

Morphological changes in enamel, as a consequence of topical fluoridation

Aurelia Spinei, Iu. Spinei
Chisinau, Republic of Moldavia

Summary

In this paper are presented results of dental examination of 330 children of 7 years old. The period of study was 6 years, in conditions according to the WHO. The prevention of caries in 81 schoolboys was conducted in a series of topical applications using a fluoride acidulated gel and aminofluoride gel. In a comparative study regarding the efficiency of the topical agent used with a *slow release* of fluoride ions in 80 children, there were applied adhesives pellicles. The local application of fluoride products was conducted by individual indications.

The application series of mineral and organic connections of a fluoride increases enamel resistance to acid attack and saturates the enamel with fluorides. Morphological changes of enamel by applying topical fluoridations is characterized by an actuation of calcium fluoride and an *increase in the density of the protective granulated layer* of the enamel surface. The comparative study analyses the effect of topical fluoride application by adhesive pellicles and demonstrates that this method is more efficient than conventional topical fluoridation.

Recent studies demonstrate that the decay-preventive efficiency of topical fluoride substances depends on the:

- chemical composition of fluoride products;
- time of contact between enamel and fluoride substances;
- penetrability in enamel of active substances.

During the last 10 years for improving the qualities and characteristics of topical fluoride substances additives are used having properties to grow the medium fluoride viscosity, and also to reduce the frequency of particles' impact, consecutively reducing the sedimentation speed and adhesive pellicle.

Improving all this properties, we can have as a result a better contact surface and growing time, finally, a better concentration of active particles.

Purpose of study

This study evaluates the topical fluoride substances through the bacterial pellicle on the enamel surfaces, and determines the changes in the adamantine structure. The objective has two stages:

- experimental and preclinic testing with two steps:

- a) *in vitro* analysis of fluoride substances through enamel structure after the demineralization applications;
- b) preclinical testing and evaluation of fluoride topical substances with recovering effect.

Clinical evaluation objectives

- a) Analysis of succeeded stages in using of fluoride topical substances with adhesive effects acid resistance of enamel.
- b) Searching and evaluation of changes in adamantine ultrastructure persisting after successive topical mineral and organic slow release fluoride.

First stage - experimental and preclinical tests

Material and methods

Influence of topical fluoride substances on the structure of demineralized enamel by typical agents has been evaluated in concordance with the deep of penetration of nitrium azotate AgNO_3 , on 43 extracted premolars with orthodontic reasons. Extracted teeth have been placed in 8 vessels with demineralization solution (synthetic hydroxiapatite) $\text{Ca}/\text{P} = 1.63$, 1 mmol/1 Ca, and active elements we have: 1. Sodium fluoride, NaF for 60 minutes;

2. FFA - fluoride phosphatic acid - 60 minutes;
3. AmF - aminofluoride for 60 minutes.

Successive influence of 2 fluoride substances have been studied by placing teeth into a vessel with:

4. NaF for 30 minutes less than FFA - 30 minutes;
5. FFA 30 minutes less than Na F - 30 minutes;
6. AmF 30 minutes less than FFA - 30 minutes;
7. FFA 30 minutes less than AmF- 30 minutes;
8. Placebo effects - 60 minutes.

Synthetic decays has been obtained by placing teeth into a vessel with gel - 17% gelatine and lactic acid and 0,5 g/l synthetic hydroxiapatite for 7 days.

Than teeth have been placed in 2% AgNO_3 solution for 3 hours.

Penetration of AgNO_3 in dental tissue has been differentiated such as:

1. Penetration of AgNO_3 less than 1/2 from the thickness of the enamel.
2. Penetration of AgNO_3 through dentine-enamel junction.
3. Penetration of AgNO_3 more than 1/3 from the dentine thickness.

4. Integral discolouration of enamel from 1/3 through 1/3 from dentine thickness.
5. Integral penetration of AgNO_3 in enamel and dentine and affecting the pulp chamber.

Studies of enamel permeability have been done comparing the effects of FFA and AmF with NaF and placebo. The best enamel resistance was obtained after successive effects of FFA and AmF - the results could be explained by the cumulative effects of anorganic and organic slow release fluorides. For improving the efficiency of decay-preventive effects of fluoride substances some additives have been introduced to change the dosage of fluoride releasing.

Adhesive pellicles have the property of adhering to smooth enamel surfaces, and in 20-30 minutes can change in gel with high viscosity and resist on dental surfaces for 2-4 hours, they don't disturb patients activities, have good taste, aesthetic appearance and are easy to apply. Comparing with conventional fluoride substances with quick fluor releasing the slow release has the following properties:

- controlled fluoride release;
- very well targeted action of active substances (adhesive films, floss, tooth-picks).

Preclinical tests permitted the appreciation of fluoride releasing speed by using TRANSIDERM-TEST equipment.

Studies demonstrate that speed of fluoride releasing is by 17,8 times reduced than conventional fluoride systems.

Results of experimental and preclinical tests were used as start point for the second stage-clinical evaluation.

Second stage - clinical evaluation

Studies have been performed on a sample of 330 7-year-old children (145 girls and 185 boys).

Period of clinical studies - 6 years.

1. Clinical examination (acusses, inspection, dental status)

Diagnosis of decays by inspection and in difficult access by transilumination.

The index for the following items was determined:

- frequency of decays;
- index CAO-S (DMFS);
- index CAO (DMF);
- rate of decay - experimented by medium number of decay (CAO) or filled surfaces (CAOS)/year
- individual level oy decay NIC for temporary and permanent teeth.

For the decay diagnosis in children and individual evaluation of topical fluoridation the following have been used:

1. Tests for evaluating the oral hygiene and pathogenical effects of dental bacterial plaque

- index for oral hygiene OHI; Green, Vermillion 1964;
- index for aproximal plaque (Lorange ;API 1975);

- colourimetric differential diagnosis of dental bacterial plaque - comparative coloured results for recent and old plaque; Bloc method 1972;
- cariogenic potential of dental plaque (after Hardwick and Manley 1952).

2. Tests for evaluating the resistance of enamel to cariogenic factors

- determining the resistance of enamel to acid agents (method proposed by Albicenko 1990);
- speed of remineralization for enamel VRS after Redinova, Leontiev 1952;
- determination the level of saturation for F (GSSF1992).

Efficiency of the previous methods has been appreciated by determining the CAO and CAO-S index, determining the aggressive rates (penetrable) decays/ simple decays and estimating the index of reducing the dental decay.

Extraclinical investigations

Studies for evaluate the resistance of enamel through demineralization agents. Influence of

fluoride substances on demineralization agents have been demonstrated by action of AgNO_3 on 28 extracted premolars (extraction for orthodontic treatment).

Electronomicroscopic (type YEM-100) researches on nondecalcinated teeth; adamantine stamps were obtained by Karpachev method (1969) and Busan (1972).

Methods of prevention for decays on children

The aggregate number of children was divided in 4 samples:

1. Sample no. 1 - 81 children (24.55%), who get a correct brushing technique, topical fluoridation with acidulated phosphatic fluoruride 1.25%, for a ,5-minute appliance of gel; with 2 grams of aminofluorure for 1 minute (referency sample).
2. Sample no. 2-80 children (24.24 %) with hygiene instructions and successive mineral, organic and anorganic slow fluoride release. Topical fluoride applications have been done in samples 1, 2 after professional oral hygiene, frequency has been individualized for each patient according to cario-reactivity and enamel structure.
3. Sample witness control no. 1, with 86 children (26.06%), simultaneously examined with referency sample no. 1.
4. Sample control no. 2; 81 children (23.15%) who received informations and educational methods.

Results

Different cariogenous activity:

- reduced decay reactivity in 24.24% children;
- medium decay reactivity in 45.56% children;
- high decay reactivity in 30.30% of children.

The decay prognostic demonstrated that 83.93% of decays will evaluate in different directions.

For stopping the evolution of decays, the following methods were used:

- preventive attitudes;
- educational methods to all samples;
- topical fluoridation - individual treatment to 77.88% of children.

Topical fluoridation has been followed by an index growth, which demonstrates the resistance of enamel to cariogenous factors. After the application of fluoride substances with slow releasing effect, the resistance of enamel has grown by 1.26 times and saturation in fluorides by 1.24 times, compared to conventional fluorides.

Analysis of GSSF, TRSI, CCPB, index after cariopreventive treatment for 6 months, demonstrated an inverted relation between the

time of contact with enamel for fluoride substances and GSSF, TRSI and CCPB index.

Macroscopic analysis for the examined extracted teeth demonstrated the sequency and frequency of demineralized areas in comparison to witness and study samples.

Deep AgNO_3 penetration was different for dental tissue as following:

- 4.87 points extracted teeth from witness sample no.1;
- 4.08 points from extracted teeth from witness sample no. 2;
- 1.81 points for extracted teeth for referency study sample no. 1;
- 1.26 points for extracted teeth referency sample no. 2.

The result of reducing of demineralization areas and limited penetration of AgNO_3 , confirms that acid resistance of enamel grew after topical slow releasing organic and mineral fluoride substances.

- electronomicroscopic analysis for demineralized enamel explained the growing number of microfissures;
- microscopical analysis of enamel surfaces after fluoride applications, followed by demineralization, showed on the enamel surface a layer of CaF_2 and a reduction of microfissures. In the bottom of the fissures calcium fluoride perles were also found.
- electronooptical analysis of the enamel stamps into a fracture area after demineralization showed total distraction of enamel prisms into the fracture area and non-modified enamel;
- FFA and AmF gel applications conserved totality the characteristics of enamel. Electronooptical aspects of enamel prisms were altered, missing the hydroxiapatite crystals and adamantine prisms.

After successive topical fluoride applications, organic and mineral with slow releasing effect, the results are:

- maintaining of adamantine prisms;
- insignificant changes of crystals clarity and interprismatic substance;
- inclusion of CaF_2 globules in central areas and extremities of adamantine prisms.

By observational and electrono-microscopical information, results concluded that in topical applications of slow released fluoride systems, fluoride ions ensure a perfect preventive effect by modifying the enamel - growing its resistance to acid agents.

The morphological results of studies have been included into CAO, CAO-S and decay frequency index.

By comparing the results - in the beginning of the study, the decay index value was approximately identical in all children and during the evolution of the study, the index changed.

CAO index was reduced in referency study sample comparing with witness (according to the fluoride applications).

A growing number of extracted teeth due to decay complications have been observed in the referency studies.

Evaluation of RC index (reduced decays) comparing to witness sample no. 1 showed:

- the most significant results in reducing CAO index have been obtained in the referency study no. 1, who got topical slow releasing fluoride system - for the samples with low and medium carioreactivity and even for the high reactivity.

- systems with slow releasing effect are more carioprotective than conventional systems by 1.12 times.

Analysis of cariopreventive measures during a 6-year period under clinicomorphological results demonstrated that the efficiency of successive topical fluoridation with slow releasing effect, was successful and also certain methods with cariopreventive results in children in the posteruptive and mineralization period of permanent teeth.

Conclusions

1. The dental decay prognostic demonstrates that in the posteruptive mineralisation period of

References

- Clarkson B.H., Wefwl J.S. Silverstone L.M. - Redistribution of enamel fluoride during white spot lesions formation; an *in vitro* study on human enamel. *Caries Res*, 1981, **15**: 158-165.
- Darby M.L. Moshby's comprehensive review of dental hygiene. 4-th ed., St. Louis, 1998: 902.
- Danila I., Amariei C. Orientari profilactice in stomatologie. Editura Syrinx-med, Constanta 1998:60-63.
- Disney J.A., Stamm J.W., Graves RC - Description and preliminary results of a caries risk assessment model. In: Bader J.D. (ed): Risk assessment in Dentistry, Department of Dental Ecology, University of North Carolina, Chapell Hill, NC, 1990:204-214.
- Featherstone M.J., Silverstone L.M. - Creation of caries like lesions in sections of teeth acid gels. *J. Dent. Res.* 1982, **61**: 278.
- Gasser P., Haikel Y., Voegel J.C., Gramain P.H. - Role of the absorbed fluoride ions on the dissolution of synthetic Hydroxiapatite. *Journal of Materials Sciences, materials in Medicine* 1995, **6**: 105-109.
- Haikel Y., Serfati R., Bentaleb A., Poumier F. - L'utilisation de polymers dans la prophylaxie de la plaque dentaire. *Le Chirurgien Dentiste de France*, 1997, **837**:27-31.
- Kadonma J., Kajoma K., Masuhara E. - *Biomaterials*, 1983, **4**: 89-93.
- Khang J. Masuhara E. - *Chem*, 1981, **182**: 273-277
- Kim S.W., Feijen J. - Surface modification of polymers for improved blood compatibility. *CRCCrit. Rev. Biocompat*, 1985, **1(3)**: 229-260.
- Lee J.H. Khang G., Park Koridel. H., Lee H.B., Andrade J.D. - Polymer surfaces for cell adhesion. Surface modification of polymers and ESCA analysis. *J. Korea Soc. Med. Biolog. Eng.*, 2000, **10(1)**: 43-51.

permanent teeth, 95.19% of children show cariogenical factors.

Results of clinical studies demonstrate that the examined children needed some educational methods (brushing, flossing, interdental cleaning) and 77.88% of children needed topical fluoridation.

- Successive topical fluoridation with organic and anorganic mineral slow releasing fluorides grew the resistance of enamel to demineralization agents by 2.17 points TRSI after fluoride gels application and by 2.73 points after slow releasing fluoride, by 1.6 and respectively, by 1.98 points GSSF.
- Morphological changes of dental enamel after slow releasing systems are shown by a growing in the density of granular protective enamel layer and inclusion of CaFi in the central area and in adamantine prisms.
- Comparative analysis for cariopreventive topical fluoridation in dental decay prevention in children show the advantages of fluoride systems with slow releasing effect which exceeded by 1.12 times the cariopreventive performances of conventional systems.
- Topical fluoridation with slow releasing systems is recommended as a prevention method in the posteruptive and mineralization period of permanent teeth.

and phosphate in saturated solutions. *Colloides and Surfaces* 1994, **88**: 157-168.

13. Leucuta S.E.E - Aspecte biofarmaceutice ale formularii medicamentelor. Farrnacia Moldovei - Realizari si perspective. Chisinau. 1999: 38
14. Maxim A., Balan Adriana, Pasareanu Marinela. Implicarea sanogenica a educatiei sanitare in profilaxia afectiunilor stomatologice la copii. Secțiunea științifica "Prevenirea afectiunilor stomatologice". U.M.F.Iasi, 7, 1994.
15. Nikiforuk J. - Understanding dental caries. Etiology and mechanisms: basic a clinical aspects. Basel. 1985, VI: 303.
16. Sertafy R., Haikel Y., Schaad P.H., Voegel J.C., Gramain P.H. - Efficiency of polymers in the prevention of rata dental caries. *J. Dent. Res.* 1995, 74:940
17. Sertafy R., Haikel Y., Schaad P.H., Voegel J.C. - Efficiency of synthetic polymers in the prevention of rata dental caries. *J. Dent. Res.*, 1998 (sous presse).

Correspondence to: Dr. Aurelia Spinei, Dr. Iu. Spinei, State University of Medicine and Pharmacy, Dimo 29/2, appt 45, Chisinau, 2045, Republic of Moldavia, tel; (3732/0422) 43 41 28