of 6% to 50% in preschool children, 24% to 100% in school-aged children, and as high as 82% in adults ages 18 to 88 years of age.

The reason for concern is that erosive tooth surface loss can be pathological if the teeth are so worn down, that they change in appearance or can no longer function properly. When natural repetitive processes such as remineralization are no longer sufficient to protect the tooth, complications can include pain, dentin hypersensitivity, pulpal

inflammation, necrosis, and pathology around the apex of the root of a tooth. There can also be increased risk of temporomandibular disorders. What follows is a discussion of physical and chemical tooth wear mechanisms and the many factors that increase the risk of tooth surface loss. Let's begin by watching a short video with Dr. Domenick Zero, from Indiana university, about the common elements of tooth wear.

Tooth wear is, you know, is a problem in the sense that, uh, as we age, uh, there, there are wear forces on the teeth. And, um, those wear forces can lead to what most of us will have as we age, which is physiologic tooth wear, there's some natural wearing away of the tooth. The problem is when that process gets accelerated. And that process gets accelerated because of exposure to, uh, food acids, excessive consumption of soft drinks, excessive, excessive consumption of, of, of, of juices that are acidic. The acid then softens the enamel, and that accelerates the wear of the biting surface of the tooth, as well as the wear of the smooth surfaces, especially if they're brushed with a toothbrush too soon after the acid exposure.

Tooth wear mechanisms and etiology. The mineral in enamel is a calcium-deficient, carbonated hydroxyapatite with the carbonate rendering the tooth more acid soluble and true hydroxyapatite. During a lifetime, once teeth are subjected to a number of physical and chemical insults that damage this more soluble hydroxyapatite of enamel, as well as the other hard dental tissues, including the dentin and cementum. The chronic destruction of hard dental tissues due to physical or chemical wear, or a combination of both, has been defined as tooth wear. While enamel is the most at risk for dental erosion, as teeth are lasting longer in more recent times, dentists have had to pay more attention to the coronal and root dentin because their exposure is becoming more common as a result of the growing issues related to tooth wear and gum recession.

We're also concerned about physical wear. There are three main types of physical tooth wear mechanisms. These include attrition, abrasion, and abfraction. Attrition is the physical wearing away of hard dental tissue due to tooth-to-tooth contact with no foreign substance intervening. It can be physiological when it is involved in the normal wear of the pre-molars and molars called occlusal wear, or is caused by a malocclusion or bad bite that damages buccal lingual, and interproximal tooth surfaces. However, attrition can also be pathological when it's caused by certain habits of the patient, particularly tooth grinding.

Abrasion is the wearing away of hard dental tissue by mechanical processes involving foreign objects, or substances repeatedly introduced into the mouth and contacting the teeth. Previously, the definition of abrasion assumed that all abrasion is pathological, but because abrasion can be caused by factors that are beneficial, the word pathological is no longer always associated with abrasion. Etiological factors include oral hygiene habits, such as using toothpaste, the major abrasive agent in Western populations, brushing teeth in a way that might be too hard or too long or excessive flossing, personal habits such as frequently putting foreign objects such as a pen in the mouth, and occupational expos- exposure to abrasive particles. A special form of abrasion is from domestication, the wear that comes from chewing food.

Abfraction occurs as a result of sheer stress in this cemento-enamel junction of the tooth, leading to the tooth flexure that causes tiny fractures in enamel and dentin. Stress that leads to tooth flexure can be caused by chewing or tooth grinding. These areas of wear and toothless typically occur at the cervical region on the tooth, and are more commonly now referred to as noncarious cervical lesions or NCCLs. And then there's chemical ware, which is what we call dental erosion. The chemical dissolution of dental tissues can be caused by acid that is extrinsic coming from items that are ingested such as acidic food and beverages, or intrinsic coming from hydrochloric acid produced by the parietal cells in the stomach. Hydrochloric acid can have a pH as low as one, so its destructive capabilities are especially severe and significantly more so than dietary acids. However, regardless of the

origin of the acid, the effect is the same, a low pH environment in the oral cavity.

The initial reaction is that an enamel first undergoes softening, followed by the loss of mineral from a layer extending a few micrometers below the surface. As softening progresses over time, dissolution can completely remove portions of the enamel or the whole enamel layer exposing the dentin underneath. When dent- when dentin is exposed to acid, first, there is a disillusion at the junction of the peritubular and intertubular dentin. Next, there's a loss of the peritubular dentin and widening of the tubule lamina. Finally, there's formation of a demineralized collagenous mix that provides some protection of the underlying tissue. However, this layer is also vulnerable to damage and can ultimately be eroded away as well.

Major causes and acid related risk factors. There are three major causes. Regurgitation, which brings erosive stomach acid into the oral cavity and can occur in bulimia or during pregnancy. Excessive consumption of acidic foods, such as sweets or even healthy foods like citrus fruits. And excessive consumption of carbonated beverages. Especially problematic is the habit of swishing soda in the mouth to prevent the uncomfortable sensation of carbonation in the throat. This habit enhances the dissolution process because the solution on the surface layer adjacent to the tooth mineral will be readily renewed. Also of concern is the increasing consumption of soda among children, it rose 20% between 1994 and 2004, and is linked to the presence and progression of erosion when other risk factors are present.

As explained before, the acid that erodes teeth can come from intrinsic or extrinsic sour- sources. An increasingly prevalent cause of intrinsic acid is the gastric acid that enters the mouth and gastroesophageal reflux disease otherwise known as GERD. In Western populations, GERD is reported to affect up to 30% of adults and an estimated 15% of people complain of weekly GERD symptoms. GERD is itself a multifactoral condition caused by diet, posture, overly strenuous exercise, alcohol consumption, pregnancy, or obesity. Other conditions that cause gastric acid to enter the oral cavity include chronic alcoholism and rumination, a psychological disorder in which patients regurgitate and rechew their food and swallow again.

Extrinsic sources of acid include excessive consumption of other acidic items such as fruit juices, alcohol, herbal teas, energy drinks, supplements such as hydrochloric acid taken for indigestion, chewable or effervescent vitamin C, aspirin, and some oral hygiene products, including some mouth rinses. There are also non-acid risk factors such as chelation. The presence of acid is not the only way in which the wear of an enamel occurs, chelation is the other. Certain agents can complex with calcium to remove it from enamel, thus triggering demineralization, or agents can complex with calcium in saliva, reducing saliva's supersaturation and the ability to remineralize the tooth surfaces. Some calcium chelating agents include mouth rinses that include the ingredient EDTA, and food and beverages that contain citric acid.

Up to 32% of the calcium in saliva can be complexd by citrate, a concentration common in fruit juices, reducing the supersaturation of saliva and driving the equation to dissolution of tooth minerals. Another non-acid erosion risk factor is dry mouth. This can be caused by dehydration, salivary gland dysfunction, or by the use of some medications such as antihistamines, antiemetics, antidepressants, tranquilizers, or illegal designer drugs. Because the mouth is dry and lacking the benefits of saliva, the teeth have significantly less protection from acids.

Chemical factors that influence erosive tooth surface loss. The term chemical factors is used to describe parameters inherent to erosive beverages, food, or other products. The three main parameters include, pH and buffer capacity. In general, the greater the buffering capacity of an edible item, the longer it will take for saliva to neutralize that product's acid. So a beverage with a higher buffering capacity could be more erosive than others within the same pH class. Even if a product is at low pH, it's possible that other factors are strong

enough to prevent erosion. Similarly, it's also possible that a less acidic product can cause erosion because it has the capacity to complex calcium, pulling the mineral out of the tooth surface to cause demineralization. While pH is an important factor, there is no specific pH of a product below which damage will occur.

The erosive character of lactic acid and citric acid in products is higher than that of acetic, maleic, phosphoric, and tartaric acids. So the acid type is important. And finally, mineral saturation, especially with respect to calcium, phosphate, and fluoride concentration. Solutions oversaturated with respect to dental hard tissue will protect against dental surface softening. A low degree of undersaturation with respect to enamel or dentin leads to a very initial surface demineralization, which is followed by a local rise of pH and increased mineral content in the liquid surface layer adjacent to the tooth surface. This layer will then become saturated with respect to enamel and will not be mineralized further. A high degree of undersaturation with respect to dental tissue will demineralize the tooth surface considerably more.

Studies have shown that a drink which contains citric acid that was supplemented with calcium, phosphate, and fluoride reduce the erosive potential of the solution. The same was true when acidic carbonated drinks from modified with these three minerals. Yogurt, which is acidic with a pH of 4.0, hardly has any erosive effect due to its high calcium and phosphate content, which makes it supersaturated with respect to the hydroxyapatite in enamel. Other parameters to consider are the calcium-chelating properties of the product being consumed, as well as the stickiness of the product, with more sticky products generally being linked to higher erosion risk.

Biological factors that influence erosive tooth surface loss, this includes saliva. This is the most important biological factor in the prevention of dental erosion. It starts acting even before the acid attack with an increase in salivary flow in response to visual or olfactory stimuli, or to chewing. This increases the buffering system and diluting, clearing, and clearing of acids on tooth surfaces during the erosive challenge. The properties of saliva that influence dental erosion include the salivary flow rate. A low salivary flow rate due to xerostomia, dehydration, use of certain medications, salivary gland pathology, or when there are no stimuli to trigger a protective salivary response such as when a patient is suffering from GERD, means that teeth are less protected during an acid attack. A high salivary flow rate on the other hand has protective effect against acid, particularly because it has the ability to clear acids from the tooth surfaces.

Saliva's chemical composition and buffering capacity are important. A higher hydrogen carbonate or bicarbonate content increases the capacity of saliva in neutralizing and buffering acids to protect against erosion. Low buffering capacity is strongly associated with increased erosion. And in addition, saliva that is supersaturated with calcium and phosphate ions is more effective at maintaining the integrity of teeth by remineralizing the hydroxyapatite in enamel, while saliva that is undersaturated with calcium and phosphate cannot replenish enamels, enamel minerals content. The degree of supersaturation of hydroxyapatite, fluorapatite, and calcium fluoride also increases as saliva flow is stimulated and increases. It's also important to note the sites poorly bathed by saliva, or mainly bathed with mucus saliva, which typically contains fewer mineralizing ions, are more likely to show erosion when compared to sites protected by saliva that is serous in nature.

The acquired pellicle. Saliva plays a role in the formation of this protein-based layer, which forms within minutes on the surface of a tooth after its removal by toothbrushing, chemical dissolution, or prophylaxis. This barrier prevents the direct contact of an acid and the tooth surface and can serve as a reservoir of remineralizing electrolytes. The protective effect could be clearly visualized by a scanning electron microscopy study, where the two hour form pellicle was able to reduce erosion by an acidic beverage. The acquired pellicle also contains salivary mucin, proteins that have the

capacity to increase enamel surface protection against demineralization.

The enzymatic composition of the pellicle also plays an important role. The presence of the enzyme carbon- carbonic anhydrase VI in the pellicle may protect against tooth erosion because it speeds the neutralization of demineralizing hydrogen ions to the tooth's surface. The pellicle reaches its full thickness in about two hours, but after this, there is further maturation that allows it to become more acid resistant. If it's removed often due to factors such as excessive brushing, it will not be allowed to reach the maximum thickness or maturation, and the risk of erosion is higher.

Where the tooth is situated in the mouth can also make it more or less susceptible to dental erosion. This is because different sites in the mouth are affected by variations in salivary flow and composition and affected by soft tissues like the tongue, and as such, facial surfaces of upper incisors have higher susceptibility to erosion because the exposure to saliva in this region is lower. Lingual surfaces of lower teeth have lower erosion susceptibility because the exposure to protective slider is higher. The most severe erosive lesions are typically found in the palatal surfaces of the upper teeth because of the abrasive effect of the tongue. It has been shown that the tongue is able to remove already softened enamel and dentin.

Behavioral factors that influence erosive tooth surface loss. These behavioral factors play a significant role in determining the extent of erosive tooth surface loss. The factors can include the manner in which dietary acids are introduced into the mouth such as sipping, gulping, swishing, or using a straw, as this affects how long the teeth are in contact with the erosive challenge. Factors can also include diets high in acidic food, including sweets, fruits, and vegetables, and acidic beverages. Oral hygiene practices such as using toothpaste or excessive tooth brushing or flossing. The use of acidic medications or oral hygiene products. Consumption of alcohol. Frequent consumption of designer drugs. And nighttime baby bottle feeding with acidic beverages.

One point of note is that even healthy dietary lifestyles, such as vegetarianism and raw foodism have been linked with more dental erosion due to the large amount of acidic fruits and vegetables consumed. Other healthy lifestyle habits, such as drinking herbal tea, such as rose hips and lemon, which have a pH of 2.6 to 3.9, may also promote dental erosion. And even cosmetic procedures may pose a problem. Some whitening gels have been found to soften and alter enamel suggesting an increased susceptibility to dental erosion.

Tooth wear can be the result of interaction between two or more of the tooth surface loss processes, and those common presentation of tooth wear involves dental abrasion with erosion. Acid partially dissolves the outer layer of mineralized tissue, which increases the potential for abrasion from toothbrushing, with or without toothpaste. For example, there can be interaction between dental attrition and dental erosion and individuals who regurgitate often, such as bulimics. With regard to risk assessment and diagnosis, it's important to evaluate the different ideological factors in order to identify which patients are at risk and to suggest preventive measures, particularly if erosion is detected early. Erosion not diagnosed in the early stages may render preventive measures too difficult. In order to assess risks, gathering information on a patient's medical and dental case history is an important first step.

Information about patient's dietary habits are the most useful, and it is advised that dentists ask their patients to record their complete dietary intake for three to four consecutive days, including time of day and quantity of all foods and beverages, as well as medications and supplements. In addition, it's useful to ask the patient about gastric symptoms like vomiting, acetates in the mouth, chronic heartburn, et cetera, drug use, alcohol, antiemetics, antihistamines, et cetera, use of acidic medicines or supplements and oral hygiene habits like the technique or frequency of brushing. It's also useful to conduct tests for unstimulated saliva flow rate, stimulated saliva flow rate, and saliva buffering capacity, to

determine if the amount and quality of saliva is posing a risk of erosion.

Clinical detection of dental erosion is important once dissolution has started. In the early stages of erosion, the appearance of the teeth is most important sign for diagnosis. Early signs include a smooth, silky-glazed enamel surface, and grooving on the occlusal surfaces. In more advanced stages, changes in the original morphology occur. In general buccal and lingual surfaces of the upper incisors appear smooth and shiny with a generalized loss of anatomy. While the palatal surfaces of the upper incisors might show smooth exposed dentin often with a halo of an enamels surrounding the lesion.

Qualitative and quantitative assessments are possible. There are many frequently adopted techniques for analyzing the erosively altered dental hard tissue and dental research. But these are routinely performed on extracted teeth in the laboratory and are not useful for clinical evaluation of patients. Due to the complex nature of dental erosion and disillusion, a single technique may not provide a full enough picture of the extent of damage and different approaches may be needed for a more complete understanding. The most established and well-evaluated techniques include, but are not limited to, scanning electron microscopy. This is a subjective qualitative method for closely observing surface alterations of teeth. It's one of the few methods that are suitable for early erosion.

Surface hardness measurements. This is a low cost quantitative measure that uses the diamond tip for calculating the tiny indentations of the tooth surface where enamel or dentin has been eroded. Surface profilometry is a time-consuming quantitative method that uses a laser beam or contact stylus to scan surface roughness. Confocal laser scanning microscopy or CLSM, provides high resolution 3-D images for quantitative assessment and interpretation of hard tissue destruction of, or mineral dissolution. Again, this is suitable for early erosion studies. Atomic force microscopy or AFM, is a quantitative method that provides enhanced visual perspectives of challenge or treated surfaces. AFM can provide surface roughness data related to earlier erosive of attack, as well as provide information related to the thickness of protective layers deposited on treated surfaces.

From a clinical perspective, it's recommended that dentists use simple methods like photography or silicone impressions to assess further progression in a clinical setting. While dental erosion is not entirely preventable, it can be slowed down considerably. To this end, building awareness in the patient and patient indication's key. Consider discussing the following with your patients. Dietary factors, including the benefits of reducing consumption of acidic foods and beverages. Behavioral habits, including not holding acidic liquids in the mouth, avoiding aggressive brushing, switching to softer toothbrush, and avoiding toothbrushing after an erosive challenge to allow the acquired pellicle sufficient time to provide protection. Medications, including those that reduce salivary flow, such as antihistamines and antidepressants and those that can trigger GERD. Causes of intrinsic erosion such as bulimia, advising the patient to seek medical attention if necessary.

Treatments may include the application of fluoride, which has been found to be especially beneficial at early stages of erosion, but not completely restorative. There's a growing body of evidence that suggests toothpaste formulated with stannous fluoride, and in particular stabilized stannous fluoride is a particularly effective agent in the prevention of dental erosion. This is due in part to its ability to deposit a stannous-containing barrier layer onto the tooth surface during brushing. Studies have demonstrated the ability of the stannous fluoride to retain on the treated tooth surface for a significant amount of time after treatment and helps to provide enhanced protection to these surfaces against erosive acid attack. The use of saliva-stimulating lozenges or medications, the application of neutralizing strategies and calcium phosphate or hydroxyapatite containing products, and the use of adhesive restorative materials or minimally-invasive composite fillings to protect the effected regions might also prove to be helpful at reducing the progression of dental erosion.

So in conclusion, dental erosion is becoming increasingly prevalent and its damaging effect is emerging as a serious public health issue. There's no doubt that erosive tooth surface loss can become pathological leaving to complications such as pain, dental hypersensitivity, pulpal inflammation, and increased caries risk, if measures are not taken to prevent the loss of dental tissue. Knowing the factors that promote dental erosion as well as preventive strategies can go a long way in averting erosion or significantly slowing its progression. The use of fluoride toothpaste formulated with stabilized stannous fluoride is particularly useful for its ability to deposit an invisible barrier layer onto exposed tooth surfaces that aids in the prevention of dental erosion. Becoming familiar with how to assess the level of damage and treat it can prevent the onset or related complications.

Let's conclude this section by discussing how this information can help you in your practice. First, fully understanding dental erosion information will help to clearly identify evidence-based and scientifically supported interventions to reduce subsurface mineral loss and making decisions regarding your patients' at-home care and reduction of the risk of both caries and overall tooth surface loss. Second, information about erosion when communicated at the level of the patient can be a powerful tool in driving compliance and overall adherence to your at-home oral care recommendations. Describing how caries and erosion develop and making the connection to your specific recommendation, instills a strong sense of trust and confidence in patients and can be far more powerful than simply instructing patients to brush more often. Thank you very much.