Infiltration, a new therapy for masking enamel white spots: a 19-month follow-up case series

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Abstract

Enamel white spot lesions are frequent and can impact patients' quality of life. The most conservative treatment in such cases is microabrasion, a technique that presents some drawbacks.

The proposed strategy is not based on the elimination of dysplastic enamel, but on masking the lesion by infiltrating the porous subsurface enamel with a hydrophobic resin that has a refraction index closer to that of sound enamel, after permeating the non-porous surface enamel through hydrochloric acid erosion.

Erosion-infiltration approaches have been proposed to treat initial caries, but this report suggests extending it to two novel indications: fluorosis and traumatic hypo-mineralization lesions.

Four cases were treated by erosion infiltration following the original protocol. They were followed up clinically at several intervals during a period of 19 months of clinical service.

The clinical results, although not perfect, satisfied the patients entirely. Erosion-infiltration could be a promising alternative for minimally invasive treatment in similar situations.

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Introduction

Given patients' increasing esthetical demands, dentists frequently face requests for treating enamel white spots. Although the appearance of these spots in mild cases does not necessarily impact patients' quality of life,[1] it does have an impact in more severe cases.[2] However, a study concerning 16-year-old teenagers with at least one enamel spot each revealed that some of them hid their smile or even occasionally limited their social life due to their spots.[3] The prevalence of white spots on the teeth, although difficult to quantify, is high. Several dental anomalies can cause these defects: fluorosis;[4] molar incisor hypomineralization (MIH); medicine intake at the time of enamel mineralisation; traumas; or initial caries. In the case of initial caries, particularly frequent after removal of orthodontic brackets,[5] simple therapeutic remineralisation was generally proposed, but did not solve the esthetic impairment in all cases. Furthermore, subsequent discoloration of these spots often appeared due to the incorporation of food pigments during the remineralisation period.[6] In cases requiring treatment, the therapeutic gradient principle[7] would consist in adopting the most conservative approach. Until now, only controlled microabrasion[8] – possibly in conjunction with bleaching or composite resin restorations – was available. In some cases, microabrasion provided satisfactory outcomes.[9] However, this technique has often been unsatisfactory[10] because it finally removed much of the tooth substance due to the lesions' depth, involving mega-abrasion in many cases.[11]

A new therapy combining erosion of the affected surfaces and infiltration – initially proposed for infiltration of incipient caries lesions – allows masking of white spots by modifying enamel optic properties.[12]

The caries infiltration technique was developed and first investigated at the Charité University of Berlin, Germany. After *in vitro* validation of this procedure, a dental manufacturer (DMG) developed a product for clinical use. This product was designed for the treatment of non-cavitated caries lesions, located in proximal and smooth surfaces. As opposed to traditional techniques that superficially seal the enamel surface (without any resin penetration into the enamel lesion),[13,14] this approach consists in infiltrating microspaces and microporosities of the subsurface lesion (up to a 450 µm depth) with a very low viscosity and high-penetration coefficient resin.[15] Its penetration is driven by capillary forces and therefore time-dependent. This infiltration technique has proven to hamper or even arrest caries progression *in vitro*,[16,17] even in aggressive environments.[18] The first clinical studies on permanent teeth after 18-month monitoring[19] or on primary teeth after 30-month monitoring[20] show a significant reduction of caries development compared to lesions receiving a classic application of fluoride varnish or intensified oral hygiene with a focus on interproximal care. The resin penetration into the caries lesion is made possible by etching the enamel surface prior to applying the resin. This acidic treatment eliminates a superficial 30 to 35 µm-deep enamel layer and allows proper penetration of the lesion body. The optimal concentra-

tion-time combination to erode the pseudointact surface layer was determined to be 15% hydrogen chloride (HCl) for 2 minutes.[21]

When treating white spots, the interesting aspect of infiltration concerns the spot's optical properties modification. We have considered extending this treatment to other types of white spots, such as those associated with fluorosis or traumatic sequellae. These lesions show irregular mineralization patterns[22] and are histologically characterized by highly porous hypomineralized subsurface enamel.[23] Permeating the surface layer may enable access to the volume of porous enamel, which could be penetrated by a resin with a refractive index (RI) similar to sound enamel afterwards. Adapting a lesion's RI to the RI of enamel would allow "masking" of the subsurface enamel alteration. Actually, the RI of healthy enamel is 1.62. The subsurface enamel microporosities of all kinds of white spots – be they fluorosis,[24] initial caries or traumatic defects – contain either water (RI = 1.33) or air (RI = 1). This difference in the RI causes light dispersion within the lesion volume and explains the whitish aspect of the lesions. The objective of infiltration in esthetic areas is thus to fill up the microporosities of hypomineralized enamel with a resin whose RI is close to that of healthy enamel (RI = 1.62), in order to mask the enamel defect. Tissue preservation in this case is maximal: the loss consists only in some of the pseudo-intact surface enamel, which has to be etched in order to make the hypomineralized pore volume of the lesion body accessible.

The purpose of this article is to discuss the mechanism of action of this new minimally invasive therapy, and to present our clinical results with up to 19-month follow-up, outlining the esthetic improvement achieved in four patients with fluorosis or traumatic white spot lesions using enamel erosion and infiltration, in conjunction with dental bleaching if necessary.

Materials and methods

Over 20 patients were treated by erosion-infiltration from June 2010 to December 2011 by Drs Jean-Pierre Attal and Gil Tirlet, either in their private office (Paris, France) or at Charles Foix Dental Hospital (Ivry-sur-Seine, France). Here we present four cases treated by Gil Tirlet: 2 fluorosis cases, and 2 traumatic cases, with a milder and a more severe case for each pathology.

Patients

Patient 1 was a 27-year-old female colleague who requested a conservative treatment to her anterior spots due to traumatic hypomineralization (Fig 1). Patient 2 was a 21-year old female and came asking for anterior laminate veneers to hide her fluorosis white spots (Fig 9). Patient 3 was a 25-year old female and wished her small traumatic white spots on 11 and 21 to be attenuated or hidden (Fig 13). Patient 4 was a 27-year-old male and wanted to know what could be done to treat his fluorosis spots on 11 and 21 (Fig 18).

PATIENT 1

Fig 1 Initial status showing multiple fluorosis spots. (Erosion-infiltration procedure)

Fig 2 15% hydrochloric acid placement.

Fig 3 Etching gel applied with gentle pressure in a circular motion.

Fig 4 Enamel appearance after hydrochloric acid rinsing and drying.

Protocol before erosion-infiltration

Prior to erosion-infiltration treatment, all patients were told that this technique presented the advantage of inducing almost no substance loss and the drawback of allowing only partial white spots' disappearance, especially in severe cases.

Patient 1 bleached her teeth at home with 10% carbamide peroxide for 21 nights. Erosion infiltration was then applied 15 days after the bleaching ended.

Erosion-infiltration procedure

The teeth were cleaned and isolated with a rubber dam. Floss was used to fix the dam for cervical lesions.

Enamel overlying the lesion was etched with 15% HCl gel (ICON etch®, DMG) for 2 min (Fig 2), rinsed with air-

Fig 5 Infiltration of the hydrophobic resin using an applicator.

Fig 6 Postoperative view.

Fig 7 Post-operative view (just after erosion-infiltration).

Fig 8 Intraoral view at 12-month follow-up.

water spray for 30 s, dried (Fig 4) and dehydrated with 100% ethanol (ICON dry®, DMG) for 30 s. After drying, water was applied and the visual aspect of the lesion was checked: at this stage, the spot should have almost disappeared. If not and where the removal of the surface layer appeared insufficient, the etching step was repeated up to 3 times and the etching gel was applied with gentle pressure in a circular motion (Fig 3).

The operating light was turned away. Then the transparent hydrophobic infiltration resin (ICON®, DMG; RI = 1.47) was carefully applied onto the etched area with the applicator for 3 min without rubbing (Fig 5), slightly dried with compressed air for 10 s, light-cured for 40 s (Bluephase®, Ivoclar) and reapplied a second time for an additional 1 min to compensate for polymerization shrinkage.

The treated surfaces were then polished with polishing cups (Greenies®, Shofu) under irrigation.

Results

Clinical results at 6 months (Figs 15, 16 and 20), 12 months (Fig 8), 14 months (Fig 17), 15 months (Fig 21) and 19 months (Fig 12) follow-up are presented.

Given the minimal substance loss due to the erosion infiltration procedure, all patients were extremely satisfied with the results, although some white spots could still be seen.

Discussion

Modern dentistry aims at reducing tooth substance loss in each treatment or restoration in order to enhance tissue preservation. Thus, teeth bearing white defects that had once been treated with crowns were progressively treated with laminate veneers and more recently by microabrasion. Although the latter was a much less invasive approach, some difficulties remained: a relatively important enamel layer had to be withdrawn since the depth of white lesions can be up to a third of the depth of enamel, milling was often associated with this procedure[25] and sometimes the white spot was still visible after the treatment.

Erosion-infiltration is a different approach: hydrochloric acid is used only to permeate the lesion, so that tissue preservation is maximal. One can consider that about 40 µm of enamel surface is eliminated.[26] Removing affected enamel is not necessary in order to remove the white spot from sight.

Erosion-infiltration inventors proposed using this technique for initial caries treatment. We propose to broaden the indications of erosion-infiltration to fluorosis and traumatic hypomineralization, since these lesions have topographic characteristics similar to initial caries white spot lesions.[23]

Concerning the first two cases presented in this article, laminate veneers could be indicated and it was actually the demand of patient 2. In both cases, the final clinical appearance is not perfect, due to the extent of the lesions. However, the patient is completely satisfied, and not a single bur was used. With erosion-infiltration, tissue preservation reaches its height.

The treatment of the last two cases could be a combination of microabrasion and composite restoration. However, erosion-infiltration is much less damaging.

Note that in severe cases, bleaching facilitates attenuation of the white spots' visibility. Bleaching should then precede erosion/infiltration, since the resin is not permeable to carbamide peroxide.

Conversely, a recent study suggests that bonding (for a composite restoration) on a surface previously treated with Icon is possible.[27] Our results and experience seem to confirm this hypothesis.

Ultimately, if the lesion is still visible after repeating the etching step three times, microabrasion may be necessary. If microabrasion is done using Icon etch®, one must be careful of the kinetics of dissolution since its HCl concentration is higher (15%) than the usual

PATIENT 2

Fig 9 Initial status, showing many fluorosis white spots.

Fig 10 Preoperative view after bleaching (before erosion-infiltration).

Fig 11 Postoperative view (just after erosion-infiltration).

Fig 12 Intraoral view at 19-month follow-up. (Composite resin was added to improve 12's morphology. 12 was later treated endodontically and bleached internally.)

Fig 13 Initial status showing small traumatic white spots on teeth 11 and 21.

Fig 14 Postoperative view (just after erosion-infiltration).

PATIENT 3

Fig 15 Intraoral view at 6-month follow-up.

Fig 16 Intraoral view at 6-month follow-up.

Fig 17 Intraoral view at 14-month follow-up.

concentration used for microabrasion (6%).

The main question remains about the aging of such restorations, on which we are unable to reach a definitive conclusion prior to further research. Tri (ethylene glycol) dimethacrylate (TEGDMA) is hydrophobic, which makes us think hydric stresses will have little influence on this material. It is what we observed up to our 19 months follow-up. Nonetheless, further follow-up is needed to conclude on this subject.

We are presently working on how to extend erosion-infiltration to the treatment of MIH lesions.

Conclusion

Erosion-infiltration was proposed to treat initial caries. We propose to extend this technique to white lesions due to fluorosis or traumatic hypo-mineralization and use the optical properties of the infiltrating resin to mask the lesion.

After a maximum of 19 months of clinical service, our results in four patients show that erosion-infiltration could be a promising treatment in such indications. Yet, before this technique could be recommended to treat all types of white lesions, longer observation periods, studies with more patients, clinical trials and a specific protocol for MIH lesions are needed to validate the clinical significance of this preliminary case series.

PATIENT 4

Fig 18 Initial status, showing traumatic white spots on teeth 11 and 21.

Fig 19 Postoperative view (just after erosion-infiltration).

Fig 20 Intraoral view at 6-month follow-up.

Fig 21 Intraoral view at 15-month follow-up.

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