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Calcium Fluoride Uptake by Human Enamel after Use of Fluoridated Mouthrinses

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The aim of this study was to evaluate, using scanning electron microscopy (SEM), the calcium fluoride uptake by human enamel *in situ* after topical application using three fluoridated mouthrinses: a neutral pH solution (Fluordent®), an acidulated solution (Fluorgard®) and a solution associated with chlorhexidine (Duplak®). Twenty-four samples from 6 third sound human molars were divided into two groups: 5-min treatment and 10-min treatment. In both the 5-min and 10-min treatment samples, those treated with the chlorhexidine-associated solution showed higher formation of CaF_2-like material. In the 10-min treatment group, the samples treated with the neutral solution showed higher formation of CaF_2. These results indicated that the products used deposited CaF_2 on the enamel surface and may be recommended to aid the prevention and control of dental caries.

Key Words: fluoridated mouthrinses, calcium fluoride, caries prevention.

INTRODUCTION

The importance of prevention to improve general oral health has been reported for many years. The use of fluoridated products is considered to be efficient for caries control (1-3). In the past it was believed that the relationship between the use of fluoride by systemic administration (general term used to define ionic forms, ion fluorine or fluoride, ionizable or non-ionic of the element) and the significant reduction of caries was due to its incorporation during enamel formation. Thus, the main objective of the therapy was to promote an increase of incorporation to its structure. Currently there is consensus that this reaction does not confer permanent resistance to caries. Low and constant concentrations of fluoride in the oral cavity are more efficient for disease control (4).

Gerould (5) was one of the first to report the deposit of CaF_2 on the surface of human enamel, observed with scanning electron microscopy (SEM), after treatment with fluoridated solutions. Other studies confirmed this finding (6,7). The hypothesis of calcium fluoride uptake by dental enamel acting as a fluoride reservoir for a long period of time has been defended (6), and others have reported that it indirectly induces the solubility reduction of the acid of plaque (3,8).

It is beyond discussion that CaF_2 deposited as a result of fluoridated topical application is the basic element in the prevention and control of dental caries. Thus, the products that induce its formation should be largely used (8,9). According to research, the constant presence of fluoride in the oral cavity acts dynamically, performing an important role in the change of dental caries pattern (1,2,4,10).

The CaF_2 mechanism of action as a reservoir releases fluoride whenever the pH falls to very low levels. In this way, CaF_2 remains adhered to the enamel surface, being released during caries (3,11). CaF_2 has a greater impact on the reactions of enamel demineralization and remineralization than the fluoride incorporated in the enamel structure (12).

It is also considered that the main role of fluoride is related to the interference in the progress of incipient caries, acting in enamel and dentin and increasing the remineralization of teeth with the same efficiency in both children and adults. The frequent use of low

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concentration fluoride compounds by patients has been shown to be very efficient against caries (13). Thus, fluoridated products with low concentration and high frequency, such as toothpaste and mouthrinse, have been used as therapeutic and preventive agents in dentistry aiming to health promotion (14-16).

Mouthrinses have been recommended by the World Health Organization as an alternative method of prevention and treatment of caries, with an impact on Public Health. Their use has led to a decrease in the appearance of caries and can be considered to be simple and inexpensive, besides presenting the advantage of use in school programs, with little work time necessary and no need for specialized personel for application (4,17).

The efficiency of the use of mouthrinses, in terms of biochemistry, for the control of caries development has been outstanding for acting in a period of up to 4 hours (4). The use of mouthrinses weekly with a neutral 0.2% sodium fluoride solution reduced the prevalence of caries in school-children by 50% (18). It was also concluded that sodium fluoride and phosphate acidulated fluoride solutions were equally effective (2,19).

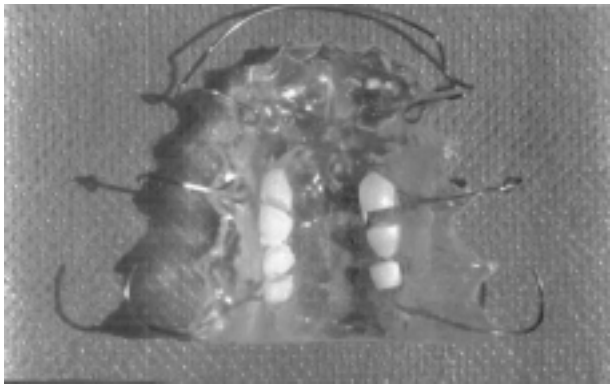

Figure 1. Maxillary retainer of acrylic resin with the samples fixed.

It has been reported that even with short-period applications, CaF_2 is deposited on enamel *in situ* after treatment with mouthrinses containing 0.2% and 0.05%

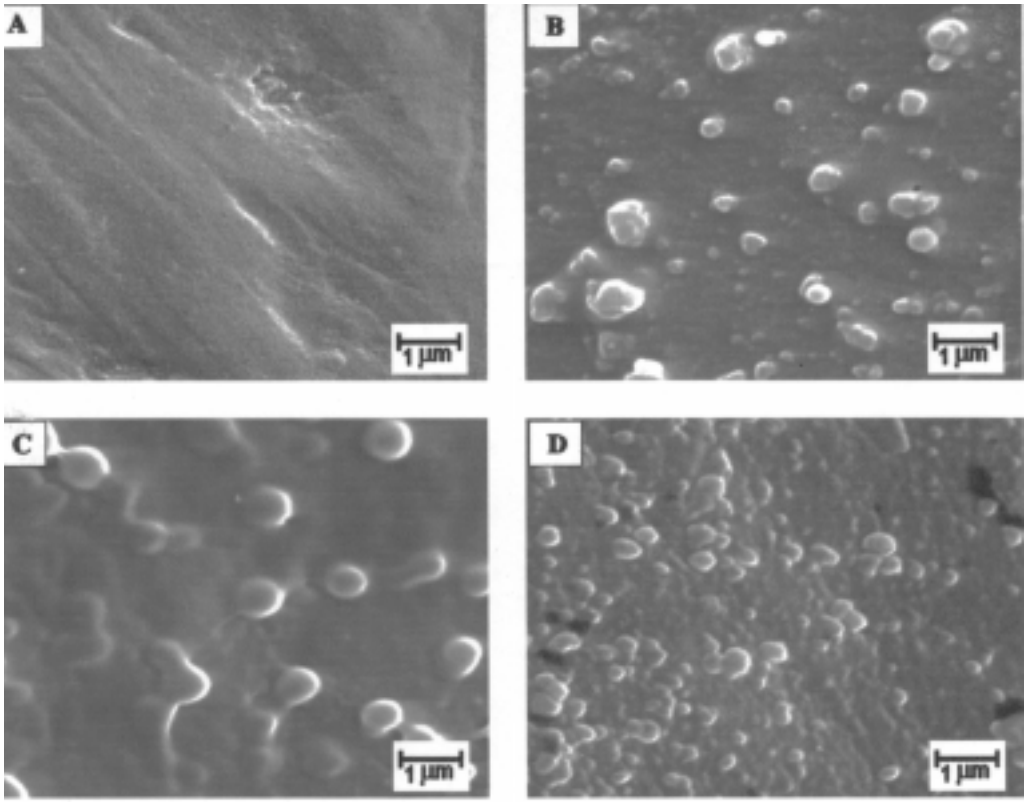

Figure 2. Photomicrographs of the deposit of calcium fluoride adsorbed on sound human dental enamel after 5-min treatment with the different fluoridated solutions. A: control; B: fluoridated solution in neutral pH; C: fluoridated acidulated solution; D: fluoridated solution associated to chlorhexidine. Original magnification, 10,000X.

sodium fluoride (8). The presence of globules of CaF_2 after the use of fluoride acidulated compounds for 5 min of treatment has also been reported (4).

The aim of the present study was to examine *in situ* the CaF_2 uptake by human enamel after the use of different fluoridated mouthrinses for 5 and 10 min.

MATERIAL AND METHODS

Six sound third permanent molars extracted for clinical reasons were stored in 2% formaldehyde until use. The teeth were polished with pumice and deionized water for 20 s and subsequently washed with deionized water and dried at room temperature.

Four 9 mm^2 enamel fragments of each tooth were obtained from the buccal and lingual surfaces of the middle third of each tooth, totaling 24 samples. These were properly identified and stored in plastic recipients containing deionized water.

Maxillary retainers were made with interproximal clasps for retention and two troughs on the exposed palatal surface to retain the enamel sections (Figure 1). Three fluoridated mouthrinses were used in two groups (A and B): Fluordent® (0.05% NaF; Johnson & Johnson Indústria e Comércio Ltda., São José dos Campos, SP, Brazil), Fluorgard® (0.05% FFA; Colgate-Palmolive Ltda., Osasco, SP, Brazil) and Duplak® (0.05% NaF and 0.12% chlorhexidine; Herpo Produtos Dentários Ltda., Petrópolis, RJ, Brazil). Both groups also had samples that did not receive any treatment (control). Group A was treated for 5 min and group B was treated for 10 min.

After insertion and gluing of the fragments in the intra-oral device, this was introduced into the oral cavity of a volunteer who rinsed with 10 ml of one of the solutions for 5 or 10 min. The solutions were used individually and on alternate days. After treatment, the samples were removed, washed with deionized water for 2 min and naturally dried. They were then placed in metallic bases and prepared for SEM.

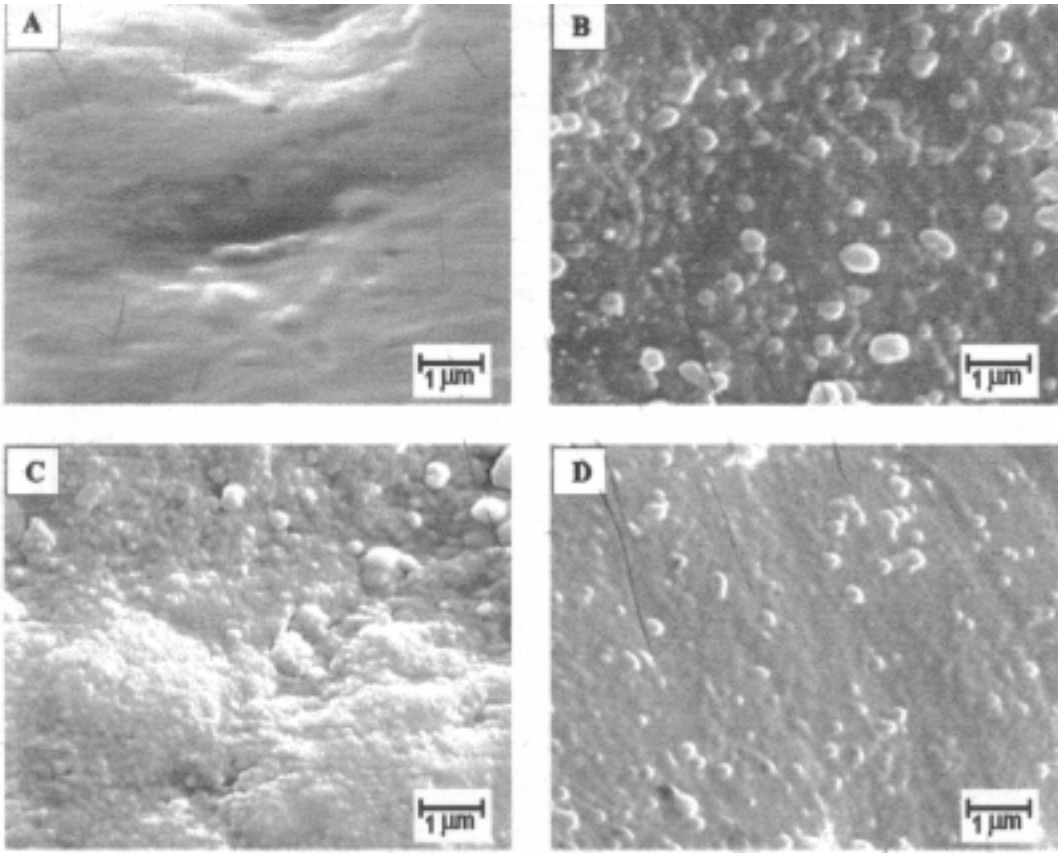

Figure 3. Photomicrographs of the deposit of calcium fluoride adsorbed on sound human dental enamel after 10-min treatment with the different fluoridated solutions. A: control; B: fluoridated solution in neutral pH; C: fluoridated acidulated solution; D: fluoridated solution associated to chlorhexidine. Original magnification, 10,000X.

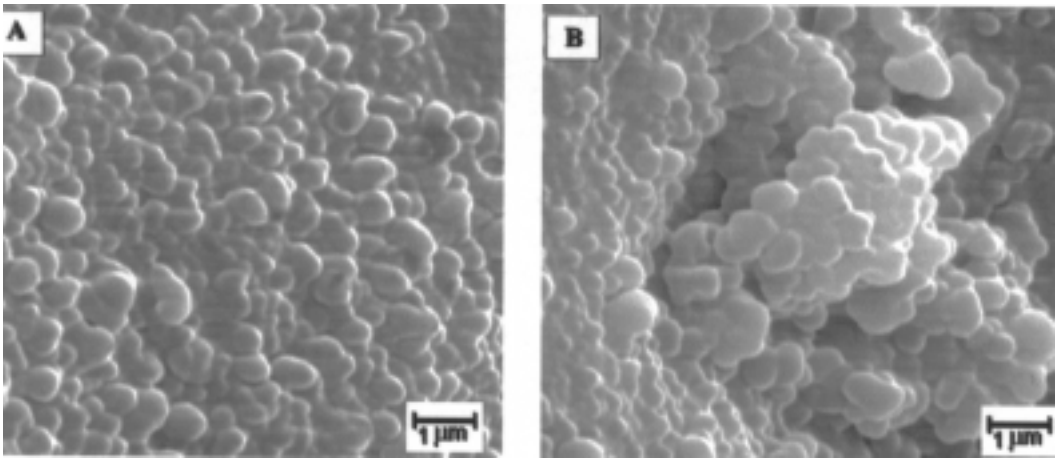

Figure 4. Photomicrographs of the deposit of calcium fluoride adsorbed on the surface of the sound human dental enamel after 5-min treatment with fluoridated solution associated to chlorhexidine. Note the agglomerated product formed. Original magnification, 10,000X.

RESULTS

Photomicrographs of the repeatedly seen areas in all samples of the same group were selected. None of the samples of the control group had any deposits on their surface (Figures 2A and 3A). In the samples treated with the fluoridated solutions, there was a variable amount of deposits for both treatments (Figures 2 and 3). The group that was treated with the chlorhexidine-associated solution for 5 and 10 min had the largest quantity of globules on the enamel (Figures 2D and 3D).

Comparing the fluoridated products used in relation to the time of treatment, it seems that the differences were not statistically significant in terms of product vs time, except for the group that was treated with the pH neutral solution.There was larger formation and deposit of CaF_2 globules with the 10-min treatment (Figures 2B and 3B). The result obtained with the use of the chlorhexidine-associated solution (Duplak®; Figure 4) was surprising. Agglomerated CaF_2-like globules could be observed.

DISCUSSION

The use of fluoride is an important instrument in preventive programs and health maintenance and its use in the form of fluoride solutions is considered to be an efficient method, because of its ease of use in collective health programs, highly contributing to caries reduction.

The main objective of the use of fluoridated products is its constant presence in the oral cavity, its frequent contact with enamel in low concentrations, that provides the cariostatic effect, by the adsorption of calcium fluoride on its surface and the release of ions during the decay of the plaque pH (1,3,4,10,14,17).

This investigation demonstrates the formation and deposit of CaF_2 after the use of commercially available mouthrinses for 5 and 10 min. When the neutral pH fluoridated solution was used, there was greater formation of globules with a longer time of treatment. This confirms that with a longer time of treatment, the formation of CaF_2 will be larger (4).

There were no significant differences in the deposit of CaF_2 between the acidulated compounds and those with a neutral pH. In this study, the largest formation of fluoride was found in the samples treated with Duplak®, with no differences between the other two products when a shorter time of treatment was used. With the 10-min treatment, the CaF_2 globules formation was similar emphasizing the efficacy the neutral pH solution. This solution had the advantage of stability, a tasteful flavor, non-irritating to the gum and no spotting of the teeth.

Since the high frequency of the use of these products in low concentrations is more effective for maintaining constant levels of fluoride in the oral cavity, reducing the solubility of the enamel and promoting the remineralization of incipient lesions, the analysis of

results suggests that the tested products can be recommended because there was formation of CaF_2 in all cases (14-16). However, careful procedures must be considered when recommending mouthrinses for children less than six years of age because they may swallow a large amount of the solutions. If use is necessary below this age, it would be wise to recommend that the person responsible for the child's care apply the solution directly to the teeth with cotton.

RESUMO

Navarro M, Monte Alto LA, Cruz RA, Prazeres J. Incremento de CaF_2 sobre o esmalte dental humano após utilização de soluções fluoretadas. Braz Dent J 2001;12(3):178-182.

O presente estudo teve como objetivo verificar, através da microscopia eletrônica de varredura (MEV), a formação e retenção de fluoreto de cálcio (CaF_2) sobre a superfície do esmalte dental humano *in situ* após tratamento tópico com diferentes soluções fluoretadas para bochecho disponíveis no mercado, durante 5 e 10 minutos. Foram selecionados três produtos: solução fluoretada em pH neutro (Fluordent), solução fluoretada acidulada (Fluorgard) e uma solução fluoretada associada à clorexidina (Duplak). Cinquenta e seis secções, obtidas de 14 terceiros molares hígidos, foram divididas em dois grupos: grupo A: 5 minutos de tratamento e grupo B: 10 minutos de tratamento. Através da análise dos resultados foi possível observar que as amostras tratadas por 5 min com solução associada à clorexidina demonstraram maior formação do produto semelhante ao CaF_2. No grupo tratado por 10 min, as amostras em pH neutro demonstraram maior incremento de CaF_2. De qualquer forma, pôde-se perceber que o produto reacional foi formado e retido em quantidades significantes em todas as situações. Estes resultados demonstraram que os produtos utilizados neste experimento foram capazes de formar e depositar CaF_2 sobre a superfície do esmalte dental, podendo ser recomendados como coadjuvantes na prevenção e no controle da cárie dentária.

Unitermos: soluções fluoretadas, fluoreto de cálcio, prevenção de cárie.

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