

Review Article

Dental fluorosis: a review

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ABSTRACT

Ingesting fluoride for prolonged periods or in doses higher than those recommended during enamel formation produces changes from the appearance of very thin white lines to serious structural defects, resulting in a pathological entity known as dental fluorosis. The severity of the changes depends on the amount of fluoride ingested; it is a disease that has an epidemiological behavior with endemic characteristics. The indicated management for TF1 and TF2 lesions is dental whitening or infiltrating resin; for TF3 and TF4 micro abrasion and/or whitening and in TF5 combined technique with macro, micro abrasion and dental whitening. It is essential that public health actions be prioritized to mitigate potential complications due to fluorosis, especially in areas identified as endemic.

Keywords: Dental fluorosis, Teeth whitening, Infiltrative resin, Fluorides

INTRODUCTION

The discovery of the anticariogenic properties of fluorides constituted one of the most important steps in the development of stomatology since it favored the development of effective measures to prevent and control dental caries. However, there is a risk of developing dental fluorosis when fluorides are ingested in concentrations above those recommended.¹

Dental fluorosis is a defect in the development of enamel that may have an etiology related to excessive consumption of fluorides. Some authors consider it as an endemic condition in areas where water has concentrations that exceed 1.5 mg/L, it is generally associated with early stages of development ranging from 20-36 months of life, although it can appear at any time during development.²

Over the past several decades the prevalence of dental fluorosis has increased dramatically in the United States and other countries, reaching almost epidemic numbers. And not only has the prevalence of fluorosis increased, but also its severity. This trend is undesirable, as it increases the risk of enamel defects, aesthetically and in the most severe cases, it can damage dental function. There is evidence that dental fluorosis in its most advanced phases can leave teeth more susceptible to the formation of cavities. In Mexico, a special geographical distribution has been found, see in the Figure 1, that crosses the states of San Luis Potosí, Zacatecas, Guanajuato, Querétaro, and Coahuila, seventeen states in the central, northwest and southwest of the Mexico present natural fluorine contamination in groundwater and its presence has been associated with rocks with quartz, feldspars, fluorite and apatite.³⁻⁵

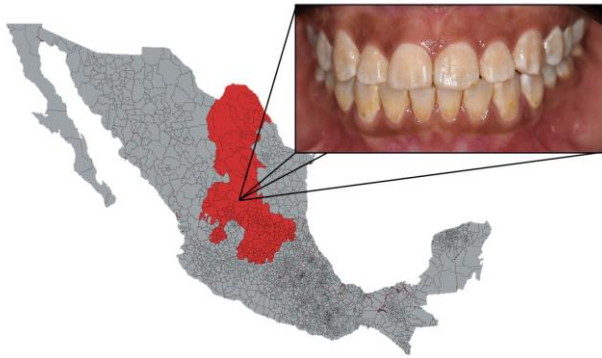


Figure 1: The geographical distribution in Mexico with the highest reports of fluorosis is seen in red.

In Mexico, states such as Durango and Chihuahua where dental fluorosis is considered endemic, up to 9.23 mg/L of fluorides have been reported in tap water.⁶ Vázquez-Bojórquez et al published in its review study in 2022 that

the fluoride content in tap and bottled water in Mexico, particularly in northern and western region, represents a public health problem since levels are above 1.5 mg/L.⁷ In an investigation on prevalence of fluorosis in Mexico in adolescents aged 12-15 years, a prevalence of 53% was identified, finding that there is high prevalence of dental fluorosis ranging from 70-91% in areas with different geographical altitudes, in areas with naturally fluoridated water, prevalence is 30% to 100%, and in areas where fluoridated salt is consumed, the prevalence is 52% to 82% (Figure 2). Level of dental fluorosis can be assessed using the modified Dean index (DI), (Table 1) DI is instrument recommended by world health organization (WHO) to evaluate dental fluorosis.^{5,8} Currently the most useful indices are Thylstrup-Fejerskov index (TFI) and DI.⁹ Regarding TFI it provides a scale from 0-9 in which it evaluates clinical characteristics in relation to histological changes that occur at different levels of severity in fluorosis, including the accumulation of fluoride in enamel, showing biological validity criteria.¹⁰

Table 1: Dean's modified index.

Dean's modified index	
Normal-Healthy (level 0)	The surface of the enamel is smooth, shiny and creamy-white, pale translucent.
Very Mild (level 1)	Small white opaque areas scattered irregularly on the tooth. They affect less than 25% of the labial tooth surface.
Mild (level 2)	White opacity of the enamel greater than that corresponding to level 1. Covers less than 50% of the surfaces.
Moderate (level 3)	White opacity of the enamel greater than that corresponding to level 2. It covers 50% or more of the tooth surfaces.
Severe (level 4)	Significant damage to the enamel surface. Hypoplasia that can affect the general shape of the tooth. The tooth has a corroded appearance and brown spots.
Excluded (level 5 or 9)	Absence of the tooth. Less than a third erupted. Combined with other alterations such as amelogenesis imperfecta. Restorations, fixed prosthesis, fractures or primary teeth.



Figure 2: Adolescent patient with fluorosis. Adolescent male patient with orthodontic treatment who presents dental fluorosis.

PATHOPHYSIOLOGY

During the amelogenesis process, the ameloblasts, which are the cells responsible for the formation of enamel, are required to transport different minerals and amino acids from the plasma to the cell interior in which the process of formation and secretion of enamel proteins will be carried out for the formation of hydroxyapatite, the main proteins involved in this process are amelogenin, ameloblastin, enamelin and tuftelin as well as metalloproteinases such as MMP-20 and kallikrein. Metalloproteinases degrade proteins in the secretion and maturation stage, but when maturation begins, they stop being produced and begin to form kallikrein, which could modify the protein matrix of the enamel as well as remodel the organic area so that that space is occupied by the inorganic part and the hydroxyapatite crystals are thicker.¹¹ The incorporation of fluorine molecules into the enamel structure frequently generates alterations in the

vesicular transport of ameloblasts as well as in the intracellular degradation of matrix proteins, which delays the elimination of proteins and prevents the thickening of the crystals, resulting in incomplete mineralization; It also inhibits kallikrein, responsible for the reabsorption of the organic part, resulting in a structure with weak crystals which produces micro and macroscopic changes from surface anomalies, increased permeability and characteristically presence of opaque whitish spots, striations or fissures, pits of sub-mineralization, and brown pigmentations.^{12,13}

TREATMENT

In recent years, a new, more conservative approach has been developed to stop and control initial carious lesions, using the technique with infiltrative resins, which are characterized by their low viscosity, allowing the inter-crystalline spaces in the demineralized enamel to be filled, occluding the microporosities that they can act as a diffusion route for acids and dissolved materials, thus achieving the formation of a barrier within the lesion,¹⁴ recent scientific evidence has shown that they can be used to treat dental fluorosis.¹⁵⁻¹⁷ The low-viscosity photopolymerizable resin allows rapid penetration into the porous enamel capable of inhibiting demineralization, masking the lesions and obliterating the microporosities within the lesion.¹⁸ When performing the infiltrating resin technique, (Figure 3) the tooth structure is preserved, it mechanically stabilizes the structure of the demineralized enamel, it occludes the micropores in the body of the lesion, there is an absence of post-treatment sensitivity and pulp inflammation, it reduces the probability of gingivitis and periodontal disease, it stops the progression of lesions and reduces the recurrence of cavities without the need to make a cavity, it does not require anesthetics, it provides excellent aesthetic results in a single visit and it is possible to obtain good acceptance by patients.^{19,20}

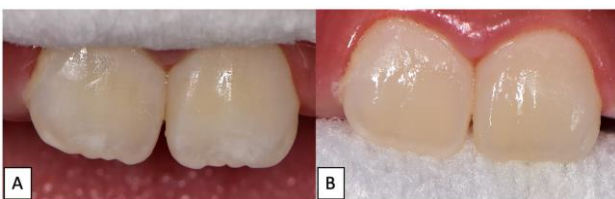


Figure 3: Patient with dental fluorosis (A) before treatment and (B) after treatment.

TECHNIQUE

The technique involves the use of absolute isolation using dental dam, clamps and, if necessary, the use of dental floss, wedges, or transparent matrices. The next thing is to clean the tooth surface by using prophylactic paste without fluoride so as not to interfere with the polymerization of the infiltrating resin; 15% hydrochloric acid is then applied within 2 minutes to etch the surface, rinse for 30 seconds with plenty of water and immediately proceed to air drying. Afterwards, 99%

ethanol is applied for 30 seconds to improve the penetration of the hydrophilic material and the surface is subsequently dried with air. Next, the infiltrative resin is applied, letting it rest for 3 minutes and at the end of the stipulated time, the excess is removed with cotton balls and light-polymerize for 40 seconds. Then, a second application of the infiltrating material is made, letting it rest for 1 minute, the excess is removed, and it is photopolymerized in a time of 40 seconds; This is done to ensure the sealing of some micropores that were not infiltrated in a first application. Finally, the surface is polished.^{14,17} The indicated management for TF1 and TF2 lesions is dental whitening or infiltrating resin; for TF3 and TF4 micro abrasion and/or whitening and in TF5 combined technique with macro, micro abrasion, and dental whitening (Figure 4).¹³

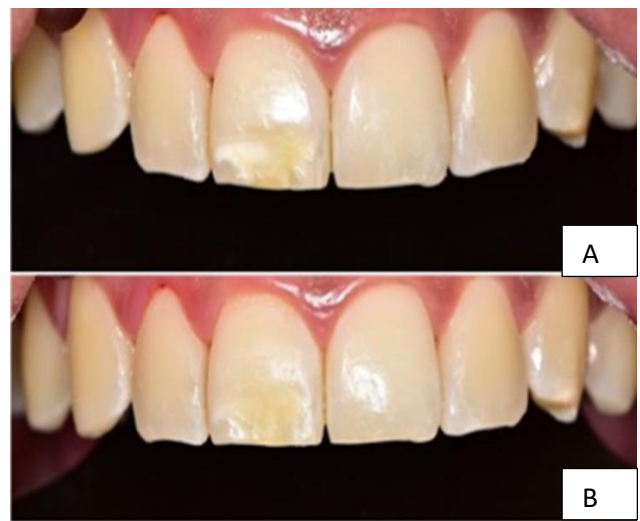


Figure 4 (A and B): Patient with fluorosis, micro-abrasion was performed, without teeth whitening.

DISCUSSION

Chronic consumption that exceeds the established limits of fluorides has been reported as a public health problem in many regions of the world. The most studied effects have been mainly related to skeletal (skeletal fluorosis) and dental (dental fluorosis) alterations; However, in recent years, adverse effects at the cellular and molecular level that affect different organs and systems such as the endothelium, kidney, gonadal, muscle, liver and neurological have been reported with a higher incidence.²¹⁻²³ Dental fluorosis manifests itself with white or brown spots depending on the degree in which it is found and this alteration is due to the excessive accumulation of fluorides in the tooth enamel. Likewise, in recent decades an increase in cases has been noted and therefore Generally, those who come to consultation are young patients, asking to remedy the problem aesthetic through methods that do not damage the teeth. Minimally invasive procedures are focused on preserving tooth structure, in that sense, in the case of dental fluorosis there is treatment with infiltrative resins.¹⁴ In the study by

Gugnani et al. carried out in 2017, they recommend using infiltrative resins to improve the aesthetic appearance of white spots caused by dental fluorosis.²⁴

The most effective treatment for lesions in stages TF1 and TF2 was dental clearance with carbamide peroxide at 15% or hydrogen peroxide at 35% for three sessions of 15 minutes each, reinforced with 10% carbamide peroxide. For stages TF3 and TF4 it was micro abrasion with 6% hydrochloric acid and silicon carbide and/or with dental clearance. For lesion TF5 was the combined technique of macro and micro abrasion with phosphoric acid at 37% or hydrochloric acid at 6%, 15% and 18%, clearance and application of infiltrating resin.¹³

Although infiltrative resin is considered a minimally invasive procedure in carious lesions and white spots, some reasons were found that can alter the success of the treatment, such as: ineffective isolation, incomplete resin polymerization and the depth of the lesion. This material works through the principle of infiltration, which is why it requires a very dry environment. Furthermore, the greater the depth of the lesion, the less likely it is to achieve complete infiltration.^{14,17}

CONCLUSION

It is necessary to provide personalized treatment in which fluorosis indices are used to determine the most effective approach in the treatment of the patient since the treatment of dental fluorosis depends on its severity, resin infiltration can be used over a longer period of infiltration, resin infiltration followed by bleaching or resin infiltration alone. In mild fluorosis, micro abrasion, bleaching, and a combination of both are also suitable treatment options. The indicated management for TF1 and TF2 lesions is dental bleaching or infiltrating resin, for TF3 and TF4 micro abrasion and/or bleaching, and in TF5 a combined technique with macro, micro abrasion, and dental bleaching. Other approaches can also be performed, such as laminated crowns and veneers. However, there have been no randomized controlled clinical trials on crowns and veneers. It is essential that in countries like Mexico where endemic states of fluorosis have been identified, public health actions are prioritized to mitigate potential complications.

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Ethical approval: Not required

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