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Enamel fluorosis – an increasingly current problem

Fluorine compounds are used in dentistry as the Basic weapon against dental caries – one of the five most frequent infectious diseases, also treated as a social disease of the 20th century. The 'career' of fluorine compounds practically started in January 1945, when the process of artificial addition of fluorides to drinking water began in Grand Rapids, Michigan. The United States was followed by Canada and a few European countries (12, 16, 25).

Fluorides are characterized not only by enormous 'healing' potential but, according to the World Health Organization, they are also some of the most hazardous environmental agents. They have earned this opinion due to their influence on cells and tissues leading to life processes inhibition and also because of considerable exposure of human organism to these compounds (16, 18, 22, 38).

Recently, higher frequency of occurrence of fluorosis has been observed both in the United States and Europe. The most popular indexes used in epidemiological evaluation of enamel fluorosis, which show the degree of progression of this type of hard dental tissues mineralization defects, are Dean Index, Thylsrup-Fejerskov Index, Tooth Surface Index of Fluorosis, Visual Analogue Scale (VAS), Fluorosis Risk Index, Chronic Fluorosis Assessment Index, enamel fluorosis index designed by Jackson as well as photographical method [8, 38, 40, 41, 44]. In order to evaluate the prevalence of fluorosis within 20 years, i.e. from 1980 till 2000, Khan et al. reviewed the literature available in Medline. The authors found that, both in places where the concentration of fluorine in drinking water was in the range of 0.7 ppm to 1.4 ppm, and in those where the concentration did not exceed 0.3 ppm, the frequency of occurrence of fluorosis increased. What is interesting, this frequency compared to the 1940s increased twice and sixteen-fold, respectively (13, 26, 44).

Average daily requirement for fluorine for an adult living in moderate climate is 2 mg F (quoted after 11), and excess of ingested fluorine compounds may lead to enamel fluorosis, osteopsathyrosis and symptoms similar to arthritis leading to limited mobility as well as strong pain (1, 2). A worrying factor observed in studies performed by Grocholewicz et al. is the fact that 31% of dentists and 27% of doctors consider dental enamel fluorosis to be the only and isolated symptom of chronic toxic influence of fluorine compounds. They do not consider the fact that fluorides may have a very negative systemic influence (19).

Dental and osseous fluorosis is a pathological state dependent on the amount of fluorine compounds dose (15). Its occurrence is conditioned by risk factors such as: high concentration of fluorides in drinking water, improper swallowing by young children and excessive amounts of fluorides ingested with food. It should be stressed that recently there have occurred, on the one hand, changes in dietary and eating habits and, on the other hand, changes in food production processes. Thus, products rich in fluorine compounds are more and more frequently constituting a significant

element of everyday diet, which can in turn lead to the development of fluorosis. Large amounts of fluorides are found in black tea produced from *Camellia sinensis* and in beverages manufactured on the basis of this tea. It is assumed that fluorine compounds constitute from 52 to 210 mg/kg of dry tea leaves mass. It should be stressed that in the process of brewing tea 40 to 90% of fluorine compounds are lost. Large amounts of fluorine compounds are also found in chocolate, chocolate biscuits, bottled mineral water, fish, sea food as well as in mechanically processed poultry. Thus, nowadays, it is highly recommended to place information about fluorides content on groceries labels. It should also be stressed that prolonged breast feeding may prevent this disorder of hard dental tissues mineralization (4, 6, 7, 17, 21, quoted after 22, 23, 24, 38, 43, 47).

Some authors point out to additional risk factors such as fluoride supplementation, socio-economical status, race, occupational exposure to these compounds and environmental pollution with anthropogenic fluorides, the result, among others, of burning sources of energy. Other considered fluorosis facilitating factors are calcium deficiency, malnutrition, conditions leading to decreased urine pH and abiding in highly elevated areas (10, 22, 32, quoted after 33, 36). In territories where there is no addition of fluorides to drinking water the following factors are considered to be the reason for fluorosis: import of groceries from regions where water is fluoridated, content of fluorine compounds in drinking water exceeding the value considered optimal in moderate climate (1 mg/l) or inappropriate usage of endogenous fluorine prophylactics methods (tablets, droplets) by exceeding individual patient needs (45). On the basis of data gathered by sanitary and epidemiological centers it was observed that in Poland excessive content of fluorine compounds is found in Pomorskie Region and in the south-western part of the country. A possible reason for this state of affairs is the fact that drinking water is drawn from underground sources (28). Additionally, it should be pointed out that WHO experts think that so far there has been no evidence that using endogenous prophylactic fluoride tablets in pregnant women increases their children's teeth resistance to dental caries (quoted after 34). It should be stressed that introduction and dosage of prophylactic fluoride tablets ought to be conditioned not only by susceptibility to dental caries but also by fluoride content in local drinking water, in ingested groceries as well as fluorine intake from other sources (31).

At present, there are serious doubts whether to use exogenous fluoride prophylactics, most of all toothpastes, simultaneously with endogenous prophylactic fluoride tablets. Although toothpastes containing fluorine compounds constitute one of the key methods in dental caries prevention, it should be stressed that using them in children must be carefully supervised and fluoride content in toothpastes as well as the amount of toothpaste used for a single brushing should be properly adapted to patient's age (20, 45).

Nowadays it is thought that in animals the most sensitive markers of excessive exposure to fluorine compounds are teeth in the early stage of their development. On the other hand, in people, the biological material facilitating the most reliable evaluation of the level of fluorides in human organism is urine. It is believed that fluorine excretion in urine is in the range of 1–3 mg in 24 hours with average daily diuresis of 0.4–2.6 l. It should also be indicated that, according to Jarkowski, in the analysis of the level of fluorides in urine it is necessary to take into account both its volume and its osmolality. At the same time, researchers are getting more and more interested in fluoride content in nails as another biomarker facilitating the evaluation of the risk for fluorosis in people (quoted after 11, 22, 29).

As we have already noted, enamel fluorosis is a developmental disorder, being a result of excessive exposure to fluorine compounds at the time of dental enamel development. Occurrence of enamel fluorosis depends on two factors – the amount of supplied fluorine compounds and the duration of exposure (16, 33). This pathological condition may be the result of exposure either to a

large single dose of fluorine compounds or to smaller but numerous doses, or to a constant exposure to low levels of fluorine compounds (27). Fluorosis is not only facilitated but also caused by excessive supply of fluorine compounds in the critical period of late stages of pre-eruptional teeth development (in case of permanent front teeth this period takes place between 15–30 months of life (15–24 months in boys and 21–30 months in girls). At the same time, it is thought that the critical period for the entire dentition takes place between 11 months and 7 years of age, while excessive fluorine compounds supply after this period does not lead to fluorosis anymore (5, quoted after 39).

On the basis of histological and biochemical studies it was found that increased fluorine intake affects ameloblasts, leading, in excretion phase, to reduction of enamel matrix production as well as to changes in its composition and ion transport mechanisms. On the other hand, in maturation phase, it leads to decrease in the activity of removing water from proteins. At the same time, it was observed that the excess of fluorine affects enucleation and enamel crystals growth, leading to the creation of irregular clusters of apatite crystals and weaker binding of the organic and mineral enamel elements as well as inhibition of lysosomal enzymes in amelogenic cells (quoted after 11, 14, 37).

The histopathological feature of enamel fluorosis is its increased porosity. Initially, the lesions can be observed along the Retzius line and next the porous area spreads continuously. In the course of the advancement of fluorosis there occurs an 80–100 μm wide area spreading from the tooth neck to the occlusal surface. The lesions are localized on the well mineralized surface area of 50 μm in width. The porous area is the hypomineralization zone. In the course of hypomineralization area enlargement, the enamel becomes more susceptible to post-eruptional injuries. So, clinically revealed stains on the enamel appear after tooth eruption but it takes place only when there is enamel porosity that occurred at the developmental stage (15, 16). Studies by Vieira et al. showed that the degree of progression of fluorosis is statistically significantly dependent on the content of fluorine compounds in dentine. The authors also observed that the amount of fluorine compounds in dentine constitutes an important index for the structure of this hard dental tissue, namely, the size of the dentinal tubules and ultrasound velocity. In serious cases, von Ebner lines become prominent and hypomineralization of this tissue is visible. It should also be stressed that the degree of progression of enamel fluorosis is responsible for mechanical characteristics of dentine, i.e. the ultrasound velocity (16, 42).

Although, according to Bowen, in most cases fluorosis amounts to nothing more than a minor cosmetic defect, many parents are not happy with the influence that this hard dental tissues mineralization disorder has on their children's appearance. It is interesting to consider the results of the study concerning the influence of fluorosis not so much on the physical appearance but the social perception. Williams et al. found that a high degree of fluorosis has a significant adverse effect on the social perception of the patient. However, comparing the social perception of patients with mild degree of fluorosis with the ones with not treated dental caries, they observed that the latter group received worse social perception (3, 30, 46).

Current therapeutic methods used in the treatment of fluorosis are teeth bleaching, facing and using crowns. Also microabrasive techniques, causing only minor enamel losses, are gaining significance. It seems that due to the increasing prevalence of fluorosis and the effects that it has on the physical appearance, the frame of mind and the social perception of the patient and thanks to technological development, there will soon appear more effective and less invasive methods of treatment of this disorder of hard dental tissues mineralization (9, 35).

To sum up, we must once again stress that due to higher prevalence of enamel fluorosis and increased exposure of human organism to fluorides it is necessary to follow certain rules facilitating, on the one hand, beneficial influence of fluorides on dental caries prevention and, on the other hand, minimizing adverse side effects of these compounds.

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SUMMARY

Fluorides are characterized not only by enormous 'healing' potential but they are also some of the most hazardous environmental agents. Enamel fluorosis is a developmental disorder, being a result of excessive exposure to fluorine compounds at the time of dental enamel development.

Occurrence of enamel fluorosis depends on two factors – the amount of supplied fluorine compounds and the duration of exposure. Due to higher prevalence of enamel fluorosis and increased exposure of human organism to fluorides it is necessary to follow certain rules facilitating, on the one hand, beneficial influence of fluorides on dental caries prevention and, on the other hand, minimizing adverse side effects of these compounds.

Fluoroza zębów – problem coraz bardziej aktualny

Fluorki charakteryzują się nie tylko ogromnym potencjałem „zdrowotwórczym", ale uznawane są za związki należące do głównych szkodliwych czynników środowiskowych. Fluoroza zębów jest zaburzeniem pochodzenia rozwojowego, będącym wynikiem nadmiernej ekspozycji na związki fluoru w okresie rozwoju szkliwa. Fluoroza zębów zależy od ilości dostarczanych związków fluoru, a także od czasu, w którym nastąpiła ekspozycja. W związku ze zwiększającą się częstotliwością występowania fluorozy zębów, jak również ze zwiększoną ekspozycją organizmu człowieka na fluorki konieczne jest przestrzeganie zasad umożliwiających z jednej strony utrzymanie korzystnego oddziaływania fluorków w profilaktyce choroby próchnicowej, a z drugiej strony minimalizujących niekorzystne efekty uboczne wywierane przez te związki.