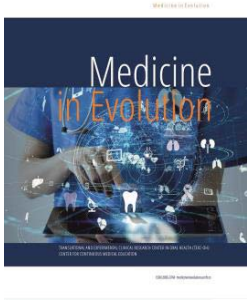
Fluorides effects on tooth structure



Hosszu T.[1], Olariu I.[1], Toser I., Radu R., Lile I.E.[1], Marian D.[1], Olariu T.[2], Ilyes (Veja) I.[1]

[1]*Department of Dental Medicine, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, Romania*
[2]*Department of Medicine, Faculty of Medicine, "Vasile Goldis" Western University of Arad, Romania*

Correspondence to:
Name: Olariu Iustin
Address: Department of Dental Medicine, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, Romania, Arad, Str. Liviu Rebreanu, nr. 86, Campusul Universitar „Vasile Goldiş"
Phone: +40 723423263
E-mail address: olariu.iustin@uvvg.ro

Received: 01 August 2024; Accepted: 10 September 2024; Published: 30 September 2024

Abstract

Dental caries involve a complex process of demineralization and remineralization of tooth enamel due to the action of organic acids produced by the microorganisms found in the dental plaque. The purpose of this study was to demonstrate the importance of the action of fluoride products on tooth enamel and how to ensure protection against the appearance of dental caries. The main mode of action of fluorine, in general, is the topical effect on the enamel surface. Even small concentrations of fluoride around the tooth inhibit demineralization and promote remineralization of the tooth surface. Incorporating fluoride (such as fluorapatite) into the enamel surface will decrease solubility and increase tooth decay resistance. In the study, we used three randomly selected fluoride products that are of professional application, and we investigated which of them has the most effective cardioprotective effect, depending on the chemical composition, the concentration of fluorine, the application mode, the frequency of application, and the risk of overdose.

Keywords: tooth decay, mouthwash, fluoride gels, fluoride varnishes, remineralization

INTRODUCTION

Dental practitioners spend their time treating dental caries; however, many dental practitioners have poor knowledge about the mechanisms of initiation of caries, how to identify at-risk patients, and how to draw up a management plan to ensure that the condition does not progress. Too often, the condition is treated, and not the cause itself [1].

When systemically ingested, fluoride helps develop tooth enamel. Initially, the researchers focused on the systemic effect of fluoride as a key factor in reducing tooth decay. However, the evidence of the systemic effect was replaced by the discovery of the fluoride reaction in the enamel micromedia, namely the stimulation of remineralization, which is of major importance in reducing tooth decay [2].

Topical fluorides

Lifetime protection against decay results from the continued presence of fluoride in low concentrations, which will enhance the remineralization of white spots, keep incipient invasive caries under control, and limit the occurrence of secondary decay for both children and children [1].

An optimal fluoride concentration in the enamel interface and saliva will help minimize the risk of decay.

Fluoride varnishes

They were developed many years ago in order to extend the contact time between fluoride and enamel. Fluorinated varnishes can be part of the prevention plan for individual patients, and indications for their use are hypersensitive areas of enamel and dentine, an alternative to sealants for the occlusal surfaces of permanent molars for receptive children until the sealant is applied, local remineralization for stains white enamel, as part of the program for the prevention of patients with active caries in temporary or permanent dentition, a routine preventive measure for medically compromised children or patients with special needs [3].

Fluoride gels

Concentrated fluoride gels are also used by clinicians for caries prevention and treatment. Studies show that concentrated fluoride gels are more effective in permanent dentition than temporary dentition, especially for first permanent molars [4].

Considerable amounts of fluoride gel during application, followed by swallowing, can lead to ingestion of large quantities of fluoride, a factor that contributes to the appearance of light fluorosis and the mineralization of permanent teeth. Therefore, these products should be used with care for patients over 10 years [3].

Fluoride mouthwash

There are two types of mouthwash: weekly and daily. The most popular is the one for daily use because it is easier to use than the one for weekly use, trying to remember the day when the product should be used. Mouthwash and brushing with a paste containing fluorine mustn't be used at the same time because their use together does not offer an additive effect. The best thing for a child to use mouthwash is when he returns from school because the plate will undoubtedly be present, where the fluoride will be incorporated and slowly released over time [4].

There are certain patients who are recommended to use daily mouthwash: children under orthodontic treatment, mouthwash can reduce demineralization around the dental apparatus; patients with hyposalivation due to medication or those with congenital absence of large salivary glands; children with medical problems due to which dental caries can be a severe problem (heart patients or patients with coagulation problems), children with active dental caries, some patients who find it difficult to brush [5].

Aim and objectives

To address the importance of preventing carious disease during childhood using fluoride-based products.

MATERIAL AND METHODS

This study is a one-year research project done in the clinic of the faculty of dental medicine regarding a basic branch of dentistry: the importance of preventing carious disease during childhood by using fluoride-based products.

We examined 30 patients between the ages of 6 and 14, accompanied by caregivers, some more cooperative, others less cooperative. It is important to remember that those included in this study gave their written consent to participate in the research.

The following data was analyzed: the incidence of caries according to the way of hygiene, the incidence of caries after fluoride application, the incidence of caries after sealing, the incidence of caries according to food, the classification of patients according to the quality of the enamel structure.

RESULTS

We examined thirty patients. Eight of them came from rural areas, presenting an increased number of caries compared to the twenty-two from urban regions. Following the anamnesis and the discussions with the caregivers, we found that patients from rural areas have minimal knowledge about prophylaxis compared to those from urban areas. depending on the way of hygiene

Of all examined patients, ten used the electric brush, and twenty used the classic (manual) brush. As a result of the examination, we found a greater number of caries processes in those who used the manual brush than in those who used the electric brush.

To demonstrate the importance of the action of fluoride products on tooth enamel and how to ensure protection against the appearance of tooth decay, we used three randomly selected fluoride products that are professionally applied and researched which of them has the most effective carioprotective effect, depending on the chemical composition, the fluoride concentration, the mode of application, the frequency of application and the risk of overdose.

An intensely fluoridated mouthwash with a high concentration of fluoride was chosen, and it is used only by specialized personnel because of the risk of overdose. It has a chemical composition similar to fluoride gels and contains the following: aqua, glycerine, propylene glycol, sorbitol, poloxamer 407, aroma, cetylpyridinium chloride, potassium sorbate, sodium fluoride, sodium saccharin, menthol, ci 42051. The chosen mouthwash is from the range of those who do not contain alcohol, mainly because the studied group is made up of children and can swallow the used substances. This product has a sodium fluoride concentration of 5%.

The fluoride gel that was selected for use in this study is also for professional applications, also due to the possibility of overdose. It has the following chemical composition: ascorbic acid, carbomer, citric acid, flavor, glycerine, triethanolamine, and stannous fluoride 1, 44% (14000 ppm).

The fluoride varnish that was chosen, as well as fluoride solutions or fluoride gels, is also used by specialized personnel. Still, it is to be remembered that it is not because of the overdose, as in the case of the first two, but because of the application method. The fluoride varnish that has been selected has a sodium fluoride concentration of 22.6 mg F / ml (22600 ppm) in a neutral natural resin base. It is, in fact, a viscous yellow material, an alcoholic solution of resins with a high concentration of fluorine.

Even though fluoride varnishes have the highest concentration of fluoride compared to solutions and gels, they have the lowest risk of overdose. Even if the varnish is swallowed, the film is very thin, and the amount of fluoride ingested is the minimum risk of partial overdose in this case. This is why fluoride varnishes can be used in children under 6 years of age.

Fluoride gels and solutions are contraindicated in children under 6 because of the risk of swallowing, which can lead to overdose. The technique of application for the three selected products is different. Thus, in the case of the first two, to increase the efficiency of the product, it is necessary to clean the teeth through professional brushing and the interdental spaces with dental floss, after which the dental arches with absorbent rollers and saliva aspirator are isolated, the teeth are spray dried, and the material is applied.

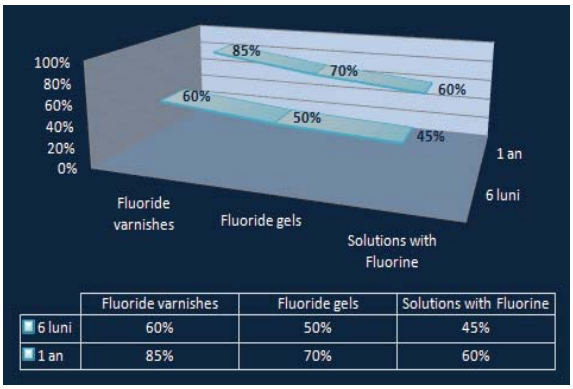
Fluoride solutions are applied by brushing on the surface of the teeth for about 4 minutes, after which the patient is not allowed to rinse his mouth, consume liquids, or eat for 30 minutes.

Fluoride gels are applied to the dental arches with the help of gutters. Approximately 2 - 2.5 ml of gel is applied to each gourd, and it stays between 4 and 30 minutes in contact with the teeth, depending on the patient's age and the degree of cooperation. After that, the patient cannot rinse the mouth or consume liquids or food for 30 minutes.

Fluoride varnishes can also be applied to unhygienic teeth (covered with bacterial plaque), which would allow even such a seizure, according to some researchers, considering that the varnish adheres to enamel even in the case of teeth that have not been perfectly dried and which they are covered with a film of saliva. In the case of this study, to increase the efficiency of the material, we have chosen that the teeth be hygiene and perfectly dry before applying the fluoride varnish, exactly as with the fluoride gels and solutions. After application, the fluoride varnish remains attached to the tooth surface between 4 minutes and 12 hours, ensuring prolonged contact with the tooth enamel, with which it performs ion exchanges for a long time (transforming the hydroxyapatite crystals into fluorapatite crystals), thus increasing the efficiency of the material. After applying the fluoride varnish, the patient is asked not to eat about 4 hours.

To investigate the efficacy of the three randomly selected fluoride materials, the studied group (30 patients) was divided into three groups of 10 patients. In each group, topical applications of fluorine with one of the three selected materials were made. The efficiency of the products was evaluated for 6 months and then after 1 year.

In the success rate of each of the products used, there is an increase in success over time. Fluoride solutions have a success rate of 45% over 6 months, but this increases if continued use for one year. Fluorine gels significantly improve over time and have a high efficiency in their use over time. The most significant increase in the success rate over time is achieved by fluoride varnishes, which accumulate a success rate of 25% over a year compared to the first 6 months.



	Fluoride varnishes	Fluoride gels	Solutions with Fluorine
6 luni	60%	50%	45%
1 an	85%	70%	60%

Figure 1. Success rate / Time depending on the type of material

Depending on the type of fluoride application, the incidence of dental caries has decreased in the total number of patients who have benefited from this treatment, which is actually the most important aspect.

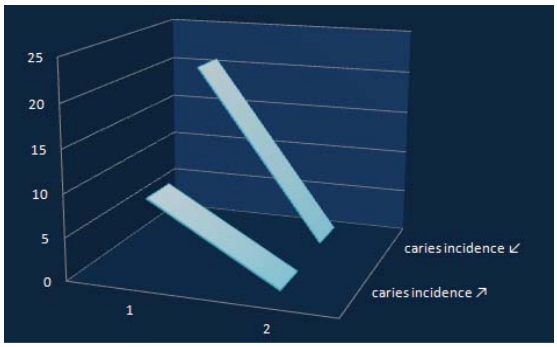


Figure 2. Caries incidence after topical fluoride application

After the patients were examined following the application of fluorine, 9 had an increased incidence of decay after fluoridation due to their diet rich in fermentable carbohydrates and poor oral hygiene. Twenty-one patients had a lower incidence of decay after fluoridation because they followed the advice regarding proper brushing and nutrition for each patient.

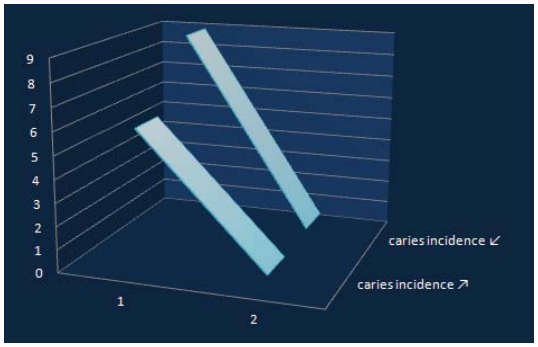


Figure 3. Caries incidence after sealing

In the treatment plan, we included sealing the molars for six years and twelve years for fifteen patients. Of these, six had an increased incidence of cavities because they did not show up for control after sealing and did not comply with the hygiene and nutrition advice

included in the treatment plan. Nine patients had a low incidence of caries. These patients showed up for control after sealing; for three of them, the sealant was applied again.

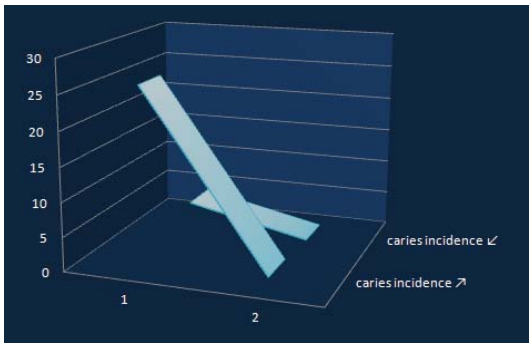


Figure 4. The incidence of caries depending on the diet mode

Of all the examined patients, twenty-six had a diet rich in fermentable carbohydrates, not respecting the diet plan made individually for each patient, thus increasing the incidence of caries. Four patients had a low carbohydrate diet, and we found decreased caries incidence. The child's diet is equally important, especially the intake of fluorine, which is made naturally through nutrition. Thus, after a brief interrogation, we concluded that of the children who participated in the study, the majority had a minimal intake of fluoride in this way, most of them lacking fluoride-rich foods such as tea and fish meat.

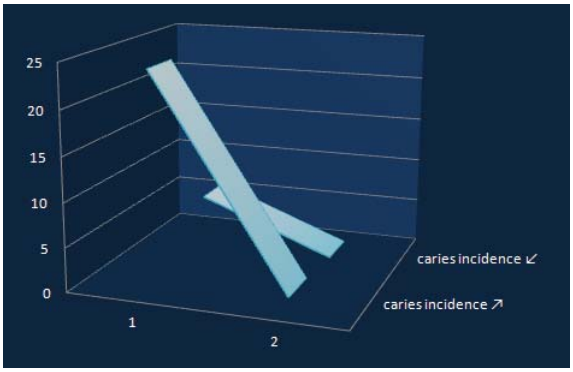


Figure 5. Classification of patients according to the quality of the enamel structure

DISCUSSIONS

The study of the data results following the examination of the studied patients revealed that twenty-four present weak mineralized enamel, a risk factor in the decay of caries. We followed these patients closely, establishing an individual treatment plan to prevent the onset of caries. Only six of the thirty studied patients have well-mineralized enamel.

Fluoride application is a non-invasive method that does not require the sacrifice of the tooth. The available fluoride application methods allow for the most efficient choice for each patient. The application of fluorine can be used even in incipient cavities, whose process is slowed down by the contribution of fluorine, which combats the demineralization of tooth enamel [6]. Each method has a different indication of use and can only be established by specialized personnel. The success of fluoride applications can be seen over time, depending on the treatment method chosen, sooner or later. The effectiveness of the treatment also depends on the patient's oral hygiene, according to the directions given by the dentist [7].

The application of fluoride on the surfaces of the teeth plays an important role in the remineralization of the demineralized enamel, which transforms the hydroxyapatite crystals into fluorapatite crystals. However, in this case, the fluoridation plan must be individualized because fluorine in large quantities is toxic [8].

Knowledge of the child's mental development is also important to enable him to cooperate during dental treatments and to establish good doctor-patient cooperation [9].

Dental doctors who work with children have to use different approaches and techniques, depending very much on the personality type of each child [10]. A child with a mild temperament may be flexible to treatment changes, and a child with a mild temperament needs more time to adapt. Difficult children respond best to a dentist who is sensitive to the child's mental needs and, at the same time, confident [11].

Risk factors such as nutrition, hygiene, and genetic substrate must be identified in each patient, and a nutrition, prevention, and treatment plan must be established [12].

CONCLUSIONS

In the success rate of each of the materials used for topical fluoride applications, we see a significant increase in their efficiency over time and a reduction in the frequency of dental caries. Fluoride solutions have a 45% success rate over 6 months, but this increases if continued use for one year (60% success rate). Fluoride gels have a success rate of 50% over 6 months, but this increases if continued use for one year (70% success rate). Significant growth over time is achieved by fluoride varnishes, which have a high efficiency in their use over time (success rate is 60% at 6 months and 85% at one year). The most significant increase in the success rate over time is the fluoride lakes that accumulate a success rate of 25% higher over a year, compared to the first 6 months.

Fluoride varnishes are the most effective, the easiest to handle and apply, the least sensitive to the presence of bacterial plaque and moisture, and have the lowest risk of overdose.

REFERENCES

1. Chankanka O, Levy SM, Warren JJ, Chalmers JM, A literature review of aesthetic perceptions of dental fluorosis and relationships with psychosocial aspects/oral health-related quality of life, Community Dent Oral Epidemiol, 2010, p 84 - 91
2. Cury JA, do Amaral RC, Tenuta LMA, Del BelCury AA, Tabchoury CPM, Low-fluoride toothpaste and deciduous enamel demineralization under biofilm accumulation and sucrose exposure, Eur J Oral Sci, 2010, p 177 - 185
3. De Almeida BS, da Silva Cardoso VE, Buzalaf MAR, Fluoride ingedestin from toothpaste and diet in 1-to-3-year-old Brazilian children, Community Dent Oral Epidemiol, 2007, p 91 - 97
4. Domen Kanduti, Petra Sterbenk, and Barbara Artnik, Fluoride: A Review of Use and Effects on Health, Articles from Materia Socio-Medica are provided here courtesy of The Academy of Medical Sciences of Bosnia and Herzegovina, 2016, p 315 – 319
5. Ekshand KR, Bakhshander A., Martignon S., Treatment of proximal superficial caries lesions on primary molar teeth with resin infiltration and fluoride varnish versus fluoride varnish only, efficacy after 1 year, Caries Research, 2010, p 243 - 250
6. Joe Mullen, History of Water Fluoridation, British Dental Journal, BDJ volume 199, 2005, p 1–4
7. Livia Maria Andaló TenutaI; Jaime Aparecido Cury, Fluoride: its role in dentistry, Braz. oral res. vol.24 supl. 1 São Paulo, 2010, p 233 - 237
8. Milsom, K.M., Blinkhorn, A.S., Walsh, T., et al., A cluster randomized controlled trial. Fluoride varnish in school children, Journal of Dental Research 90(11), 2011, p 298 - 305

9. LORENZ K., BRUHN G., HEUMANN C., NETUSCHIL L., HOFFMANN T., How to select study designs and parameters to investigate the effect of mouthrinses Part I: rationale and background, Journal of Physiology and Pharmacology, 60, no 8, 2009, p. 77-83
10. Mayuri Bhikaji Nepale, Siddhartha Varma, Girish Suragimath, Keshava Abbayya, Sameer Zope, Vishwajeet Kale., A prospective case-control study to assess and comparethe role of disclosing agent in improving the patient compliance in plaque control. Journal of Oral Research and Review Vol. 6, Issue 2, July-December 2014, p 197 - 204
11. Sheiham, Aubrey; Moysés, Samuel Jorge; Watt, Richard G.; Bönecker, Marcelo., Promoting the Oral Health of Children: Theory and Practice, Second Edition, Quintessence Publishing USA, 2014, 449 - 456
12. Tănase, Mihaela; Zmarandache, Daciana şi Luca, Rodica (2016), Experienţa carioasă a molarului unu permanent la un lot de copii trataţi într-un serviciu de specialitate, Revista română de stomatologie, Vol. LXII, nr.4, Ed. Medicală Amaltea, 2016, p 211 – 217
13. Ilyes I., Lile I.E., Berari A., Marian D., Freiman P.C., Olariu I., Stana O.L., Stana A., Flueras R., Hosszu T. The role of fluoride in the prevention of tooth decay. Medicine in Evolution Volume XXIX, No. 4, 2023