

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

**MIGUEL ANGEL MUÑOZ**, DDS, MS<sup>\*†</sup>, **LUIS ALFONSO ARANA-GORDILLO**, DDS, MS<sup>\*‡</sup>,  
**GIOVANNA MONGRUEL GOMES**, DDS, MS<sup>\*</sup>, **OSNARA MONGRUEL GOMES**, DDS, PhD<sup>§</sup>,  
**NARA HELLEN CAMPANHA BOMBARDA**, DDS, PhD<sup>||</sup>, **ALESSANDRA REIS**, DDS, PhD<sup>§</sup>,  
**ALESSANDRO DOURADO LOGUERCIO**, DDS, MS, PhD<sup>§</sup>

## 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.

(J Esthet Restor Dent 25:32–39, 2013)

\*PhD Student, School of Dentistry, Department of Restorative Dentistry, State University of Ponta Grossa, Ponta Grossa, Paraná, Brazil

†Adjunctive Professor, Department of Restorative Dentistry, Faculty of Dentistry, Universidad de Valparaíso, Valparaíso, Chile

‡Professor, Department of Restorative Dentistry, School of Dentistry, University Santiago de Cali, Cali, Colombia

§Adjunctive Professor, School of Dentistry, Department of Restorative Dentistry, State University of Ponta Grossa, Ponta Grossa, Paraná, Brazil

||Assistant Professor of Removable Prosthodontics, State University of Ponta Grossa, Ponta Grossa, Paraná, Brazil

## INTRODUCTION

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 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 subsequent optical and physical changes. The critical period for clinically significant dental fluorosis in human maxillary central incisors is during the age range of 15 to 30 months.<sup>5,6</sup> The main consequence of dental fluorosis is compromised esthetics. In its mildest forms, enamel fluorosis appears as loss of translucency at the tip of the summit of the cups of the premolars, molars, or incisal border of the anterior teeth, poorly 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>3,8</sup> Traumatic dental injuries (TDIs) are considered an emerging public health problem.<sup>9,10</sup> TDI to primary teeth may compromise both primary teeth and their permanent 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>

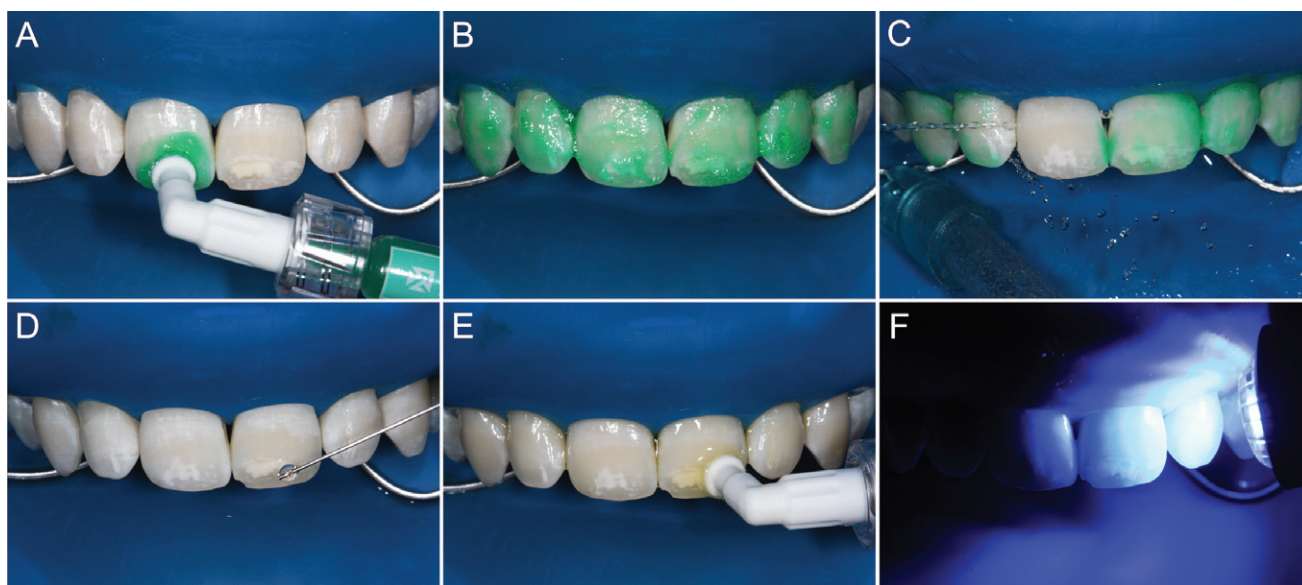
A new material for caries infiltration is an alternative therapeutic approach to prevent further progression of enamel lesions. The goal of this treatment is to occlude the microporosities within the lesion body by infiltration with low-viscosity light-curing resins that have been optimized for rapid 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 1–4); and in the other two cases, as mild fluorosis (Figures 5 and 6). 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



**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.

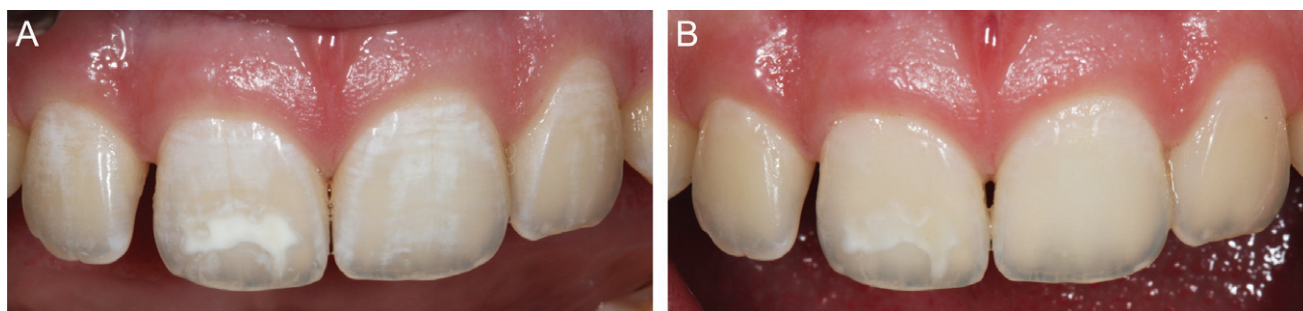


**FIGURE 2.** A–B, Application of conventional rubber dam and erosion of the surface layer with 15% HCl (Icon-etch, DMG); C, subsequently, the etching gel is thoroughly washed away (30 seconds) using water spray; D, lesions desiccated by application of ethanol (Icon-dry, DMG) for 30 seconds and subsequent air-drying; E, application of the resin infiltrant for 3 minutes (Icon-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.

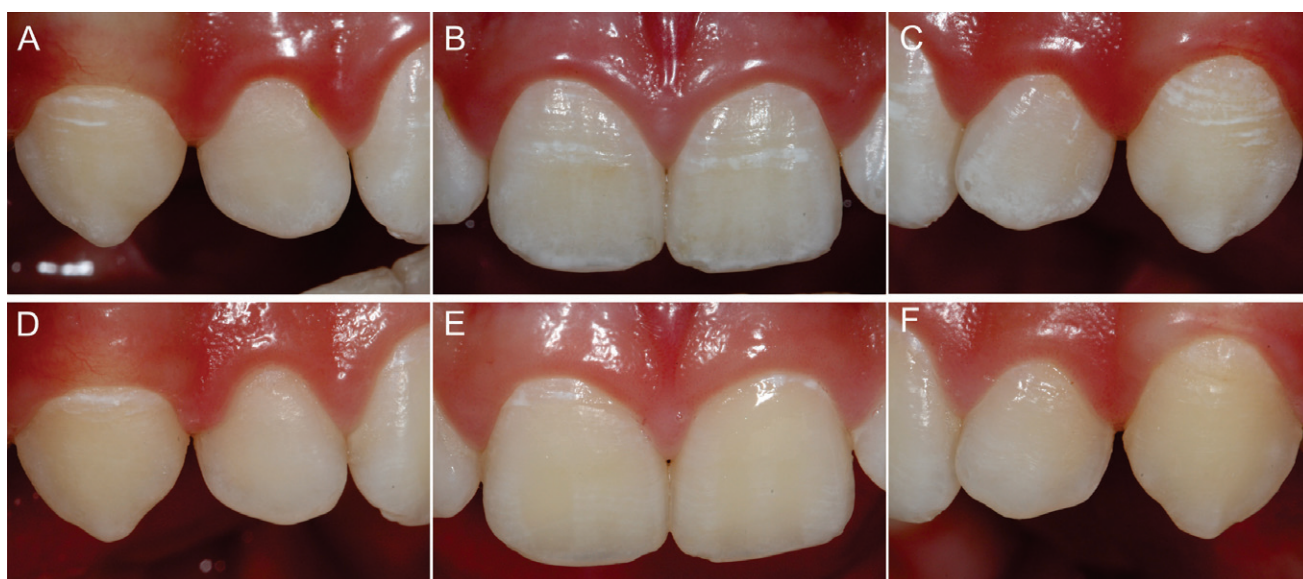


**FIGURE 3.** Improved esthetic result after 4 months. Some trauma-induced staining on the central incisors can be observed probably due to being too deep.





**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.



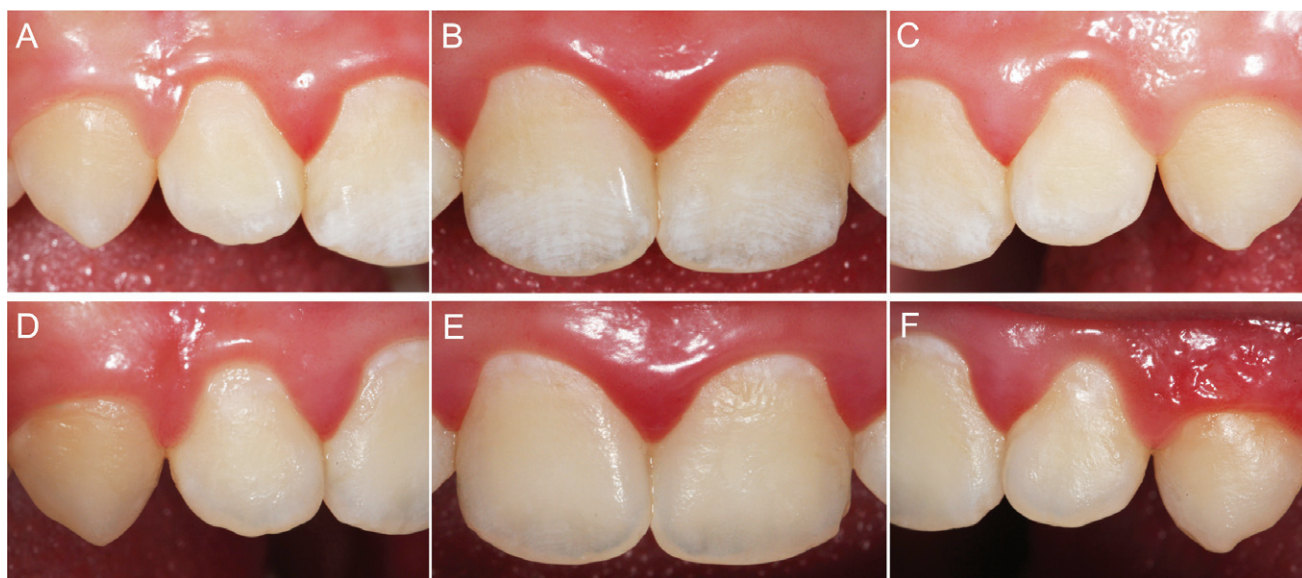
**FIGURE 5.** Case 3, mild fluorosis. A–C, Before treatment; D–F, 1 week after treatment. Improvement in this case was considered successful.

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

Treatment planning was based on alternative minimal intervention, avoiding treatments with more predictable results that would require greater tooth structure reduction, such as microabrasive or macroabrasive procedures. Thus, the enamel infiltration technique with resin infiltrant (Icon, DMG, Hamburg, Germany) was selected for the treatment of all cases presented. Each 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 application of a 15% hydrochloric acid gel (Icon-etch) for 120 seconds (Figure 2B). To achieve a homogeneous



**FIGURE 6.** Case 4, mild fluorosis. A–C, Before treatment; D–F, 1 week after treatment. Improvement in this case was considered successful.

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).

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).

## 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, 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> 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 has been investigated in different types of studies.<sup>30–32</sup> A positive side effect of resin infiltration is that enamel lesions lose their whitish appearance when their microporosities are filled with the resin and look similar 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 has a very low viscosity, low contact angles on enamel, and high surface tensions<sup>36</sup> with properties that optimize their rapid penetration into the capillary structures of the enamel caries lesion body. However, the mineralized 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>

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 the classical techniques of microabrasion<sup>22</sup> and bleaching<sup>37</sup> suggested several risks, although both are considered conservative. However, the resin infiltration technique was considered the treatment option because

no mechanical enamel removal is required for blending. With this technique, only 30 to 40  $\mu\text{m}$  are eroded<sup>24</sup> in contrast with enamel microabrasion with enamel removal of around 360  $\mu\text{m}$  when applied in 5-second intervals and repeated 20 times.<sup>22</sup> Moreover, erosion of sound and demineralized enamel is similar in the two earlier mentioned techniques because no pressure is applied; thus, the enamel loss is marginal.

The stains diagnosed in this case report have the common feature of presenting a high degree of porosity, the factor that makes them noticeable and therefore makes it feasible to treat them with resin infiltration. The visually perceptual improvements in the cases presented are due to blending enamel lesions by resin infiltration, which is based on changes in light scattering within the lesions.<sup>26,34</sup> The opaque appearance of these lesions, especially when they are desiccated, is due to the difference in refractive indexes (RIs) between the enamel crystals and medium inside the porosities that causes light scattering.<sup>38</sup> The microporosities of the lesions are filled with either a watery medium (RI 1.33) or air (RI 1.0).<sup>38</sup> Therefore, when these spaces are filled with resin infiltrant (RI 1.46),<sup>34</sup> the difference in RIs between porosities (1.62 blending<sup>38</sup>) and enamel (1.65<sup>26</sup>) is negligible, and lesions appear similar to the surrounding sound enamel. In the two first cases (Figures 1 and 4), the hypoplasia stain did not allow a total blending. It has been reported that active lesions show only thin 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 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 hypoplastic lesions, thicker surface layer, and infiltration behavior are similar to those of an inactive lesion, which could probably justify the result of partial blending of the hypoplasia stain. Repetition of HCl erosion was thought of for these cases, but it was decided to follow the manufacturer's recommendation strictly. Different application times should be analyzed in future studies. Although enamel microabrasion could have been used, there would have



been a high risk of wear that may have required the use of a restorative material.

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 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.

Thus, resin infiltration is a relatively fast treatment option for blending mild-to-moderate fluorosis and hypoplasia stains on labial tooth surfaces because the procedures are applied to the teeth simultaneously unlike enamel microabrasion procedures in which the product is applied tooth by tooth and usually more than 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 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 a feasible alternative without the need for abrasion and 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 larger sample size of patients is required.

## DISCLOSURE AND ACKNOWLEDGEMENT

The authors do not have any financial interest in any of the companies whose products are discussed in this paper. The authors are also grateful to Dr. Jaime

Sarmiento, Adjunctive Professor, Department of Restorative Dentistry, Faculty of Dentistry, Universidad de Valparaíso, Chile for critical revision of this paper.

## REFERENCES

1. Aoba T, Fejerskov O. Dental fluorosis: chemistry and biology. *Crit Rev Oral Biol Med* 2002;13:155–70.
2. DenBesten PK. Biological mechanisms of dental fluorosis relevant to the use of fluoride supplements. *Community Dent Oral Epidemiol* 1999;27:41–7.
3. Robinson C, Connell S, Kirkham J, et al. The effect of fluoride on the developing tooth. *Caries Res* 2004;38:268–76.
4. Thylstrup A, Fejerskov O. Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. *Community Dent Oral Epidemiol* 1978;6:315–28.
5. Evans RW, Darvell BW. Refining the estimate of the critical period for susceptibility to enamel fluorosis in human maxillary central incisors. *J Public Health Dent* 1995;55:238–49.
6. Bårdsen A. “Risk periods” associated with the development of dental fluorosis in maxillary permanent central incisors: a meta-analysis. *Acta Odontol Scand* 1999;57:247–56.
7. Dean HT. The investigation of physiological effects by the epidemiological method. In: Moulton FR, editor. *Fluorine and dental health*. Washington: American Association for the Advancement of Science 1942;19:23–31.
8. Riordan PJ. Perceptions of dental fluorosis. *J Dent Res* 1993;72:1268–74.
9. Marcenes W, al Beiruti N, Tayfour D, Issa S. Epidemiology of traumatic injuries to the permanent incisors of 9–12-year-old schoolchildren in Damascus, Syria. *Endod Dent Traumatol* 1999;15:117–23.
10. Glendor U. Epidemiology of traumatic dental injuries—a 12 year review of the literature. *Dent Traumatol* 2008;24:603–11.
11. de Amorim Lde F, Estrela C, da Costa LR. Effects of traumatic dental injuries to primary teeth on permanent teeth—a clinical follow-up study. *Dent Traumatol* 2011;27:117–21.
12. von Arx T. Developmental disturbances of permanent teeth following trauma to the primary dentition. *Aust Dent J* 1993;38:1–10.
13. do Espírito Santo Jácomo DR, Campos V. Prevalence of sequelae in the permanent anterior teeth after trauma in their predecessors: a longitudinal study of 8 years. *Dent Traumatol* 2009;25:300–4.
14. Andreasen JO, Sundström B, Ravn JJ. The effect of traumatic injuries to primary teeth on their permanent

- successors. I. A clinical and histologic study of 117 injured permanent teeth. *Scand J Dent Res* 1971;79:219–83.
15. Diab M, elBadrawy HE. Intrusion injuries of primary incisors. Part III: effects on the permanent successors. *Quintessence Int* 2000;31:377–84.
16. Carvalho V, Jacomo DR, Campos V. Frequency of intrusive luxation in deciduous teeth and its effects. *Dent Traumatol* 2010;26:304–7.
17. Akpata ES. Occurrence and management of dental fluorosis. *Int Dent J* 2001;51:325–33.
18. Croll TP, Cavanaugh RR. Enamel color modification by controlled hydrochloric acid-pumice abrasion. I. Technique and examples. *Quintessence Int* 1986;17:81–7.
19. Waggoner WF, Johnston WM, Schumann S, Schikowski E. Microabrasion of human enamel in vitro using hydrochloric acid and pumice. *Pediatr Dent* 1989;11:319–23.
20. Ardu S, Castioni NV, Benbachir N, Krejci I. Minimally invasive treatment of white spot enamel lesions. *Quintessence Int* 2007;38:633–6.
21. Loguercio AD, Correia LD, Zago C, et al. Clinical effectiveness of two microabrasion materials for the removal of enamel fluorosis stains. *Oper Dent* 2007;32:531–8.
22. Tong LS, Pang MK, Mok NY, et al. The effects of etching, micro-abrasion, and bleaching on surface enamel. *J Dent Res* 1993;72:67–71.
23. Paris S, Meyer-Lueckel H, Kielbassa AM. Resin infiltration of natural caries lesions. *J Dent Res* 2007;86:662–6.
24. Meyer-Lueckel H, Paris S, Kielbassa AM. Surface layer erosion of natural caries lesions with phosphoric and hydrochloric acid gels in preparation for resin infiltration. *Caries Res* 2007;41:223–30.
25. Meyer-Lueckel H, Paris S. Improved resin infiltration of natural caries lesions. *J Dent Res* 2008;87:1112–6.
26. Rocha Gomes Torres C, Borges AB, Torres LM, et al. Effect of caries infiltration technique and fluoride therapy on the colour masking of white spot lesions. *J Dent* 2011;39:202–7.
27. Reston EG, Corba DV, Ruschel K, et al. Conservative approach for esthetic treatment of enamel hypoplasia. *Oper Dent* 2011;36:340–3.
28. Chandra S, Chawla TN. Clinical evaluation of the sandpaper disk method for removing fluorosis stains from teeth. *J Am Dent Assoc* 1975;90:1273–6.
29. Limeback H, Vieira AP, Lawrence H. Improving esthetically objectionable human enamel fluorosis with a simple microabrasion technique. *Eur J Oral Sci* 2006;114(Suppl 1):123–6; discussion 127–9, 380.
30. Meyer-Lueckel H, Paris S. Progression of artificial enamel caries lesions after infiltration with experimental light curing resins. *Caries Res* 2008;42:117–24.
31. Paris S, Hopfenmuller W, Meyer-Lueckel H. Resin infiltration of caries lesions: an efficacy randomized trial. *J Dent Res* 2010;89:823–6.
32. Paris S, Meyer-Lueckel H. Inhibition of caries progression by resin infiltration in situ. *Caries Res* 2010;44:47–54.
33. Kielbassa AM, Muller J, Gernhardt CR. Closing the gap between oral hygiene and minimally invasive dentistry: a review on the resin infiltration technique of incipient (proximal) enamel lesions. *Quintessence Int* 2009;40:663–81.
34. Paris S, Meyer-Lueckel H. Masking of labial enamel white spot lesions by resin infiltration—a clinical report. *Quintessence Int* 2009;40:713–8.
35. Phark JH, Duarte S Jr, Meyer-Lueckel H, Paris S. Caries infiltration with resins: a novel treatment option for interproximal caries. *Compend Contin Educ Dent* 2009;30(SpecNo 3):13–7.
36. Paris S, Meyer-Lueckel H, Cölfen H, Kielbassa AM. Penetration coefficients of commercially available and experimental composites intended to infiltrate enamel carious lesions. *Dent Mater* 2007;23:742–8.
37. Lee SS, Zhang W, Lee DH, Li Y. Tooth whitening in children and adolescents: a literature review. *Pediatr Dent* 2005;27:362–8.
38. Kidd EA, Fejerskov O. What constitutes dental caries? Histopathology of carious enamel and dentin related to the action of cariogenic biofilms. *J Dent Res* 2004;83(Spec No C):C35–8.
39. Kim S, Kim EY, Jeong TS, Kim JW. The evaluation of resin infiltration for masking labial enamel white spot lesions. *Int J Paediatr Dent* 2011;21:241–8.

---

Reprint requests: Alessandro Dourado Loguercio, DDS, MS, PhD, Universidade Estadual de Ponta Grossa—Pós-graduação em Odontologia, Rua Carlos Cavalcanti, 4748, Bloco M, Sala 64A—Uvaranas, 84030-900, Ponta Grossa, Paraná, Brazil; email: aloguercio@hotmail.com  
This article is accompanied by commentary, Alternative Esthetic Management of Fluorosis and Hypoplasia Stains: Blending Effect Obtained with Resin Infiltration Techniques, Joe C. Ontiveros, DDS, MS  
DOI: 10.1111/j.1708-8240.2012.00528.x



Copyright of Journal of Esthetic & Restorative Dentistry is the property of Wiley-Blackwell and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.