

Dental Fluorosis: Management from the Least to the Most Invasive Treatment, Based on a Series of Clinical Cases

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Abstract :- Dental fluorosis is a dental pathology caused by excessive ingestion of fluoride during the first years of life. Excess of fluoride will thus disrupt the normal formation of enamel crystals during amelogenesis and lead to the formation of an often unsightly porous enamel. The degree of severity of fluorosis can be established precisely using different classifications and depends on the ingested dose, the frequency of ingestion, the age of the subject and individual variability. The reason for consultation of patients with fluorosis is mainly aesthetic. The choice of treatment was based on the stage of fluorosis. There are currently very conservative therapies such as whitening or micro-abrasion, which can effectively treat mild or even moderate fluorosis. Treatment with bonded ceramic veneers or full-coverage prostheses is only indicated for cases of moderate and severe fluorosis because of their aesthetic interest and their mechanical and biological properties. It will therefore be appropriate for the partitionner to make a precise diagnosis and to choose the best suited therapy to his patient.

Our paper will present and discuss 3 clinical cases about the management of dental fluorosis.

Keywords:- Fluorosis, Therapeutic Gradient, Whitening, Micro Abrasion, Ceramic Veneer, Crown.

I. INTRODUCTION

Fluoride is a natural mineral element that is essential. It is used since the 1940s for its cario-protective action and is recognized as the main factor responsible for the spectacular decrease in the prevalence of dental caries observed in the world. (1/2)

The sources of fluoride are multiple. It can be through systemic way, such as, the drinking water, the fluorinated milk, the salt... Or topical way, such as, the toothpaste, the fluorinated varnish, the mouthwash, and the fluorinated Gels. (3)

In Tunisia, drinking water naturally contains in some regions, high or average doses of fluoride. The region of

South-West (Gafsa, Sidi Bouzid, Mednine...) constitutes a very rich zone in fluoride with a content higher than 6 ppm. (45)

Excessive intake of fluoride for several months or years during the period of tooth formation (between birth and 8 years, the age at which enamel formation is complete) can cause a pathology called "fluorosis". The latter is one of the syndromes of chronic fluoride intoxication with bone and/or dental lesions. (3)

Excessive concentrations of fluoride can disturb the functioning of the cells responsible for the formation of enamel (ameloblasts), which prevents the proper maturation of the enamel. It is clinically manifested by a dyschromia, symmetry of lesions and sometimes porosities (4)

Ludmila Manuila, Pierre Lewalle (2004, the medical dictionary): "Dental fluorosis, due to the consumption of water that is too rich in fluoride, is manifested by white and brown spots on the enamel, which are irreversible". (5/6)

There are major classifications that will allow to establish with precision the degree of damage of the dental surfaces : Dean's index and Thylstrup Fejerskov's index. (7/8)

Dean's classification is the oldest classification (1942) but is still in practice today. This classification is employed by the WHO and applied clinically to define the clinical aspects of fluorosis. The patient's score is based on the two most severely affected teeth. If two teeth have different degrees of disease, the score of the less affected tooth is used.

It has six levels, which classify the occurrence of fluorosis from "normal" to "severe" (9) :

- *Score 0 : Normal : The enamel is translucent. The dental surface is smooth and shiny. The shade is normal and uniform.
- Score 1: Fluorosis questionable, doubtful : The enamel shows some small defects of translucency (occasional small white spots).

- *Score 2:* Fluorosis very mild, very low : Small opaque white areas are irregularly distributed on the enamel surface represent less than 25% of the surface of the tooth concerned.
- *Score 3:* Mild, low fluorosis: The white opaque areas of enamel are more extensive but do not represent more than 50% of the tooth surface
- *Score 4:* Fluorosis moderate : All enamel surfaces are affected but the shape of the teeth remains unchanged. Brown stains may be present.
- *Score 5:* Severe fluorosis: All enamel surfaces are affected. Hypoplasia is so marked that the shape of the tooth may be altered. Brown stains are widespread. Incisal edges and occlusal surfaces are abraded.

The purpose of this article is to present the different techniques for the management of dental fluorosis through a series of clinical cases.

➤ *Clinical Cases :*

• *Clinical Case n°1*

A 27 year old man (M.H), non-smoker, from Tataouine (South West of Tunisia), was referred to the prosthetic department in the dental clinic of Monastir , expressing dissatisfaction with the appearance of his smile. He wanted to solve his aesthetic problem as soon as possible and to take

into account his health and financial conditions. The clinical examination was performed on clean and dry teeth with adequate lighting. It showed the absence of carious lesions and cracks. The brown spots are generalized, with the form of horizontal lines bilateral and symmetrical to the midline. The shape of the teeth remained unchanged. (figure 1.a). We established the diagnosis of moderate dental fluorosis of Dean's index 4.

After a discussion with the patient, a microabrasion treatment with Opalustre® (figure 1.b) was proposed. Following his agreement, we started by applying a layer of abrasive mixture (2mm) on the vestibular surfaces of the teeth (figure 1.c). Circular movements were performed with a rubber prophyl cup (Opalustre®) for 5 to 10 seconds followed with rinsing, for each cycle (figure 1.c-d).

After 5 application cycles, an evaluation of the situation was carried out. A decrease in the saturation of the brownish color of the stains, and a harmonization of the hue were noted. After that, we made the application of a fluoride gel 2%, for 4 to 5 minutes with the polishing cup (Opalustre®), to remineralize the surface of the tooth and provide postoperative sensitivity (figure 1.e). Photographs were taken after a micro-abrasion session (Figure 1.f), and after 6 months of follow-up (figure 1.g).



Fig 1 Treatment of a Moderate Fluorosis Index 4 of Dean by Micro-Abrasion

• *Clinical Case n°2 :*

A 26-year-old patient (T.B), from Sidi-Bouzyd (South-West of Tunisia), was consulted for an aesthetic problem in our department of fixed prosthesis in Monastir, suffering from generalized brown spots with a sensitivity to cold. The clinical examination shows the absence of carious lesions and restorations. All enamel surfaces were affected by brown stains. During the smile, the patient discovers from the right first premolar to the left first premolar. The enamel hypoplasia was so marked that the shape of the teeth was altered. Pits were marked by a hooking of the probe. The simple passage by a probe N°17, on the vestibular faces, gave the patient. The incisal edges and occlusal surfaces are abraded. We established the diagnosis of dental fluorosis of Dean's index 5 (figure 2.a-b).

For this patient, 2253tw as proposed to treat the fluorosis with a combined treatment. A preliminary micro-abrasion with Opalustre® followed by ceramic veneers from the right first premolar to the left first premolar.

After the patient's agreement, we started with the placement of the rubber dam isolation, then, the micro abrasion with opalustre® paste was performed (figure 2.c). After 6 cycles of application, a decrease in the saturation of the brownish color of the stains was noted, as well as a harmonization of the hue. (figure 2.d)

The mock-up has been realized from a digital wax up using the direct self-molding technique (figure 2.e). A silicone key (mask) is loaded with an injectable self-polymerizing acrylic resin (Protemp®), (figure 3.f). The preparations were made according to the technique of butt margin (figure 2.g-h). The choice of the shade of the ceramic veneers was made on the chair, respecting the patient's requests.

Then, a digital impression was made with an intra-oral optical camera directly in the mouth (3 Shape) (figure 2.i). In the laboratory, the dental technician designs and manufactures the lithium disilicate ceramic veneers (IPS e.max Press ®) using CAD/CAM (figure 2.j-k-l).

After removal of the ceramic veneers, the bonding was done under rubber dam isolation (figure 2.m). The treatment of the enamel surface was ensured by an adhesive system of the MR type. An orthophosphoric acid etching with a concentration of 40% was used (figure 2.n), respecting the double etching technique (30 seconds), followed by a grooving with water for 30 seconds (figure 2.o).

After bonding, photos were taken after the removal of the dam (figure 2.p-q). A clinical control, after 3 months follow-up, has been done (figure 2.r-s-t).



Fig 2 Treatment of Severe Fluorosis with a Combination of Microabrasion and IPS E.Max® Ceramic Veneers by CAD/CAM.

- *Clinical case n°3*

A 23-year-old healthy patient (R.B), non smoker, from Gafsa (South-West of Tunisia), consulted us, in the service of fixed prosthesis of Monastir, to solve his aesthetic problem. The clinical examination showed the absence of carious lesions, abrasions and defective restorations. A transillumination examination was performed. It showed the absence of dental cracks. Fine horizontal white streaks were distributed over the entire tooth surface. These opaque stains were also presented on the cusps and incisal edges. The shape of the teeth remained intact. We established the

diagnosis of dental fluorosis of Dean's index 2 (figure 3.a). An armchair treatment with 16% hydrogen peroxide was proposed and accepted by the patient. After placement of the liquid rubber isolation dam (Figure 3.b), to provide gingival protection. The product was applied to the vestibular surface of the teeth for 45 minutes: 15 minutes per cycle (figure 3.c). Each cycle includes, product placement followed by light curing (figure 3.d), and water grooving at the end of the 15 min. A picture was taken at the end of the session (figure 3.f).



Fig 3 Treatment of a Dental Fluorosis Dean's Index 2 by Hydrogen Peroxide on the Chairside Under Liquid Rubber Dam Isolation.

II. DISCUSSION

Several studies have established the causal relationship between the use of water containing fluoride and the prevention of dental caries. Fluoride in drinking water can be found naturally or after being added artificially to prevent tooth decay. According to the World Health Organization (WHO) in 1986, fluoride at a concentration of 1 ppm or 1 mg per liter of water has the greatest cariostatic effect without causing aesthetic disadvantages. Water fluoridation is adopted in many countries and remains the most effective method of prevention and treatment of dental caries compared to other prevention methods (toothpaste, drug supplementation, professional treatment). (3/44)

The overexposure during the mineralization phase to high doses (greater than or equal to 0.1 mg per kg / Day) in the body can cause dental fluorosis. Excessive ingestion of fluorides after the age of 8 will not cause dental fluorosis.(10)

In Tunisia, the south-west region (Gabes, Gafsa, Kairouan, Mednine , Sidi Bouzid , Tataouine), has a danger quotient (QD) >1. These regions are considered as risk areas for dental fluorosis, caused by high doses of fluoride in water(6 ppm). Therefore, this pathology presents a very frequent aesthetic diagnostic element in these regions. (45)

The earliest sign is the color change showing many thin horizontal white lines across the surface of the teeth. At higher levels of fluoride exposure, these become more defined and thicker. Cloudy areas and thick opaque bands also appear on the affected teeth which may be associated with pits, hypoplastic enamel or even missing enamel. In fact, the opaque white appearance of the enamel is caused by an increase in the porosity of the underlying structures. Due to interactions with various food coloring agents, whitish stains can turn yellow or brownish-black. This disease generally affects the entire dentition, all sides of an affected tooth are equally affected at the time of eruption and homologous teeth are always affected with the same degree of severity. (11)

The principle of preservation of dental tissue has a direct impact on the life of a tooth when it is restored. The therapeutic gradient, "is a practical concept that should guide the practitioner's thinking when faced with an aesthetic request." (Thirlet and Attal 2009). When several therapies can be considered, the solution most adapted to the clinical case must be chosen in the spirit of tissue preservation. (7) This gradient must be applied in the management of enamel anomalies.

For dental fluorosis, the gradient starts with whitening and microabrasion, then infiltrated resin, and in the most complex cases, more invasive therapies. (12/13)

Dental whitening is the first step in the treatment of stains caused by fluorosis. This technique respects the principles of tissue economy and is the least invasive technique in the treatment of dental fluorosis. (14). Bleaching is the result of an oxidative chemical reaction that allows the release of nascent oxygen. This lightening agent must penetrate the hard tissue without altering it and act on the pigments that are responsible for the coloring and ensures its degradation following a redox reaction. This leads to changes in the absorption characteristics of light, which leads to a reduction in the color of these molecules. (15/16). Whitening techniques are indicated as first-line treatment for simple fluorosis (up to stage 3 of Dean's classification). The results are variable depending on the patient and the clinical situation. The final aesthetic result is difficult to predict because there is a strong individual variability. This technique is contraindicated when there is a very large pulp chamber, dental hypersensitivity, gingival recession, enamel cracks or significant enamel loss, allergy to the products used, and teeth with extensive restorations. (17/18). Chairside sessions improve the color of fluorotic teeth, but the combined treatment with a mouthpiece worn on an out patient basis for 15 days offers better responses to fluorosis and stability over time. (19)

Micro-abrasion is a non-invasive, simple, fast and inexpensive technique. It is mainly used for mild to moderate fluorosis. It removes superficial stains from the tooth enamel in a controlled manner (between 20 and 200 microns, depending on the concentration of the acid and the time of use). Brown stains are more superficial than white stains, which yield to micro-abrasion in 75% of cases, whereas for brown stains the success rate is close to 100%. (20). The principle of micro-abrasion with Opalustre is based on a double mechanical and chemical action. The mechanical action is performed with a diamond cup and a burr, and the chemical attack is obtained with a 6.6% hydrochloric acid-based micro-abrasive paste containing microparticles of silica carbide and pumice powder (21). The operative protocol consists of applying a layer of abrasive mixture (2mm) on the vestibular surfaces of the teeth. After installing a waterproof surgical field. Install a rubber cup on a low-speed contra-angle handpiece (1000rpm) that will move alternately over each tooth for 5 to 10 seconds for each cycle. Between each step, rinse with water, dry and reassess the tooth surface before each new application. However, if no improvement is seen after 6 to 7

application and rinsing cycles, it is most likely that the discoloration is too deep. After treatment, the tooth surface should be carefully polished with a silicone polishing burr or fine disk to achieve a smooth surface, and a 2% fluoride gel (sodium fluoride, tin fluoride, sodium bicarbonate) should be used for 4-5 minutes to remineralize the tooth enamel surface and prevent post-operative sensitivity. (22/23)

Then erosion-infiltration is a minimally invasive and painless technique. Its first indication was to stop and prevent non-cavity caries progression at the proximal or vestibular level. It is linked to the Icon®DMG system, its principle consists in infiltrating the porosities within the enamel (following the dissolution of the mineral phase) through the Icon and thus preventing the diffusion of cariogenic acids. (24/25). This technique includes, in a first step, a demineralization performed with a 15% hydrochloric acid solution and, in a second step, an infiltration of the very low viscosity hydrophobic photopolymerizable composite resin. The infiltration of the porosities in the lesion is done by a resin with a refractive index (1.52) that is close to a healthy enamel (1.62), which improves the transmission of light photons through the hypo-mineralized enamel and restores its translucent appearance. This infiltration leads to an increase in the mechanical strength of the demineralized enamel as well as an improvement in the resistance to demineralization of the healthy enamel.(26/27/28). Indeed, applications with an aesthetic aim are indicated such as the treatment of vestibular dyschromia: white spots linked to fluorosis, MIH or even spots corresponding to the after-effects of a trauma. Icon® is contraindicated in cases of deep lesions, exceeding the outer third of the enamel, in cavities as well as in cases of allergy or intolerance to one of the components of the material. (29)

Composite resin veneers is a technique that has many advantages in the context of anterior restorations, including being less expensive for the patient, more conservative in terms of dental tissue and can be performed in a single clinical session. (30). This solution can be chosen in the short term in order to satisfy an aesthetic demand while waiting for a more perennial rehabilitation (have a limited lifespan in time, and can stain over the years). It is a very conservative additive approach based on a layering technique with different layers of composites each replacing a type of dental tissue, reproducing the optical qualities of enamel and dentin. The goal is to achieve a biomimetic effect that allows light to pass through the restoration in a similar manner to natural teeth. (31)

In cases of treatment of enamel anomalies, the complex layering protocol can be simplified because usually the morphology of the tooth remains intact and only the dyschromic part has been removed by microblasting or milling. In more severe cases, the incisal edge may be affected by hypomineralization and will therefore need to be restored. The complex layering technique will be required with the help of study models, laboratory wax-ups and silicone keys.

When the non-invasive techniques found their limits and could not meet the needs of the patients, the prosthetic solutions found their indications. (32/33). Since the 1980's, with the development and evolution of bonding materials and technologies, today's ceramic veneers have the reliability and aesthetic qualities required to correct discoloration problems while allowing tissue sparing. (34/35)

Among the multitude of ceramics, only some can be used for the creation of dental veneers. These ceramics are characterized by good optical properties: their translucency must correspond to the pre-restoration discoloration of the teeth. The more the tooth is having a color that we want to correct, more the ceramic will have to be opaque or in thick layer in order to mask the dyschromia. These ceramics must also have a large vitreous phase that can be etched to increase their bonding ability. Currently, the most commonly ceramics used are: feldspathic ceramics, leucite-reinforced feldspathic ceramics, lithium disilicate-based ceramics and infiltrated aluminous ceramics. (36/37)

When the bonding protocol is mastered, veneers can not only restore the mechanical properties of natural teeth, but also increase their strength compared to a healthy untreated tooth. Bonding increases the strength of the ceramic restoration by creating a unique body between the restoration and the tooth. (38/39). Fluorite enamel has an impact on the way ceramic veneers are assembled, we note the effectiveness of the adhesive systems on fluoride enamel, whose adhesive material penetrates 3.5 μm into the enamel when using phosphoric acid (Mordant and Rinse (MR) adhesive systems), while the material penetrates only 1 μm in the case of a self-etching system (SAM). (40) Therefore, the use of an MR type adhesive system is much more effective for enamel-resin bonding and more stable over time than the SAM system for fluorite teeth. (41)

For the concentration of ortho-phosphoric acid, studies were performed on fluorotic teeth to examine the effects of orthophosphoric acids in different concentrations of 35%, 40% and 45% on bonding. Maximum bond strengths were achieved when phosphoric acid of 40% concentration was used. (41)

Also, hypermineralized fluorotic enamel, where hydroxyapatite is replaced by fluoroapatite, is more difficult to etch than healthy enamel. The double etching technique must then be used. Hence, for moderate fluorosis, it is recommended to double the enamel etching time (30 seconds) for best conditions with 37% phosphoric acid in order to obtain an effective bonding strength and to remove the 50-80 μm thick outer layer of hypermineralization. (39)

In certain situations such as moderate fluorosis, a preliminary treatment by a hydrogen peroxide (H_2O_2) whitening must be considered before the realization of the ceramic veneers in order to attenuate the dental dyschromia and to harmonize the basic color for a better aesthetic result. It is recommended, after using hydrogen peroxide at 35% concentration, to delay the bonding of the veneers for

approximately two weeks to reduce the risk of failure and veneer delamination. (42)

The light transmission of the veneer can be, in some cases, a good indication given these advantages, but in other situations, it is a real problem, especially when the support is strongly dyschromic as in cases of severe fluorosis. Therefore, the use of full-coverage prostheses (ceramic-ceramic or metal-ceramic prosthesis) is the solution of choice. (43)

The full-coverage crown restoration is only indicated in cases of severe fluorosis with very deep dark discoloration or significant enamel loss. It may also be indicated in cases of vertical dimension loss associated with fluorosis. It is a macro-invasive technique (as opposed to veneer restoration which is micro-invasive) which will affect the structural integrity of the tooth. (12)

III. CONCLUSION

Fluorosis represents a fairly frequent reason for consultation, the damage of which is often aesthetic and more or less important depending on the degree of severity of the fluorosis.

A precise diagnosis will be made by the practitioner following the clinical examination in order to choose the most appropriate therapeutic solution according to the clinical case.

Tissue preservation nowadays is an essential prerequisite for any modern dental treatment. The partitionner should therefore choose the most conservative treatment possible according to the clinical case while respecting the therapeutic gradient.

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