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

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Abstract

Enamel white spot lesions are frequent and can have an impact on patients quality of life. The most preservative treatment in such cases was microabrasion, a technique which had some drawbacks.

The proposed strategy is not based on the elimination of the 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.

The erosion-infiltration strategy had been proposed to treat initial caries, but this report suggests extending it to two newer indications: fluorosis and traumatic hypo-mineralization lesions.

Four cases are presented. They were treated by erosion infiltration following the original protocol. They were followed during up to 19 months of clinical service.

The clinical results, although not perfect, satisfied the patients entirely. Erosion-infiltration could be a promising minimally invasive treatment in such indications.
Introduction

Given the increasing esthetic demand of our patients, dentists frequently face requests for treating white spots on the enamel. If the appearance of these spots in mild cases does not necessarily impact the patients’ quality of life, it does have an impact in more severe cases. 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 limited their social life occasionally due to their spots. The prevalence of white spots on the teeth, although difficult to quantify, is high. Several dental anomalies can cause these defects: fluorosis, MIH (Molar Incisor Hypomineralization), medicine intake at the time of enamel mineralisation, traumas, inflammations or initial caries. In the case of initial caries, particularly frequent after removal of orthodontic brackets, simple therapeutic remineralisation was generally proposed, but did not solve the aesthetic impairment in all cases. Furthermore, subsequent discoloration of these spots often appeared due to the incorporation of food pigments during the remineralisation period. In cases requiring treatment, the therapeutic gradient principle would consist in adopting the most conservative approach. Until now, only controlled microabrasion – possibly in conjunction with bleaching or composite restorations – was available. In some cases, microabrasion provided satisfactory outcomes. But this technique has often been unsatisfactory because it finally removed much of the tooth substance due to the lesions depth, involving mega-abrasion in many cases.

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

The caries infiltration technique was developed and first investigated at the Charité University of Berlin, Germany. After in vitro validation of this procedure, the DMG company (Hamburg, Germany) 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 carious lesion, acting as a resin barrier on top of the tooth surface, the
objective of this approach was to infiltrate microspaces and microporosities of the subsurface lesion (up to a 450 µm depth) with a very low viscosity and high-penetration coefficient resin.\textsuperscript{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,\textsuperscript{16, 17} even in aggressive environments.\textsuperscript{18} The first clinical studies on permanent teeth after 18 months monitoring\textsuperscript{19} or on deciduous teeth after 30 months monitoring\textsuperscript{20} show a significant reduction of caries development compared to lesions receiving a classic application of fluoride varnish or intensified oral hygiene with focus on interproximal care. The resin penetration into the carious 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 concentration-time combination to erode the pseudointact surface layer was determined to be 15% HCl for 2 minutes.\textsuperscript{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. Theses lesions show irregular mineralization patterns\textsuperscript{22} and are histologically characterized by highly porous hypomineralized subsurface enamel.\textsuperscript{23} The removal of 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 the RI of the lesion to the RI of enamel would allow «masking» of the subsurface enamel alteration. Actually, the refraction index (RI) of healthy enamel is 1.62. The microporosities of the subsurface enamel of all kinds of white spots - were it fluorosis,\textsuperscript{24} initial carie or traumatic contain water (RI=1.33) or air (RI=1). This difference in 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 hypomineralised enamel with a resin whose RI is close to that of healthy enamel, 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 hypomineralised pore volume of the lesion body accessible.
The purpose of this article was to discuss the action mechanism 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). 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 colleague who requested a conservative treatment to her anterior spots due to traumatic hypomineralization (Fig 1). Patient 2 was 21 and came asking for anterior laminate veneers to hide her fluorosis white spots (Fig 9). Patient 3 was 25 and wished her small traumatic white spots on 11 and 21 to be attenuated or hidden (Fig 13). Patient 4 was 27 and wanted to know what could be done to treat his fluorosis spots on 11 and 21 (Fig 18).

Protocol before erosion-infiltration

Prior to erosion-infiltration treatment, all patients were told that this technique, with the advantage of inducing almost no substance loss, would probably allow partial, but not complete, disappearance of their white spots, 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 bleaching ended.

Erosion-infiltration procedure

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

The enamel overlying the lesion was etched with 15% HCl gel (ICON etch®, DMG, Germany) for 2 min (Fig 2), rinsed with air-water spray for 30 s, dried (Fig 4) and dehydrated with 100% ethanol (ICON dry®, DMG, Germany) 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, Germany. 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 month (Fig 15, 16, 20), 12 month (Fig 8), 14 month (Fig 17), 15 month (Fig 21) and 19 month (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 the cost in tooth substance of 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 layer of the enamel had to be withdrawn since white lesions depth can reach a third of the enamel, milling was often associated\(^{25}\) and sometimes the white spot was still visible in the end.

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 the affected enamel is not necessary for the white spot not to be seen. 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 two first cases presented in this article, laminate veneers could be indicated and it was actually the demand of patient 2. In both cases, the optic result is not perfect, due to the lesions extent. However, the patient is completely satisfied, and not a single bur was used. With erosion-infiltration, tissue preservation reaches its height.

In both the last cases, their treatment could combine microabrasion or even a composite restoration. Erosion-infiltration is much less mutilating.

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 concentration used for microabrasion (6%).
The main question remains concerning the aging of such restorations, on which we will not be able to settle yet. 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 19 months.

Nonetheless, further follow-up is needed to settle 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.

Up to 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 can 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 performance of this preliminary case series.
Figure legends

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.

Fig 5 Infiltration of the hydrophobic resin using an applicator.

Fig 6 Post-operative view.

Fig 7 Post-operative view (just after erosion-infiltration).
**Fig 8** Intraoral view at 12-month follow-up.

**Patient 2**

**Fig 9** Initial status, showing many fluorosis white spots.

**Fig 10** Pre-operative view after bleaching (before erosion-infiltration).

**Fig 11** Post-operative view (just after erosion-infiltration).
Fig 12 Intraoral view at 19-month follow-up. (Some composite resin was added in order to improve the morphology of tooth 12. This tooth later became discoloured since it was treated endodontically and will be treated by internal bleaching)

Patient 3

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

Fig 14 Post-operative view (just after erosion-infiltration).

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.

Patient 4

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

Fig 19 Post-operative view (just after erosion-infiltration).
**Fig 20** Intraoral view at 6-month follow-up.

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


