

CONSIDERATIONS REGARDING THE UP-DATE IN TOPICAL FLUORIDATION IN PEDIATRIC DENTISTRY

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Abstract. For 50 years, it was generally believed that the major caries – preventive effect of fluoride was pre-eruptive. But there is a general agreement today among scientists in the field of fluoride research that the caries-preventive and the caries controlling effects of fluorides are almost exclusively post-eruptive, as topical fluoridation, because fluoride reduces the demineralisation effects of organic acids produced by the cariogenic bacteria in the dental plaque and accelerates remineralisation after the attack.

Key-words: fluoride, cariogenic bacteria, reminelization

Rezumat. Timp de 50 de ani s-a considerat că fluorul poate realiza o prevenție eficientă a cariilor dentare, dacă este administrat în perioada preeruptivă. Ultimele cercetări au stabilit că prevenirea leziunilor carioase prin intermediul fluorului se realizează și în perioada posteruptivă, prin aplicații topice, deoarece fluorul reduce gradul de demineralizare indusă de bacteriile acidogene și accelerează remineralizarea leziunilor.

Cuvinte cheie: fluorul, bacterii cariogene, remineralizare

INTRODUCTION

In 1901 Dr Frederik Mc.Kay (1) observed, in Colorado Springs, the permanent coloration of teeth, which he called the 'brown spots of Colorado'. A number of studies carried-out by Trendley Dean and Frederik Mc Kay (2) between 1931-1938, established that the stained enamel does not appear if the level of fluor (F) in the drinking water is not higher than 1 ppm. Dean showed that the frequency of dental caries is lower in the areas with high level of fluoride in the drinking water and demonstrated by experimental studies the caries-preventive effect of water with a fluoride concentration of 1ppm. These studies are guiding the way for other

research regarding the water fluoridation.

In 1950's industrial fluoridation of salt (Switzerland) is started and begin the studies regarding the milk fluoridation.

The administration of fluoride tablets is an efficient method, but it is necessary a continuous and attentive watching in order to avoid the over-dose outcomes.

In what the methods of fluoride topical application consist of there are a great variety of methods which have been studied since 1940 at the same time with the appearance of first toothpaste with NA fluoride content. Afterwards there have been introduced in tooth paste composition some other substances such as: sodium mono-fluorine-

phosphate (Ericson ,1967,Lu 1987) and amino-fluorides (Marthaler,1968) (3). It was also studied the efficiency of fluoridated varnishes, gels and solutions of professional and individual usage, in reducing the dental caries prevalence with a rate between 20 to 40%.

Mechanisms of fluoride action

The caries - preventive effect of fluorine is known with more than 50 years ago. The recommendations of general usage of fluorine were based on presuming that fluorine incorporation in the enamel's hydroxy-apatite increasing its resistance at the carious acid attack. These suppositions are doubted in the present, as the epidemiological studies proved that the local effect of fluorine in tooth's surrounding environment is of a greater importance. There is a general agreement among scientists on the fact that the caries-preventive effects and decay control are mostly

post-eruptive, topic (4). Fluorine is accumulated in the bacteria plaque liquid as Ca fluoride on the enamel surface .During the acid attack the Ca fluoride is dissolved. The enamel surface is behaving like filter with micro -pores and H and F ions are defusing into the carious lesion , increasing the amount of fluorine in the active lesions compared with the nearest unaffected enamel. Inside the lesion the F ions are reducing the demineralisation of enamel crystals during the acid attack and accelerate remineralisation by the crystals enlargement and accumulation of fluoride-apatite on the crystals' surface when the Ph becomes higher (5). The presence of a carious lesion on a molar's mesio-lingual surface can be successfully stopped if the patient is maintaining a strict control of the approximal bacterial plaque and the using of fluoridated tooth paste (fig1).

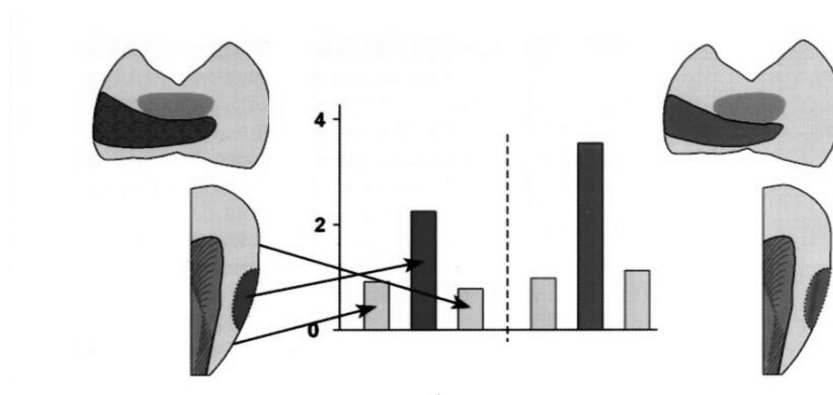


Fig. 1 Carious lesion of enamel on the mesio-lingual surface of the mandible second molar. Lesion which is stopped in evolution by plaque control and local fluoridation (by Per Axelsson)

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Remineralisation of that area is usually incomplete. The continuous access to a reduced concentration of fluorine is determining a remineralisation which is more complete rather than a higher fluorine concentration that induces a quicker remineralisation of the lesion's external surface (sealing the filter's micro-pores). As a result the enamel surface will be less susceptible to caries than the initial intact surface (5). The total amount of fluorine is increased in lesions which are stopped in evolution.

The vehicle can be the drinking water, fluoride tablets or specific topical agents such as tooth paste, gels, are solutions for oral rinsing. The late research are concentrating on the increase of efficiency of topic treatment by understanding the mechanisms of fluorine action which is interfering in the enamel's solubility equilibrium but is exerting effects on the phospho-calcic metabolism, in the kinetic of dissolving and precipitating of crystals

as well as the inhibition of demineralisation and the increase of remineralisation. Fluorine also affects the bacterial metabolism, especially the acid production and the tolerance to acid reducing the bacterial plaque attaching (6).

Physico-chemical integrity of enamel in the oral environment is totally dependent on the chemical composition and chemical behaviour of the surrounding liquids (saliva and plaque fluid).

The main facts which are governing the apatite stability in the enamel are the Ph and the free active concentrations of calcium, phosphate and fluorine. The extent of clinical carious lesions is implying a complex interrelation between a few facts from the oral environment and the dental tissues. A simplified clear example of the major events is illustrated in figure 2, being modified by Fejerskov and Clarkson (1996) (7).

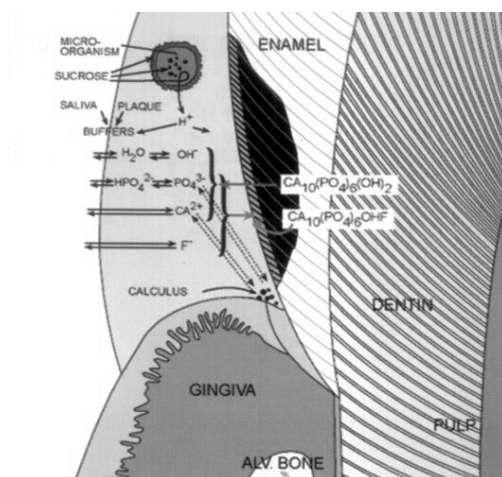


Fig. 2 Development of dental enamel (by Per Axelsson)

The process is initiated by bacterial fermentation of carbohydrates, which leads to organic acids formation and a Ph decrease. Initially the H ions will be reduced by the tampon systems which are found in bacterial plaque and saliva, but when the Ph continues to drop (the H ions are increasing) the fluid environment will be private from the OH and PO₃ ions witch react with H ions resulting H₂O and HPO₂ molecules. When there is total depriving the Ph can drop under its critique value of 5.5 and the liquid phase becomes unsaturated without affecting the hydroxiapatite. Though, when the surface of enamel is covered by a deposit of bacterial metabolic process from inside this bio-mass, it determines Ph fluctuations with an excessive decrease having as result the dissolution of mineralised surface. This is happening between two chemical constituents. When the surrounding liquid phase is unsaturated with

hydroxiapatite (HA) and supra-saturated with fluoride apatite (FA), HA is dissolving and FA is forming. The resulting lesion is a carious lesion in witch the dissolution of HA is taking place in the deeper layers and the FA formation is happening on the enamel surface. The greater there is the super-saturation in FA, the larger the amount of fluorine captured into the superficial layer of enamel. A better mineralization of the enamel surface and a lower demineralisation in the profound layers of the carious lesion are beginning. If the HA and FA are super-saturated, both types of apatite are dissolving at the same time and the enamel is being removed layer by layer and the resulting lesion is of erosive kind. The tropical fruits, the fruits juices, the carbonated drinks, champagne are all unsaturated and capable of causing demineralisation of erosive kind (fig. 3).

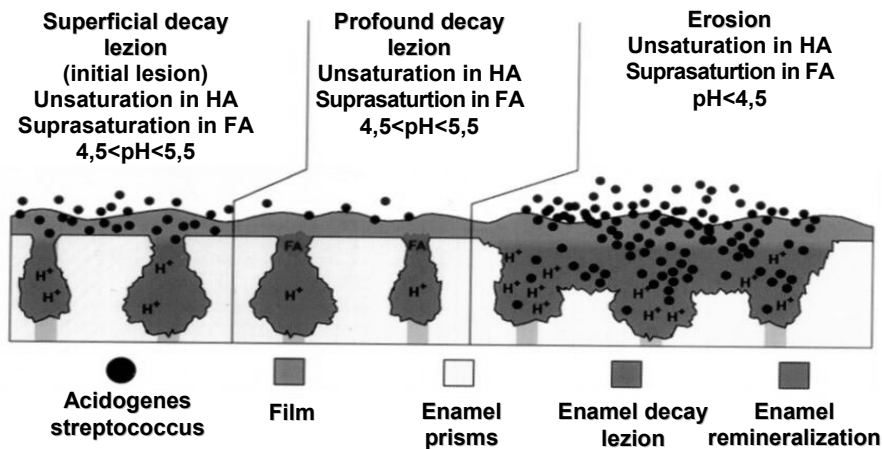


Fig. 3 Mechanism of enamel development (by Per Axelsson)

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During the carious attack the fluorine concentration on the crystals surface as well as the fluorine concentration in the liquid environment are both of great importance. In order to reduce the dissolving rate, fluoridation of the

superficial crystals is necessary and it can be realised by using any method but it only will maintain if the solution which washes the crystals contains enough fluorine. Otherwise all the crystals' surfaces will be dissolved.

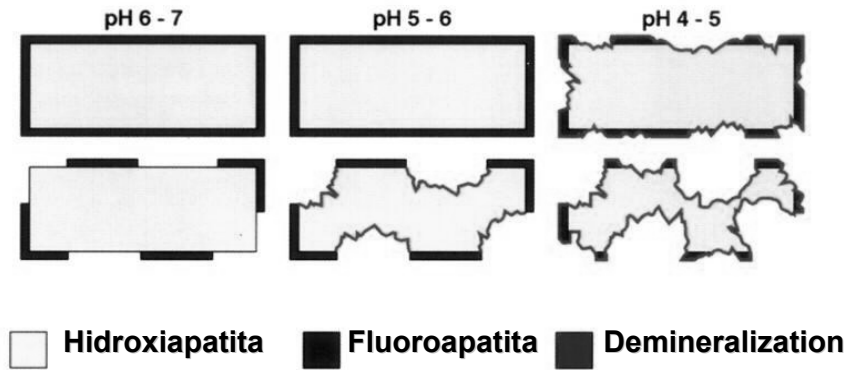


Fig. 4 Dissolving of enamel crystals (by Per Axelsson)

Research studies regarding the cariostatic effect of Ca fluoride on the tooth surface have been carried out (Qgaard and colab.1992) (4).

Ca fluoride spheres which have been formed are covered by a layer of phosphate and proteins.

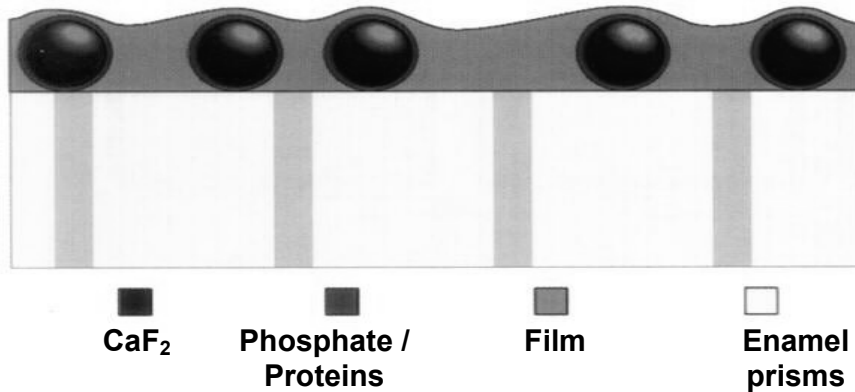


Fig. 5 Tooth surface after local fluoridation has been made (Ph 7.0) (by Per Axelsson).

At a neutral Ph the Ca fluoride precipitate on the apatite crystals and enamel surface can be determined by the applications of dissolved fluorides with a high concentration. Because of

the slow dissolving and a prolong retention, is supposed that the solid Ca fluoride to behave as fluorine releasing source in tooth's liquid environment.

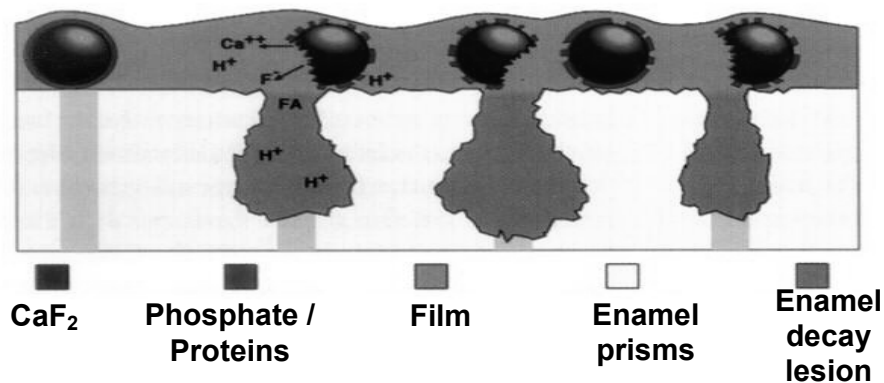


Fig. 6 Tooth surface during the acid attack (Ph4.5-5.5) (by Per Axelsson)

When all the Ca fluoride is being dissolved, the deposit must be renewed by repetitive fluoride applications. Dissolution of Ca fluoride seems to be the key to caries-preventive effect because only the free fluoride ions have effect upon the enamel's solubility. The dissolution of Ca fluoride spheres which are covered by phosphates and proteins is increasing at the same time with the Ph dropping (fig. 5), so that more fluoride ions can be released during the cariogenic attack (8).

Fluorine ions will react with H ions for diffusing into the carious lesion, this way slowing down the rate of decay progression. Though, this mechanism is suggesting that the supply of Ca fluoride will vanish quicker in patients with a high level of carious activity. Because of that an efficient plaque control is necessary for bringing the Ph value up to 7 and for that fluoride repeated applications have to be made. This way the enamel carious lesions can be stopped from progressing and the carious surface is being remineralised with FA (9).

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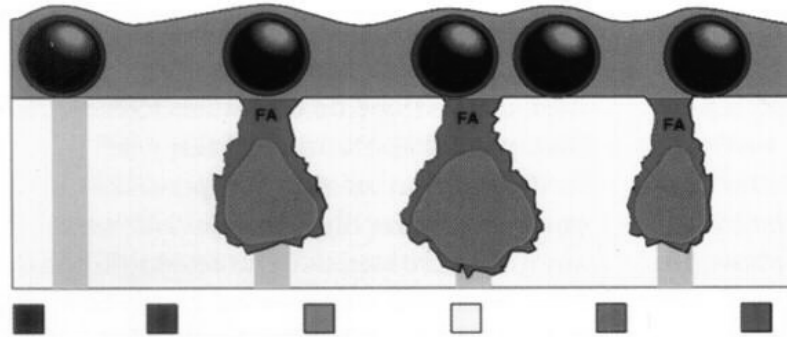


Fig. 7 Tooth surface after acid attack (by Per Axelsson)

Figure 8 (Modified after Ten Cate and Featherstone, 1996) is comparing the enamel lesions which are stopped from progressing by the short term

usage of fluoridated solutions with a high fluorine concentration along with those with a low fluorine concentration for a long term use.

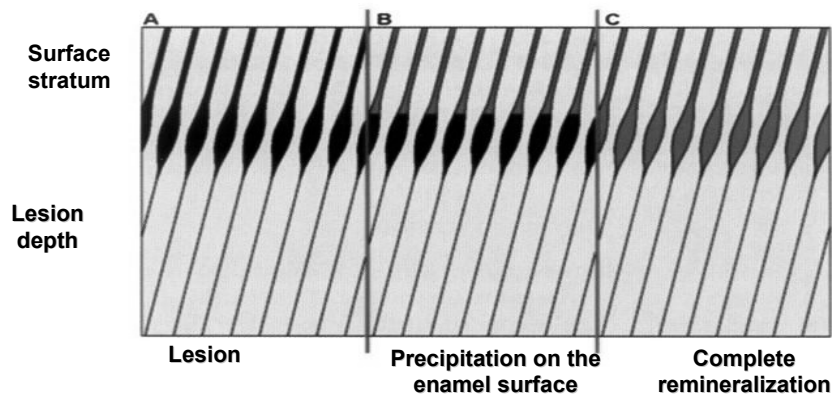


Fig. 8 Development and stopped from progressing of an enamel lesion (by Per Axelsson)

Figure 9 modified after Thylstrup (1994) is comparing a carious active enamel lesion with moderate changes in Ph value, stopped from progressing by bacterial plaque control and topical

fluoridation, with an active lesion with different Ph values, stopped from progressing by the bacterial plaque control but without topical fluoridation (10).

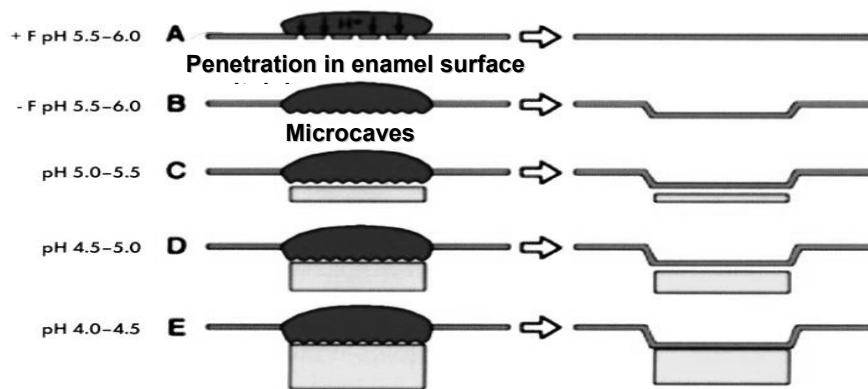


Fig. 9 An enamel lesion which is stopped from progressing (by Per Axelsson)

Methods of topical fluoridation

The local application is without a doubt the most important method of fluorine administration in order to control and prevent dental caries. The most important effects of locally used fluorine are inhibitor of demineralisation and the increase of remineralisation. The wide spread individual use of fluoridated tooth paste in association with the improvement of oral hygiene is the most important factor which contributes to reduce of caries in individuals with regular practicing of these methods. Topical fluoridation agents are available for individual care and for professional care. The fluoridation agents were being used for home care are: tooth paste, tooth-

picks, dental floss, oral rinse solutions, artificial saliva and chewing gum.

Fluoridated agents of professional use are: gels, prophylactic paste, solutions for oral rinse, GI cements and other agents with slow fluorine release. Among these the tooth paste with fluorine content is the topical agent with the most common use. It is used by approximate number of 450 million people compared with the 20 million which are using oral rinses and the 20 millions benefiting of professional fluorine applications (8).

Tooth paste

Tooth paste is used for making easier the mechanic removal of bacterial plaque by brushing and as vehicle for some active agents (fluorine, chemical

agents for plaque control, anti-tartar agents).

Fluoridated agents in tooth pastes could be: inorganic fluorine < sodium fluorine (NaF), sodium mono-fluorine-phosphate (Na₂FPO₃), tin fluorine (SnF₂) potassium fluorine (KF), aluminium fluorine (AlF₃), organic fluorine (fluoridated amines), combinations with fluorine (sodium fluorine + sodium mono-fluorine-phosphate, fluoridated amine + tin fluorine, fluoridated amine + sodium fluorine).

European Union rules are limiting the fluorine concentration used in tooth paste to 0.15%. The caries reducing rate that is resulting from the epidemiological studies which were carried out was of 25-30% (Johnson, 1993). The cumulated effect for lifetime is estimated to a 50% or more (9).

Wooden toothpicks which are impregnated with sodium fluorine and chlorohexidine are offering an optimal accessibility to proximal surfaces from the posterior zone with maximum risk being an appropriate way for decay preventing and controlling and of gingival and periodontal affections.

Oral rinses

Mouth rinsing with 10 ml fluoridated solution (0.025%F) for one minute after each brushing is an efficient addition for caries controlling in susceptible patients.

Fluoridated gels

For adults with high risk for caries these represent an efficient addition to daily used fluoridated toothpaste. The content of 0.5F neutral sodium fluorine, fluorine acid phosphate, tin

fluorine or fluoridated amine + sodium fluorine.

Fluoridated artificial saliva

It is recommended for patient suffering of xerostomia and could be found under the shape of gel or spray; it ameliorates the symptoms and reduces the risk of rampant caries in this patients.

For the products of professional use the fluorine concentration is higher and it can be of 1-2%. For an optimal access of fluoridated compounds before the application the bacterial plaque is being removed by professional brushing.

Fluoridated solutions and gels for professional use are similar to those for individual use but their level of fluorine is higher.

Fluoridated varnishes are justifying their anti-caries effect by combining the removal of bacterial plaque with professional brushing, the protection of susceptible dental surface from the contact with re-accumulated and the slow fluorine release. Among the restorative materials the GI cements are releasing the biggest quantity of fluorine; these can be recharged with the fluorine coming from other sources (the daily use of toothpaste) being efficient for secondary decay prevention in patients with caries susceptibility.

Fissure sealing is an efficient method of decay control especially in patients with high level of caries prevalence and incidence being recommended for these patients the sealing of first and second permanent molars as soon as possible (11).

CONCLUSIONS

1. The efficiency of local fluoridation is net superior to general fluoridation, proving that the caries preventive effect and caries control are mostly posteruptive, topic.
2. Into the carious lesion the fluorine ions are increasing remineralisation by crystals enlargement and the accumulation of fluorapatite on crystals' surface.
3. The Ca fluorine precipitation inside the incipient carious lesion followed by fluorine release is a key mechanism caries reducing effect of topical fluoridation agents.
4. Most important in reducing dental caries prevalence is the association between the use of fluoridated tooth paste and the strict control of bacterial plaque.

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