

Minimally invasive esthetic management of dental fluorosis: a case report

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Abstract

Dental fluorosis is a dental condition caused by excessive intake of fluoride during enamel formation, which can lead to color abnormalities or defects on the tooth surface. The resultant abnormal appearance ranges in severity from mildly white and opaque to dark brown, which substantially affects patients' esthetic characteristics and self-confidence. Treatment methods include tooth whitening or restoration. This clinical report describes the use of a minimally invasive esthetic technique in a 22-year-old woman with moderate dental fluorosis. The treatment plan included enamel microabrasion, at-home bleaching for 2 weeks, and subsequent resin infiltration for each tooth under a rubber dam. After 2 years of follow-up, evaluation of the patient's esthetic appearance revealed that teeth affected by dental fluorosis could be successfully treated with a minimally invasive technique involving microabrasion, at-home bleaching, and resin infiltration.

Keywords

Dental fluorosis, microabrasion, at-home bleaching, resin infiltration, rubber dam, esthetics, dental enamel

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Introduction

Dental fluorosis (DF) is a developmental disturbance of enamel caused by the intake of a large amount of fluoride during enamel development, resulting in pathological changes to ameloblasts that impede the formation of normal hydroxyapatite crystals.¹ The reported prevalence of decayed, missing, or filled teeth among

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12- to 15-year-old children in the United States decreased from 57.3% between 1988 and 1994 to 50.6% between 1999 and 2004,² while the prevalence of enamel fluorosis among such children increased from 22.6% between 1986 and 1987 to 40.1% between 1999 and 2004.³ This change may be related to the widespread application of ingested fluoride from caries prevention materials (e.g., toothpastes, mouth rinses, drinking water, and dietary supplements).⁴

Changes from DF primarily manifest as abnormal enamel color or shape. According to its severity (measured using Dean's Index), DF can be classified into three main types: mild (chalky), moderate (pigmented), and severe (defective).⁵ Mild DF consists of tiny white striations that are barely noticeable, especially when an affected tooth is wet with saliva and harbors plaque. Moderate to severe fluorosis consists of mottled enamel with brownish discoloration, along with pitting and wear on the enamel surface due to poor enamel mineralization.⁶

Several treatment methods have been proposed to improve the appearance of DF, including the placement of veneers or full crowns, composite restoration, microabrasion, bleaching, and/or resin infiltration.⁷⁻¹⁰ The selection of one or more techniques depends on disease severity. Because most patients seeking DF treatment are young, prosthetic treatment options result in excessive removal of tooth structure.⁷ A minimally invasive esthetic technique is presumably an appropriate option for initial management of DF. Microabrasion is reportedly less effective in the treatment of fluorotic stains, compared with bleaching, and might be useful for removal of mild fluorotic stains.⁸ However, a combination of microabrasion and bleaching has demonstrated greater improvement for teeth with DF.⁹ Enamel infiltration with low-viscosity resins was initially developed for incipient carious

lesions, but has recently been applied in DF treatment; better esthetic results have been achieved by using resin infiltration alone or in combination with at-home bleaching.^{10,11}

In this report, we describe a patient with moderate DF who was successfully treated with a minimally invasive esthetic technique, including enamel microabrasion, at-home bleaching, and subsequent resin infiltration.

Case report

A 22-year-old woman was referred to the Department of Stomatology in Xuzhou Central Hospital for treatment of poor esthetic appearance in all teeth. She complained that her teeth exhibited irregular chalky white and brown spots that substantially affected her appearance and smile (Figure 1); she had not previously undergone treatment to address this complaint. She lived near Xuzhou, China, which is a region rich in coal resources. The combustion of coal and coal bricks has been reported as an important source of gaseous and aerosol fluoride, both of which can easily enter exposed food products and the human respiratory tract.¹² This phenomenon might have contributed to the onset of DF in the patient.

That patient had a bilateral class I molar occlusal relationship and demonstrated



Figure 1. Frontal photograph before whitening treatment. The Tooth Surface Index of Fluorosis score was 4.

good oral hygiene. No signs of gingivitis or restorations were found upon clinical examination. Radiographic examination revealed that all teeth displayed a uniform periodontal ligament space and intact laminae dura. The distribution of chalky, opaque white and brown spots on anterior and posterior teeth supported a diagnosis of DF with a Tooth Surface Index of Fluorosis score of 4 (Figure 1).¹³

The treatment plan proposed to the patient included enamel microabrasion with silicon carbide particles and 6.6% hydrochloric acid slurry, followed by at-home bleaching with a 10% carbamide peroxide gel for 2 weeks (6–8 hours per night) and subsequent resin infiltration treatment.

At the initial visit, the patient provided informed consent for treatment. Rubber dam isolation was implemented bilaterally for all treated teeth (from the first molar to the incisor) to protect gingival tissue. A slurry mixture (Opalustre, Ultradent Products, Inc., South Jordan, UT, USA) was placed on the labial surfaces of the treated teeth. A polishing cup (Opalcups, Ultradent Products, Inc) was then applied for 1 minute with a slow-speed contra-angle handpiece to remove some overmineralized enamel for subsequent tooth bleaching and to flatten the tooth surface. Intermittent water rinses were implemented during enamel microabrasion treatment. This procedure was repeated two times and fluoride varnish was applied.

At-home bleaching was performed 1 week after microabrasion. During this treatment, impressions were obtained using vinyl polysiloxane silicone (Aqualis, Dentsply Sirona Inc., Charlotte, NC, USA) and customized dental arch trays were constructed for at-home bleaching. The patient wore maxillary and mandibular trays with a 10% carbamide peroxide gel (Opalescence PF 10%, Ultradent Products, Inc.) overnight for 14 days. During whitening treatment, the patient brushed her teeth with a desensitization toothpaste each

morning to reduce symptoms of dentin hypersensitivity. Photographs were taken after completion of the at-home bleaching treatment (Figure 2).

Resin infiltration therapy was initiated 2 weeks after completion of the at-home bleaching, following resolution of dentin hypersensitivity. Before resin infiltration, the brown stains on the facial surfaces of maxillary central incisors were removed by means of macroabrasion with a water-cooled fine tapered diamond bur (no. 3195 FF; Mani Inc., Utsunomiya, Japan) (Figure 3). Affected teeth were then rinsed and thoroughly cleaned with a large amount



Figure 2. Teeth with severe dental fluorosis were treated with microabrasion and at-home bleaching. Some brown stains remained in the maxillary central incisors.



Figure 3. Brown stains on the facial surfaces of maxillary central incisors were removed by macroabrasion with a water-cooled fine tapered diamond bur (no. 3195 FF) before resin infiltration.

of water; a rubber dam was placed before the initiation of treatment. A resin infiltration system (Icon, DMG Chemisch-Pharmazeutische Fabrik GmbH, Hamburg, Germany) was used in accordance with the manufacturer's instructions. For this patient, the labial surfaces of her teeth were etched with Icon-Etch gel (three times for 2 minutes each). After the teeth had been rinsed with water and completely dried with Icon-Dry (DMG Chemisch-Pharmazeutische Fabrik GmbH), an ample amount of Icon-Infiltrant (DMG Chemisch-Pharmazeutische Fabrik GmbH) was applied onto the treated tooth surfaces and incubated for 3 minutes, then light-cured for 40 s at 600 mW/cm^2 (Variable Intensity Polymerizer Junior, BISCO Dental Products, Schaumburg, IL, USA). Icon-Infiltrant was re-applied for 1 minute and light-cured. The excess material and rubber dam were removed and the tooth surfaces were polished with polishing paste (Flairesse Prophylaxis Paste, DMG Chemisch-

Pharmazeutische Fabrik GmbH) by means of polishing cups (Figures 4 and 5).

Final evaluation of the treatment outcome was performed at 1 week after completion of resin infiltration therapy. Although minor hypocalcified white spots remained in the cervical regions of the teeth, both the patient and the dentist were satisfied with the results; the final Tooth Surface Index of Fluorosis score was 1 (Figure 6). Moreover, the patient's teeth exhibited excellent esthetic appearance at the 2-year follow-up visit (Figure 7).

Discussion

Excessive fluoride intake hinders the development of enamel in childhood.¹ Scanning electron microscopy analyses have shown that normal enamel exhibits uniform enamel column size, similar crystal size, and a consistent directional arrangement. Mild DF is characterized by uneven



Figure 4. Resin infiltration treatment process. a) Maxillary teeth were etched with an Icon-Etch gel. b) Teeth were completely dried with Icon-Dry. c) Teeth were infiltrated with Icon-Infiltrant. d) The process was repeated on mandibular teeth.



Figure 5. Frontal photograph after resin infiltration treatment.



Figure 6. Frontal photograph at 1 week after completion of treatment. The final Tooth Surface Index of Fluorosis score was 1.



Figure 7. Excellent esthetic appearance was maintained at the 2-year follow-up visit.

enamel surface, wider gaps between enamel columns, larger micropores, and disordered crystal arrangement. Moderate and severe DF are characterized by the loss of

normal enamel column shape and size.¹⁴ With increasing fluoride intake, both the number and depth of pores in the enamel surface gradually increase in teeth with DF; the capacity for adsorption of exogenous pigments also increases, thus providing a physiological basis for the application of bleaching treatment to affected teeth.^{8,14}

Recent research has shown that a single whitening method (e.g., microabrasion or at-home bleaching) is only effective for teeth with mild discoloration; it is difficult to obtain good whitening effects in teeth with DF, especially those with moderate to severe disease.^{8,15} A hard pathological enamel layer may be present on the tooth surface in teeth with DF, which prevents the entry of bleaching agents (e.g., hydrogen peroxide or carbamide peroxide) into the deep layer of enamel. Therefore, our patient first underwent microabrasion treatment with silicon carbide particles and 6.6% hydrochloric acid, as described previously.^{16,17} Through the etching/dissolution effects of hydrochloric acid and grinding effects of silicon carbide particles, approximately 25 to 200 μm of overmineralized enamel tissue can be removed,¹⁸ this enables a bleaching gel with 10% carbamide peroxide to enter deeper enamel layers and achieve thorough tooth whitening. However, enamel is reportedly demineralized after dental bleaching treatment with different concentrations of a carbamide peroxide gel, such that a large number of honeycomb-like pores can be observed in the enamel layer of teeth with moderate or severe DF upon scanning electron microscopy examination.^{14,19–21} Because these honeycomb-like pores between enamel columns are filled with air, which has a distinct refractive index compared with enamel, a chalky appearance remains in teeth with moderate or severe DF when evaluated under natural daylight.

In our patient, following microabrasion and dental bleaching treatments, the tooth

surfaces continued to exhibit a chalky appearance. Resin infiltration treatment was thus performed after at-home bleaching. During infiltration, capillary forces allowed the low-viscosity infiltrant to penetrate into the honeycomb-like lesions in enamel. Because the refractive index of the infiltrant in our patient was similar to that of enamel (the respective refractive indexes of infiltrant and enamel are 1.51 and 1.62),^{22,23} light scattering was reduced; this diminished the visible color differences between enamel and lesions. This change is presumably why resin infiltration has been suggested for the treatment of post-orthodontic white spot lesions²⁴ and appears to be effective for esthetic treatment of DF.^{8,10} After resin infiltration treatment, the chalky appearance was greatly improved in our patient's teeth; her esthetic outcome was much improved when evaluated under natural daylight.

Notably, some in vitro studies have shown that demineralized enamel treated with resin infiltration may lack color stability and be more susceptible to staining;^{25,26} however, the use of a polishing procedure can significantly reduce the color change.²⁷ Our patient underwent a thorough polishing procedure after resin infiltration and subsequently ensured maintenance of oral hygiene, which might have resulted in the excellent esthetic appearance at the 2-year follow-up visit.

In conclusion, the findings in this report imply that the use of a minimally invasive esthetic technique involving enamel micro-abrasion, dental bleaching, and resin infiltration is safe and effective for the esthetic treatment of DF.

Ethics statement

Written informed consent was obtained from the patient for publication of the case report and any accompanying images. This report was approved by Ethics Review Committee of Xuzhou Central Hospital (XZXY-LL-20160120-022).

Declaration of conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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