

Case Report

Minimally Invasive Dentistry for Pre-Eruptive Enamel Lesions—A Case Series

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Abstract: Pre-eruptive enamel lesions occur during tooth formation and include fluorosis, traumatic hypomineralization, and molar incisor hypomineralization. Minimally invasive treatment approaches, such as microabrasion, should be considered for these cases. This article presents a case series of three patients with pre-eruptive enamel defects in esthetically compromised tooth regions which were treated with the microabrasion technique: two fluorosis cases, moderate and advanced, and one hypomineralization case of traumatic etiology. In Cases 1 and 3, there was a significant improvement in esthetics with a total resolution of the enamel defects. However, a slight yellowish coloration may be detected at close observation. In Case 2 (advanced fluorosis), although there was no full resolution of the white spots, there was a clear improvement in esthetics. Microabrasion is a safe and effective, minimally invasive treatment for pre-eruptive enamel lesions. It does not require local anesthesia, it is less destructive than restorative interventions, and allows good esthetic outcomes with no significant postoperative sensitivity. Its efficacy is directly related to the lesions' severity and depth. Although there are some limitations, further improvement can be achieved with dental bleaching. More invasive treatments might be considered if results are still unsatisfactory.

Keywords: enamel; fluorosis; hypomineralization; microabrasion; minimally invasive

1. Introduction

Smile esthetics is a constant concern for patients, especially for the young generations. Enamel defects involving color alteration, mainly those in the anterior region, often compromise the esthetic appearance of teeth [1]. White enamel lesions are an example of a clinical condition corresponding to an enamel hypomineralization, which translates into a porous enamel surface that can, depending on the severity of each particular case, affect patients' lives and wellbeing [1–3]. These white defects can be classified as pre- or post-eruptive lesions [1].

Post-eruptive white enamel lesions correspond to the early stages of the carious disease which we refer to as white spot lesions (WSLs) [1]. WSLs occur due to the accumulation of organic acids produced by bacteria, which compromise the balance of the demineralization and remineralization process [4]. As such, they develop in sites prone

to plaque accumulation such as the labial cervical third or around orthodontic appliances. They are chalky-white and most present well-defined outlines and a continuous enamel surface with a slight roughness [1,4]. On the other hand, pre-eruptive lesions occur during tooth formation and include fluorosis, traumatic hypomineralization, and molar incisor hypomineralization, among others [1]. Dental fluorosis results from the excessive fluoride incorporation during amelogenesis. Clinically, it translates as symmetrical lesions of homologous teeth and affects several teeth at once [1]. Horowitz et al. [5] proposed a classification for fluorosis—the Tooth Surface Index of Fluorosis (TSIF)—by which the teeth are classified from 0 to 7 based on the extent of coronal involvement and clinical appearance. In milder cases (TSIF 1–3) there is a progression of the affected tooth surface area by white enamel defects. At more advanced stages (TSIF > 4) the enamel presents alterations in surface texture, such as pits and fissures, and/or color changes [1,5]. Another example of pre-eruptive white enamel lesions, traumatic hypomineralization, results from periodontal trauma of the deciduous preceding teeth or periapical infections during the maturation stage of the ameloblasts [1]. Clinically, lesions may present with different shapes, outlines, localization, and color, but they mostly appear as punctiform lesions on the incisal third of only one tooth, usually a maxillary anterior tooth, in a unilateral pattern. The opponent mandibular tooth may also be affected [1]. Regarding molar incisor hypomineralization (MIH), it is characterized by the appearance of well-defined white, yellowish, or brownish opacities limited to the occlusal half of at least one of the first permanent molars associated, or not, with lesions of permanent incisors [1]. It may also affect, although less commonly, canine cusps and second permanent molars. Unlike WSLs, fluorosis, and traumatic hypomineralization, the lesions are not located at a subsurface level. Instead, MIH begins at the dentin–enamel junction and progresses outward [1]. Differential diagnosis might be difficult sometimes, but it is essential for the treatment success and improvement in esthetics.

Before considering a more invasive restorative approach for these enamel defects, minimally invasive procedures must be considered in an attempt to improve esthetics with minimal tooth structure loss. Depending on the depth of the enamel lesions, clinicians might be able to considerably solve or soften the appearance using these methods. Treatment options vary between remineralization with casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) or products containing fluorides, infiltrative resins, such as ICON® (DMG, Hamburg, Germany), dental bleaching, and microabrasion [1].

The microabrasion procedure allows for the removal of superficial and intrinsic defects from teeth with minimal enamel loss. A smooth, regular, and lustrous enamel surface is obtained through a combined effect of abrasion and erosion—the “abrosion effect” [6–9]. It was first described by Croll and Cavanaugh [8,9], in which they proposed using hydrochloric acid at 18% and pumice to improve brown spots in the enamel and it has been modified throughout the years. Nowadays, several safe microabrasion slurries have been developed with different combinations of acids and abrasive particles [10].

The aim of this article is to describe the microabrasion technique for the management of pre-eruptive enamel lesions, describing the clinical protocol and the immediate esthetic outcomes.

2. Materials and Methods

2.1. Cases' Selection and Description

This article presents a case series of three patients who reported to the Dentistry Department of the Faculty of Medicine (University of Coimbra) presenting enamel defects in esthetically compromised tooth regions. A complete assessment of all patients' medical history was performed, as well as an intraoral examination to determine the etiology of the discolorations.

Case 1 (Figure 1) was diagnosed with a moderate case of fluorosis (TSIF 4). Case 2 (Figure 2) was diagnosed with an advanced case of fluorosis (TSIF 5). Case 3 (Figure 3) was diagnosed with traumatic hypomineralization, due to trauma of the preceding pri-

mary teeth. All treatment options were presented and discussed along with each patient. Written informed consent was obtained from each patient, and after careful evaluation, the microabrasion technique was selected.



Figure 1. Case 1 with a moderate case of fluorosis diagnosis (TSIF 4). (A): Preoperative photograph showing enamel defects on teeth 11 and 21. (B): Rubber dam isolation with floss ligatures. (C): Opalustre® (Ultradent Products, Inc., South Jordan, UT, USA). (D): OpalCups™ Bristle (Ultradent Products, Inc., South Jordan, UT, USA). (E): Application of a 1 mm thick layer of the microabrasive product (Opalustre®) over the enamel defects. (F): OpalCups™ Finishing (Ultradent Products, Inc., South Jordan, UT, USA). (G): Final polishing with a fluoride paste. (H): Immediate postoperative photograph.



Figure 2. Case 1 with a moderate case of fluorosis diagnosis (TSIF 4). (A): Preoperative photograph showing enamel defects on teeth 11 and 21. (B): Immediate postoperative photograph.

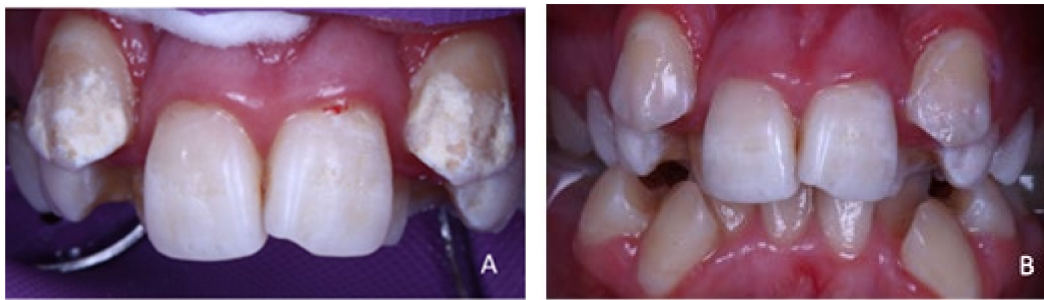


Figure 3. Case 2 with an advanced case of fluorosis diagnosis (TSIF 5). (A): Preoperative photograph with rubber dam isolation showing enamel defects on teeth 13, 11, 21 and 23. (B): Immediate postoperative photograph.

2.2. Microabrasion Procedure

The procedure was similar in all of the reported cases. Firstly, a preoperative intraoral photograph was taken for future reference (Figure 1A) using an adequate camera (Canon 80D) and lens (macro 100 mm, L series, Canon), and the appropriate parameters for intraoral photography (F25, shutter speed 1/125, and ISO 100). In all the cases, teeth were cleaned with water and a prophylaxis brush and the operative field was isolated with a rubber dam (Figure 1B). Petroleum jelly was applied around the cervical portion of the teeth to prevent leakage of the hydrochloric acid or damage to the gingiva. Once the teeth were cleaned and isolated, the microabrasion product, a 6.6% hydrochloric acid slurry (Opalustre[®], Ultradent Products, Inc., South Jordan, UT, USA) (Figure 1C), was applied in a 1 mm thick layer over the enamel defects and the product was spread over the lesions using a specially designed rubber cup (OpalCups[™] Bristle, Ultradent Products, Inc., South Jordan, UT, USA) (Figure 1D,E) in a low-speed handpiece (500 rpm according to the manufacturer's instructions) under light pressure for 10–12 s. Between applications, the teeth were rinsed with water. The procedure was repeated 10 times in each tooth, which was deemed the maximum times the product could be applied without losing too much enamel. In the end, a 700 ppm fluoride polishing paste (CleanJoy, VOCO, Germany) was applied with a specially designed rubber cup (OpalCups[™] Finishing, Ultradent Products, Inc., South Jordan, UT, USA) (Figure 1F) in a low-speed handpiece (2000 rpm according to the manufacturer's instructions) to polish and remineralize the enamel (Figure 1G). The rubber dam was then removed, and a postoperative intraoral photograph was taken (Figure 1H). Patients were also evaluated for postoperative hypersensitivity immediately after treatment and then again after one week and one month.

3. Results

Regarding Case 1 (Figure 2), the immediate postoperative photograph shows a significant improvement in esthetics with a total resolution of the brown defects. However, a slight yellowish coloration may be detected at close observation. The same applies to Case 3 (Figure 4), in which the white enamel defect on tooth 11 was solved but an underlying yellowish coloration was revealed. As for Case 2 (Figure 3), the teeth were affected by a more advanced case of fluorosis, with pitting in teeth 13 and 23. Even though there was no total resolution of the white spots, there was a clear improvement in esthetics as the microabrasion procedure was able to provide more uniformity, smoothness, and luster to the enamel. As for postoperative hypersensitivity, all three patients reported no effects either immediately or in the follow-up evaluations.

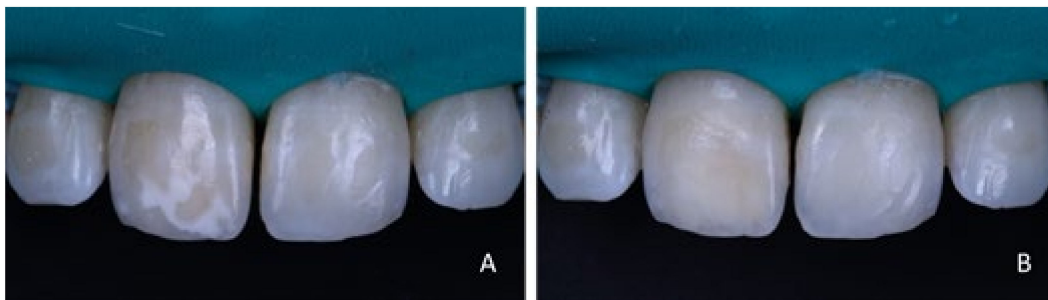


Figure 4. Case 3 diagnosed with traumatic hypomineralization. (A): Preoperative photograph with rubber isolation with floss ligatures showing a white enamel defect on tooth 11. (B): Immediate postoperative photograph.

4. Discussion

One of the biggest challenges dental clinicians face is the resolution of unesthetic enamel defects, which may vary in etiology, color, extension, and depth. Hypomineralization is the common feature to all white enamel defects, which include white spot carious lesions, dental fluorosis, traumatic hypomineralization, and molar incisor hypomineralization, and different treatment approaches might be used to improve the esthetic appearance of these lesions [1], which is of utter importance since these enamel defects present an optical problem due to their higher pore volume [2,3]. It is important to have a proper differential diagnosis based on clinical appearance, localization, and extension of lesions, and a detailed medical and dental history to select the best treatment for each case.

For WSLs, post-eruptive enamel defects, the recommended treatments are remineralization [1,4,11,12], microabrasion [6,11,13–15], and/or resin infiltration [1,4,6,11,12,14,16]. These are all valid treatment approaches; however, remineralizing agents, such as fluorides, suffer from very superficial effects and high pH-dependency [17]. When it comes to fluorosis and traumatic hypomineralization lesions, even though they differ in clinical aspects, the treatment approaches are similar since they include microabrasion associated, or not, with dental bleaching [1,6,15], and resin infiltration may also be a possibility [1,6]. Molar–incisor hypomineralization, however, unlike other enamel defects, starts from the dental–enamel junction and not the enamel subsurface [1]. In severe cases, microabrasion or resin infiltration may be attempted to attenuate the appearance [1,6], but in mild cases, no treatment is recommended since microabrasion and other techniques would require the removal of two thirds of sound enamel [1].

Microabrasion is a safe, practical, and quick technique and is used nowadays by a great number of clinicians to manage enamel defects. It is a minimally invasive treatment approach, it does not require local anesthesia, and it allows good esthetic results with no significant postoperative sensitivity [15]. This technique has evolved throughout the years and several studies have shown the importance of the combined use of abrasive and erosive actions. Not only is the abrasive component important to neutralize the erosive action of the acids, but the use of pumice alone is insufficient to remove the outer enamel layer [7]. Opalustre® (Ultradent Products, Inc.), which was used in all the clinical cases, is a premixed slurry of 6.6% hydrochloric acid and silicon carbide microparticles. Its main advantage over other products is that, being a premixed slurry, it is more easily applied. According to some authors, other alternatives include using phosphoric acid at 35–37.5% and pumice, individually or by mixing them before application [7,15]. Due to the caustic and toxic effects of the hydrochloric acid component of the Opalustre® product (Ultradent Products, Inc.) [18], it is important to assure proper isolation, which was why in all the cases a rubber dam was used. However, with the use of the rubber dam, teeth become much more dry, and will need time to rehydrate, since the air that replaces the organic fluids when teeth become drier has a lower refractive index ($RI_{\text{air}} \approx 1 < RI_{\text{organic fluids}} = 1.33$), and the difference between healthy enamel ($RI_{\text{hydroxyapatite}} = 1.62$) and the enamel

defects becomes more obvious, which is why it is necessary to reevaluate the results at a second appointment [1].

The good esthetic outcomes achieved through the microabrasion technique are due to the fact that the mineralized tissue in the enamel surface is compacted within the organic area, and the outer layer of prism-rich enamel is replaced with a densely compacted prism-free layer, creating a fluorapatite-rich surface layer [6,7,10,15]. This prism-free layer of enamel will refract and reflect the light differently, which translates to a clinically smooth, shiny, and lustrous enamel, and camouflages any mild color imperfections in the underlying enamel—the “abrosion effect” [6,10,15]. Since the enamel surface becomes smoother, plaque adhesion is reduced, which is also a great advantage [15]. However, there are also some drawbacks when using microabrasion since the dental surface may acquire a yellowish appearance due to the fact that there is a reduction in enamel thickness, and the underlying dentin may become more visible [6,10], which is noticeable in the final photographs of Case 1 and 3. Nevertheless, if the Opalustre product is correctly used according to manufacturer’s instructions, only approximately 10–200 µm of the outer enamel layer is removed, which is considered as clinically acceptable [19]. Moreover, Yetkiner et al. [11] showed that even though microabrasion had a favorable outcome initially, this might not be resistant to discoloration by smoking, consumption of tannin-rich foods, and long-term use of cationic agents. The efficacy of the microabrasion procedure is also directly related to the severity and depth of the lesions [7], which can be confirmed by Case 2 where, even though it was not possible to achieve full resolution of the lesions due to the severity of the case, it was still possible to improve esthetics significantly. The microabrasion technique is recommended for stains or defects that are no deeper than a few tenths of a millimeter in enamel [20], which is why proper evaluation with a photopolymerizer’s light might be useful to decide between this technique and resin infiltration. By using the photopolymerizer and allowing the light to go through the tooth, it is possible to distinguish between deeper lesions, which appear darker, and more superficial lesions, which appear in a lighter shade. As for contraindications, this technique should not be carried out in uncooperative patients, patients with a history of sensitivity to hot, cold, or acidic foods, and patients with dentinogenesis or amelogenesis imperfecta [15].

When necessary, the microabrasion technique may be combined with other treatment approaches in order to improve the final esthetic result. Treatments such as dental bleaching may be useful to whiten the yellowish part of the tooth when there is a great enamel reduction and reduce contrast with the rest of the surface [6,10,18,21]. If, afterwards, there is still a need to further improve results, a resin-infiltration technique may be attempted and later, if necessary, a direct composite restoration. Some authors suggest the use of macro reduction prior to the microabrasion procedure in cases of advanced fluorosis with pitting [6,10]. Sunfeld et al. [6,10] showed how the use of a high-speed tapered fine diamond bur and copious irrigation to remove the superficial layer of the stained enamel was able to drastically improve the final results in severe cases of fluorosis. However, this procedure is more invasive and should therefore be, as much as possible, used only in cases where microabrasion and resin-infiltration techniques were attempted and proved insufficient.

5. Conclusions

Microabrasion is a safe and effective minimally invasive treatment for patients with enamel defects, namely pre-eruptive lesions. It is less destructive than restorative interventions and allows good esthetic outcomes with no significant postoperative sensitivity. Although there are some limitations to this technique, further improvements can be achieved if necessary when combining this procedure with other treatment approaches.

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