The decreasing of carious index by using toothpaste based on amine fluoride

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Fluoride is in present time the chemical agent which is used most frequently in the fight against dental decay. His action consists not only in reducing the solubility of hard dental tissues in acid medium, but also making possible the accumulation of different minerals (Ca, P) on the enamel surface.

In dental prophylaxis fluoride is used under different compounds with sodium or potassium, forming alkaline salts, or attached by a covalent link to the phosphor atom, forming monofloride-phosphate.

A special category of fluoride compounds is represented by organic fluoride: amine fluoride.

For the first time, in 1954, *Wainriht* showed in his study the high permeability of enamel to organic molecules like urea. This aspect made him ask himself if it was not possible to enrich the contains of the enamel with fluoride by using organic molecules as carrier, which were chemically bonded to amino fluoride.

In 1957, *Muhleman, Schmidd* and *Konig* published the results of their studies *in vitro*, in which they demonstrated that some compounds with amino fluoride were obviously superior to those with inorganic fluoride in reducing the solubility of the enamel.

In the same year, *Irwin, Leaver* and *Walsh* published the results of their experiments *in vitro*, which demonstrated that monoamine-aliphatic compounds offered protection to the enamel against acid decalcification.

In 1967, *Muhleman* demonstrated the superiority of organic fluoride comparing to inorganic fluoride in preventing dental decay. He observed that amine fluoride had a pronounced affinity regarding enamel, by raising the quantity of fluoride in the enamel and also having an antienzyme effect on the microbial activity of dental plaque.

His conclusions were the following: amino fluorides produce the most powerful enrichment in fluoride of the enamel, even in low concentration. The carious preventive action is due to fluoride on one side and to the anti-enzyme effect of the organic fraction on the other side and also by arresting the formation of dental plaque, as a result of the tensioactive properties.

In this way amine fluorides were born in GABA S.A.-BASEL laboratory.

The commercial products, which contain amine fluoride or compounds of this with tin-fluoride in their formula, are present under different forms:

- gels,
- fluids,
- dentifrice,
- mouth rinse.

Toothpaste with amine-fluoride

In the beginning of the year 1945, investigations were made regarding the efficiency of including amine-fluoride in toothpaste. Those investigations covered a lot of active ingredients in different chemical combinations.

The fluoridated products which were tested for their carious inhibiting properties, while incorporated in toothpaste were: NaF, APF, SnF, MFP and amine-fluoride.

The purpose of using dentifrice was first of all physiognomic; dental surfaces were cleaned and breath was refreshed. The second purpose had a therapeutically effect because some substances were increasing the efficiency of brushing and because some of them were the vehicle of active ingredients in oral cavity.

Dentifrice contains two types of ingredients: base ingredients and therapeutically ingredients.

As base ingredients we mention:

- abrasive substances: precipitates of calcium carbonate,
- tensioactive agents: detergents,
- wetting agents: glycerin,
- emulsion: colloids,
- flavoring agents: menthe piperita, menthe spicata,

- conservation agents, oxidant, colorants.

As therapeutically ingredients we mention:

- based on fluoride: amine-fluoride, tin-fluoride, MNF, NaF,
- plaque inhibiting agents: lactoperoxidaze,
- desensitizing agents: potassium chloride, potassium nitrate, and strontium chloride,
- agents for calculus removal: pyrophosphate, zinc.

An important aspect of the carious-preventive action of fluoride is the time of action. From this point of view the availability of the fluoride from saliva is considered a fundamental parameter of the carioprotective effect of fluoride.

By including sodium lauril sulfate in toothpaste, the bio-availability of the fluoride in saliva is increasing, due to the increasing of moistening capacity which favors the initial depositing of fluoride on dental surfaces and oral mucosa.

The flavored agents of the toothpaste have the effect of reducing the availability of the fluoride by a simple dilution and by stimulating the salivary flux.

The carious prophylactic effect of the toothpaste, which contains sodium fluoride or amine-fluoride, is well known and is no doubt about it. As a rule, the studies made for comparing the effect of fluoridation, from different fluoride products, were made *in vitro* or *in situ* because the necessary time for a clinical study was too large.

There are many studies in literature, which compare the incorporation of fluoride in healthy enamel or demineralized enamel, followed by the application of solution or pastes with NaF or AmF.

Sometimes amine-fluorides were used in combination with tin-fluoride, which had also an antibacterial effect due to the tin. This effect was explained probably by the citotoxic action of metallic ions (especially Cu, Ag, Hg.). Initially, a complex deposit was formed on the enamel surface, which could have a protective effect. The compound was instable in basic medium and that is why its stabilization became imperative, by combining it with amine-fluoride, which has an acid pH. Some of the disadvantages are: they could impregnate the dental surface in patients with an inadequate oral hygiene, who frequently complains of the bad taste of tin fluoride products.

Commercial products:

- Elmex,
- Elmex children's toothpaste - 1250 ppm F,
- Elmex menthol free - 1250 ppm F,
- Elmex sensitive plus - 1400 ppm F,
- Meridol - 1400 ppm F.

The fast distribution of fluoride and its concentration on the enamel surface

Because of the surface activity, amine-fluorides are rapidly scattered in the oral cavity and they ensure a proper moistening of all dental surfaces. They cover the dental surface with a homogeneous molecular layer and transport the fluoride wherever is necessary. The special structure of the amine-fluoride is responsible for the fast distribution of the fluoride and also of his concentration on dental surfaces.

On the opposite, in the case of inorganic fluoride, the correspondent ion (e.g. Na) does not have the role of transportation; fluoride is distributed randomly in the oral cavity.

Amine-fluoride covers the dental surfaces with a homogeneous molecular layer. This continuity of the film prevents it for being rapidly washed away by saliva, which makes amine-fluorides active agents for a long time.

The increasing of fluoride absorption and the forming of a deposit on dental enamel

If a solution which contains fluoride is brought in contact with the dental surface, on the enamel surface and also on dentin surface globularly precipitates of CaF_2 will form, the fluoride ions being capable to react with hydroxyapatite from the enamel surface. This precipitates formed after this topical application were first described in 1945 by *Gerould, Cooley (1960) Scott, Picard and Wycoff (1962); Muhlemann, Rossinschi and Schait (1967); Gwinett, Buonocuore and Sheykholeslam (1972); Wei (1975); Joost Larsen and Fejerskov (1978); Wefel and Harless (1981).*

The deposits were studied by diffraction with X-ray and the analyses showed the existence of a layer enriched with fluoride absorbed on the dental surface.

In order to show the intensity of the deposits and the microstructure of the precipitates on dental enamel, techniques of electronic microscope were applied.

The intensity of the deposits was correlated with the quantity of calcium and fluoride from the dental surface.

The quantity of fluoride absorbed was significantly higher in dentin compared to the quantity absorbed in enamel, aspect explained by the porosity of the surface, with a highly organic content, by the presence of the tubules and the great surface of crystallites.

The large surface of the dentin is important, because a higher number of calcium ions are avail-

able to react with fluoride, resulting CaF_2 *(Saxegard, 1987).*

The acidity of the product containing fluoride has a great importance, because of the influence that this aspect has on the quantity of fluoride absorbed.

Only in an acid environment the reaction between fluoride and enamel results in a final and long time standing fluoride absorption.

As hydrocarbons, amine-fluoride in natural state has a moderate acid pH; in the commercial products the value of pH is between 4.5-5.

This value of the pH and the surface activity leads to an increased absorption of fluoride on the enamel surface and the formation of fluoride deposits for a long time.

The superior resistance of enamel to acid attack

The reaction between acid products with fluoride and hydroxyapatite in enamel determines in the first stage the forming of the precipitates of CaF_2, which are deposited as a fine layer (1-2 microns) on the enamel surface.

The amine-fluorides are concentrated in a homogeneous layer on enamel surface due to their surface activity and they are forming a protective, adhesive layer. The acid reaction between the amine-fluoride and enamel is possible in the presence of a high concentration of fluoride which is responsible for the connection between calcium and the most superficial layer of the enamel. The saliva does not wash calcium away, on the opposite, it is fixed on the enamel surface as CaF_2 compound. This superficial layer is responsible for the protective activity against decay and is much more resistant than the profound layer of the enamel.

Promoting the remineralization of the initial carious lesions

The protective layer of CaF_2 represents an oral deposit of fluoride, from which the fluoride is discharged continuously in small quantities. It seems that on the surface of healthy enamel, the deposits of CaF_2 are not formed *(Bruni, 1983),* the demineralization and the defects are the ones responsible for the forming of CaF_2 *(Nelson, 1988).* It is considered that these deposits are controlled by the variation of the environment acidity *(Ogaard, 1990).*

Insoluble in water *(Bruni and co.)* and in neutral medium saliva, CaF_2 is dissolved in an acid medium and discharges fluoride in high quantities and could induce the reprecipitation of hydroxyapatite.

The continuous presence of a lower concentration of fluoride in saliva increases and accelerates the natural protective mechanism of remineralization. In this way, the mineral deficit of initial carious lesions could be balanced, the initial carious lesion is stopped in evolution and the lesion is remineralised.

Material and method

45 patients were involved in this study, comprising 12 students from medical school, aged 20-30 years old and 33 children aged 8 to14.

The patients were divided in 4 groups: 3 experimental and one witness.

-10 children, pupils in a public school, form **group 1** - the children are coming from families with medium socio-economical level.

- **group 2** is formed by 11 children, also from a public school.

- 12 institutionalized children form **group 3**.

- 12 students form **group 4.**

The study was carried on for one year and a half. The following indices were assessed in the beginning, at the end of the third month, at 6, 9, 12, 15, 18 months:

- DMFt-index,

- PI-index Silness and Loe, monitorizing the accumulation of plaque with the evaluation of its thickness at the gingival border,

- The gingival bleeding index *(Muhlemanand and Son),* assessing the inflammation of the gingival tissue.

The materials used in this study were Meridol products: toothpaste and mouth rinses witch contain amine-fluoride in combination with SnF as active substances.

The witness group used for brushing a placebo toothpaste which contained the same ingredients as Meridol products, but did not contain the active agents of this product.

Group 2 used Meridol toothpaste.

Group 3 was thought how to use the toothpaste and the mouth rinse Meridol.

Group 4 used the placebo toothpaste and the mouth rinse Meridol.

The participants were instructed to brush their teeth twice a day and after that to wash their mouth with solution (mouth rinse Meridol - 10 ml) for one minute.

In the beginning of the study, the dental files of all participants were completed, the dental status before any therapeutically measures was established.

After that, the participants in the study were involved in a program consisting in information about dental health; in this dental health education

program the parents, grandparents and the personal from the orphanage were also involved.

The health education program was divided in two sections: one consisting in information and the other one consisting in technical advises - correlated with age and educational level.

The link between the necessity of hygiene measures and oral health was explained. We explained the internal mechanism of producing dental decay, the importance of a proper dietary program, and the protective action of dental hygiene.

The technical indications were focused on showing different methods of brushing with revealing of technical skills.

In order to make these lessons more pleasant, we used different materials: videotapes, booklets for adults and children.

Results and discussions

Before we started the study, we registered the following indices: plaque index, bleeding index and carious index for each patient.

In the witness group, 6 children of 10 showed a moderate accumulation of white material at the gingival margin (dental plaque score 2) and 4 children showed dental plaque score 3.

In the second group, the following scores were registered: score 2 in 7 children and score 3 in 4 children.

A similar situation was observed in the third group, where 8 children had score 2 and 4 children had score 3.

For the adults group, the plaque index showed: score 2 in 3 patients and score 1 in the rest.

Regarding bleeding index, the scores for the witness group were 3 in 2 patients, 2 in 4 patients and the last ones had score 1.

In the second group 7 children had score 1 and only 4 children had score 2.

On the other hand, in the institutionalized children, 8 had score 2 and 4 score 3, which means that bleeding was present on probing and also a changing in color.

In adults, 5 had score 4, 1 score 1 and 3 had score 3.

Using the toothpaste alone we obtained the decreasing of dental plaque, but the Meridol toothpaste showed better results than the placebo toothpaste. The importance of the active ingredients is obvious.

By combining Meridol toothpaste with Meridol mouth rinse we obtained better results than combining placebo toothpaste with Meridol-mouth rinse, but even this combination was more effective than using only the toothpaste. By introducing the mouth rinse we obtained a better control of dental plaque.

The results of the study showed the fact that by using Meridol toothpaste, Meridol mouth rinse we obtained a decrease of the dental plaque index and also of the bleeding index, this findings being correlated with the results that already exists in the literature *(Banoczy and co., 1989).*

The properties of the amine-fluoride, which are the grounds for obtaining these results, are:

- the fast distribution of fluoride and its concentration on dental surface; this is conferred by a special structure: tensioactive agents.
- its tensioactive properties increase the contact time with the dental plaque 4 times.
- the increase of the absorption and the forming of a deposit of fluoride on the enamel surface is ensured by its tensioactive properties and also by the acid environment.
- the resistance of enamel to acid attack is ensured by the existence of the CaF_2 precipitates.
- promoting the remineralization of initial lesions by realizing high quantities of fluoride during the acid attack.
- antibacterial properties.

These properties explain the data that we obtained, but the active ingredients of each product cannot be active unless the technical skills for hygiene are not correct and efficient.

The third group, formed by institutionalized children had the best results, fact that we could explain by the existence of a good, healthy diet, with regular hours, the alimentation being followed by hygiene oral measures under close supervision.

We couldn't find the same situation in the children coming from families because in this children the oral hygiene measures were inadequate regarding the technique and the time, the diet and also the feeding hours were unproper, the parents giving children sweets between meals, different snacks and sweet beverages, which were not followed by oral hygiene measures.

The technical skills obtained by institutionalized children during educational lessons were much better than the oral hygiene techniques obtained after information provided by families.

In adults, even if their intellectual level permitted a good communication, they were not so receptive to learn new methods of brushing, considering from their point of view that their personal skills were good and they did not have to improve their personal hygiene status.

The anticarious and gingivoprotective measures of the active ingredients of Meridol, AmF and tin-fluoride were confirmed in the present study.

Much more than that, the fact that side effects were not observed (like the coloration of teeth, as in the use of clorhexidine) recommend these products for a long time usage (mouth rinse - once a day) in order to obtain individual prophylaxis at the the patient's home.

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