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Clinical Technique/Case Report

Treatment of Fluorosis Spots Using a Resin Infiltration Technique: 14-month Follow-up

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Clinical Relevance

Moderate fluorosis spots may be treated by the infiltration of low-viscosity resin-based material.

SUMMARY

The aim of this study was to report a clinical case of moderate fluorosis spots treated with infiltration of low-viscosity resin. A commercial resin was applied to the facial surfaces on the anterior teeth in both the maxillary and mandibular arches. The white spots of fluorosis lost their whitish appearance and appeared similar to sound enamel. This technique, which might constitute an alternative to white-masking of fluorosis spots, showed optimal esthetic results.

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INTRODUCTION

Dentists often encounter patients who have extrinsic or intrinsic changes in tooth color. Examples include tooth discolorations with white spots, which are often caused by an excess of ingested fluoride, leading to dental fluorosis.[1] Fluorosis can be caused by foods and fluids originating from soils containing fluoride, as well as by drinking water that has been fluoridated.[2,3] Fluorosis spots are clinically characterized by being opaque, and they histologically involve hypomineralization or porosity of the enamel.[4]

The treatment options for fluorosis are limited. For the mildest forms of fluorosis, bleaching has been recommended.[5,6] Clinical treatments for moderate dental fluorosis include enamel microabrasion, in which the outer affected layer of enamel is abraded from the tooth surface in an acidic environment.[7-10] For severe spots, composite restorations combined with enamel microabrasion or the application of esthetic veneers can be performed. For more severe cases, prosthetic crowns might be necessary.[5]

A novel technique for incipient caries lesions was recently developed[11]: infiltration of low-viscosity light-cured resins can inhibit demineralization and mask white-spot lesions,[12] showing good clinical applicability for clinicians and very high acceptance

Figure 1. *Clinical aspect of the patient presenting white-yellow spots on all teeth.*

by patients.[13] Case reports and short-term *in vitro* studies have shown that these low-viscosity resins reduced visibility of white-spot lesions as an additional positive effect,[5,12,14-16] due to having a refractive index similar to the enamel.[16,17] Clinical studies have also shown the efficacy of this technique in controlling incipient caries progression and on proximal lesions,[18,19] and it could inhibit further demineralization of white-spot lesions that form during orthodontic treatment.[20] However, little is known about the action of the technique on the white spots of fluorosis.

Therefore, the purpose of this case report is to present a treatment option for patients with moderate fluorosis by using infiltration of low-viscosity resins. Included is the 14-month follow-up to show short-term restoration stability and esthetics.

CASE REPORT

A 26-year-old woman was referred to the dental clinic reporting dissatisfaction with the appearance of her smile. At the initial clinical examination and anamnesis, generalized fluorosis spots in the maxillary and mandibular arches were observed (Figure 1). The periodontal health of the patient was satisfactory, and a radiographic examination revealed no abnormalities of the supporting tissues. The pattern of the demineralization was intense white spots, which were diagnosed as moderate fluorosis, suggesting that infiltration of low-viscosity resins would be a reliable option for this case.

The patient was systemically healthy and presented an overall plaque index and gingival index less than 10%, and the restorative area was free of visible plaque. After careful prophylaxis with oil-

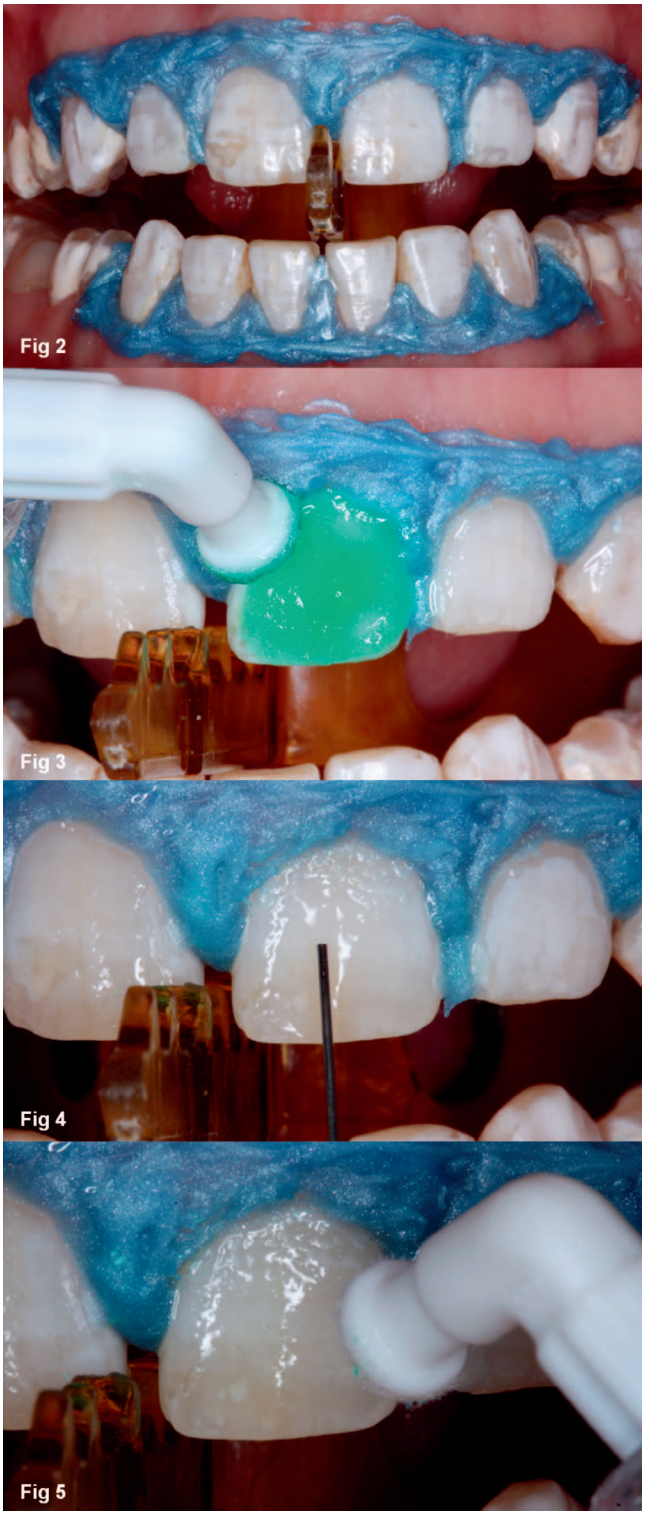

Figure 2. *Immediate aspect of the gingival protection.*
Figure 3. *Initial etching gel aspect (15% hydrochloric acid gel, ICON-Etch).*
Figure 4. *Drying enamel with highly concentrated alcohol (ICON-Infiltrant).*
Figure 5. *Application of the ICON resin infiltration.*

Figure 6. *Immediate clinical aspect after resin infiltration: (a) maxillary and (b) mandibular.*

free paste, the operative field was partially isolated with lip retractor, cotton roll, and a gum shield (Figure 2), as well as eye protection for the patient during the procedure. The resin infiltration technique was performed according to the manufacturer's instructions on the upper and lower premolars, canines, and incisors. The surface layer of enamel was eroded by the application of 15% hydrochloric acid gel (ICON-Etch, DMG, Hamburg, Germany) for 120 seconds (Figure 3). Subsequently, the etching gel was thoroughly washed away for 30 seconds using a water spray and then dried. Then the enamel surfaces were desiccated using ethanol (99%; ICON-Dry, DMG) for 30 seconds, followed by air drying (Figure 4). At this point, low-viscosity resin (ICON-Infiltrant, DMG) was applied to the enamel surfaces of the eroded teeth and was allowed to penetrate for three minutes (Figure 5). Excess material was removed from the surface using a cotton roll before light curing. After the infiltration of the low-viscosity resin, it was light-cured for 40 seconds with an intensity of 1400 mW/cm^2 (Radii LED Curing Light, SDI, Bayswater, Australia). The application of infiltrating resin in the same tooth was repeated once for 1 minute, followed by light curing for 40 seconds.

Finally, the roughened enamel surface was polished with high-luster polishing paste, using goat-hair brushes and cotton buffs (Sof-lex, 3M ESPE, Saint Paul, MN, USA). Immediately after the restoration procedure, a good final aspect was observed (Figure 6a,b). Improvement in appearance was noted after 6 and 14 months (Figure 7).

Figure 7. *Result after 14 months of clinical follow-up.*

DISCUSSION

The described case showed esthetic improvement immediately following application of the low-viscosity resin, which could be an alternative to masking or mitigating the white spots caused by dental fluorosis. The described product was chosen to be a minimally invasive treatment because dentistry has changed dramatically in recent years. Noninvasive or minimally invasive procedures have become the first choice of technique.[21] Furthermore, this treatment was chosen because the patient is young and has healthy teeth without dental caries or other periodontal abnormalities.

Other treatments were excluded due to cost and the possibility of intensive wear on the tooth structure. The best approach was discussed, and the possibilities of direct veneers in composite resin and indirect facets in ceramics were assessed. However, the adhesion required by these techniques led our group to try a more conservative treatment. The patient's initial complaint was the whitish appearance of her teeth and not their diastemas.

Various treatment protocols can be performed depending on the level of involvement and the severity of the fluorosis. Usually, these approaches include enamel microabrasion, which dissolves minerals and removes a thin layer of enamel,[22,23] the extent of removal depending on the type and concentration of acid used, the abrasive particles, and the duration and number of applications.[24] However, there is no consensus regarding how long and in how many repetitions microabrasion should be performed to achieve a good result without exposing the dentin.[1] The inherent consequences can cause discomfort to the patient.[25] Another

potential treatment is bleaching therapy with hydrogen peroxide to mask white fluorosis. Some studies have shown that bleaching is sufficient to improve esthetics.[9,26] Bleaching, such as with carbamide peroxide (10%-20%) and hydrogen peroxide (1%-10%), can be performed in vital teeth.[27] Home bleaching can be used in more resistant cases or when faster results are desired.[28] However, side effects of home bleaching, such as post-treatment sensitivity, are commonly encountered.[26,29] The microabrasion technique and bleaching are widely used because they are conservative. Some dentists have associated the two techniques.[9,30,31]

Esthetic restorations, such as glass ionomer, composite resin, or even prosthetic crowns, are used for white spots,[30] but they involve tooth reduction, which is an invasive treatment.[9,10] The problem with this treatment is that many patients are children or young adults, as was the patient in this case, resulting in excessive wear at an early age.[14]

In 1976, Robinson and others were among the first to describe the infiltration technique for caries lesions using a resorcinol-formaldehyde resin. However, this resin was not used due to its toxicity.[15,32] Recently, a similar technique was developed that aimed to create a barrier inside the caries lesion to replace the lost mineral.[11] A further advantage of this technique was masking of the white-spot lesions of caries.[20] Moreover, demineralized enamel treated with resin infiltration shows approximately the same microhardness and surface roughness of sound enamel, indicating that this material can be used for the treatment of enamel subsurface lesions.[33,34] Additional applications in orthodontics have been proposed. Resin infiltration increases the resistance of healthy enamel to demineralization, showing that pretreatment with resin infiltration is a beneficial approach to increasing the shear bond strength of brackets to demineralized enamel. Furthermore, the bonding to infiltrated enamel has demonstrated good adhesion.[35-38]

White spots are more visible when the teeth are dry because the refractive indices of enamel, water, and air are different.[39] Enamel has a refractive index of 1.62. When enamel is porous, water can fill the pores, and the refractive index decreases to 1.33. When dried, the water in the pores is replaced with air, and the refractive index is equal to 1.0; ie, it is more visible. The infiltration resin fills the pores, rendering white spots negligible because the refractive index becomes very similar to that of healthy enamel (1.52).[17,39,40]

The commercial infiltration product used was based on triethylene glycol dimethacrylate (TEGDMA), a monomer with hydrophilic characteristics, low viscosity, and a high penetration coefficient, which facilitate penetration into the pores of the enamel.[41] It is necessary for the tooth surface to be mineralized for the resin to infiltrate the enamel via the application of hydrochloric acid. Fluorosis spots already have porous enamel; therefore, the resin can penetrate more easily. Ethanol at a 99% concentration is used to remove water from the pores, facilitating the resin's penetration.[41] The resin must be applied twice because the first application causes contraction of the material as the monomers convert to polymers, resulting in the generation of spaces. The second application must fill these spaces.[15] The resin infiltration procedure mimics polishing, as it combines acid erosion and resin infiltration of the enamel surface. This process occurs because the last resin layer generally undergoes incomplete polymerization due to oxygen inhibition in the superficial layer.[42] In polishing, it is necessary to remove the excess resin, and this removal can also prevent future staining.[17] A previous study showed enamel staining with resin infiltration after immersion in coffee and wine. However, the type of polishing described above reduced such enamel staining.[43]

Sometimes cavities are associated with these spots, and such lesions require restorative treatment.[44,45] Resin infiltration can be used as a bonding agent because it consists of resin monomers, thus facilitating restorative treatment and eliminating the need to use an adhesive system.[35]

We noted an improvement over the course of time (immediately, 6 months, and 14 months), perhaps due to the absorption of water by the resin, which was not completely removed by the alcohol. This absorption can lead to a reduction in optical interfaces in the light path.[46] In this case, the esthetic outcomes of infiltration showed adequate durability for 14 months, and it is the first presentation in the literature about fluorosis spots. Another study showed that at six-month follow-up, only multibracket-induced white spot lesions were observed.[20] Thus, resin infiltration proved to be a good option to mask spots associated with mild to moderate fluorosis. Moreover, it is a relatively quick, inexpensive, and minimally invasive treatment.[47]

Furthermore, resin infiltration has been used for other purposes, such as molar incisor hypomineralization[48] and mechanical barriers between the enamel and dentin to protect against attack by erosive acids.[49] An *in vitro* study showed the effects

of ICON with or without the application of hydrochloric acid and concluded that there is a protective effect against the progression of erosion.[49] However, there have been no data reporting that the infiltration of resin is resistant to acids. In this study, ICON showed surface and morphology aspects that improved the stability and quality of infiltration, which could be beneficial in resisting wear from toothbrushing.[49]

CONCLUSIONS

This case report demonstrated that the resin infiltration technique is a conservative approach that improves the esthetic appearance of white spots from mild to moderate fluorosis, masking them in a short time interval. Furthermore, these esthetic results showed adequate stability over 14 months of follow-up.

Regulatory Statement

This work was conducted in accordance with all the provisions of the local human subject's oversight committee guidelines and policies of Federal University of Pelotas. The approval code is: 96015-560.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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