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Aesthetic Treatment of Dental Fluorosis in a 9-Year-Old Girl: Case Report

SUMMARY

***Background/Aim**: Dental fluorosis is a specific disturbance of tooth formation caused by excessive intake of fluoride. The discoloration of teeth is the most common reason for parents to seek treatment. The purpose of this paper is to describe the therapeutic management performed in a 9-year-old girl with fluorosis. **Case report**: A clinical case of a 9-year-old girl diagnosed with fluorosis is reported. The treatment of this clinical case was achieved using microabrasion, which is a minimally invasive method. This technique improves the aesthetics of the teeth without causing significant loss of dental tissue; a characteristic making microabrasion applicable to children as well. Its implementation involved the combined use of 18% hydrochloric acid and pumice on the enamel surface of upper incisors. The improved appearance of the teeth was aesthetically pleasing and, consequently, the patient gained in self-confidence. **Conclusions:** In the literature, several treatment choices are proposed, depending on the severity of the fluorosis. In our case, microabrasion was applied and the aesthetic outcome satisfied both the patient and the dentist.*

Key words: Fluorosis, Bleaching, Microabrasion, Treatment, Discoloration

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Introduction

Dental fluorosis is a disorder caused by chronic excessive fluoride intake during the period of the development of the teeth[1]. In 1931, three different scientific groups, working in different locations around the world, discovered the correlation between the fluoride content in drinking water and dental fluorosis[2-4].

The use of fluoride in preventive dentistry has been shown to be the most effective measure against dental caries, yet it is also associated with the increased prevalence of dental fluorosis in many countries. It has been proven that exposure to 1 ppm fluoride in drinking water reduces the caries increment by 50-60%[5,6]. When the fluoride in potable water exceeds 1,5 ppm, aesthetic problems usually appear on tooth surfaces[7]. Water is the most common source for fluoride intake[8,9]. In addition, fluoride can also be found in drinks[10,11], toothpaste[12] and infant formulas[13,14]. Specifically, the exposure of young children (for example, 0-3 years old) to fluoride through toothpaste, has been associated with a high prevalence of dental fluorosis[15]. In the literature, a few indices have been suggested to describe and classify enamel fluorosis[16,17]. Nowadays the most commonly used are Dean's Index (DFI)[18] and Thylstrup and Fejerskov Fluorosis Index (TFI)[19].

Dean's Index[18] rates the clinical image of the two most affected teeth. As a result, based on the severity, the case is rated as normal (0), questionable (0.5), very mild (1), mild (2), moderate (3) and severe (4). In questionable dental fluorosis there are minor aberrations from the usual translucency of the enamel, while opaque, paper-white areas are typical findings in very mild (<25% of the surface), mild (25<x<50% of the surface) and moderate dental fluorosis (100% of the surface). Moreover, in severe cases the entire enamel surface is affected and the most common feature is discrete or confluent pitting.

On the other hand, the Thylstrup and Fejerskov Index[19], which was modified in 1988, can measure the severity of fluorosis in a single tooth. This makes it suitable for determining the clinical management, even for a single infected tooth. Depending on the severity of

the situation, a score from 0 to 9 is given. Teeth scored with TFI 1-3 are characterized as mildly fluorosed, while teeth with TFI 4-5 are rated moderately fluorosed and teeth with TFI 6+ are the severe cases. More specifically, in mild dental fluorosis white opaque lines and even wider white opaque areas can be seen on the enamel. Furthermore, in moderate dental fluorosis the whole enamel surface is opaque, white and chalky and even exhibits pits. Finally, in severe dental fluorosis a part or even the whole enamel surface is lost.

The discoloured and porous enamel of fluorosed teeth can be aesthetically unsatisfactory, impacting on patient's psychological state of mind[20-22]. It has been proposed that the repercussions resulting from the excessive intake of fluoride on soft tissues of children are reversible, on condition that there is a cessation of fluoride intake and the patients consume supplementary calcium, vitamin D3, ascorbic acid and antioxidants[23,24]. Nevertheless, there is no such evidence regarding hard tissues. Therefore, in most cases the therapeutic management of the cosmetic problem is needed, which should be as minimally invasive as possible. The aim of this study is to describe a clinical case of a 9-year-old girl, who was diagnosed with mild-to-moderate dental fluorosis, and the treatment procedure which was performed.

Case Report

A 9-year-old girl presented at a private dental office accompanied by her mother. Her medical and family history were unremarkable and the main reason for visiting the dentist was the child's smile, which was characterized by white opaque spots on the upper and lower incisors. The patient was a resident of the town of Langadas, where the concentration of fluoride in the drinking water ranges from 0,3 to 15,5 ppm.

Figure 1. Clinical picture of the 9-year-old girl. Mild-to-moderate dental fluorosis

The clinical examination revealed that almost the entire enamel surface had a white, chalky appearance leading to a diagnosis of mild-to-moderate severity dental fluorosis, according to the TFI Index (Figure 1). An improvement in the girl's self-esteem through improving appearance of her smile was considered to be essential. On account of the fact that the patient was quite young, the dentist decided to perform microabrasion on the upper incisors, since it is a minimally invasive technique for removing white opaque spots from the enamel surface.

A rubber dam was applied to protect soft issues and ensure a dry and clean operating field, and biofilm was removed from the upper incisors by dental prophylaxis. Then, a paste of 18% hydrochloric acid and pumice slurry was applied on the labial surface of the incisors. The outer surface of the enamel was abraded with the use of a rotating brush at low speed (Figure 2). After 5 seconds of performing the abrasion, the paste was rinsed off and the enamel surface was reevaluated (Figure 3). Following the same method, a second application was performed (Figure 4), in the case of the upper right central incisor, a third application was considered to be necessary (#11). Finally, a 2% neutral sodium fluoride gel was applied for 4 minutes so as to prevent postoperative sensitivity (Figure 5). After the completion of the treatment, a significant improvement in the appearance of the girl's smile was achieved and the result satisfied both the patient and the dentist (Figure 6). No postoperative sensitivity or pain was mentioned by the patient. One year later she came to the dental office for the arranged follow-up and the tooth surfaces were found to remain even and glossy.

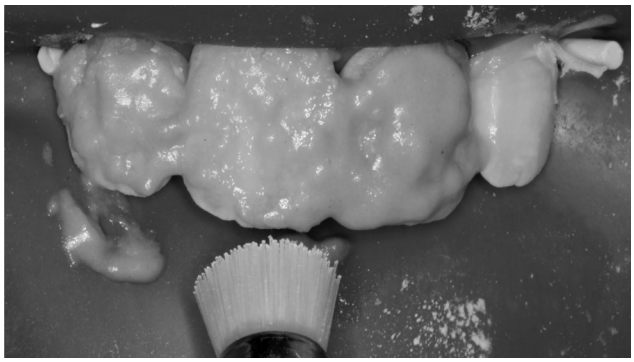

Figure 2. The enamel was abraded with a paste of 18% hydrochloric acid and pumice slurry and a rotating brush at low speed

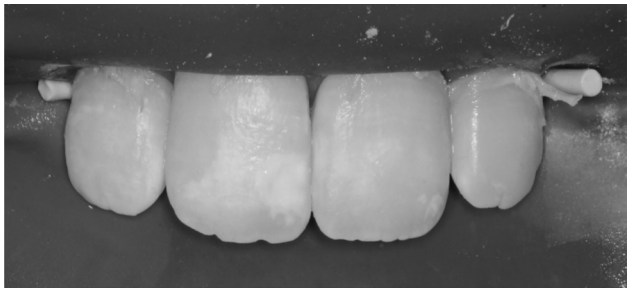

Figure 3. Appearance of the teeth after the 1st application

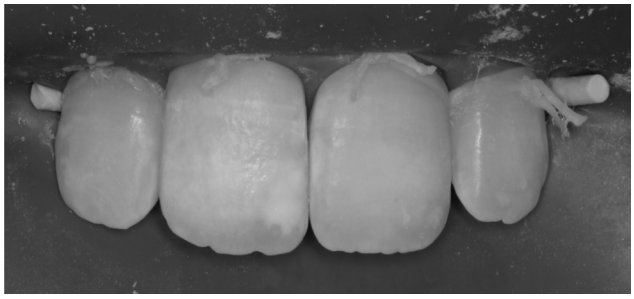

Figure 4. Appearance of the teeth after the 2nd application

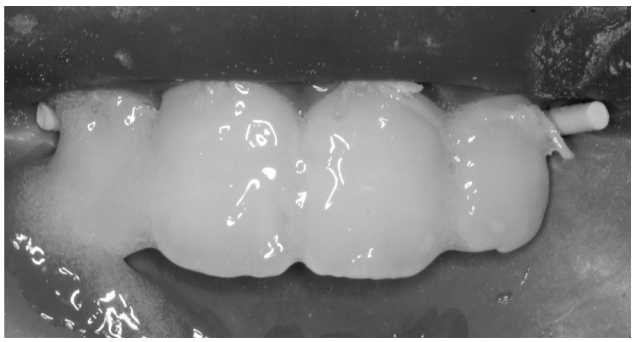

Figure 5. 2% neutral sodium fluoride gel

Figure 6. Final aesthetic result

Discussion

An aesthetic appearance of the teeth is the key to a beautiful smile and something valued by people of all ages and genders. Aesthetic problems could have a negative impact on a patient's psychology, limiting their social life[20-22,25].

Fluoride levels in plasma are associated with disturbances of amelogenesis. Studies in rat incisors suggest that chronic plasma levels of 2 μmol/L or peak levels over 10 μmol/L are able to cause dental fluorosis. The severity of the defect on ameloblasts and the enamel matrix depends on the dose and duration of fluoride exposure[26]. It has been suggested that in the secretory stage, hydroxyapatite crystals are formed with a higher fluoride content leading to a greater number of amelogenins binding to the crystals. Consequently, the interaction between proteins and crystals is altered. Hydrolysis of the enamel matrix proteins is delayed. Therefore, they are retained in the matrix during the maturation stage. This causes a rise of pH that delays the modulation of ruffle-ended ameloblasts to the smooth-ended form which comprise the superficial layer of aprismatic enamel[27]. In the maturation stage, sustained exposure to fluoride leads to the formation of a highly hypomineralized subsurface enamel, which is responsible for the clinical appearance of opaque white areas[26]. Fluoride affects the ameloblasts. In fact, fluoride is responsible for subameloblastic cyst formation. These cysts can develop into deep cervical and shallow coronal pits at the enamel surface, while the underlying enamel is highly hypermineralized[26,27]. Excessive intake of fluoride during the formation of enamel has a negative effect on the enzymically breakdown and removal of amelogenins[28,29]. Protein and water retention prevents the formation of the crystals of the enamel matrix, resulting in a porous subsurface.

The volume and depth of the subsurface pores increase as the severity of dental fluorosis rises[19]. The more severe the dental fluorosis is, the more porous the enamel surface appears[19]. In mild cases, the enamel is characterized by white lines, following the perikymata. In several cases, the white lines are merged, whilst in other cases, clearly opaque areas can be seen in between them. In moderate cases, the whole enamel surface may be opaque and white. In view of the fact that concentration of fluoride in the water of the town of Langadas ranges from 0,3 to 15,5 ppm, while the acceptable level of fluoride in potable water has been found to be 1,5 ppm[7], it stands to reason that our patient's teeth had been affected to such an extent that almost the entire enamel surface appeared white and chalky. After tooth eruption, the porous subsurface of fluorosed enamel can absorb pigments, triggering tooth discoloration. In cases of wide porous areas, an occlusal trauma could lead to fragmentation and the detachment of enamel resulting in the creation of pits[19]. Pigments permeate the porous substrate of fluorosed enamel, causing discoloration to happen. The colour of the enamel varies from yellowish to bright brown, dark brown or even black. The more severe the dental fluorosis, the more porous the enamel subsurface[19].

In the literature a variety of management options are presented. Akpata suggested that bleaching should be performed as a treatment option in cases of mild fluorosis (TFI 1-2), based on the theory that pigments can be located in the outer layer of the porous enamel subsurface, hence they can be easily dislodged with the use of a bleaching agent[30]. The application of phosphoric acid to the hypomineralized enamel facilitates the infiltration of the bleaching agent into the porous subsurface enamel. Atia and May suggested that bleaching, microabrasion or the combination of these two should be performed as a treatment option in cases of mild fluorosis (TFI 1-3) in

the paediatric patient[31]. Bharath *et al.* proposed that mild and moderate fluorosis in children can be managed with microabrasion or McInnes solution bleaching (consisting of HCL36%, $H_2O_2$30% and Diethyle Ether), since both of them achieve aesthetic results and an absence of postoperative sensitivity[32]. Moreover, Bussadori *et al*. performed bleaching on an 8-year-old boy with fluorosis[33]. They used a dual activation system with 35% hydrogen peroxide and achieved a satisfactory outcome. Furthermore, Atia and May mention that individual stains in mild fluorosis could also be managed with composite resin; however, the removal of the discoloured enamel or application of an opaquer should be performed beforehand[31].

Another treatment choice, which is mentioned in the literature, is the resin infiltration technique[34,35]. It is actually a micro-invasive treatment for the management of non-cavicated lesions and its aim is the deep penetration of a light-curing resin into the porous enamel lesions, so as to fill them[34]. Consequently, teeth become less opaque white and there is an improvement in their appearance[36]. However, further research is required in this area.

Akpata suggested microabrasion for the treatment of TFI=4 scored teeth, as pigments could be found so deeply inside the porous subsurface enamel that it is fanciful to believe that they could be completely removed exclusively by bleaching[30]. Microabrasion removes the porous subsurface enamel and pigments simultaneously. Hence, with microabrasion, management of dental fluorosis would be as optimally preservative as possible. Similarly, Khandelwal *et al.* effectively performed microabrasion on a paediatric patient with moderate fluorosis[37]. This is a rather conservative technique and, should it fail to meet the patient's requirements, some other more invasive methods may be required[38]. For instance, Wallace and Deery recommend the use of composite resin in cases of moderate and severe dental fluorosis where bleaching and microabrasion have failed to meet the patient's and dentist's expectations[35].

For cases with TFI ≥5, Atia and May proposed that microabrasion should be followed up with composite resin veneers[31]. As regards teeth with TFI=5-7, which have lost more than 50% of their enamel surface, and teeth with TFI=8-9, application of ceramic veneers and crowns is recommended[31,39,40]. However, this technique should only be used in adults, due to the fact that immature teeth have a quite wide pulp chamber and the position of the gingival margin is not in a constant level yet[31,35]. Taking all of the above into consideration, the treatment options for discoloured fluorosed teeth are bleaching, microabrasion, resin infiltration, composite resin, aesthetic veneers and crowns. In the literature, the criteria for the application of these techniques vary.

Microabrasion is the controlled removal of superficial stains from the enamel. In the literature, it is the first choice for conservative, minimally invasive treatment, suggested for the aesthetic improvement of teeth which have either innate spots (dental fluorosis) or exogenous spots on the surface of the enamel[41-43]. It is considered to be the treatment of choice for mild dental fluorosis (TFI=1-3), whilst it can also be applied in teeth with moderate fluorosis (TFI=4)[30] and it is usually combined with bleaching in order to achieve a more effective result[44]. In comparison with other restorative procedures, microabrasion causes a minimal loss of dental structure, it does not inflict postoperative pain or sensitivity on the patient and, in most cases, it is accomplished in a single session, causing insignificant discomfort to patients[42-46]. In general, microabrasion is suggested when the depth of discoloration is a maximum of 0,2-0,3 mm[47]. The amount of enamel lost by microabrasion ranges from 12 μm to 200 μm and it is affected by the duration of the process[35,48,49]. Furthermore, it has been found that the concentration of Ca and P in the outer layer of enamel is significant lower in young patients (18-24 years old) than in the older ones (>55 years old). This fact indicates that conservative, minimally invasive procedures are preferable when treating children and adolescents[50]. The instant and stable results obtainable after the complete removal of the spots, rather than by covering them with restorative material[42], and the lack of pulpal and periodontal irritation are among the benefits of this method[42,46]. Phosphoric acid etching is performed on surface of the discoloured tooth, followed by the application of a fine-gritted paste made of pumice slurry and 18% hydrochloric acid in order to abrade the enamel surface. It is a technique that removes the porous enamel in conjunction with the unwanted pigments. Pastes with a lower concentration of hydrochloric acid can be found on the market. For instance, Prema Compound (Premier Dental Company) contains 10% hydrochloric acid and a silicon carbide abrasive powder. In addition, Opalustre (Ultradent) is comprised of 6.6% hydrochloric acid and silicon carbide microparticles[49,51]. Due to the use of acid during the microabrasion, it is crucial to use a rubber dam throughout the procedure. Not only does it protect soft tissues from irritation, but it also prevents materials from falling into the patient's mouth and limits any contact with saliva. The paste can be applied on the tooth surface with the help of a polishing cup or a rotating brush on low speed (approximately 100 rpm)[52] or by slightly pressing a tongue depressor[53]. In our case, after microabrasion, a significant improvement in the colour of the upper incisors was noticeable and the tooth surface appeared sleek and glossy. The factors which contribute to this result are mild mechanical abrasion of the enamel surface combined with erosion by the acid. In addition, the application of amorphous calcium phosphate (ACP) is recommended so that postoperative hypersensitivity is avoided[52]. It should be also mentioned that the Casein phosphopeptide - Amorphous calcium phosphate Complex

(CPP-ACP) brings about a reduction in the white opacity of the fluorosed enamel, boosting the remineralization[54,55].

The clinical dentist should be aware of all the possible treatment choices, be able to evaluate their positive and negative aspects and choose the most suitable treatment for each case based on the patient's specific necessities. In cases of mild-to-moderate dental fluorosis, a minimally invasive approach achieves an aesthetic and affordable result.

Conclusions

The excessive use of fluoride in potable water, diet and dental health products have led to an increase in the prevalence of dental fluorosis which needs to be treated for aesthetic reasons. Mild-to-moderate dental fluorosis can be treated by microabrasion and produces impressive results. Microabrasion is a safe, minimally invasive technique, which can be combined with other methods when the stains are persistent.

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