CURRENT CHALLENGES ON DIAGNOSIS AND MANAGEMENT OF DENTAL EROSION - LITERATURE UPDATE AND CASE REPORT

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ABSTRACT

Aim of the study. The aim of the current study was to identify, analyze and systematize current information on the characteristics of dental erosion and to present a case report describing the clinical steps of a minimally invasive restorative technique in a patient with dental erosion. **Methods.** A systematic electronic search was carried out in four electronic databases (Pubmed, Embase, Web of Science, and Scopus), selecting articles published form 2018 to present date. After evaluation 55 studies were finally analysed. **Results.** The most common causes of dental erosion are gastroesophageal reflux disease (GERD), the consumption of acidic foods and drinks, bulimia, and certain medications. Environmental factors, such as exposure to sports drinks and acidic environmental vapors or industrial chemicals, can also contribute to dental erosion. Preventive measures include reducing risk factors, increasing protective factors and desensitization treatments. Restorative treatment involves minimally invasive additive strategies or more radical options, depending on case severity. Additionally, a case report is presented which describes the clinical steps of the Injection Moulding Technique, used for the management of dental erosion in a GERD patient. **Conclusion:** Recent years significant advances in understanding dental erosion have important implications for clinical practice and public health and highlight the need for continued targeted research in this area. Injection Moulding Technique is a novel, minimally invasive restorative option in clinical situations dealing with dental erosion, more consistent and predictable than freehand techniques.

Keywords: *dental erosion, erosive dental lesions, etiology, prevalence, diagnosis, prevention, treatment, case presentation.*

INTRODUCTION

Dental erosion represents the mechanism of tooth wear, in which non-bacterial acids of intrinsic or extrinsic origin, or a combination of both induce the loss of minerals from dental hard tissues (Schlueter *et al*., 2020). Erosion appears frequently together with mechanical wear of the tooth structure, such as abrasion and attrition and is known as erosive tooth wear.

The early diagnosis of erosive lesions is still challenging for most professionals and is usually identified as the rapid progress of tooth wear where there is already dentin hypersensitivity and the absence of lesion staining (Warreth *et al.,* 2020). Also, other cases of erosive wear occur in the process of slow progression, which does not generate symptoms due to the response mechanism of the dentin-pulp complex that promotes the obliteration of dentinal tubules (Schlueter *et al.,* 2020). In this context, direct exposure to acids in the oral cavity promotes the demineralization of hydroxyapatite due to the undersaturation of minerals concerning the surrounding microenvironment.

Erosive tooth wear damages the function and aspect of the natural dentition, leading to

dentine hypersensitivity, which can result in high discomfort and pain (Schlueter *et al.*, 2020, Warreth *et al.*, 2020).

The aim of the current study was to identify, analyze and systematize current information on the characteristics of dental erosion and to present a case report describing the clinical steps of a minimally invasive restorative technique in a patient with dental erosion.

MATERIAL AND METHODS

To obtain significant data on the characteristics of dental erosion, a systematic

electronic search was carried out in four electronic databases (Pubmed, Embase, Web of Science, and Scopus), selecting articles published form 2018 to present date. MeSH terms and the subject index used for the search were as follows: dental erosion, etiology, mechanism, prevalence, diagnosis, management, treatment, and tooth erosion.

The designed search strategy considered previous studies in the field and their most cited descriptors. The keywords were: (“dental AND erosion“ OR ”etiology”) AND (mechanism OR prevalence OR management OR treatment) AND ”dental erosion”). A duplicates search was performed by identifying references of the search strategy and exporting them from each database to Mendeley’s reference management software (Elsevier, Amsterdam, The Netherlands).

From the initial electronic search of the four databases, 817 articles were identified: 312 from PubMed, 108 from Embase, 176 from Scopus and 221 from Web of Science. After eliminating the duplicate articles, a total of 466 remained. After reading the title and abstract and 55 remained. The main findings on etiology, prevalence, diagnosis and management are presented below.

RESULTS AND DISCUSSIONS

Etiology

Dental erosion involves damaging of the hard dental tissue by acidic substances of intrinsic or extrinsic source or both. The only intrinsic origin of acid related to dental erosion is gastric juice, which occurs in conditions such as gastro-esophageal reflux, vomiting or rumination, leading to palatal erosion. Patients with respiratory pathology and reflux disease present higher incidence of dental erosion than those without associated reflux (Vieira *et al.*, 2020, Ortiz *et al.*, 2021, Chan *et al.*, 2020, Valenzuela *et al.*, 2021). Frequent vomiting caused by eating disorders, pregnancy, alcoholism, and cyclic vomiting syndrome also lead to dental erosions (Valenzuela *et al.*, 2021, Nota *et al.*, 2022, O’Toole *et al.*, 2018).

Extrinsic sources can be dietary, pharmacological and lifestyle or environmental. Frequent acidic dietary intakes per day (such as carbonated, sweetened, alcoholic or sports beverages and acidic food, especially found in vegetarian diets), in the presence of other risk factors (such as xerostomia, use of a hard bristled toothbrush), are associated with erosion (Liska *et al.*, 2019). For carbonated soft drinks, fruit juices and sports drinks, the risk is higher in young people. Alcohol consumption can be considered as an intrinsic agent of dental erosion and as an extrinsic factor because it often leads to gastric reflux syndrome, where the gastric juice damages the tooth structure (Buzalaf *et al.*, 2018, Lussi *et al.*, 2019).

Pharmacological extrinsic etiologic factors of dental erosion are represented by the medications and dietary supplements (vitamin C, aspirin, iron preparations) which are acidic and potentially erosive (Lussi *et al.*, 2019, Skold *et al.*, 2022). Other treatments induce

low salivary flow rates (antihistamines, antiemetics, antidepressants, anti-Parkinson, diuretic medications, radiotherapy), causing a decrease in the protective capacity of the saliva against acidic attack. Some medications induce nausea and vomiting, leading to acidic gastric juice present in the oral cavity (Skold *et al.,* 2022, Carvalho *et al.*, 2018).

A study on prevalence of dental erosions in athletes showed that up to 85% of them presented this type of dental pathology. Sports drinks and swimming pool water are the incriminating factors in the lifestyle of professional athletes and swimmers, increasing the risk of dental erosion (Carvalho *et al.,* 2018, Nijakowski *et al.,* 2022, Tripodi *et al.,* 2021). Work related exposure also happens to wine tasters or workers in battery factories or other places that involve acidic vapours in the work environment (Tripodi *et al.,* 2021). Genetic predispositions can also play a factor, a recent study shows (Tulek *et al.*, 2021).

Prevalence

The increased prevalence of dental erosion is linked with high intake of acidic beverages and foods, especially in the well-developed countries (Kreulen *et al.,* 2020). This phenomenon can be found in both primary and permanent teeth with an estimated global prevalence of dental erosion in primary dentition ranging from 30% to 50% and from 20% to 45% in permanent teeth Lussi *et al.*, 2019). Almost all middle-aged populations and more than half of children and adolescents are affected by dental erosions (Schlueter *et al.,* 2018). Deciduous teeth have a weaker structure and therefore are more susceptible to rapid extending erosions, with the severity increasing in the preschool population. People who exhibit signs of erosive tooth wear in the primary dentition have increased chances of displaying the same wear in the permanent dentition (Donovat *et al.,* 2021, Assuncao *et al.,* 2019, Van't Spijker *et al.,* 2019). Erosive dental damages are cumulative and irreversible and the increasing trend will most likely continue due to dietary trends, having a long-term impact on the oral and general health of the population (Van't Spijker *et al.,* 2019). An European analysis found that around one third of adults (18–35 years old) had dental erosion, similar to the prevalence in America or Japan: where prevalence was 25% and 26.1%, respectively. The increasing risk can be observed especially in adolescents and young adults from Europe and USA (Schlueter *et al.,* 2018, Skold *et al.,*, 2022, Carvalho *et al.,* 2018).

Diagnosis

Several diagnostic methods have been developed to identify dental erosion. These include visual examination and use of BEWE (Basic Erosive Tooth Wear Examination) index, measurement of tooth wear with the help of dental casts, the use of imaging techniques such as optical coherence tomography (OCT) in early-stage dental erosion detection (Warreth *et al.,* 2020, Schlueter *et al.,* 2018).

Management

Firstly, the source factors for dental erosion should be identified and controlled. Prevention and early detection are crucial, and a multidisciplinary approach should be considered, especially if the etiology of dental erosion is determined to be intrinsic (Schlueter *et al.,* 2018).

In the case of intrinsic factors, the treatment for gastro-esophageal reflux disorder includes preventive and restorative dental treatments at the same time with gastroenterological management, while psychological counseling helps eating disorder patients (Lussi *et al.,* 2019, Assuncao *et al.,* 2019). Recent studies

advise patients to brush their teeth with soft bristled toothbrush only after 10 to 30 minutes after an acidic episode and rinse with a fluoride containing mouthwash (Ngoc *et al.*,, 2018, Murray *et al.*, 2018, O'Toole *et al.*, 2018). As for extrinsic there are the following recommendations: dietary regime, behavioral management, salivary stimulants for xerostomia. Fluoride varnish application as well as other modes of fluoride therapy can also be introduced to enhance remineralization of the dentition (Schlueter *et al.*, 2018).

Secondly preventative management offers a range of agents, materials, and products for desensitization treatment (Moraschini *et al.*, 2018). This treatment can be done at home or in-office and includes toothpastes, mouthwashes and chewing gums, gels, solutions, varnishes, resin sealers, glass ionomers, and dentin adhesives or laser techniques (Borges *et al.*, 2018, Liu *et al.*,, 2020, Chawhuaveang *et al.*, 2022, Huysmans *et al.*, 2018).

Topical anti-erosive agents can be categorized as fluorides, calcium phosphate-based agents, organic compounds, and other anti-erosive agents. Fluorides in saliva lead to formation fluorapatite on teeth through remineralization, but fluorides have limitations -the protection of a CaF or NaF layer is relative, and the addition of fluoride only promotes remineralization in the initial stages and high systemic intake has side effects). Research shows promising results of polyvalent metal ions (Sn, Ti) added to fluoride toothpastes (Frese *et al.*, 2019, Trentin *et al.*, 2021, West *et al.*, 2021, Pererira *et al.*, 2022, Epple *et al.*, 2022).

Other suitable replacers for fluorides are calcium phosphate-based agents silver diamine fluorides and hydroxyapatite-based toothpaste -more evidence suggests (Fernando *et al.*, 2019, Yu *et al.*,2018, Ne *et al.*,, 2022, Zheng *et al.*, 2022, Butera *et al.*, 2022, Zanatta *et al.*, 2020, Fiorillo *et al.*, 2022).

Some organic compounds are anti-erosive by forming a protective layer, by modifying salivary pellicle or by inhibiting the proteolytic activity of dentine collagenases. This is a new direction for innovation and recent studies, even if little in number and strength of evidence, show a new potential for treatment options in the domain of biomimetic remineralization materials. Examples of organic treatment in dental erosion are represented by polymers, peptide/proteins (P11-4 peptide in conjunction with fluoride application), amelogenin and non-amelogenin, amorphous calcium phosphate, ions flow and other techniques (Augusto *et al.*, 2022, Dawasaz *et al.*, 2022, Grohe *et al.*,2021, Wang *et al.*, 2021).

Unfortunately, patients usually address to the dental office only when significant dental tissue damage is already installed. These clinical situations frequently require specific dental treatment, ranging from minimally invasive to more radical options, depending on the severity of the case. For superficial tooth wear resin sealants or bonding agents can be applied over the dentin. For moderate lesions the dental restorations need to conservative, such as additive protocols involving direct resin composite or indirect ceramic partial coverage restorations. Less conservative dental restorations need to be used in severe cases of dental erosions, especially if the occlusal vertical dimension has decreased, involving full coverage crowns, fixed partial prosthodontics or removable overdentures as part of full oral rehabilitation. Materials with high resistance, such as reinforced glass ceramics, non-precious metal or gold are indicated when dealing with parafunctions. Of the few studies

available, one has compared the use of indirect materials with resin composites in cases of severe generalized tooth wear, reporting ten-year survival rates of 74.5% and 62.0% respectively (Smales *et al.,* 2018). Another analysis demonstrated high success in use of direct hybrid composites for cases of generalized toothwear (Vajani *et al.,* 2020).[49] Regular recalls are crucial for maintaining good treatment results and treatment should always involve preventive and minimally invasive procedures whenever possible (Bartlett *et al.,* 2019, Hemmings *et al.,* 2018, Varma *et al.,* 2018, O'Sullivan *et al.,* 2021, Salem *et al.,* 2021).

Case Report

An example of a minimally invasive additive restorative treatment protocol would be the injection molding technique (IMT). Our case report presents a 54-year-old male patient with generalized dental erosions due to gastro-esophageal reflux disorder, who was treated with the IMT. Due to its many advantages, such as easy achievable correct dental anatomy and occlusion, verifiable aesthetics, phonetics and occlusion, a predictable workflow and easy implementation and repairing – it is a predictable approach with acceptable results Ammannato *et al.,* 2018).

Treatment protocol for IMT technique:

After visual examination and extensive anamnesis, the diagnosis of 3rd degree generalized dental erosions induced by gastric juice caused by gastro-esophageal reflux disorder was established.

Figure 1. Initial clinical status- 3rd degree dental erosion in a 42 yrs. old GERD patient

Conventional impressions of both dental arches were taken and transformed into diagnostic casts. These were digitally scanned and transformed into digital casts. A digital wax-up was performed of the final ideal treatment result and then printed 3D into 4 different models: 2 maxillary and 2 mandibular ones, one of each having all teeth waxed-up and the other ones having one tooth waxed-up and the next without wax-up alternatively (Fig. 2a, 2b, 2c, 2d).

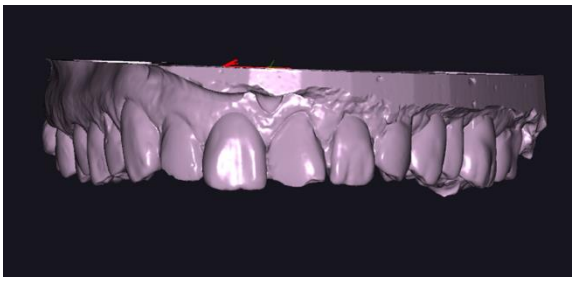

Fig. 2.a Digital maxillary with alternative wax-up

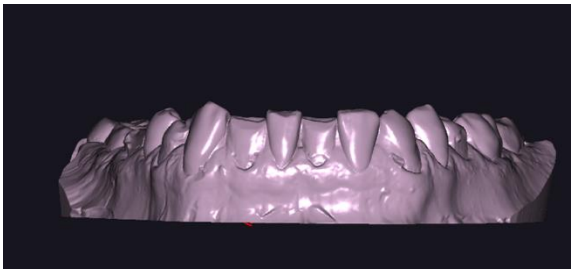

Fig. 2.b Digital mandibular with alternative wax-up

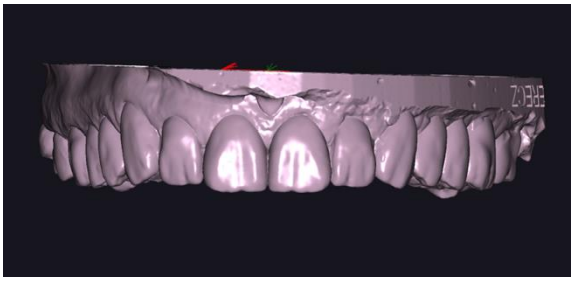

Figure 2c. Digital full-arch maxillary wax-up

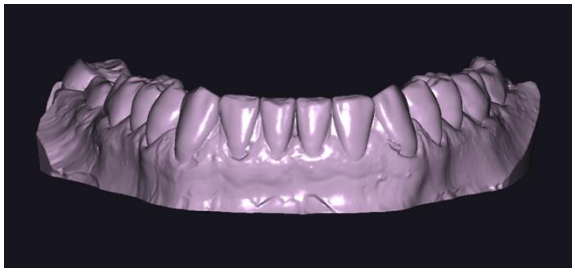

Figure 2d. Digital full-arch mandibular wax-up

For the clear splint to make the mock-up, the Injection Moulding Technique Kit from GC (Japan) was used in-office. ExaClear silicone (GC, Japan) was injected into metallic dental impression trays and placed onto the printed wax-up (Fig. 3).

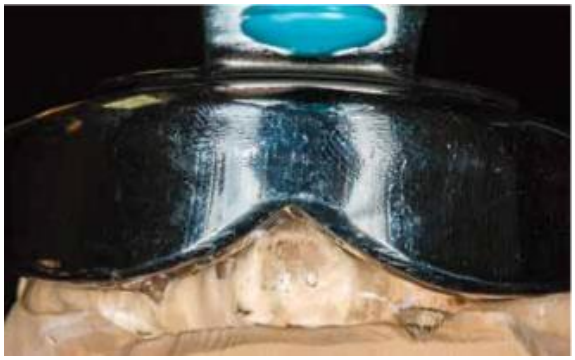

Figure 3. For mock-up splint Exaclear silicone is placed over dental cast with wax-up.

Next a hole in the center of each tooth was made with cylindrical turbine burs to create space for injecting the flowable composite (Fig. 4).

Figure 4. Hole drilling into transparent silicone splint for mock-up

For each tooth dental isolation was done with Teflon, Optragate (Ivoclar Vivadent, Switzerland) and cotton rolls, followed by dental etching with 37% phosphoric acid (Ortho Etching Gel, GC Japan), bonding (G2 Bond Universal, GC Japan), photopolymerization and placement of the silicone splint (Fig 5a, 5b, 5c).

Fig. 5a. Clinical step of isolation, etching and bonding

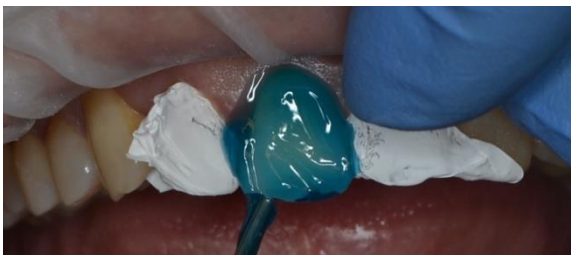

Fig. 5b. Clinical step of etching

Fig. 5b. Clinical step of bonding

Then G-aenial Universal Injectable flowable composite (GC Japan) was injected for each tooth separately, using the silicone splint with teeth having alternatively wax-ups first and only after the silicone splint with full-arch wax-up, to avoid having the composite stick to the neighboring teeth (Fig 6).

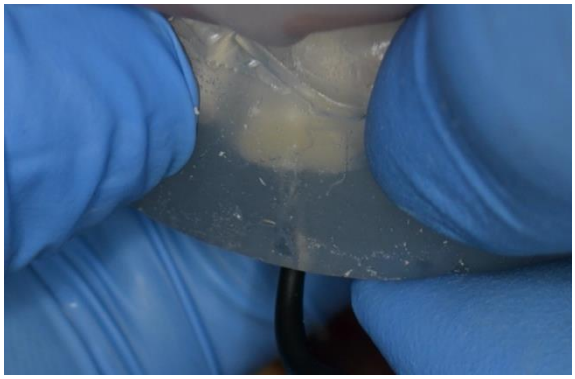

Fig. 6. Clinical step of injecting flowable composite

After injection of flowable composite, the splint was removed, a final photopolymerization made, the excess material removed and the dental restoration polished, until all teeth were completely restored one by one (Fig. 7a, 7b).

Fig. 7a, 7b. Final clinical situation

The IMT aims at providing this copy/paste approach by using modern injectable resins. Alternative techniques include the index technique as described by Ammannato and colleagues (Ammannato *et al.*, 2018). Also, the partial and full moulding techniques as described by Dietschi and Saratti (Dietschi *et al.*, 2020). IMT has the limitations of working best on mono-shade restorations and having a greater treatment time and cost than freehand composites. The IMT does require some finishing but significantly less than freehand restorations. It can be used for both purely additive and in subtractive/additive techniques., but it is mainly intended for fully additive direct restorations.

The technique described is minimally invasive and inexpensive, and it can be used for definitive as well as translational restorations. The treatment goals are to establish adequate function and esthetics, with advantages including minimal tooth structure loss and cost-effectiveness. Stable and predictable results can be achieved with proper planning and a careful workflow.

This novel technique is more precise than freehand techniques while avoiding unpleasant surprises for the patient. Furthermore, it does not require complex clinical skills and it is easy to teach.

CONCLUSIONS

1. Over the past years, there have been significant advances in our understanding of dental erosion, its causes, risk factors, diagnosis and especially prevention and management.
2. The information presented in this article will help researchers, academics and students to characterize the scientific results regarding dental erosion, to evaluate therapeutic strategies and to identify significant topics and questions that will help to design future research with the aim of the prevention of the disease.
3. Injection Moulding Technique is a novel, minimally invasive restorative option in clinical situations dealing with dental erosion, more consistent and predictable than freehand techniques.

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