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DETERMINATION OF FLUORINE IONS PENETRATION DEGREE INTO ENAMEL BY EMPA

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Résumé
Des dents saines ont été traitées de façon exogène par différents produits fluorés. Le fluor a ensuite été analysé par sonde électronique. Les résultats montrent que la meilleure prophylaxie des caries est assurée par des composés fluorés organiques plutôt que minéraux.

Abstract
Exogen application of different preparations was done at completely healthy teeth of children up to 11 years. A month after application of fluorine, the relative teeth were extracted and the same were prepared by standard methods for investigation by electron microprobe ARL, type SEMQ.

The results obtained showed that the highest degree of fluorine ions migration was stimulated by organic "fluorite" (amin fluoride). Very poor results were obtained by NaF, while the values obtained by "fluor-protector" ranges between these two preparates.

All up to date investigations showed that protective characteristics of fluorine against caries formation were reached only in case when enamel surface contained fluorine concentration of 10³, μg. Thus, our results undoubtedly proved the fact that the first condition for good prophylaxis is obtained by application of aminofluoride and then by "fluor-protector".

INTRODUCTION
One of the most important tasks imposed to modern stomatology when taking into consideration a high degree of caries extension and its great pathological importance, is certainly the application of preventive measures against this disease.

It was established, long ago, that apart from oral hygiene, the fluorine microelement, being in quantity of approximately 1-2 mg/l, a natural component of a drinking water, prevents caries formation even up to 60%. Therefore, from 1945 on it has been the practice in the United States for fluoride to be added to the drinking water and since recently it has been utilized almost all over the world; in some countries fluoride is added to the common salt and milk while in many ot-
hers the tablets containing fluoride are given to children from their birth till the moment the teeth mineralization process is completed. The fluorine brought endogenously into organism is built into hard teeth tissues during their development thus bettering their resistance against acids and caries formation.

Apart from endogen, the exogen i.e. local applications of different fluoride solutions are used for coating of enamel of already cut teeth. The principal aim of this method is to build the fluorine ions into apatite crystal lattice, by substituting OH-ions so that the fluorapatite, the resistance of which is far greater against acids that are known as agents of the initial caries, can be formed. Fluorine itself inhibits bacterial enzymes, as well, thus reducing the possibility of caries beginning.

LOCAL APPLICATION OF FLUORIDE IN CARIES PREVENTION

Bibby was the first who used the local application of fluoride in caries prevention and was followed both by Knutson who utilized the NaF solution (1) and Muller who applied tin fluoride (1). It is evident that organic fluorides have been widely utilized from early sixties (2,3). Besides the mentioned, a considerable number of complex fluoride compounds such as sodiumfluorophosphate, acid fluorophosphate, magnesiumsilico-fluoride etc. started being applied. The preparations containing lacquers containing lacquers are very frequently used nowadays in order to prolong the influence of fluoride ions on enamel surface (1). One of the basic problems appearing during local application of fluoride deals with prolonged duration of higher fluorine concentration on surface enamel layers after local application of fluoride compounds.

Great is the number of authors who investigated the fluorine concentration in teeth enamel after local application of different analytical methods among which microchemical ones analysing enamel layers, obtained by successive polishing and etching by strong acids, are most frequently used (1). In spite of the fact that the thickness of a cut enamel layer can be determined with great accuracy during the mentioned investigation, microchemical methods cannot provide us with precise concentration profile of fluorine in tooth enamel. The method of chemical analysis is a destructive one and presents average fluorine concentrations in enamel layers thickness of approximately 15-20 \( \mu m \) with relatively great errors.

That is the reason why Baud and Bang (4), as well as Johnson (5) used both the method of electron microanalysis and proton activation analysis (6,7). The purpose of this paper was to establish the degree of fluorine ions penetration into enamel after local application of different fluoride preparates and to determine their values in everyday stomatology practice.

EXPERIMENTAL

For local application, we used entirely intact first premolars that were extracted from children because of orthodontic reasons. Soft sediments were removed from teeth crowns and the same were treated with different fluorine preparates for local application (4 x 3 min.). The 2% dissolution of NaF was used for local application, as well as fluor-protect, inorganic fluoride with polyuretan lacquer and aminofluoride. The investigated and controlled samples were cut along-side and prepared in the standard manner for investigation by electron microprobe (8).
There were two main reasons why we decided EMPA to be the method of our investigation. Namely, the method of electron microanalysis is not a destructive one, and the study of profiles i.e. fluorine distribution in tooth hard tissues is the most close to the conditions existing 'in vivo'. Then, this method is characterized by a high absolute sensitivity comparing to other microanalytical methods (lo^-14 to lo^-16 g) and by the locality "in situ" ranging from several to ten \( \mu m^3 \) (8).

The relative measurements were carried out by electron microprobe of ARL firm, type SEMQ under the following conditions:15 kV, 30 nA, TaP-crystal with standard CaF\(_2\) (8).

Investigation of fluorine profiles concentration was performed both at investigated teeth and controlled samples in two lines: in fissure and parallel to the fissure.

RESULTS AND DISCUSSION

The obtained fluorine profiles concentration in controlled samples showed very low values of fluorine in enamel (approximately 400 ppm), although they are somewhat higher 450-790 ppm in first 2-3,\( \mu m \) (Fig.1)

![Fluorine Concentration in Enamel](image)

**Fig. 1**

When comparing fluorine profile in enamel both of investigated teeth and controlled samples, 4 local applications in duration of 3 minutes, 2% NaF, fluor-protector and aminofluoride salts, it can be noticed that there exists a difference depending on the utilized preparation, place of application and measurements performed in fissure and parallel to it (Fig.2 and 3).

It was proved that fluorine ions migration is always greater in the very fissure than at the plane enamel surface what can be explained by poor mineralization and presence of more organic substances in fissure comparing to other parts of enamel, therefore a greater heteroionic exchange is possible in the very fissure.

It is characteristic that in both investigated profiles i.e. in fissure and parallel to it, the fluorine from organic preparations showed a higher migration degree. The fluorine from inorganic fluorides showed the lowest migration, while the values of fluorine mi-
FLUORINE CONCENTRATION IN ENAMEL AFTER LOCAL APPLICATION OF AGENTS
- parallel to a fissure -

Fig. 2

FLUORINE CONCENTRATION IN ENAMEL AFTER LOCAL APPLICATION OF AGENTS
- in fissure -

Fig. 3
It was particularly important to determine the fluorine ions penetration degree into enamel after local application. Brudevold was of the opinion that fluorine penetrates into enamel after local application up to 100 μm (1). The research work of some authors suggested a possibility of ions migration, while the others stated that the migration after local application is quite limited and ranges from 10-20,μm (9).

The results obtained during our investigations, presented in this paper show that fluorine ions migration is considerably limited, being the highest in the first 5 μm and then the relative fluorine values rapidly increase to be almost equal to the values of fluorine in controlled samples at approximately 10,μm

CONCLUSION

The results obtained during our research work showed that the protective fluorine effect can be expected in cases when fluorine concentration within the outer enamel surface is approximately 1000 ppm. It was also proved that aminofluoride salts and fluor protector have all prerequisites to be good protectors.

On the basis of penetration degree and realized fluorine concentration in teeth enamel, as well as the simplicity of everyday application in stomatology, it can be concluded that aminofluoride is chosen to be the preparate used in caries prophylaxis.

LITERATURE