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Color Masking of Developmental Enamel Defects: A Case Series

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Clinical Relevance

White developmental enamel lesions can be successfully masked using the resin infiltration technique, resulting in a satisfactory esthetic appearance of affected teeth.

SUMMARY

Developmental defects involving color alteration of enamel frequently compromise the esthetic appearance of the tooth. The resin infiltration technique represents an alternative treatment for color masking of these lesions and uniformization of tooth color. This technique is considered relatively simple and microinvasive, since only a minimal portion of enamel is removed. This article illustrates the color-masking effect with resin infiltration of fluorosis and traumatic hypomineralization lesions with a case series. The final esthetic outcomes demonstrated the ability of the resin infiltrant to mask the color of white developmental defect lesions, resulting in satisfactory clinical esthetic improvements. However, in more severe cases, the color-masking effect was not complete.

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INTRODUCTION

Because of patients' increasing desire for esthetic smiles, dentists are more often required to treat abnormalities in tooth color. White color alterations can occur as consequences of post- or pre-eruptive damage.[1] White spot lesions are posteruptive alterations that take place when demineralization overcomes the remineralization, within the dynamics of the carious process. These lesions are characterized by a loss of mineral beneath a pseudo-intact surface layer, and these increased porosities present in the lesion subsurface, resulting in the whitish appearance of enamel.[2,3]

The most frequent pre-eruptive whitish enamel lesions are fluorosis, traumatic hypomineralization, and molar-incisor hypomineralization (MIH). Fluorosis is caused by excessive long-term ingestion of fluoride during tooth development, characterized histopathologically by a relatively well-mineralized outer surface layer, beneath which a diffuse hypomineralization, or porosity in subsurface enamel, occurs.[4,5] Fluoride has been shown to affect predominantly the maturation stage of enamel formation, and the hypomineralization increases with the fluoride exposure, reflecting in different degrees of severity, with increasing clinical effects in the esthetic appearance of the teeth.[6] The clinical manifestation of milder forms of fluorosis-induced enamel changes appears as narrow white lines following the perikymata, cuspal snowcapping, and a snowflaking appearance without defined bor-

ders.[7,8] The main characteristic of this damage is the symmetrical involvement of homologous teeth and often the involvement of several groups of teeth.[1]

The traumatic hypomineralized lesion is a consequence of a periodontal disturbance involving the primary tooth, affected by luxation (displacement) injuries, during the mineralization phase of the permanent tooth.[1] In addition, periapical infection of a deciduous tooth can also affect the germ of its permanent successor.[9] The degree of damage to the permanent successor depends on the stage of crown formation, with clinical appearance varying in extension, limits, shape, location, and color. These discolorations are the result of an accelerated deposition of minerals and are generally punctiform, well defined, present in the incisal third of tooth crowns, and often limited to one tooth.[1,10] The histological characteristic of these lesions is similar to white spot demineralizations and fluorosis, since it involves subsurface hypomineralization under a relatively well-mineralized surface.[1,7]

Molar incisor hypomineralization is defined as hypomineralization of systemic origin in at least one of the four permanent first molars, frequently associated with affected incisors.[11] The lesions often present a surface layer with increased mineral content, but the nature of MIH-affected enamel is highly variable regarding mineral content, hardness, and porosity.[12] In MIH defects, hypomineralization begins at the enamel-dentin junction and not at the surface of the enamel, and in mild cases, it is often situated in the inner third of the thickness of enamel.[1]

All of these conditions result from a reduction of the mineral phase, altering the chemical composition of enamel and, consequently, its optical characteristics. However, in each case, the hypomineralization assumes distinct topographical forms.[1] The correct diagnosis is essential to determine the most adequate treatment for each particular discoloration, which involves bleaching, microabrasion, resin infiltration, and, in the most severe cases, restorations.

The resin infiltration technique was introduced as an alternative therapeutic approach based on the penetration of a low-viscosity resin, with high penetration coefficient, into the intercrystalline spaces of the porous lesion, rehardening the demineralizing tissue and inhibiting further progression of the enamel caries lesions.[13,14] In addition, as the subsurface lesions are filled with resin, a positive effect regarding color masking of the whitish lesions can be observed; therefore, this technique has been used in esthetically compromised areas.[3,15]

These masking effects were initially observed in enamel carious lesions, with satisfactory outcomes demonstrated in both *in vitro* investigations[16,17] and clinical cases.[3,18] This motivated the application of the resin infiltration technique as an attempt to mask white lesions resulting from developmental defects, such as fluorosis and traumatic hypomineralization injuries.[19]

The objective of this clinical case series is to describe the resin infiltration technique for masking developmental enamel lesions presenting white discolorations, illustrating the clinical steps related to the technique and the immediate esthetic outcomes.

CLINICAL CASES REPORT

This article presents a case series of five patients aged between 17 and 26 years who exhibited enamel white discolorations in esthetically compromised tooth areas. Anamnesis and clinical assessment were performed to determine the etiology of discolorations. All patients or parents signed an informed consent authorizing the treatments and use of images. The treatment decision was based on minimal intervention dentistry, using the resin infiltration technique with low-viscosity resin (Icon, DMG, Hamburg, Germany) as an attempt to mask these lesions.

Cases 1 and 2 (Figures 1 and 2) were diagnosed as very mild and mild-to-moderate fluorosis. Case 3 (Figure 3) was considered fluorosis associated with hypomineralized and hypocalcified defects. Cases 4 and 5 (Figures 4 and 5) were classified as hypomineralized spots resulting from injuries to the permanent incisor as a consequence of trauma to the primary tooth.

When lesions were close to the gingival margin, a conventional rubber dam with ligatures was used to protect the oral soft tissues, deflect the gingival tissue, expose the cervical portion of the tooth, and provide a clean and dry working field. On the other hand, when no deflection of the gingival tissue was necessary, a resinous gingival barrier (liquid rubber dam) was used.

After cleaning with prophylaxis pumice, the affected areas were etched with 15% hydrochloric acid (Icon-etch) for two minutes and then washed with water spray for at least 30 seconds. At this time, the lesions were assessed for color alteration, and if

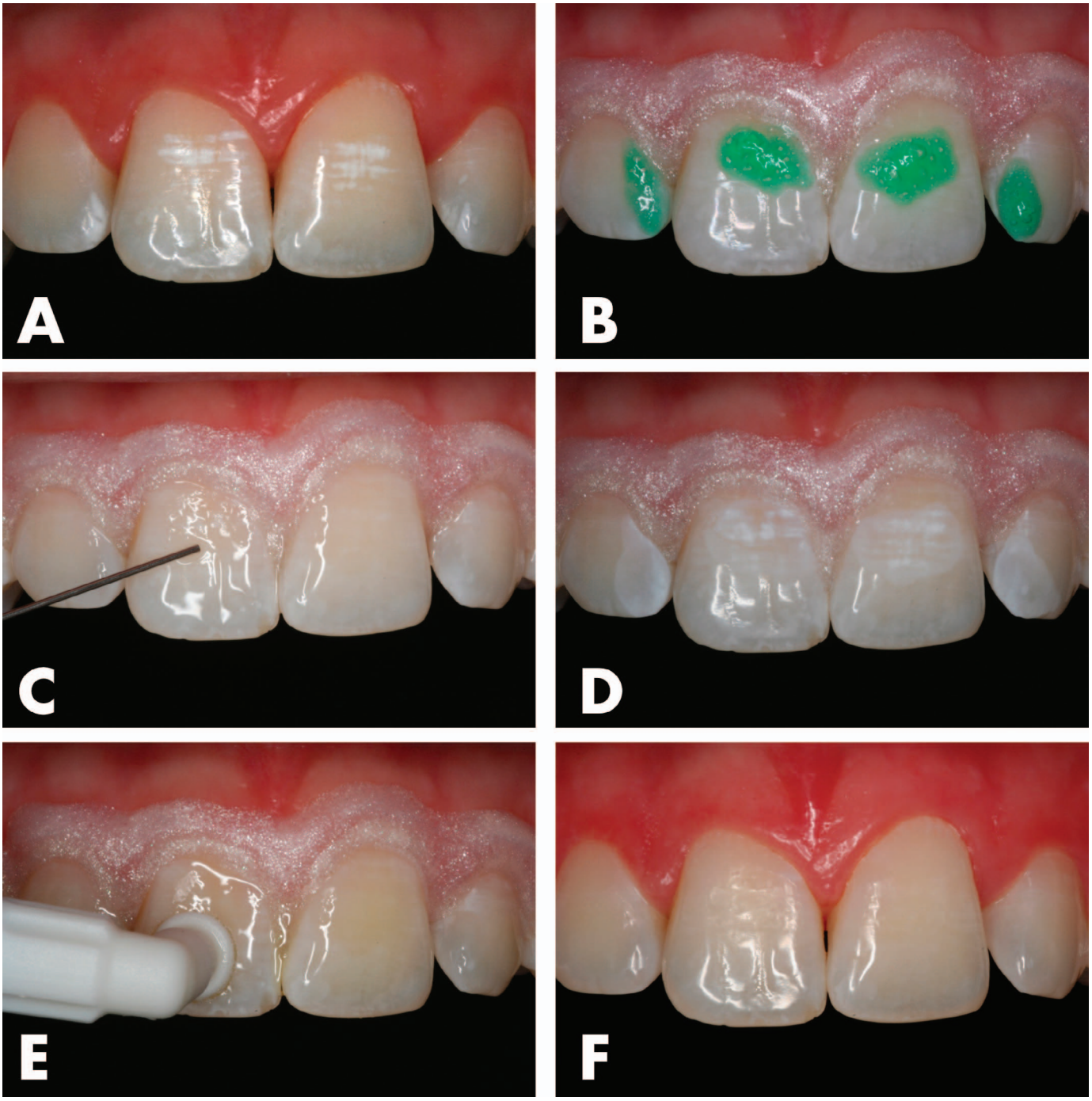

Figure 1. *Case 1, fluorosis TF 1. (A): Preoperative view, with white color alteration in the middle portion of the central incisors, corresponding to the position of the perikymata and a slight snowcapping of mesial angles of lateral incisors. (B): Resinous gingival barrier in position and 15% hydrochloric acid application (three applications of two minutes). (C): Ethanol application, with preview of the masking effect. (D): Enamel appearance after drying. (E): Infiltration of the resin. (F): Postoperative view with improved esthetic appearance.*

no visual color change was obtained with water, the etchant was applied again for an additional two minutes, until some color alteration could be observed at the wet eroded surface. The surface was then air dried, and ethanol (Icon-dry) was applied for 30 seconds to maximize the water removal inside the lesions. The lesions were air dried again, and the surfaces exhibited a chalky white appearance. The resin infiltrant (Icon) was then applied on the lesion surface, and it was allowed to penetrate for three minutes. Excess resin was removed using a blow of air, and light curing was performed for 40 seconds.

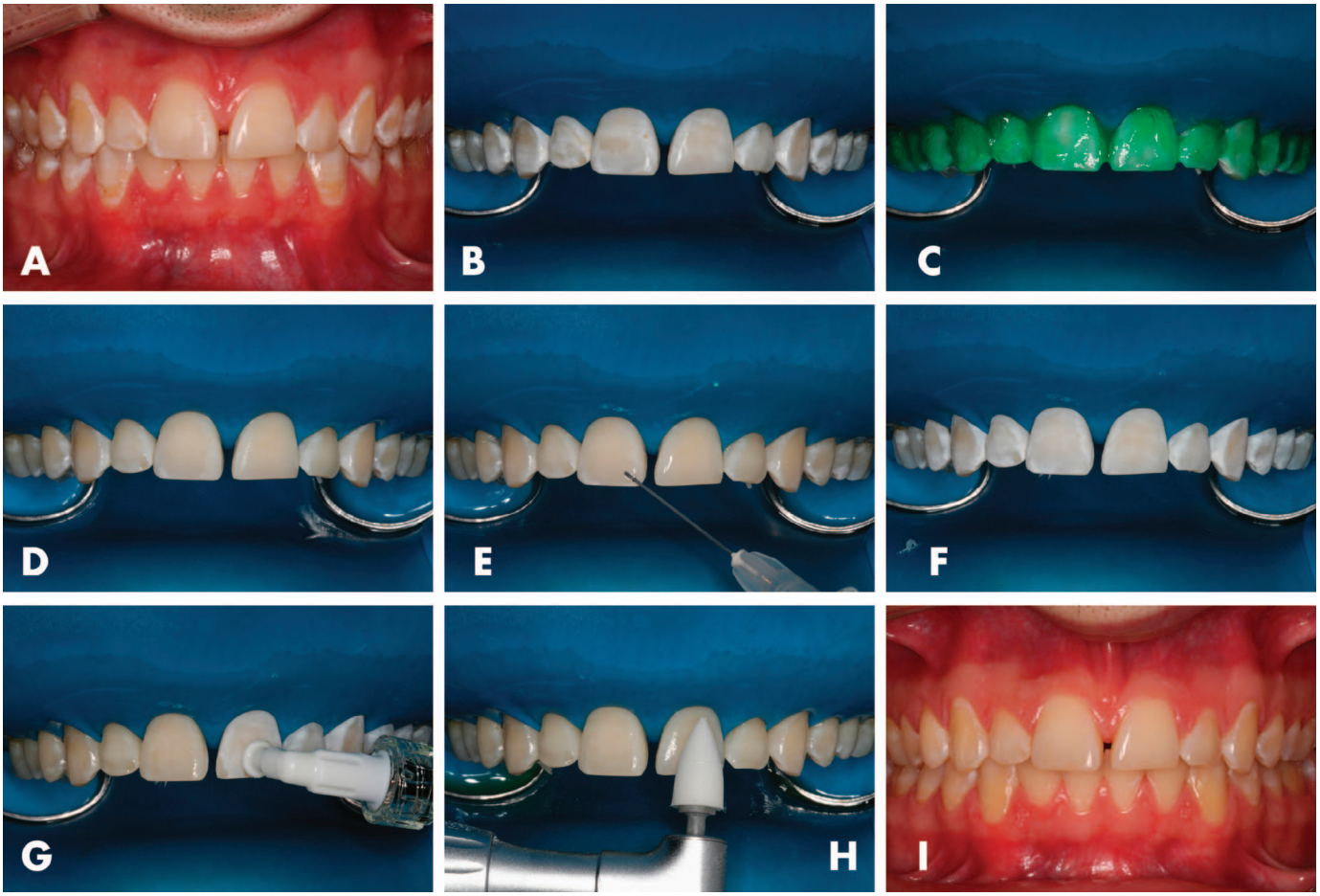

Figure 2. *Case 2, fluorosis TF 3. (A): Preoperative view, with irregular cloudy white areas spread over the crowns. (B): Rubber dam positioned in the superior arch. Ligatures were performed in all affected teeth with the knot in the lingual side. (C): Fifteen percent hydrochloric acid application (two minutes in all teeth and two additional applications of two minutes in the most affected areas) (D): Wet eroded surface, exhibiting a preview of the masking effect (E): Ethanol application. (F): Enamel appearance after drying. (G): Infiltration of the low-viscosity resin. (H): Polishing procedures. (I): The same technique was repeated in the lower arch, postoperative view with improved esthetic appearance.*

The resin infiltrant application was repeated for one minute, followed by light curing for 40 seconds. The surfaces were polished using fine-grained abrasive flexible discs, rubber points, and finishing strips, depending on the treated area. An immediate esthetic improvement, with partial or total color masking, could be observed after treatment. The final pictures were obtained one week after the end of the treatment, allowing rehydration of the teeth and gingival tissue repair.

DISCUSSION

Contemporary dentistry often endeavors to offer clinical solutions for dental problems with minimal involvement of sound tooth tissues. Different approaches have been used to improve the esthetic appearance of white hypomineralization lesions. Tooth-whitening techniques have been employed, with the aim of bleaching regular enamel, camouflaging the white-involved areas, and making the tooth color more uniform. Nevertheless, the results are not always satisfactory, and in many cases, microabrasion with pumice and hydrochloric acid needs to be performed. Enamel microabrasion can produce acceptable esthetic improvement in shallow lesions,[20] and although the amount of enamel loss is related to the acid type and concentration, abrasive particles, duration and number of applications, and

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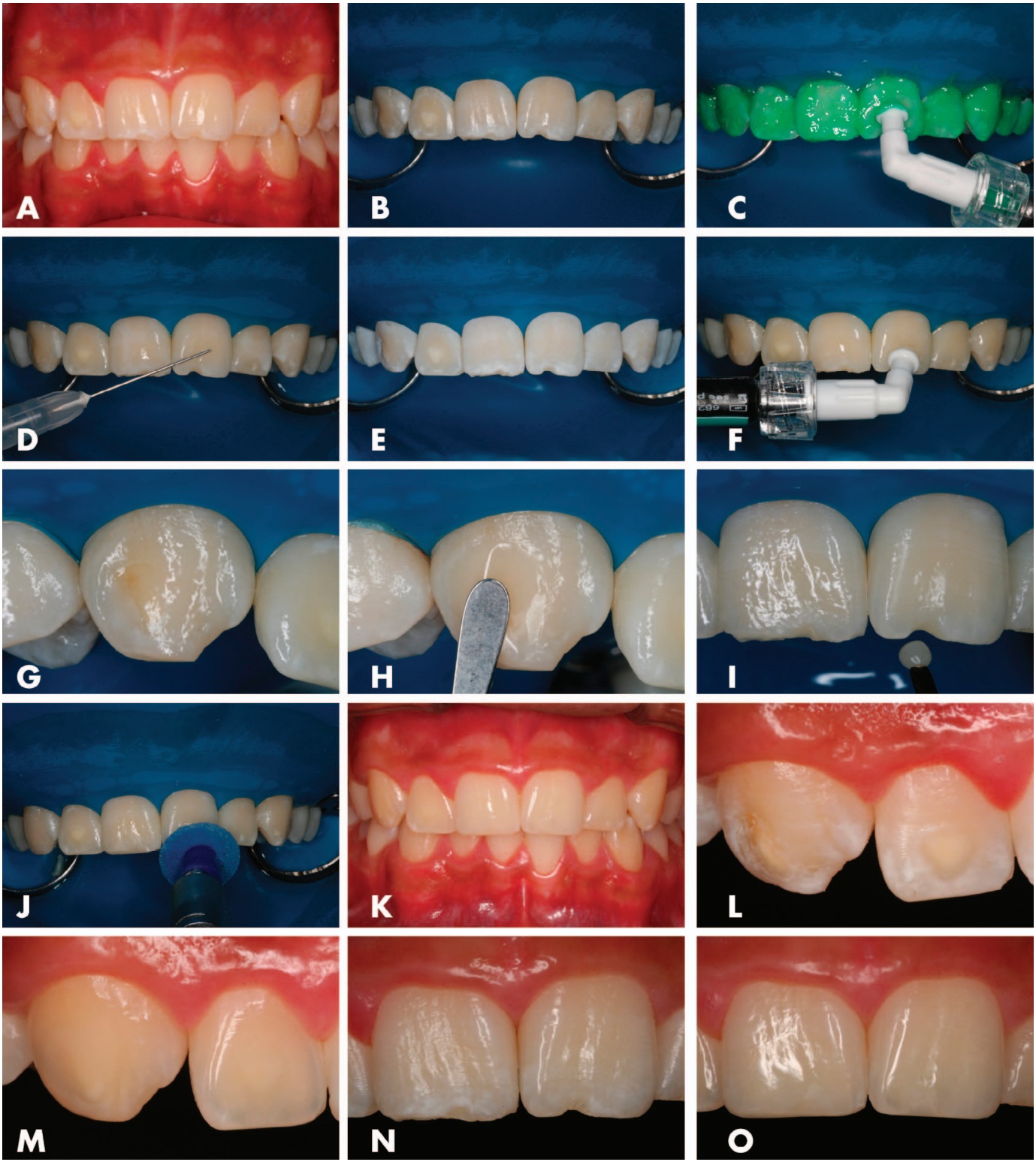
Figure 3. *Case 3, fluorosis TF 1 associated with hypoplasic defects. (A): Preoperative view, with very mild fluorosis distributed through the teeth, hypocalcificacion defect in the central part of the right lateral incisor, and hypoplasic defects in the superior right canine and incisal borders of central*



maxillary incisors. (B): Rubber dam in place. (C): Fifteen percent hydrochloric acid application for two minutes in the labial face of the teeth; two additional applications were performed in the lateral incisor and canine for two minutes each. (D): Ethanol application, showing a preview of the masking effect. (E): Enamel appearance after drying. (F): Resin infiltration. (G): Aspect of the maxillary canine after infiltration. (H): Composite resin restoration of the hypoplasic area, using the infiltration resin as the bonding agent. (I): Restoration of the incisal defects. (J): Polishing of composite restorations. (K): Postoperative view, with satisfactory improvement of esthetic appearance. (L): Preoperative view of the right canine and lateral incisors. (M): Teeth after resin infiltration and restoration of canine. (N): Preoperative view of the central incisors. (O): Upper central incisors after infiltration of the labial side and restoration of the incisal border..

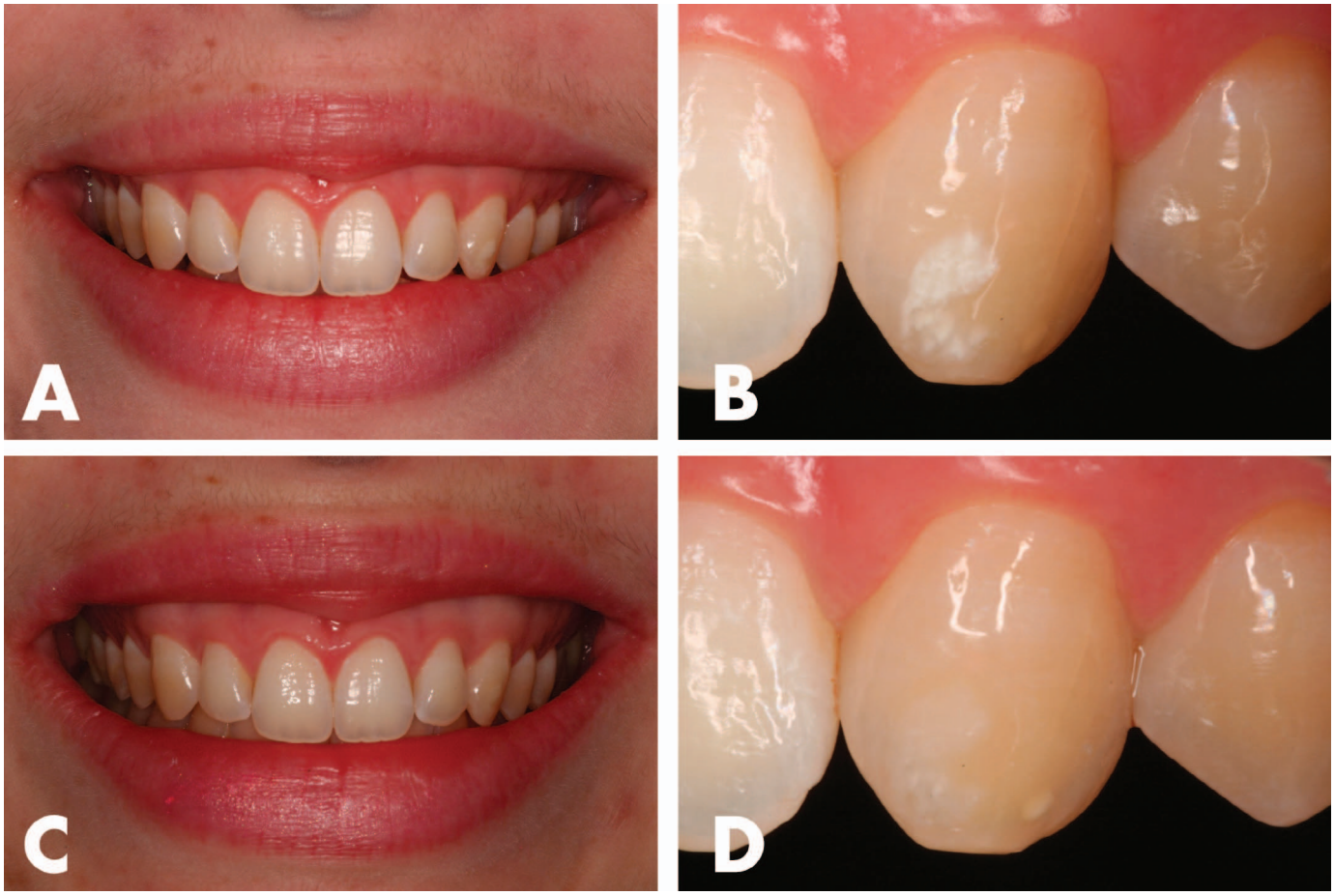


Figure 4. *Case 4, hypomineralized enamel defect, related to injury affecting the antecessor primary tooth. (A and B): Preoperative view, showing the white color alteration in the middle portion of the left superior canine, extending to incisal. (C and D): Postoperative view with improved esthetic appearance. Although some areas still exhibit staining, probably due to the greater depth, a satisfactory outcome was obtained.*

pressure, it invariably results in considerable enamel reduction.[21,22]

The resin infiltration technique is based on the penetration of a low-viscosity resin inside the capillary structure of the hypomineralized subsurface layer. Nevertheless, the surface layer hampers resin penetration because of its low pore volume. Thus, the hydrochloric acid is used to promote superficial erosion, removing about 30-40 μm of the surface, enabling the material to infiltrate the porous lesion.[23] Since the refractive index of the infiltrant material ($RI_{Icon} = 1.52$) is close to enamel ($RI_{hydroxyapatite} = 1.62\text{-}1.65$), when the lesion is filled, the optical properties of affected enamel are modified and lesions are masked.[17]

In the previously described white discolorations, the mineral phase is diminished and replaced by organic fluids, therefore altering the chemical composition of enamel. This causes a difference in the refractive index of enamel, since there are two different phases, altering the light scattering and causing the whitish appearance.[1]

Since the fluorotic and hypomineralized enamel exhibits a subsurface reduced mineral content, similar to an initial caries lesion, the indication of the low-viscosity infiltration resin technique was recently broadened to mask the undesirable esthetic appearance in these cases.[19,24] Nevertheless, because of the high variety of traumatic hypomineralization topographic characteristics, the results of treatment using infiltration are difficult to predict. In fact, this case series presents an improvement of the esthetic appearance of the white discolorations, with patient satisfaction. However, the masking effect was not always complete, mainly in the cases of traumatic hypomineralized discolorations. This may be related to the histology of these defects, since their depth and morphology are highly variable. In some cases, the defect presents a circular shape, forming an acute angle with the enamel surface,

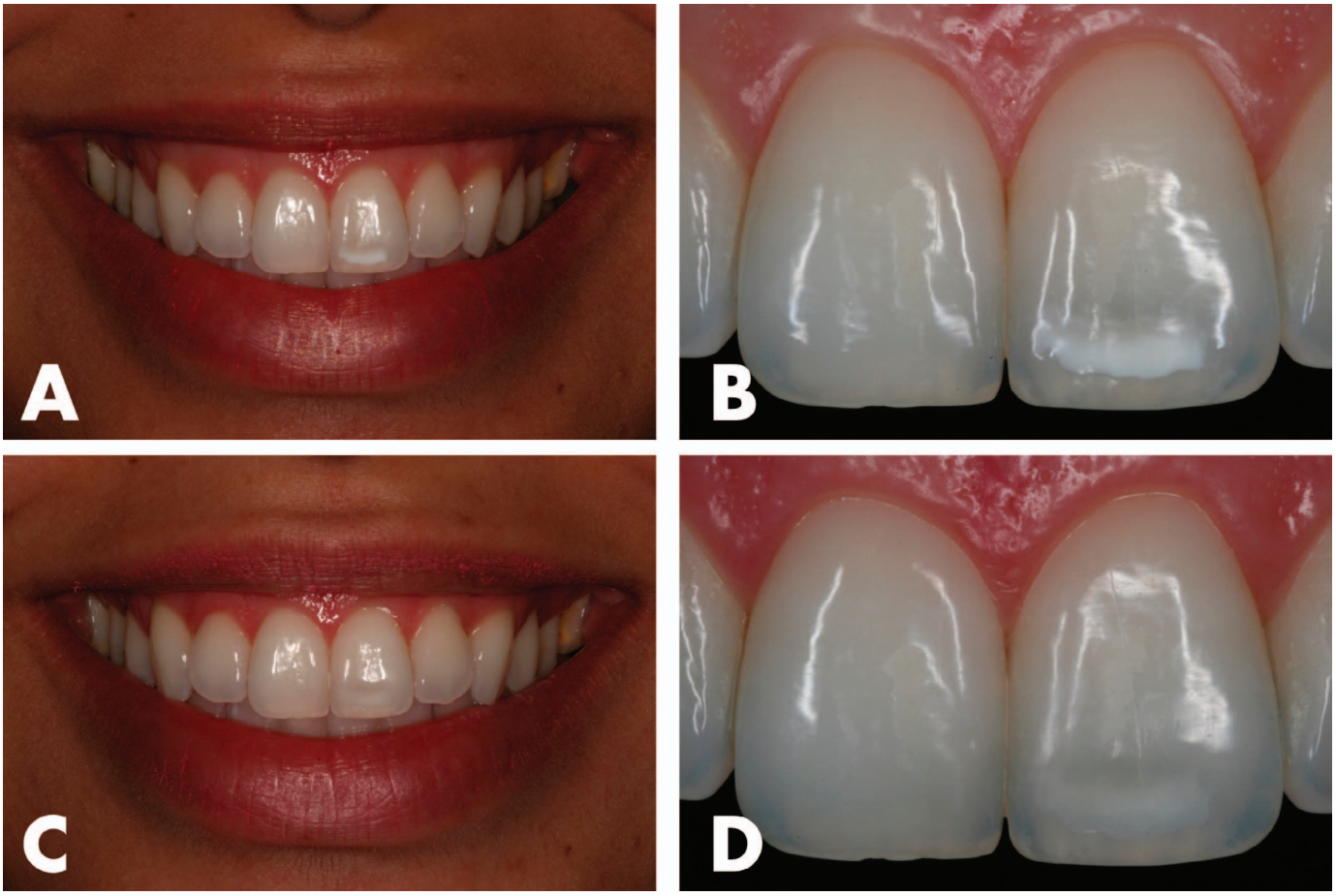


Figure 5. *Case 5, hypomineralized enamel developmental white defect, caused by trauma affecting the primary tooth. (A and B): Preoperative view, showing the delimitated white color alteration in the incisal part of the right central incisor. (C and D): Postoperative view with improved esthetic appearance. In this case, the hydrochloric acid was applied three times (two minutes each application). The lesion was satisfactory masked, although a slight white discoloration can still be observed after infiltration.*

which hampers the infiltration of the resin on the margins and results in a visual contouring of the lesion known as the "edge effect."[1] Since the hydrochloric acid eliminates the surface layer, it allows further infiltration into the center part of the lesion. If the margins of the lesion do not contact the enamel surface (because of the acute angle formed), the erosion does not occur in the surface of the lesion but in the surface of the sound enamel, preventing the penetration of the resin in the outline.[1] On the other hand, in fluorosis and carious white spot lesions, the angle formed between the lesion and the surface is obtuse, providing a more efficient infiltration of the lesion after erosion.[1]

A very important aspect related to the infiltration technique is the protection of the gingival margin, given that the hydrochloric acid should not contact the soft tissues. Especially in cases of fluorosis (and carious white spot lesions), the color alteration can be spread throughout the crown, reaching the cervical area of the tooth. Thus, the placement of the rubber dam is critical, since appropriate ligatures on all affected teeth are needed (as shown in cases 2 and 3). These ligatures retract the gingival tissue, exposing completely the cervical area of the tooth, allowing the infiltration of this region, and, consequently, avoiding the presence of white discolorations near the gingival margin, which would compromise the esthetic outcomes. However, this procedure should be carefully performed to avoid damage to the gingiva and reduce patient discomfort. The use of a liquid rubber dam is not appropriate in these cases, as it does not retract the gingival tissue and usually covers part of the cervical area of the tooth (as presented in case 1).

In cases in which an additional restorative intervention is combined with infiltration (when hypoplasic defects or cavities are associated with white spot areas), the infiltration resin can be used as bonding agent, since it is based on resinous

monomers, facilitating the restoration technique and eliminating the need to use an adhesive system as a separate step.[25]

In addition, it should be pointed out that resin-based materials present an oxygen-inhibited superficial layer, which could be more susceptible to surface staining because of incomplete polymerization.[26] Attempts to deal with this are the application of an air barrier before light curing, such as glycerin gel, and/or surface polishing. The *in vitro* results of the staining behavior of the infiltration resin are not completely elucidated, but it was shown that it is important to polish the infiltrated lesions adequately to avoid further surface staining.[17] In a previous study, some staining was observed after immersion of infiltration-treated enamel in coffee and wine. Nevertheless, the repolishing of the specimens reduced these staining effects.[27]

CONCLUSIONS

It can be concluded that the resin infiltration technique can be successfully used to mask fluorosis and hypomineralyzed areas of enamel. This case series presented an improvement of the esthetic appearance of the lesions, with satisfactory outcomes, although in more severe cases, the color masking was not complete.

Conflict of Interest

The authors 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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