



## Review Article

## Diagnosis and minimally invasive management of erosive tooth wear

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## ABSTRACT

Tooth wear is a very common dental condition. The extent of wear sometimes can be catastrophic with severe tooth tissue loss which may result in poor esthetics. Main three types of wear are attrition, abrasion, erosion. Attrition is wear of teeth by the opposing teeth. Abrasion is wear of teeth by faulty tooth brushing. Erosion is wear of teeth by some acids. The aim of this article is diagnosis and prevention to avoid loss of tooth tissue, structural damage and which may lead to extensive restorative treatment.

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## 1. Introduction

Tooth wear is a very common dental condition. In some cases the extent of wear can be catastrophic with severe loss of tooth tissue, resulting in poor esthetic and functional outcomes. Traditionally, the main three types of wear are described as attrition, abrasion, and erosion. “Attrition” is wear of teeth by opposing teeth; “abrasion” is wear of teeth by an external object, such as a toothbrush, and “erosion” is wear of teeth by acids. Some believe that tooth wear results from contributions from all three processes and others classify smooth surface lesions as erosion and any lesions on the occlusal surfaces as attrition. Acids play a major role in tooth wear. Erosion doesn’t often happen in isolation. There are contributions from attrition and abrasion. This article will discuss “erosive tooth wear,” a terminology that has been accepted by international authorities as a good representation of the above concepts.<sup>1</sup>

## 2. Pathological or Physiological Wear

Physiologically tooth wear happens with time so with age some wear is expected and normal. Dental caries is always pathological and is preventable. In an 75 years old patient, we can expect wear and tear of teeth but the same level of wear in a younger patient in 20 years old young can be pathological. It is very important to consider this when we assess patients and classify wear as pathological or physiological.

## 2.1. Prevalence

Pathological erosive wear is most common which involves 2% and 30% of adults and children.<sup>2–5</sup> A recent multicenter pan-European study assessing erosive wear in 3,187 patients between age group 18 to 35 year olds reported that 30% of adults had visible tooth wear, 3% of which was severe.<sup>6</sup>

## 2.2. Etiology of erosive tooth wear

The processes involved in erosive tooth wear are very different than those involved in dental caries. Acids in

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dental caries are produced as a result of fermentation of sugars by bacteria in dental plaque over time, and surfaces affected by caries are normally covered with dental plaque. Erosive tooth wear results when acids either from foods and drinks or regurgitated/vomited from the stomach contact the teeth directly. In this process no bacteria are involved and the tooth surfaces are usually plaque-free and clean. The processes involved in erosive tooth wear are not simple and there is an interaction of various factors that could result in tissue loss. Acids contact the teeth, resulting in demineralization and softening of the tooth surface. This is referred to as “early erosion,” and at this stage the process is reversible and re-hardening can occur. If the process continues, the softened surface is eventually lost. This process is accelerated by attrition or abrasion which results in more tissue loss.<sup>7-9</sup> Current research and thinking has focused on prevention of demineralization and facilitation of rehardening/remineralization to prevent the process from starting, or reverse it once it has started. The reversal of the process can happen either through natural, inherent biological defense mechanisms or through the application of products. Saliva and pellicle provide natural protection against demineralization and facilitate remineralization.<sup>10-14</sup>

### 3. Sources of Acids

#### 3.1. Dietary acids

Various acidic foods and drinks have been reported to have erosive potential. These can be categorized into carbonated drinks, juices and smoothies, sports drinks, citrus fruits, vinegar and lemon. Categorizing foods and drinks in this simplistic way can be misleading. Some other points to consider are the titratable acidity, buffering capacity, and mineral contents of the foods and drinks, and not simply the pH. Titratable acidity measures the amount of acid in a solution; pH measures the strength of the acid. Other important factors include the method, frequency, and timing of the consumption.<sup>15</sup>

#### 3.2. Regurgitated acids and medical conditions

Acidic contents from the stomach can enter the oral cavity either by voluntary vomiting or involuntary regurgitation. Medical conditions that have been reported to be linked to erosive wear are eating disorders (anorexia and bulimia nervosa), gastro-esophageal reflux disease, laryngopharyngeal reflux, chronic alcoholism, pregnancy, and dietary rumination, a condition in which people repeatedly and unintentionally spit up (regurgitate) undigested or partially digested food from the stomach, re-chew it, and then either reswallow the food or spit it out. One of the conditions most investigated in relation to erosive tooth wear is gastro-esophageal reflux disease. Symptoms of gastro-esophageal reflux disease

are very common and have important adverse effects on patients’ health and quality of life. Up to 10% of the population seeks medical advice for reflux-related problems. There is no doubt that gastro-esophageal reflux disease and erosive tooth wear are related, but exactly why some people with gastro-esophageal reflux disease also suffer from erosive wear and others do not has not been established. Some theories are that the acid travels up into the mouth in some and not in others, the regurgitated juice may be non-acidic in those without erosive wear, and saliva and pellicle may vary between individuals.<sup>16</sup>

Symptoms and signs of gastro-esophageal reflux disease are either esophageal or extra-esophageal. The most common esophageal symptoms are heartburn and regurgitation. It is important to also consider the extra-esophageal symptoms, such as chronic cough and asthma, in relation to erosive wear, as these symptoms are usually indicative of acid traveling farther up the esophagus and therefore more likely to enter the oral cavity. A more recent term used for this group is “laryngo-pharyngeal reflux.” The prevalence of gastro-esophageal reflux disease-related chronic cough ranges from 5% to 41%. The prevalence of dental erosion in gastro-esophageal reflux disease patients ranges from 5% to 47.5%, with a mean of 32.5%. Another important point to remember is that some patients suffering from gastro-esophageal reflux disease have no other symptoms and signs other than erosive wear, a condition often referred to as “silent reflux.”<sup>17-19</sup>

**Table 1:** Titratable acidity of some drinks

Beverage	pH	Titratable acidity	Erosive potential
Carbonated water	5.3	0.1	Low
Cola drinks	2.5	0.7	Medium
Carbonated orange	2.2	2	Medium
White wine	3.7	2.2	Medium
Orange juice	3.9	6.1	High
Apple juice	3.2	7.5	High

**Table 2:** Various symptoms of gastro-esophageal reflux disease

Typical esophageal symptoms	Atypical extra esophageal symptoms
Heartburn	Cardiac: non cardiac chest pain
Regurgitation	Pulmonary: chronic cough, asthma
Bloating	ENT: hoarseness, laryngitis, pharyngitis
Belching	Oral: dental erosion
Dysphagia	
Nausea	
Barrett’s esophagus	
Adenocarcinoma	

**Table 3:** Risk factors associated with dietary and regurgitated acids

Dietary acids	Regurgitated acids
Amount	Timing
nature	Frequency
With meals or between meals	Distance travelled up
Method of consumption	Daytime or nocturnal
Time taken to drink	Association with other symptoms
Habits such as swishing	

### 3.3. Diagnosis of erosive tooth wear

Diagnosis of erosive tooth wear includes not only information about patients' complaints and concerns, but a thorough investigation of their lifestyle. This includes assessment of their diet in a holistic manner, including consumption of foods and drinks that are erosive, as well as those that are refluxogenic. The dietary analysis needs to be comprehensive and include all the risk factors. Some important points are snacking, sipping and swishing of erosive drinks, as well as frequency and amount consumed. In terms of regurgitated acids, questions should be asked regarding when, how often, and how far up the acid travels. Patients' stress levels in relation to possible bruxism, lifestyle in terms of exercise, and other routines and various habits need to be thoroughly analyzed. One area of debate is the importance of delaying tooth brushing after the consumption of an acidic food or drink. Salivary remineralization after exposure to acids has been suggested to offer some protection, hence delaying tooth brushing after consumption of acids has been suggested.<sup>20–25</sup>



**Figure 1:** Erosive wear on a lower molar with dish-shaped/cup-shaped wear facets.



**Figure 2:** Wear as a result of attrition with flat corresponding wear facets.



**Figure 3:** Wedge-shaped wear facet on an upper canine primarily due to abrasion.



**Figure 4:** Wear facets due to a combination of attrition and erosion. There are corresponding wear facets due mainly to attrition and those that do not correspond due to erosive wear.

### 3.4. Clinical indices

There are a number of indices to help assess the severity of erosive tooth wear. Some indices score erosion in isolation while others assess tooth wear regardless of the etiology.<sup>26,27</sup> Within the last 10 years a new scoring system, the BEWE (Basic Erosive Wear Examination), was developed that uses a similar concept to the BPE (Basic Periodontal Examination) used in periodontal disease assessment. The index is designed for use in general



**Figure 5:** Erosive wear caused by gastro-esophageal reflux disease and restored using composite restorations and the Dahl principle. The palatal composite restorations have been carried out directly and the labial composite restorations are indirect veneers. The wear facets have been stained which suggests discontinuing wear.

practice to assess and record the presence and severity of erosive tooth wear, and not meant to be an accurate and reproducible assessment of all the facets, much in the same way as BPE is used. This is then followed by the necessary preventive measures being put into place. The index uses a 4-point scale, 0–3, where 0 is no erosive wear and 3 is hard tissue loss involving greater than 50% of the surface being scored.<sup>28</sup>

**Table 4:** BEWE score

0	No erosive wear
1	Initial loss of surface texture
2	Distinct defect, hard tissue loss <50%
3	Hard tissue loss >50%

### 3.5. Other investigations

Other investigations may be necessary to reach a diagnosis. One example is a diet history sheet preferably over seven days, but at the very least capturing dietary intake during the week and also the weekend. Another example includes a reflux symptoms questionnaire. A validated and simple example is the RDQ (Reflux Disease Questionnaire).<sup>29</sup> A referral to the medical practitioner for the assessment of reflux may be indicated. Additionally, the use of a mouth guard/splint may be indicated to diagnose possible bruxism.

## 4. Management of Erosive Tooth Wear

### 4.1. Management goals

Management of most dental conditions is changing, with research concentrating on prevention and minimally invasive approaches to treatment. Erosive

tooth wear is no exception, and, in fact, recent research and our further understanding of the processes emphasize the importance of this approach. This, together with the complicated nature of any restorative treatment of teeth affected by erosive tooth wear, means that the word management is a more suitable term than treatment for most cases. The aims of minimally invasive management of erosive tooth wear.

### 4.2. Steps in the management of erosive wear

1. Reduce acids
2. Neutralize acids
3. Strengthen defense mechanisms
4. Strengthen dental tissues
5. Protect dental tissues
6. Monitor

### 4.3. Reduction and neutralization of acids

Reduction and neutralization of acids can be achieved first by means of diagnosis and identification of the source of acid to reduce the contact time between the acids and enamel/dentin. Some of these have been mentioned previously, e.g., reduction of frequency of intake, avoiding snacking outside meal times, and swallowing the drink without swishing in the mouth. Regurgitated acids can also be reduced by simple lifestyle adjustments. Consumption of refluxogenic foods, such as fatty foods, spicy foods, onions, and pickles, should be reduced. Advice can also be given regarding reducing the consumption of alcohol and avoiding intake of large meals, in particular shortly before going to bed. Treatment of gastro-esophageal reflux disease is mainly by the use of medications including over-the-counter antacids or more effectively by the use of proton pump inhibitors (PPIs). These medications are highly effective in the control of reflux and regurgitated acids but like most medications have side effects. Concerns have been raised regarding long-term proton pump inhibitors therapy, including increased susceptibility to gastrointestinal and respiratory infections and risk of hip fracture. It is therefore highly desirable to consider non-medical methods to control acid reflux.<sup>30–32</sup>

### 4.4. The role of saliva and pellicle

The role of saliva and pellicle has been highlighted in recent research. Natural saliva is the most important inherent factor in the prevention of demineralization and facilitating remineralization in the processes involved in erosive wear. Saliva dilutes, neutralizes, and buffers acids. This results in the removal and reduction of acids in the oral cavity, but also the neutralization of any remaining acids.<sup>33–37</sup> Because of its inorganic components, another important role for saliva is to help remineralize enamel, although a complete remineralization is unlikely.<sup>38</sup>

Saliva also has a key role in the formation of acquired pellicle on the tooth surface, which starts immediately after tooth brushing. The important role of pellicle against erosive tooth wear has been shown in the literature. However, the preventive potential of pellicle varies between individuals and various formed pellicles. Studies have shown the differences in composition of pellicle proteins between individuals with and without erosion.<sup>33,39</sup> Stimulation of saliva to increase the flow rate and improve its buffering capacity can, therefore, be a preventive approach in the management of erosive wear, both in cases of dietary erosion and gastro-esophageal reflux disease. Previous work has shown the possible use of chewing gum as a simple method of reducing and neutralizing acids with some promising results. Future work and product development can also be aimed at modifying pellicle to enhance its protective potential.<sup>40</sup>

#### 4.5. Strengthening dental tissues

Strengthening the dental tissues can be achieved by various available products. The role of fluoride-containing products has been investigated in enamel, with promising results. This is important in the reversal and remineralization of early erosion. The role of fluoride-containing products in cases of dentin exposure has not been shown as effectively as enamel, although this area needs further research. There has been an increased focus by various oral health companies on the development of products to target erosive wear. The mode of action of fluorides is very similar to caries in terms of reversal of demineralization and influencing remineralization, hence resulting in hardening of the surface. Recent work has further suggested that various formulations of fluoride-containing products could have differing outcomes. Sodium and stannous-containing fluorides have been cited as being effective. The use of products containing high levels of fluoride has also been advocated. Various other products, such as tooth mousse, have also been specially formulated for this effect.<sup>41,42</sup>

#### 4.6. Protection of the tooth surface

Protection of the tooth surface can be carried out by the application of a dentin bonding agent. This may have a beneficial effect against sensitivity, but has also been shown to reduce the progression of wear. The problem with this approach is the average time the bonding agent tends to remain on the tooth is three months, and therefore will need to be replaced regularly. Fissure sealants have shown slightly more durability in these situations.<sup>43,44</sup>

#### 4.7. Monitoring

Monitoring is an important aspect in the management of tooth wear. One needs to ascertain whether the wear

is progressing or is historical. If it is progressing, monitoring will provide information about the rate of progress. Restoration of teeth while the wear is progressing, and without correct diagnosis and preventive measures to reduce the wear and eventually halt the process, is likely to result in failure of the restorative work. In fact, existing restorations can sometimes be utilized as reference points to monitor the progression of wear. The main method of monitoring at present is by the use of dated study models. Clinical features such as staining of the wear facets could also indicate slow progress.

#### 4.8. Treatment

The most common reason for treatment is patient-driven due to the appearance. Once the wear becomes severe there are other indications, such as the preservation of the structural integrity of the tooth and problems associated with restoration of a short clinical crown. Restorative treatment of teeth affected by erosive wear is complicated and time consuming. The main issues are the large number of teeth involved, as well as dento-alveolar compensation. This results in the loss of space for restorations. Generally speaking, erosive wear can be categorized into local or general wear. Localized wear most commonly tends to affect the upper anterior teeth, although in some cases, due to particular habits or the direction of travel of the refluxate, acids can only affect a couple of posterior teeth. Generalized wear tends to affect many anterior and posterior teeth. In terms of restorative treatment, the treatment concepts are discussed separately.

#### 4.9. Localized wear

Wear facets affecting areas such as the labial or buccal surfaces that are not in occlusion can simply be restored using composite restorations or veneers (direct or indirect). The problem arises when the wear is on the palatal surfaces of upper anterior teeth or occlusal surfaces of posterior teeth. In these cases, as most often no space is present for any restorations, the most common approach is to use the Dahl principle. As teeth wear down they become shorter, but contact is maintained through dento-alveolar compensation. In the 1980s, the concept of a Dahl appliance was introduced with the aim of reversing this compensation and, hence, recreating the space needed for restoration. This principle is often used when the palatal surfaces of upper anterior teeth have been affected. These surfaces are built up using composite resin to gain the necessary space. Initially the only teeth in contact are the anterior teeth, but the anterior teeth intrude and the posterior teeth extrude and allow posterior tooth contacts to be regained, leaving a space for restoration of the affected surfaces. In some instances the restorations can remain and no further treatment is necessary. In other cases the teeth

may need to be crowned. The Dahl principle is effective in most cases, but on the rare occasions that it is not, other restorative options need to be pursued.<sup>45</sup>

#### 4.10. Generalized wear

In cases where the wear affects several anterior and posterior teeth, the restorative procedures are more complicated, often requiring reorganization of the occlusion, change in the occlusal plane, occlusal plane, occlusal vertical dimension, and full mouth rehabilitation. This usually results in restoration of most, if not all the teeth. In some cases, due to the resulting short clinical crowns, crown lengthening surgery is also indicated. Further expansion on these procedures is beyond the scope of this article; needless to say, this option should be attempted as a last resort. This is due to problems with longevity of restorations and need for replacement, and the destructive nature of the treatment. In terms of materials, the two concepts are adhesive materials without need for much preparation, or crowns. The advantages of composite restorations are their conservative nature and effects of bonding and, hence, strengthening the remaining tooth tissues. However, composite restorations can stain and the longevity of the restorations has been shown to be less than crowns.

#### 5. Conclusion

Future developments through further research are promising as we gain a better understanding of the processes involved in erosive wear and the role of saliva and pellicle, better diagnostic methods, better methods of in vivo monitoring including intraoral scanners and newly developed and targeted products for prevention and re-hardening/remineralization.

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None.

#### 7. Conflict of Interest

None.

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