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A comparative assessment of fluoride concentration available in saliva using daily prescribed topical fluoride agents

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Abstract
The aim of the present study is to evaluate the presence of fluoride in saliva after applying professional use products on the surface of dental enamel. The absorption of the fluoride ions from the oral fluids in the sound enamel is low and limited at a neutral pH. If the fluoride ions are present in the mouth at the time when the pH is decreasing and the carious lesion is starting, their effect is to inhibit the demineralization of the enamel by promoting the remineralization.
The study was carried out with 20 student's of10-15 year-old children from School. All of them had good oral and general health, and normal salivary flow. The fluoridated gel was applied in individual trays made after the imprint of the dental arches. The fluoride concentration was measured in the salivary samples collected before the fluoridation and after, at 15 minutes, 1 hour, 2h, 12h.
The high fluoride concentration in saliva after the use of Fluoride gel may be important on dental caries prevention in children or adults, especially for individuals with compromised salivary flow or the ones who live in deficient fluoride areas. However, further clinical research is necessary to clarify this issue.

Keywords: fluoride, remineralization, saliva, fluoride concentration

Introduction
In using fluoride for caries prevention, the aim is to maximise the benefits in terms of reduced caries levels while minimising the risk of dental fluorosis. Fluorosis is a disturbance in enamel formation which occurs when excess fluoride is ingested during tooth development. The appearance of fluorosis varies from almost imperceptible fine white lines on the tooth to pitting and discolouration of the tooth. The severity of fluorosis is related to the timing, duration of exposure and dose of fluoride ingested [1].
Most research on fluorosis has focused on the permanent upper central incisors because of their prime aesthetic importance. Although some researchers have estimated very precise risk periods for the development of fluorosis in the upper central incisors (age 15–24 months for boys and age 21–30 months for girls) [2], a systematic review of the dental literature on risk periods for fluorosis concluded that no specific period of enamel formation could be singled out as being the most critical for the development of fluorosis in these teeth [3]. The author of the review concluded that the duration of fluoride exposure during enamel formation, rather than specific risk periods, would seem to explain the development of dental fluorosis in the upper permanent central incisors. Long exposure of more than 2 years during the first 4 years of life increased the risk of developing fluorosis in the upper central incisors. A longitudinal study from the United States (the Iowa Fluoride Study) calculated total fluoride intake in a cohort of children at 3–4 month intervals during the first 4 years of life. Examination of these children at age 9 revealed that while fluoride intake during the first two years of life was most important to fluorosis development in the upper permanent central incisors, fluoride intake during each year of the first four years of life was also associated with fluorosis in these teeth [4].
The threshold level of fluoride above which fluorosis of aesthetic concern may occur is not accurately known. However, empirical evidence suggests that the often quoted "optimal" value for fluoride ingestion of 0.05 to 0.07 mg F/kg body weight per day is a useful upper limit for fluoride intake in children [5], and this has become the standard reference range in investigations into fluoride intake [6]. Consumption of fluoridated water, ingestion of fluoride toothpaste, inappropriate use of fluoride supplements, and infant formula have all been implicated as individual risk factors for dental fluorosis [7]. The most important factor in determining the prevalence and severity of fluorosis is the total amount of fluoride ingested from all sources during the first few years of life, but this can be extremely difficult to measure accurately.
The primary and most important action of fluoride is topical, when the fluoride ion is present in the saliva in the appropriate concentration [8]. Hydroxyapatite is the main mineral responsible for building the permanent tooth enamel after the development of the teeth is finished8. During tooth growth, the enamel is constantly exposed to numerous demineralization processes, but also important remineralization processes, if the appropriate ions are present in the saliva. These processes can either weaken or strengthen the enamel. The presence of fluoride in an acidic environment reduces the dissolution of calcium hydroxyapatite. The main action is inhibition of demineralization of enamel, which is carried out through different mechanisms. There are different cariogenic bacteria in the plaque fluid the most important being *S. mutans*. When bacteria metabolize sugars, they

produce lactic acid which decreases the pH in saliva. When the pH falls below the critical level of hydroxyapatite (pH 5.5), the process of demineralization of enamel takes place and caries is formed. At the beginning, the process is reversible and it is possible to reduce the formation of new lesions with appropriate preventive measures. If fluoride is present in plaque fluid, it will reduce the demineralization, as it will adsorb into the crystal surface and protect crystals from dissolution. Because the fluoride ion coating is only partial, the uncoated parts of the crystal will undergo dissolution on certain parts of the tooth, if the pH falls below level 5.5. When the pH rises above the critical level of 5.5, the increased level of fluoride ion leads to remineralization, because it absorbs itself into the enamel and forms Fluor hydroxyapatite [9]. After repeated cycles of demineralization and remineralization, the outer parts of enamel may change and become more resistant to the acidic environment due to a lowered critical pH level of newly formed crystals (pH 4.5).

The most important effect of fluoride on caries progression is thus on demineralization and remineralization processes. It has also been proposed, that the fluoride ion can affect the physiology of microbial cells, which can indirectly affect demineralization. Fluoride ions affect bacterial cells through several mechanisms. One of them being a direct inhibition of cellular enzymes – glycolytic enzymes, H+ATPases). It affects cellular membrane permeability and also lowers cytoplasmic pH, resulting in a decrease in acid production from glycolysis [8].

Fluoride prevents caries mainly by its topical effect. Dental caries result when plaque, a sticky film of bacteria on the surface of the tooth, feeds on sugar and food residue to produce acid, which dissolves the surface of the tooth (demineralization). Bathing the surface of the tooth with as little as 1 ppm of fluoride causes a dramatic decrease in enamel solubility. Ingested fluoride, on the other hand, has little effect on caries, but contributes significantly to the development of fluorosis [10].

The aim of the present study is to evaluate the presence of fluoride in saliva after applying professional use products on the surface of dental enamel.

Methodology

The study was carried out with 20 students of10-15 year-old children from School. All of them had good oral and general health, and normal salivary flow. The fluoridated gel was applied in individual trays made after the imprint of the dental arches. The fluoride concentration was measured in the salivary samples collected before the fluoridation and after, at 15 minutes, 1 hour, 2h, 12h.

Fluoride was analysed by the direct method, using a fluoride specific electrode and an ion analyser. Prior to the samples analysis, a set of standards (ranging between 0.025-3.2 ppm F) was prepared in triplicate, using serial dilution from a 100 ppm NaF stock solution.

Results & Discussion

The data from the 20 students were collected and presented as below.

Table 1: Age Group

Age	No. of Cases
10 years	2
11 years	3
12 years	3
13 years	4
14 years	5
15 years	3
Total	20

Table 2: Concentration of Fluoride in Saliva

Time	Concentration of Fluoride in Saliva
Initial	0.08
15 mins	20.1
60 mins	7.5
120 mins	2.5
12 hr	1.5

All the methods of topical fluoride applications have, as a common base, the increasing of the fluoride in the dental hard tissues [11]. The latest studies show that just o small part of the ionic fluoride in incorporated in the enamel at the moment of application, the directly clinical effect and the incorporation of the fluoride in the sound enamel being of little importance [12]. The model of the fluoride levels variation in this study is similar to other studies and is explained by the CaF2 formation [13], which represents the major product of the reaction between fluoride with enamel, and which precipitates wherever the dental hard tissues are exposed to a high concentration of fluoride, inhibiting the enamel demineralization and enhancing the remineralization.

The highest concentrations of fluoride released by fluoridated products may be due to the composition and viscosity of the product. This can be explained because the more fluid products can be spread over a larger area of the block, which increases the contact surface with the surrounding saliva and provides greater release of fluoride. In addition, the longer contact time of the product with the enamel provides greater efficacy against dental caries [14].

The fluoridated products evaluated released fluoride concentrations able to interfere with the cariogenic process (>0.1 ppm). Thus, dental surgeons can use these products in individuals with high dental caries risk. As the products are available in varied forms, the clinician should consider the better convenience. This is especially important to populations with high risk of dental caries, such as cerebral palsy children, in which preventive measured should be associated with instructions directed to caregivers [15].

Because it is an in vitro study, the dynamics of human saliva, which may interfere with the release of fluoride [16], as well as other physiological conditions inherent to humans, such as swallowing and chewing and body temperature. However, despite the limitations, the present study provides application in the clinical scenario, since it guides the choice of fluoridated products by dental professionals according to the patients' needs. Besides that, this study may guide the convergence of resources and practices for the improvement of the oral health of populations [17].

Conclusion

The high fluoride concentration in saliva after the use of Fluoride gel may be important on dental caries prevention in children or adults, especially for individuals with compromised salivary flow or the ones who live in deficient fluoride areas. However, further clinical research is necessary to clarify this issue.

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