EROSIVE TOOTH WEAR – WHY CLINICIANS SHOULD BE AWARE OF THIS CONDITION

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Palavras-chave: Erosão Dentária. Diagnóstico. Prevenção.

RESUMO

Introdução: O Desgaste Dentário Erosivo é definido como um processo químico-mecânico que leva a uma perda cumulativa de tecido dentário duro, sem que ocorra o envolvimento de bactérias. **Objetivo**: atualizar os cirurgiões-dentistas sobre os principais tópicos a respeito do Desgaste Dentário Erosivo. **Fonte de dados:** principais bases científicas (PubMed, Lilacs) nos últimos 10 anos, com as palavras-chave: erosão dentária, diagnóstico e prevenção. Foram selecionados os artigos clássicos sobre o tema para a realização da revisão integrativa de literatura. **Síntese de dados**: A prevalência de Desgaste Dentário Erosivo tem sido reportada na literatura em porcentagens que variam de 10% a 80% em crianças e de 4% a 82% em adultos. A abordagem clínica do Desgaste Dentário Erosivo deve incluir um diagnóstico precoce, a avaliação dos diferentes fatores etiológicos, a identificação do risco e a proposta de medidas preventivas para retardar a progressão dessa condição. Essas medidas incluem a aplicação de fluoretos, o uso de dentifrícios com baixa abrasividade, monitoramento clínico e, em casos mais graves, a aplicação de selantes e procedimentos restauradores. Pacientes diagnosticados com transtornos alimentares ou com refluxo gastroesofágico são considerados um dos grupos de risco mais importantes para o desenvolvimento dessa condição. **Conclusão:** Os clínicos devem estar atentos a essa condição de prevalência crescente, uma vez que a perda de estrutura dentária é irreversível, promovendo medidas preventivas eficazes, desde os estágios iniciais, contribuindo assim para o controle e redução do Desgaste Dentário Erosivo entre seus pacientes.

Keywords: Tooth Erosion. Diagnosis. Prevention.

ABSTRACT

Introduction: Erosive tooth wear (ETW) is defined as a chemical-mechanical process leading to the cumulative loss of hard dental tissue without the involvement of bacteria. **Objective:** to give to clinicians an overview about most important ETW topics. **Data source:** main scientific data base (PubMed, Lilacs) in the last 10 years, with the keywords: dental erosion, diagnosis and prevention. Classical articles were selected for the realization of an integrative literature review. **Data synthesis**: the prevalence of ETW has been reported to range from 10% to 80% in children and 4% to 82% in adults. The management of ETW should include early diagnosis, the evaluation of different etiological factors, risk identification and the proposal of preventive measures to avoid the progression of the condition. These measures include fluoride exposure, use of low abrasive toothpastes, clinical monitoring, and in more severe cases sealant application and restorations. Patients suffering from eating disorders with purging behaviour and gastroesophageal reflux disease are considered the most important risk groups. **Conclusion**: Clinicians should be aware of this condition with growing prevalence, once substance loss is an irreversible condition, providing prompt preventive measures during the early stages that are essential to reduce ETW.

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INTRODUCTION

Erosive tooth wear (ETW) is defined as a chemical-mechanical process leading to the cumulative loss of hard dental tissue without the involvement of bacteria.[1,2] Recently, some authors claimed to modify the denomination into 'biocorrosion', which embraces the chemical, biochemical, and electrochemical degradation of tooth substance caused by endogenous and exogenous acids, proteolytic agents, as well as the piezoelectric effects only on dentin. Beside this effort, ETW is the most known term, used on the recent European Consensus.[1]

Enamel dissolution occurs both at the enamel/acid interface, as well as within a partly demineralized thin softened layer of enamel, in a process called near-surface demineralization,[3] leading to loss of minerals, and consequently, loss of tooth substance. Therefore, ETW is clinically characterized as shiny, silky- glazed, but sometimes dull, excessively smooth tooth surfaces, with the absence of perikymata.[4,5]

The prevalence of ETW has been reported to range from 10% to 80% in children and 4% to 82% in adults.[6] Regarding deciduous teeth in children up to 7 years old, some results from a systematic review indicate that the prevalence of ETW into the dentin increases significantly with age.[7] In Brazilian teenagers ETW prevalence ranged from 7.2% to 38.2%.[8,9] The large variation in the results of the studies seems to be mainly due to the studied differences, different indexes used to ETW detection, as well as to the adjustments of acidic beverage consumption.[6]

The most important sources are dietary acids (acidic foods and drinks) and gastric acids (regurgitation and reflux disorders).[10,11] It is increasingly recognized as a common condition with complications such as tooth sensitivity, altered aesthetics and loss of occlusal vertical dimension.[6]

The management of ETW should include an early diagnosis, the evaluation of different etiological factors, risk identification and the proposal of preventive measures to delay the progression of the condition.[12] Considering that the substance loss is an irreversible condition, prompt preventive measures, during the early stages, are essential to reduce ETW.[13] On this paper, we aimed to resume the main aspects about Erosive Tooth Wear, through a integrative review of the literature based on most recent papers, classic researchers about ETW, to help clinicians to deal with this condition, with growing prevalence.

DATA SOURCE

Main scientific data base (PubMed, Lilacs) published in the last 10 years, with the keywords: dental erosion, diagnosis and prevention. Classical articles were selected for the realization of an integrative literature review.

DATA SYNTHESIS

DIAGNOSIS

The first step to deal with this condition is an accurate diagnosis. During an initial phase, teeth could look as shinier as sound ones, thus the condition may not be detected by most of clinicians. Diagnosis requires a thorough knowledge of both morphological patterns typical of this type of wear and the factors that are likely to contribute to the development of ETW. An accurate anamneses, including findings related to dietary habits (including beverages) and medical background are essential to target risk groups.

On past several indexes were used to measure and follow up the teeth surfaces. In 2008, a new scoring system, the Basic Erosive Wear Examination (BEWE), has been designed to provide a simple tool for use in general practice, teaching and researches and to allow comparison to other more discriminative indices.[14] The grading includes four levels which is neither too precise nor too crude, and the threshold values should be easy to learn and to calibrate. This index has less scores, which improves the use on epidemiological researches, but still can discriminate small changes on toot surface, being also helpful to use at clinical practice, providing accurate information about patient condition during time.[14] The most severely affected surface in each sextant is recorded with a four-level score and the cumulative score classified and matched to risk levels which guide the management of the condition (Tables 1 and 2, Figure 1).

When ETW reaches dentin, the lesions progression increase, once dentin is less mineralized than enamel. The dentine is exposed to the oral environment, which may explain the cases of hypersensitivity. The appearance of lesion, as well as cupping and grooving on occlusal surfaces, are considered typical signs of 'early' erosive tooth wear.

Erosive tooth wear lesions in restored teeth are known by margin degradation and restorations rising above the level of the adjacent tooth surface. This process starts at enamel and could develop until dentin is exposed (rounding of cusps and grooves).[1] Differential diagnosis should include ETW lesions and Non-Carious Cervical Lesions (NCCLs). With respect to ETW lesions, the cervical margin of enamel is preserved, once the crevicular fluid protects this area against acid attack, while most of triangular shape lesions of NCCLs are located on enamel-dentin junction.[2,5]

The outermost layer of aprismatic enamel and the absence of perikymata in deciduous teeth make the diagnosis of tooth wear in its early stages difficult in daily practice. Optical assessment of ETW has been tested to improve diagnosis. The mode of action of these devices is based on the fact that abrasion of eroded teeth results in the partial removal of the softened enamel tissue and an increase in the specular reflection intensity due to smoothing of the etched enamel surfaces.[15] This tool had been tested in extracted permanent and deciduous teeth, with good results in intra and inter examiners values, especially in permanent teeth.[16] More studies should be developed to improve the performance in deciduous teeth and to test at clinical conditions. Besides the accurate clinical examination, important information about patient should be investigated.

Table 1: *Criteria for grading erosive wear (Barlett, Ganss, Lussi, 2008):*

Score	Description
0	No erosive tooth wear
1	Initial loss of surface texture
2*	Distinct defect, hard tissue loss < 50% of the surface area
3*	Hard tissue loss ≥ 50% of the surface area

*Note:*in scores 2 and 3 dentine often is involved*

Table 2: *Risk levels as a guide to clinical management (Barlett, Ganss, Lussi, 2008):*

Risk level	Cumulative BEWE score of all sextants	Clinical Management
None	Less than or equal to 2	Routine maintenance and observation. Repeat at 3-year intervals
Low	Between 3 and 8	Oral hygiene and dietary assessment, and advice, routine maintenance and observation. Repeat at 2-year intervals.
Medium	Between 9 and 13	Oral hygiene and dietary assessment, and advice, identify the main aetiological factor(s) for tissue loss and develop strategies to eliminate respective impacts. Consider fluoridation measures or other strategies to increase the resistance of tooth surfaces Ideally, avoid the placement of restorations and monitor erosive wear with study casts, photographs, or silicone impressions. Repeat at 6–12-month intervals.
High	14 and over	Oral hygiene and dietary assessment, and advice, identify the main aetiological factor(s) for tissue loss and develop strategies to eliminate respective impacts. Consider fluoridation measures or other strategies to increase the resistance of tooth surfaces. Ideally, avoid restorations and monitor tooth wear with study casts, photographs, or silicone impressions. Especially in cases of severe progression consider special care that may involve restorations. Repeat at 6–12- month intervals.

Note: The cut-off values are based on experience and studies of one of the authors (A. L.) and could to be reconsidered.

Erosive tooth wear: targeting risk groups and patient-related risk factors

The risk for developing erosive lesions varies depending on a person's background, behaviour, medical variables and dietary practices. Among patients suffering from eating disorders with purging behaviour and gastroesophageal reflux disease (GERD) a clear impact on ETW prevalence and severity can be detected.[17]

Regarding exogenous causes, it has been stated a possible dose- response relationship between ETW and the consumption of acidic diets.[18,19] However, some people who consume dietary acids develop erosive lesions and some do not.[20] These individual variations could be addressed to saliva protecting effect and oral hygiene habits. The same controversial results apply for the association between drugs and medication intake or occupational acid exposure and ETW prevalence.[18]

The lack of well-designed controlled epidemiological studies makes it difficult to find strong evidences related to the likelihood of developing ETW for all risk groups.[17,18,21] Dental professional must pay special attention in such groups and carry out a diagnostic protocol, in order to prevent further health implications.

Intrinsic source of acid

Gastroesophageal reflux disease

According to a recent longitudinal study, nearly 60% of patients diagnosed with ETW present significant gastroesophageal reflux disease (GERD), despite other minor reflux symptoms.[22] A current study conducted in India, among pediatric patients suffering from GERD, detected that the occlusal

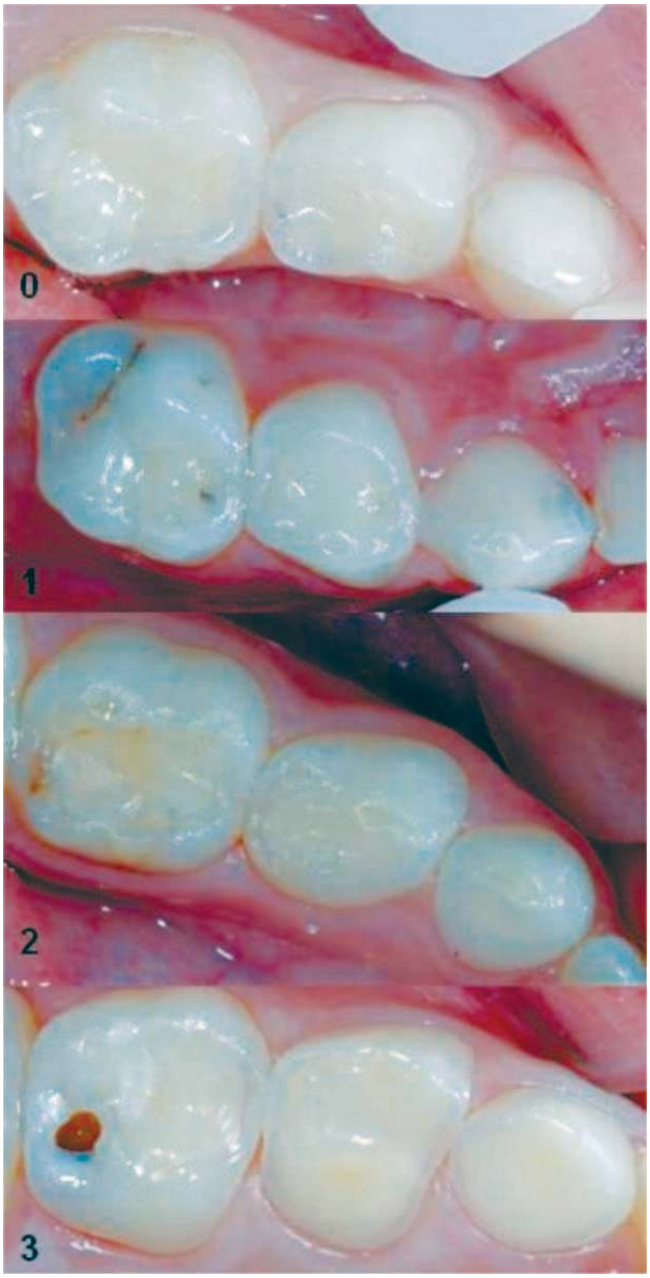

Figure 1: *Deciduous teeth classified as BEWE Scores.*

surfaces of maxillary primary molars and mandibular permanent molars were mostly affected by ETW.[23] The presence of ETW, especially in posterior teeth, can be a vital sign to suspect of GERD and refer the patient to proper diagnosis.

Regarding the dental implications caused by GERD, Figure 2 shows the upper and lower arches of a ten-year-old Caucasian boy, patient at the Pediatric Clinic at the Faculty of Dentistry of Federal University of Minas Gerais, Brazil. The child was complaining of recurrent pain, particularly in posterior teeth, while eating hot and cold foods and when brushing his teeth.

According to his parents, the child had been under medical supervision by a gastroenterologist since the age of 6, when he was diagnosed with GERD. His medical treatment consisted in lifestyle changes, such as in sleeping position and the use of antacids. Besides the presence of reflux, an important finding regarding the patient's oral hygiene is worth mentioning: his mother reported that since she noticed his molars were no longer with a white color, she started brushing them harder to "get them rid of that yellowish dirt". The erosive lesions were being erroneously confused with dental plaque. Figure 3 shows the patient's toothbrushes, indicating that an excessive force was used to brush the teeth, leading to more surface loss.



Figure 2: *Upper and lower dental arches of a 10-year-old patient showing typical images of erosive tooth wear lesions on deciduous teeth secondary to gastroesophageal reflux.*



Figure 3: *The toothbrushes used by the patient with erosive tooth wear*

Eating disorders

Nowadays, beauty standards spread in the media are reinforcing self- insecurity, especially among young people. Body dissatisfaction and the obsession with physical attractiveness are contributing to harmful behaviours, developed as attempts to lose or control body weight.[24] In this scenario emerge eating disorders with the highest rates of morbidity and mortality of any mental disorder among adolescents [25], who go untreated, reach only partial recovery or do not recover. [26]

Dental implications such as ETW have been reported as oral manifestations associated with eating disorders, its risk behaviour and purging practices.[27-29] Bulimic behaviour directly causes ETW due to compensatory methods, such as self-induced vomiting (SIV) practices[30] and acidic food choices.[19] According to a systematic review, several studies have identified significantly higher values of ETW among diagnosed patients suffering from eating disorders compared to control groups.[30] Due to dental implications, dentists may be capable of suspecting eating disorders and contributing to early referral for specific treatment.[30,31] However, it has been detected a need for dentists with communication skills to provide an open and empathic recognition approach toward patients with eating disorders.[31]

Celiac disease

Celiac disease (CD) is the world's most common food intolerance genetic disorder, affecting nearly 1% of people worldwide.[32] Patients suffering from CD develop an immune response that is subsequently triggered by the ingestion of gluten. The disease presents many clinical manifestations, ranging from severe malabsorption to minimally symptomatic or non-symptomatic features. The first recognizable symptom is often an oral manifestation, instead of the typical gastrointestinal symptoms.[33]

Oral manifestations, such as a delay in dental eruption, a reduction of salivary flow, and an increased likelihood of dental enamel defects in both deciduous and permanent teeth may be observed in cases of CD.[34,35] Those patients may also present reflux and vomiting symptoms,[36] which represent concurrent factors for the development of ETW. Therefore, oral examination can be an important auxiliary tool for the identification of cases of the disease.

Figure 4 shows a 23-year-old Caucasian male, who was referred to a private dental service by a physician, due to his dental implications. The patient had been diagnosed with CD and silent gastroesophageal reflux three years before the dental consultation. He had adhered to a strict gluten-free diet, was not under medication, but consumed approximately one liter of soda daily. Thus, the association of intrinsic and extrinsic sources of acids may explain the large tooth surface loss affecting his upper and lower dental arches.

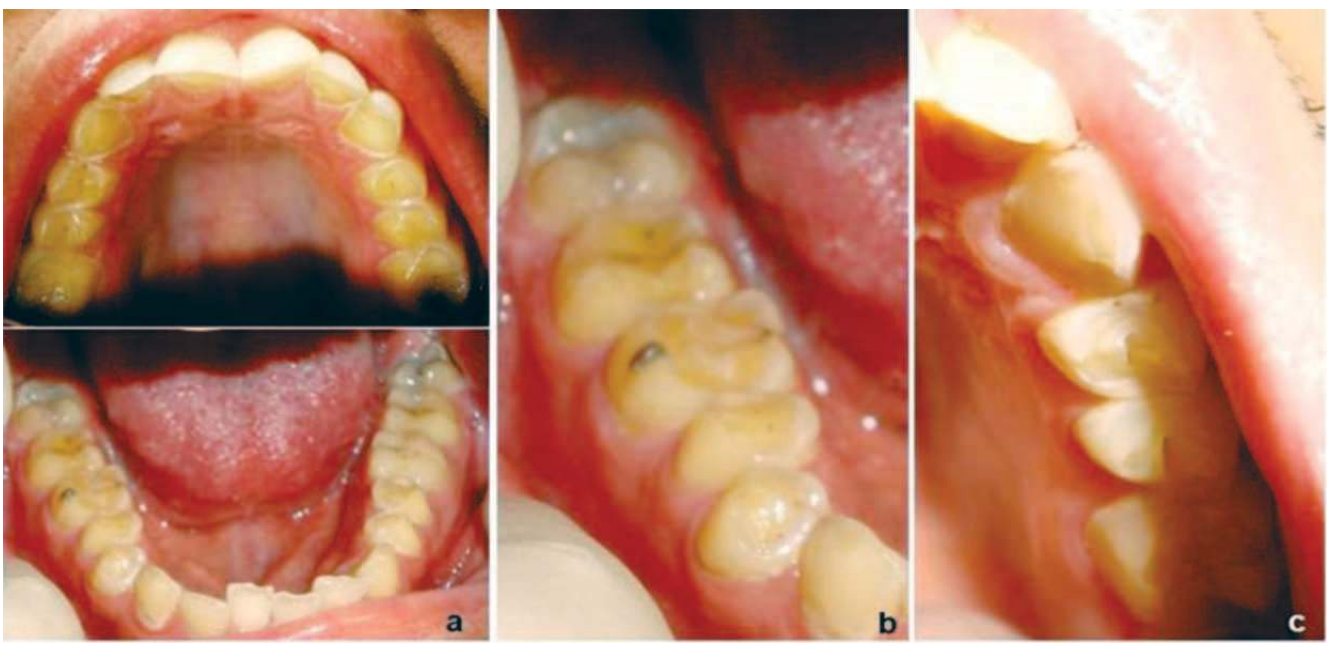

Figure 4: *(a) Upper and lower dental arches of a 23-year-old patient showing erosive tooth wear lesions in permanent teeth secondary to celiac disease, silent gastroesophageal reflux and daily consumption of carbonated beverages; (b) Typical high-resolution image of erosive lesions on posterior mandibular teeth (c) palatal and occlusal surfaces of maxillary premolar teeth are mainly affected.*

Extrinsic sources of acid

Diet

The frequency and pattern of consumption of acidic diets have been pointed out as the major etiological factors in the prevalence and incidence of ETW.[20,37,38] Even though, there is scientific evidence supporting that some dietary components such as acid snacks/sweets, carbonated beverages and natural fruit juices increase the prevalence of ETW, whereas milk presents a protective effect.[39] The erosive potential of foods may be modulated by:

• its frequency of consumption[21] (e.g. greater frequency of carbonated and sports drink consumption has been associated with higher incidence of ETW,[40] and the frequency of drinking natural fruit juices was associated with higher prevalence of this condition);[41]

• Contact time of erosive foods/drinks with the teeth;[21]

• When/ how the food is eaten (e.g. swishing of soft drinks before swallowing, acidic food intake between meals).[42,43]

Despite knowing that acidic foods, such as citric fruits seem to have an association with ETW, it must be clear that the consumption of fruits should not be discouraged, when it is part of a balanced diet. The World Health Organization recommends a consumption of at least 400 grams of fruits and vegetables per day, in order to avoid the onset of chronic conditions.[44]

Therefore, monitoring dietary habits is clinically valuable and should be focused on reducing daily intake of acidic drinks,[43] discouraging dietary acids between meals/ bedtime and abolishing habits that increase the contact time of the acid with oral cavity.[21,43] The consumption of dairy products particularly after an acidic intake and use of straws correctly positioned (posteriorly positioned toward the back of the mouth) are also advisable.[21] Those advices are even more important considering the risk groups mentioned in the section of 'intrinsic sources of acid', once the diet can exacerbate the tooth surface loss caused by the medical condition.

It is important to know when, how, how often and how much a particular drink or foodstuff is ingested. Therefore, an accurate clinical examination and anamnesis must be conducted by the clinician, to identify possible erosion- related risk factors and plan strategies to control them.[45] It is known that behaviour changes are not easily achieved but offering alternatives and targeted behavioural interventions may increase treatment success.[20]

Legal drugs and medications - the hidden etiological factors

Among the numerous causative factors for ETW, it is fundamental to take into consideration different drugs prescribed for patients that might have been overlooked or underestimated and are 'hidden' aetiological factors.[46,47] Several therapeutic medications have the potential to indirectly or directly cause ETW.[46]

Some medicines reported to have a causative role in ETW due to their inherent acidity secondary to prolonged use are listed below:

• Medications available in effervescent and dispersible form; [48]

• Oral supplements dispensed as chewable and effervescent tablets (e.g. Vitamin C and minerals); [49,50]

• Acetylsalicylic acid (Aspirin); [51]

• Asthma medications.[17,52]

In addition, there are some medications that differently from the drugs previously mentioned have an indirect association with ETW secondary to their side effects, such as medications that cause reduced salivary flow, or drugs likely to cause gastroesophageal reflux or induce vomiting.[46]

Scientific evidence associating ETW with the use of these medicaments is still lacking. However, regular and prolonged use of some medications might bear the risk of causing this condition.[47] It is the responsibility of clinicians to clarify this issue among patients and colleagues making them aware of drugs that may contribute to negative potential effects towards oral health.[46]

Occupational exposure

Acid exposure might also be identified in occupational environment due to acidic vapours and chemicals (e.g. battery, ammunition and galvanizing factories) and acidic liquids (e.g. wine tasters, professional swimmers).[45] Consequently, more attention should be given to workers submitted to such conditions to maintain the overall health of those risk groups.[53]

Many points were raised in this review with respect to extrinsic and intrinsic potential risk factors for ETW. However, researchers have suggested that susceptibility to erosive wear differs among individuals due to factors in the

oral environment and sustainability of the enamel.[54] Therefore, the clinicians should keep in mind that for certain patients, only minimal acidic challenges may be sufficient to cause dental implications, while other people might never develop erosive lesions, even with prolonged exposure to acids.[54]

With respect to patient-related risk factors it is also worth mentioning the importance of buffer capacity and salivary flow. It has been stated that erosive potential related to tooth enamel is positively correlated with buffering properties in two aspects: the strength of buffering influences the rate of neutralization by saliva and the duration of an erosive challenge.[3] Buffering also has a role in the intrinsic capacity of the product to erode dental tissues. Moreover,

the rate of dissolution of enamel seems to be related to titratable acidity and buffer capacity, but the relationship between these variables dependent on acid type and pH. [3]

It is also important to stress that patients who suffers from xerostomia and oral dryness as a consequence of medicines should be aware of the potential negative effects such as reduced salivary flow rate/ or buffer capacity of the saliva that increases the risk for erosive tooth wear.[3,15]

PREVENTION AND TREATMENT

With respect to ETW prevention, the benefits of toothpaste compounds containing fluoride are greater than the adverse effects, such as abrasivity. Various active ingredients have been tested with respect to their ability to form acid-resistant precipitates on dental surfaces.[5] When compared to non-fluoride toothpastes, fluoride-containing toothpastes have better preventive effects against ETW. However, in order to develop toothpastes that promote the formation of more acid-resistant precipitates, other formulations have been tested using amine or stannous fluoride compounds, as well as phosphates or biopolymer additives.[55]

Some *in vitro* studies evaluated the effect of commercial toothpastes that claim to provide anti-erosive effects compared to conventional fluoride toothpastes.[56,57] Conventional NaF toothpastes were able to reduce erosive tissue loss even in severe erosive conditions but had limited efficacy with respect to brushing abrasion. The formulations that claimed anti-erosive effects were not superior; however, tin-containing toothpaste had promising anti- erosion potential, which was counteracted by abrasion effects.[57] The abrasiveness of toothpastes play an important role, especially at early stages of ETW, by presenting lower relative dentin abrasivity (RDA) values could be more important than which kind of fluoride the toothpaste contain.[56]

Even though toothbrushing is fundamental for maintaining good oral health, it also may have a negative impact on tooth wear, particularly with respect to ETW.[58] To evaluate how patients brush their teeth, if they use too much strength and even the type of toothbrushes (with soft or hard bristle) are important steps to prevent abrasion. Enamel seems to be prone to suffering from the type of toothbrush bristle, duration and method of brushing.[2,42] Therefore, it is important to advise a change in detrimental brushing habits to prevent ETW, instead of asking patients to wait before brushing their teeth.[2] In fact, recent findings have shown that after erosive challenges, no specific waiting period prior to tooth brushing can avoid ETW, in other words postponing toothbrushing is not clinically advisable.[21]

Although toothpastes and mouthrinses are the most common products of daily use to prevent ETW, the application depends on patient compliance. In some severe cases, this could not be enough to stop ETW progression. In this situation, another treatment measures can be implemented, applying some acid-protective layers on affected surfaces. Depending on the filler content and the abrasion stability of the resin coatings, adhesives and fissure sealants have proved to prevent enamel and dentine wear for limited periods of time.[59] As the resin coating of fissure sealants is significantly thicker than the coating of a bonding agent, surface sealants provided a longer duration of protection against erosive wear. Clinically, the coating of exposed dentine on palatal surfaces of anterior teeth with a bonding agent lasted for 3 months,[60] while a fissure sealant remained on teeth for approximately 6–9 months.[61]

The loss of tooth structure could cause tooth sensitivity, aesthetics impairment and loss of occlusal vertical dimension, leading to restorative treatment indication. On the other hand, teeth with previous restorations can be exposed to erosive and abrasive challenges, which could interfere with its durability.[6] Despite ETW being an emerging theme in recent studies, there are aspects that have yet to be better explored, especially regarding the properties of adhesive systems, restorative materials and their application in deciduous teeth. In a recent *in vitro* study, different adhesive protocols were tested, with no significant difference among conventional adhesive systems or self-etching adhesives, with or without fluoride, regarding microleakage evaluation.[62]

More studies should be done to evaluate the stability of restorations in eroded substrate, to guide treatment decisions. By now, we should advice clinicians to postpone as much as possible restorative procedures, especially in young patients, until the main etiological factor of ETW were not controlled. Furthermore, whenever restorative procedures are required, adhesive materials with minimal sound substrate removal should be indicated.

CONCLUSIONS

In order to provide the best preventive and therapeutic measures for patients, dentists must primarily investigate all risk factors related to the patient, bearing in mind concealed factors (like silent gastroesophageal reflux) as well as other important aspects associated with the erosive potential of drinks and foodstuff such as the concentration of relevant mineral constituents (calcium and phosphates) that leads to the lack of a unique 'critical pH' value concerning dental erosion. These risk factors should then be coupled with the evident signs of erosive tooth wear observed during the clinical examination. Preventive measures should be initiated as early as possible to reduce the erosive challenge and to increase protective and defensive factors, thus

bringing the equilibrium back to the oral environment.

It is important to recognize that mineral and surface loss in ETW is an irreversible process, and due to the large longevity of sound teeth with dental caries decreasing prevalence, these teeth could be exposed for a long period to acid and abrasive challenges. In this scenario, recognize the initial signs of ETW and control this condition as soon as possible will improve oral health in long term to our patients.

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