# Alternative Esthetic Management of Fluorosis and Hypoplasia Stains: Blending Effect Obtained with Resin Infiltration Techniques

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## ABSTRACT

**Statement of Problem:** New light-polymerized resin composites optimized for rapid infiltration of enamel lesions with resin light curing monomers are commercially available today to prevent enamel lesions from further demineralization and provide a highly conservative therapy. In addition, this technique has proved to be effective treatment for blending white spot lesions because the microporosities of infiltrated lesions are filled with resin.

*Purpose:* This clinical report presents and describes cases in which the minimally invasive infiltrant resin technique was used for blending different microporous lesions, mild-to-moderate fluorosis, and hypoplasia stains related to traumatic dental injuries.

**Results:** The fluorosis stain showed visually perceptual improvements. In the cases of hypoplasia, stains were not completely blended. However, the general clinical outcomes of these cases were considered successful and recovered the patients' self-esteem.

**Conclusion:** Based on the results obtained, it could be concluded that the resin infiltration technique shows promising results and could be considered a minimally invasive procedure for mild-to-moderate fluorosis and hypoplasia stains.

## **CLINICAL SIGNIFICANCE**

This case study allows a better understanding of the concept of the resin infiltration technique applied in other types of porous lesions, increasing its use as a therapeutic alternative for esthetic purposes in the philosophy of minimally invasive dentistry.

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## INTRODUCTION

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Certain tooth colors, hypocalcifications, surface
imperfections, and other perceived flaws are subjective
measurements with important esthetic considerations.
These qualities can also suggest disruption of normal
tooth development. This has led to the use of different
esthetic techniques with different degrees of
invasiveness and tissue conservation.

Dental fluorosis is a condition of enamel 11 hypomineralization because of the effects of excessive fluoride on ameloblasts during enamel formation<sup>1-3</sup> resulting in surface and subsurface porosities<sup>4</sup> and 14 subsequent optical and physical changes. The critical 15 period for clinically significant dental fluorosis in 17 human maxillary central incisors is during the age range of 15 to 30 months.<sup>5,6</sup> The main consequence of 18 dental fluorosis is compromised esthetics. In its mildest forms, enamel fluorosis appears as loss of translucency in at the tip of the summit of the cups of the premolars, molars, or incisal border of the anterior teeth, poorly 22 demarcated opacities, faint white flecks, spots, or striations.<sup>1,3,4,7</sup> The white striations reflect accentuated striae of Retzius and von Ebner lines<sup>2,8</sup> Traumatic 25 dental injuries (TDIs) are considered an emerging 26 public health problem.<sup>9,10</sup> TDI to primary teeth may compromise both primary teeth and their permanent 28 successors.<sup>11–13</sup> Severity of sequelae is associated with different factors.<sup>13–15</sup> Discoloration (white, yellow, or brown) of enamel and enamel hypoplasia are the most common and milder states of TDI.<sup>16</sup> Hypoplasia is characterized by reduced enamel thickness of varying degrees, as well as pits and other irregularities, and although the hardness and transparency of the enamel remain intact, the extent of irregularities varied from tiny spots to large areas.<sup>14</sup>

Several techniques have been proposed to improve the appearance of tooth stains. Teeth discolored by fluorosis or hypoplasia may be managed by performing enamel bleaching, microabrasion, placement of veneers, or artificial crowns. The choice among these treatments depends on the severity of the disease.<sup>17</sup> Usually, enamel microabrasion is the chosen technique. This therapy removes superficial parts of the lesion by abrasion with a slurry of hydrochloric acid and pumice,<sup>18–20</sup> or commercially available products with various acids at different concentrations, combined with abrasive agents and certain gel solutions.<sup>21</sup> Unfortunately, with this technique, substantial amounts of enamel often have to be eroded to improve appearance.<sup>22</sup> The inherent danger of using a strong acid intraorally, and the inconvenience and time required for application have led to the search for a safer, quicker, easier method.<sup>21</sup>

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A new material for caries infiltration is an alternative therapeutic approach to prevent further progression of enamel lesions. The goal of this treatment is to occlude the microporosities within the lesion body by infiltration with low-viscosity light-curing resins that have been optimized for rapid penetration into the porous enamel.<sup>23</sup> After etching the lesion surface with hydrochloric acid gel,<sup>23,24</sup> a resin infiltrant is applied on the lesion. The resin penetrates into the lesion body driven by capillary forces.<sup>25</sup> A positive side effect of resin infiltration is that enamel lesions lose their whitish appearance.<sup>26</sup> With the aim of improving the esthetic appearance of four patients, this clinical case report presents and describes the minimally invasive infiltrant resin technique for blending different microporous lesions, mild-to-moderate fluorosis, and more intense discoloration/hypoplasia staining related to TDI.

## CASE REPORT

Four patients between 12 and 16 years of age were attended at the School of Dentistry Postgraduate Clinic of the State University of Ponta Grossa accompanied by their respective fathers, who reported discomfort caused by the presence of stains in the maxillary incisors. After clinical examination and taking the patients' medical history, the stains were diagnosed as follows: in the first two cases, as mild-to-moderate enamel fluorosis and hypoplasia related to TDI (Figures 1 and 4A); and in the other two cases, as mild fluorosis (Figures 5A–C and 6A–C). Treatment decision making considered the importance of the smile during adolescence and implications for self-esteem and personal relationships. Ethical approval was granted by the Institutional Review Committee of the State



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**FIGURE 1.** Case 1, mild-to-moderate fluorosis and hypoplasia related to traumatic dental injury before treatment. Note the white (tooth 8) and yellow (tooth 9) stains diagnosed as trauma-induced stains in the incisal third of the central incisors.



**FIGURE 2.** A–B, application of conventional rubber dam and erosion of the surface layer with 15% HCl (lcon-etch, DMG); C, subsequently, the etching gel is thoroughly washed away (30 seconds) using water spray; D, lesions desiccated by application of ethanol (lcon-dry, DMG) for 30 seconds and subsequent air-drying; E, application of the resin infiltrant for 3 minutes (lcon-infiltrant, DMG); F, after removal of surplus material, the area is light-polymerized for 40 seconds. After this, a second coat of the resin infiltrant is applied, and it was polymerized (or light-curing) after a 1-minute delay.

University of Ponta Grossa, and full written consent
was obtained from both the subjects (4) and their
parents.

14Treatment planning was based on alternative minimal15intervention, avoiding treatments with more predictable16results that would require greater tooth structure17reduction, such as microabrasive or macroabrasive18procedures. Thus, the enamel infiltration technique19with resin infiltrant (ICON, DMG, Hamburg, Germany)20was selected for the treatment of all cases presented.21Each kit for each patient contained three syringes: one

acid gel (Icon-etch, DMG, composed of 15% hydrochloric acid, water, silica, and additives), one ethanol (Icon-dry, DMG), and one resin infiltrant, (Icon-infiltrant, DMG, composed of tetraethylene glycol dimethacrylate, additives, and initiators), which was applied in accordance with the manufacturer's instructions.

The conventional rubber dam was applied to protect soft tissues and achieve clean and dry working conditions (Figure 2A). After the teeth were cleaned using prophylaxis paste, the surface layer was eroded by

#### ALTERNATIVE ESTHETIC MANAGEMENT OF FLUOROSIS AND HYPOPLASIA STAINS Muñoz et al



FIGURE 3. Improved esthetic result after 4 months. Some trauma-induced staining on the central incisors can be observed probably due to being too deep.



**FIGURE 4.** Case 2, mild-to-moderate fluorosis and hypoplasia related to traumatic dental injury. A, before treatment. Note the white stains diagnosed as trauma-induced stains in tooth 8; B, results after 1 month. Some trauma-induced staining can be observed probably due to being too deep.

application of a 15% hydrochloric acid gel (Icon-etch) for 120 seconds (Figure 2B). To achieve a homogeneous etching pattern, the manufacturer's recommendation to stir the gel from time to time was followed during application, using the smooth surface-tips included in the respective product kit. Subsequently, the etching gel was thoroughly washed away for 30 seconds using water spray (Figure 2C). The etching procedure removed superficial discolorations and the more highly mineralized surface layer, which otherwise might hamper resin penetration.<sup>23</sup> To remove the water retained within the microporosities of the lesion body, lesions were desiccated by application of ethanol for 30 seconds (Icon-dry) and subsequent air-drying (Figure 2D). To maximize water removal, this step should be repeated at least once. After air-drying, the whitish appearance of enamel lesions was more pronounced (Figure 2D).

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Colour

A resin infiltrant (Icon-infiltrant) was applied on the lesion surface using smooth surface-tips and allowed to penetrate for 3 minutes (Figure 2E). Because the aim of infiltration is to create a diffusion barrier inside the lesion and not on top of the lesion surface, resin surplus on the tooth surface was wiped away using a cotton roll before light polymerization for 40 seconds. Excess resin was cleaned out of the proximal spaces using dental floss. After light curing (Figure 2F), it is recommended that the application (allowing the material to sit for 1 minute) and light polymerization (40 seconds) of the resin infiltrant should be repeated once to minimize enamel porosity. Finally, the roughened enamel surface was polished using disks and silicone polishers to avoid rediscoloration by food stains. An improvement in the esthetic appearance was achieved in all cases. From the perspective of visual perception, the fluorosis stains were well blended (Figures 3–6). However, in the cases of TDI, the hypoplasia stains were not completed (Figures 3B and 4B).

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## DISCUSSION

Correct diagnosis according to lesion depth and prognosis of the technique are crucial factors in the treatment decision-making process and in the success of the case.<sup>27</sup> Thus, in these cases, each participant was diagnosed according to Dean's classification<sup>7</sup> system,



FIGURE 5. Case 3, mild fluorosis. A–C, before treatment; D–F, one week after treatment. Improvement in this case was considered successfully.



FIGURE 6. Case 4, mild fluorosis. A–C, before treatment; D–F, I week after treatment. Improvement in this case was considered successfully.

and the Thylstrup and Fejerskov scale.<sup>4</sup> The goal of
clinical management of tooth discoloration is to
produce an acceptable cosmetic result as conservatively
as possible. Conservative treatment options, such as
microabrasion, can produce dramatic improvements in
stains, providing satisfactory results<sup>17</sup> before more
invasive procedures are considered, if necessary. Several

techniques have been devised<sup>18–21,28,29</sup> to treat esthetically objectionable fluorosis and discoloration/hypoplasia.

The most common microabrasion procedure is a chemical and mechanical technique that consists of blending an abrasive acid material into a firm paste.<sup>18,21</sup>

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This is applied to the discolored buccal surfaces of the teeth manually, or with a rubber cup at low speed, to dissolve mineral and remove thin layers of enamel. This technique has shown that the amount of enamel removed from the labial surfaces of treated teeth is not clinically significant depending on the protocol used. However, there is no consensus regarding the number of times it is necessary to apply the material in order to safely achieve complete removal of discoloration or the maximum number of times this can be done without exposing the dentin. This is problematic causing many clinicians to be uncomfortable with this technique.

The efficacy of resin infiltration in arresting caries lesions 14 has been investigated in different types of studies.<sup>30–32</sup> A 15 positive side effect of resin infiltration is that enamel 16 lesions lose their whitish appearance when their microporosities are filled with the resin and look similar 18 to sound enamel.<sup>33–35</sup> Therefore, this treatment has been used not only to arrest enamel lesions but also to improve the esthetic appearance of labial-surface white spots.<sup>26</sup> The resin infiltrant is a light-polymerizable material that 22 has a very low viscosity, low contact angles on enamel, 24 and high surface tensions<sup>36</sup> with properties that optimize their rapid penetration into the capillary structures of the 25 enamel caries lesion body. However, the mineralized 26 surface layer hinders resin from penetrating into the lesion;<sup>23,24</sup> therefore, this technique requires removal of this layer. For this purpose, 15% hydrochloric acid is used for 120 seconds.<sup>23,24</sup> 30

In the cases presented, the patients' age range was between 12 and 16 years, and their teeth had large pulp chambers. Considering the foregoing, the application of 35 the classical techniques of microabrasion<sup>22</sup> and bleaching<sup>37</sup> suggested several risks, although both are 36 considered conservative. However, the resin infiltration technique was considered the treatment option because no mechanical enamel removal is required for blending. 39 With this technique, only 30 to 40  $\mu$ m are eroded<sup>24</sup> in 40 contrast with enamel microabrasion with enamel removal of around 360 µm when applied in 5-second 42 intervals and repeated 20 times.<sup>22</sup> Moreover, erosion of 43 sound and demineralized enamel is similar in the two 44 earlier mentioned techniques because no pressure is 45 46 applied; thus, the enamel loss is marginal.

The stains diagnosed in this case report have the 47 common feature of presenting a high degree of 48 porosity, the factor that makes them noticeable and 49 therefore makes it feasible to treat them with resin 50 infiltration. The visually perceptual improvements in 51 the cases presented are due to blending enamel lesions 52 by resin infiltration, which is based on changes in light 53 scattering within the lesions.<sup>26,34</sup> The opaque appearance of these lesions, especially when they are 55 desiccated, is due to the difference in refractive indices (RIs) between the enamel crystals and medium inside 57 the porosities that causes light scattering.<sup>38</sup> The 58 microporosities of the lesions are filled with either a 59 watery medium (RI 1.33) or air (RI 1.0).<sup>38</sup> Therefore, 60 when these spaces are filled with resin infiltrant (RI 61 1.46),<sup>34</sup> the difference in refractive indices between 62 porosities and enamel (1.62 blending<sup>38</sup>—1.65<sup>26</sup>) is negligible, and lesions appear similar to the surrounding 64 sound enamel. In the two first cases (Figures 1 and 4), 65 the hypoplasia stain did not allow a total blending. It has been reported that active lesions show only thin 67 and porous surface layers that are easier to infiltrate than inactive lesions.<sup>38</sup> If more inactive lesions are supposed to be infiltrated, the application of ethanol 70 can be used to confirm the complete erosion of the surface layer. The color of desiccated lesions should change during ethanol penetration. If color does not change, ethanol will not reach the lesion body because of surface layer remnants.<sup>34</sup> The depth of hypoplasic 75 lesions, thicker surface layer, and infiltration behavior are similar to those of an inactive lesion, which could 77 probably justify the result of partial blending of the hypoplasia stain. Repetition of HCl erosion was thought 79 of for these cases, but it was decided follow the 80 manufacturer's recommendation strictly. Different 81 application times should be analyzed in future studies. 82 Although enamel microabrasion could have been used, 83 there would have been a high risk of wear that may 84 have required the use of a restorative material. 85

When compared with enamel microabrasion<sup>22</sup> or conventional restorative techniques, resin infiltration is much less invasive,<sup>24</sup> and only negligible tooth substance must be sacrificed by etching and polishing. In the same way as in some bleaching and enamel microabrasion techniques, the esthetic outcome of resin 87

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#### ALTERNATIVE ESTHETIC MANAGEMENT OF FLUOROSIS AND HYPOPLASIA STAINS Muñoz et al

infiltration cannot be precisely predicted.<sup>39</sup> But even if all whitish parts of a lesion do not completely disappear, resin infiltration usually leads to a considerable improvement in appearance.

6 Thus, resin infiltration is a relatively fast treatment 7 option for blending mild-to-moderate fluorosis and 8 hypoplasia stains on labial tooth surfaces because the 9 procedures are applied to the teeth simultaneously 10 unlike enamel microabrasion procedures in which the 11 product is applied tooth by tooth and usually more than 12 one time.

## CONCLUSION

The use of the proposed minimally invasive "infiltrant resin technique" to treat teeth with mild-to-moderate enamel fluorosis may allow significant improvement in 18 the appearance and color uniformity of teeth in a relatively short working time. Although the results in hypoplasia stains related to TDI were partially blended, in general, improvement in these cases was considered successful and recovered the patients' self-esteem. Thus, the resin infiltration technique may be considered 24 a feasible alternative without the need for abrasion and 25 mechanical tooth preparation. Although the results of this case report are encouraging, further evaluation of this technique for different types of lesions and in a 28 larger sample size of patients is required.

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