Dental fluorosis: Exposure, prevention and management

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Abstract

Dental fluorosis is a developmental disturbance of dental enamel, caused by successive exposures to high concentrations of fluoride during tooth development, leading to enamel with lower mineral content and increased porosity. The severity of dental fluorosis depends on when and for how long the overexposure to fluoride occurs, the individual response, weight, degree of physical activity, nutritional factors and bone growth. The risk period for esthetic changes in permanent teeth is between 20 and 30 months of age. The recommended level for daily fluoride intake is 0.05 - 0.07 mg F/Kg/day, which is considered of great help in preventing dental caries, acting in remineralization. A daily intake above this safe level leads to an increased risk of dental fluorosis. Currently recommended procedures for diagnosis of fluorosis should discriminate between symmetrical and asymmetrical and/or discrete patterns of opaque defects. Fluorosis can be prevented by having an adequate knowledge of the fluoride sources, knowing how to manage this issue and therefore, avoid overexposure.

Key words: *Dental fluorosis, fluoride sources, prevention, dentistry management.*

Introduction

Dental fluorosis is a developmental disturbance of dental enamel, caused by successive exposures to high concentrations of fluoride during tooth development, leading to enamel with lower mineral content and increased porosity. The severity of dental fluorosis depends on when and for how long the overexposure to fluoride occurs, the individual response, weight, degree of physical activity, nutritional factors and bone growth, suggesting that similar dose of fluoride may lead to different levels of dental fluorosis (1). Other factors that may increase the individual susceptibility to dental fluorosis are altitude (2), malnutrition (3) and renal insufficiency (4).

Esthetics changes in permanent dentition are the greatest concern in dental fluorosis, which are more prone to occur in children who are excessively exposed to fluoride between 20 and 30 months of age. It is also important to remind that the critical period to fluoride overexposure is between 1 and 4 years old, and the child would not be at risk around 8 years old (5).

The safe level for daily fluoride intake is 0.05 to 0.07 mg F/Kg/day. Above this level, the risk of developing fluorosis due to chronic fluoride consumption will be evident (6).

Researches in areas with or without the addition of fluoride (F) in drinking water have identified 4 sources that increase the risk for dental fluorosis, which are: fluoridated drinking water, fluoride supplements, topical fluoride (especially fluoride toothpastes), and formula prescribed for children. Furthermore, some children's industrialized food can also have an important contribution to daily consumption of fluoride.

The use of fluoride is considered an important factor in the prevention and management of dental caries, inhibiting demineralization and stimulating remineralization. Due to the widespread of other fluoride sources a decline in dental caries and an increase in the prevalence of dental fluorosis have been documented in communities with and without fluoridated drinking water (7,8). In populations supplied with fluoridated drinking water, the prevalence of dental fluorosis will depend on the duration of time that a certain fluoride concentration is kept constant in the body during tooth development. Epidemiological data on this matter are, however, scarce in the literature.

The prevalence of fluorosis in permanent incisors of 8-9 years-old-children, living in communities supplied with fluoridated and non-fluoridated water was 54% and 23%, respectively (8). Catani et al. (9) described that the prevalence of fluorosis in areas with oscillating and homogenous fluoride content in water was 31.4%, and 79.9%, respectively. These values are within the variation from 35% to 60% reported from fluoridated communities in the United States (10). The reasons for these variations have not been, however, explored. Catani (9) suggests that the variations might be related to controlling for the optimal fluoride concentration in the public water supply of these different municipalities.

Fluorosis can be prevented by monitoring the amount of fluoride that children up to 6 years old are exposed, therefore, the dentist must be aware of the main sources of fluoride to prevent fluorosis and instruct parents or caregivers on how daily dose should be managed in order to achieve success in prevention. The fluoride sources are described as follows:

- *Water fluoridation*

The important role of fluoride in the prevention of dental caries is evident and turns the water fluoridation into a public health measure. The fluoride level supplied in water can vary from 0.7 to 1.0 ppm, depending on the seasons of the year (11). Thus, as the ambient temperature gets warmer, the water intake increases, requiring lower levels of fluoride in drinking water. Fluoridated water is, directly or indirectly, responsible for 40% of dental fluorosis, through water intake or children's formula and food prepared with drinking water. The other 60% are attributed to other sources of fluoride (12).

In a systematic review, where 214 studies were analyzed, McDonagh et al. (13) observed a decrease in the number of caries-affected teeth and an increase in dental fluorosis, depending on the fluoride intake. They also stated that the prevalence of dental fluorosis indicates that children are ingesting other sources of fluoride besides drinking water. In areas where drinking water is obtained directly from deep wells, dental fluorosis is often endemic and in many cases, the deeper the wells, the higher the fluoride concentration in drinking water.

In order to prevent fluorosis, the pediatric dentist has to instruct parents about the fluoride content in the drinking water and when it is not known, look for this information in the local water supply service. If a child drinks well water or bottled water, the pediatric dentist may assist the parents or caregivers in getting an analysis of its fluoride content, and afterwards decide together whether the child needs a fluoride supplement or not. Dentists also should educate parents about diet, such as children's formula, food or sodas that need water to be manufactured and can indirectly participate in the development of dental fluorosis. Therefore, parents should also limit the amount of fluoride in bottled beverages.

- *Fluoride supplements*

Fluoride supplements are recommended for children living in fluoride deficient areas. The recommended daily dose is based on children's age and on the concentration of fluoride in drinking water. Studies have identified fluoride supplements as a risk factor for dental fluorosis, both in fluoridated (14) and non-fluoridated areas (7). In fluoridated areas, the risk of dental fluorosis from use of fluoride supplements is almost 4 times higher than in non-fluoridated areas (15).

The risk of dental fluorosis originated from the use of

fluoride supplements is well established. Therefore, clinicians must be aware of the optimum concentration of fluoride needed in water, before prescribing them. Fluorosis can be prevented if pediatricians, as well as dentists, follow the new guidelines for fluoride supplements, and be aware that these supplements are not recommended for children who are exposed to water supplies with an adequate amount of fluoride.

- *Topical fluoride*

The excessive fluoride intake, in consequence to the inadequate use or swallowing of fluoride-containing toothpastes, is also responsible for the development of dental fluorosis. Children up to 5 years old swallow around 30% of the amount of toothpaste used every time they brush their teeth. If fluoridated water is consumed at the same time, a potential risk of dental fluorosis occurs (16).

Two alternatives have been suggested to reduce the consumption of fluoride:

Firstly, a reduction in the amount of toothpaste used should be achieved by educating parents to offer small, and therefore safe, amounts of toothpaste. For children between 4 and 6 years old, parents can be taught to use an amount equivalent to "a pea size", dispending toothpaste over the toothbrush with the "transverse technique". For children in a more tender age, parents should simply touch the toothbrush inside the toothpaste cover or tube, instead of squeezing it on the toothbrush (16). It has to be always reminded that children under six years old should be monitored during tooth brushing, encouraged not to swallow toothpaste, and not to use fluoridated mouth rinses.

The second alternative is the development of dentifrices with low fluoride concentration, which are already available in many countries. Some studies did not found significant differences in the anticaries effectiveness between the fluoride toothpastes with low (500-550 ppm) and standard concentration of fluoride (1.000-1.1000 ppm) (17,18). Nevertheless, some other researches are still controversial when considering the effectiveness of low fluoride toothpastes (19, 20). However, several studies assessed children older than 6 years old, which are not in risk of dental fluorosis anymore. We cannot assume that similar results would be seen in primary teeth as in permanent teeth since the literature indicates that there may be differences between primary and permanent enamel in reactivity to cariogenic challenges (21). In addition, the oral cavity of young children (2–6 years old) is much smaller than that of children aged 12 or more, so the amount of F necessary for caries preventive effects may not be the same in these age groups. Without the confirmation of studies that show their anticaries effectiveness, it seems that the best balance between the prevention of caries and dental fluorosis is obtained with low concentrations, approximately 400-550 ppm of fluoride, in preschool children (17, 22). The choice of using a fluoride-containing toothpaste or not, depends on caries activity and risk, on children's age and the ability to spit the dentifrice during oral hygiene.

Studies considering the relative toxicity of the professional topical fluoride application in children are scarce in the literature; however, it is important to prevent the toxicity risks that can occur, mainly in little children.

Whenever topical fluoride is applied, such as acidulated phosphate fluoride (APF) at 1, 23% and sodium fluoride at 2.0% in gel, some recommendations and suggestions should be followed in order to prevent or reduce the potential ingestion of fluoride. These are: to reduce the concentration of fluoride in the product and decrease the application time; to confection individuals trays recovered with foam and trimmed; to maintain the seat in a vertical position so that the patient remain seated; to always use a saliva ejector; to remove the excess of fluoride with a gauze; and to request the patient to spit as much as possible after the fluoride application. This method is, however, appropriate for children above 3 years old.

Based on the risks of the overexposure to fluoride and the prevention of dental fluorosis, another presentation of acidulated phosphate fluoride was developed, the fluoride dental foam. According to manufacturers' instructions, the product is safer because of its lower ability to flow and the smaller amounts requires for application, when compared to the gel. Indeed, the use of fluoride dental foam is considered a safe method with respect to toxicity, due to its quick adhesion to the dental surface and slow dissolution, making it feasible to be used specially in the young children. It is important to clarify that the properties offered by the fluoride dental foam goes beyond prevention of fluorosis and includes effectiveness in the prevention of caries (23, 24). Four-minute fluoride foam applications, every six months, would be effective reducing the increment of dental caries in the primary dentition and newly erupted permanent first molars (23,24). However, there are few clinical studies in the literature considering the effectiveness of this foam, and it needs to be more investigated to support the foam advantages.

Diagnostic and Treatment

The adequate diagnosis of fluorosis requires inspection of dry and clean dental surfaces, under a good light source. The clinical appearance of mild dental fluorosis is characterized by bilateral, diffuse (not sharply demarcated), opaque, and white striations that run horizontally across the enamel. The opacities may coalesce to form white patches. In the more severe forms, enamel may become discolored and/or pitted. Upon eruption into the mouth, fluorosed enamel is not discolored, the stains develop over time due to the diffusion of exogenous ions (ex, iron and copper) into the abnormally porous enamel.

Nowadays, the differential diagnosis between fluorosis and non-fluoride-induced opacities needs to establish differences between symmetrical and asymmetrical and/or discrete patterns of opaque defects (25). These criteria imply that all symmetrically distributed and non-discrete opaque conditions of enamel are fluorosis. Diagnostic difficulties occur mostly with mild forms of fluorosis, or when a mix of fluorotic and non-fluorotic conditions is evident. It's important to emphasize that non-fluoride enamel opacities include all categories of opacities not defined as fluorosis, i.e. dental hypoplasia lesions that are commonly characterized as discrete, demarcated white or discolored opacities often affecting a single tooth and, less frequently, multiple teeth, with a symmetrical distribution (25), and result from a wide variety of systemic or local factors.

Controlling the fluoride intake is the best preventive measure for dental fluorosis, however when this is already installed and causing esthetic problems to the patient, some treatment techniques are described in the literature and will depend on the severity of the condition. The dental fluorosis classification criteria developed by Thylstrup and Fejerskov Index (TFI) (26) is very appropriate to determine the kind of treatment, based on biological aspects of dental fluorosis, and classifying individuals into categories: mild (TFI = 1-3), moderate (TFI = 4-5) and severe (TFI = 6-9).

Bleaching and enamel microabrasion techniques are conservative, and provide highly satisfactory results, without excessive wear of sound dental. They may be used in cases of TFI = 1-2 and TFI = 1-4, respectively (27). Some authors (28,29) described the association of both techniques (microabrasion and bleaching) in cases of TFI = 1-4. Firstly, microabrasion is carried out, and in the next appointment, the bleaching. Those authors concluded that the whole technique provides regularization, planning and recovery of the standard color.

According to Loyola-Rodriguez et al. (30), microabrasion is carried out by rubbing an abrasive paste prepared with pumice stone and 37% phosphoric acid gel over the pigmented enamel surface, during 10 seconds, and then washing it during 20 seconds. A 10% chloridic acid solution can be also used associated with different abrasive particles. Some sessions can be done, with breaks of 15 days, until good results are obtained (30).

Some studies have shown that bleaching is enough to improve esthetics results. Active agents of carbamide peroxide (10-20%) and hydrogen peroxide (1-10%) can be used on vital teeth (30). The association of home and in-office bleaching is interesting in more resistant cases or when the time of treatment has to be shortened. In these cases, the treatment must begin with 35% hydrogen peroxide, and be followed by home teeth bleaching under professional supervision.

Composite resin and resin-modified glass ionomer are also used for treating discolored areas(TFI = 1-3). Composite restorations can be associated to microabrasion or to esthetic veneers in cases of type TFI≥ 5. For TFI = 8-9, the use of prosthetic crowns might be needed (27).

Conclusions

To identify the different ways of intake fluoride by children is important to evaluate which sources represent some risk for the development of dental fluorosis. The dentist has to consider the recommendations for professional topical fluoride application, as well as instruct the parents or caregivers in what refers to the age for toothpaste introduction, and the amount and concentration to be used in each age, in order to diminish the prevalence of dental fluorosis.

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