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Comparison of fluorine level in the tissues of healthy teeth and teeth with decay process

Tooth decay is a pathological process caused by extracorporeal factors, which consists in decalcification and proteolytic decomposition of hard tissues of a tooth that is susceptible to this disease. It is a social disease, because it affects nearly 100% of the population, especially in developed countries. If not treated, it leads, depending on the speed of hard tissue demineralization, to loss of dentition and many complications, which may cause disorders in all body functions. Tooth decay etiology has not been finally explained so far. According to Keyes, the development of decay process is conditioned by coexistence of three basic factors, i. e. the presence of acid-forming microorganisms, the presence of carbohydrates, which are a basis for enzymatic bacterial changes, and the susceptibility of tooth tissues to acid demineralization. Teeth with a proper organic and inorganic structure are more resistant to the activity of external cariogenic factors. A fundamental macro- and microstructure of tooth hard tissues is being shaped from the first weeks of intrauterine life (forming of milk teeth buds) until about 18–20 years of age (ending of roots of wisdom teeth development) and undergoes further slight modelling under the influence of various endo- and exogenous factors.

In the present state of knowledge it is emphasized that the essential cariostatic part is played by trace elements i.e. strontium, zirconium, molybdenium, and first of all fluorine. Fluorine gets into the organism as a result of environmental exposure. The mechanism of fluorine preventive activity is multidirectional. It takes part in a process of enamel fluoroapatites formation, which have better crystalline properties than hydroxyapatites, are less dissolvable in acids, and this makes the tooth tissue less susceptible to the decay process. It was also found that fluorine takes part in remineralization of slight enamel defects, and influences enzymatic processes of decay-forming microorganisms. Fluorine, combining with a magnesium ion of bacterial enolase, blocks carbohydrate changes of microorganisms. It has also an influence on glucose transport through the cell membrane of acid-forming bacteria. Literature shows that the level 1,000 ppm F in superficial layers of enamel secures optimal protection against decay (1). The amount of fluorine in tooth enamel depends on the concentration of this element in the air, drinkable water, food and preparations used in decay prevention.

The aim of the study was to examine quantitative fluorine content in tooth tissues with the decay process, tissues of teeth without decay and tissues with diseases different than those of decay origin.

MATERIAL AND METHODS

The research included 164 patients at the age from 8 to 68. Material for the research were extracted teeth, which initially underwent scaling, and then had fillings removed and were washed in distilled

water. The extracted teeth were divided into three groups. The first group were 35 teeth (healthy) extracted for orthodontic and periodontological reasons, without fillings and decay defects, the second one were 25 teeth with wedge defects and the third one were 104 teeth with decay. After drying, the teeth tissues were crushed in a mortar until a uniform powder was obtained. The examined material was mineralizd in the perchloric acid and nitric acid and then hydro-extracted. To fluorine denotation a solution from the above sediment was taken. The level of fluorides was measured potentiometrically with the help of fluoride ion-selective electrode in relation to a reference electrode.

Test CRT was used for the estimation of tooth enamel susceptibility to dissolution.

RESULTS AND DISCUSSION

It was found that in the examined teeth the decay process, the average fluorine content in hard tissues was lower than in healthy teeth extracted for orthodontic or periodontological reasons, whereas the highest fluorine content was found in teeth with diseases of non-decay etiology, e.g. wedge defects in the region of tooth neck, whose development is related to occlusion disorders and activity of parafunctional forces. The results concerning fluorine level in each group are shown in Table 1.

Table 1. Fluorine level in ppm in particular teeth groups

	N	X	SD
Healthy teeth	35	304.8	54.6
Teeth with wedge defects	25	383.5	62.1
Teeth with decay	104	235.6	48.6

The above findings confirm the fact of high susceptibility to cariogenic factors of tissues with scanty amounts of fluorine compounds. Analyzing particular tooth groups depending on the age of patients, it was observed that the fluorine level was higher in teeth taken from younger patients, especially in the group of healthy teeth and teeth with wedge defects. Differences amount on average in the group of healthy teeth to 17.0%, in the group of teeth with wedge defects to 15%, and for teeth with decay tissues to 10.3%. Differences depending on sex were not observed. Younger patients' age was up to 30 and that of older patients – above 30. Differences depending on the age of patients may result from a greater contact of younger patients with fluoride prevention, used individually especially in the stage of teeth development, as well as from greater exposure to environmental pollution with compounds containing fluorine ions.

The object of the study was also fluorine content with regard to teeth division into three morphologico-functional groups. When comparing incisors, canine teeth, premolar teeth and molar teeth in particular age groups, no important differences were observed.

To estimate teeth enamel susceptibility to dissolution, test CRT was applied with the use of discs impregnated with crystal violet (Hexamethylene-4 hydrochloride of fuchsin) with the range of colour change from yellow and green to violet and blue at ph 0.1–1.5. The time of colour reappearance determined the level of tooth susceptibility to the activity of the acid. The lowering of enamel dissolubility in the acid was expressed by the lenghtening of reaction time and was essentially different for teeth with higher fluorine content, which is confirmed by greater acid resistance of fluorohydroxyapatites than that of enamel apatites.

Differences in chemical structure of tooth harder tissues depending on the kind of pathology of these tissues or the lack of it, are also confirmed in the available literature. A higher content of F, Mn, Cu and lower of Mg and Fe was observed in teeth with wedge defects (7).

Table 2. Fluorine level in ppm depending on age

	Patients below 30			Patients above 30		
	N	X	SD	N	X	SD
Healthy teeth	31	302.4	53.6	4	250.9	42.6
Teeth with wedge defects	12	392.3	57.3	13	331.2	43.2
Teeth with decay	36	237.3	42.5	68	212.8	48.6

The level of fluorine cumulation in teeth depends not only on the prevention used, but also on the amount of this element in the environment. Comparison of children groups from different regions of Poland showed that the lower fluorine content and thereby greater susceptibility to acid etching is typical of regions of low industrialization (5). It is emphasized that fluorine is of great importance as early as in the stage of teeth tissues forming, which is confirmed by tests on animal models (3).

CONCLUSIONS

1. In the examined teeth with decay process the average fluorine content in hard tissues is lower than in healthy teeth, and the highest fluorine content was observed in teeth with wedge defects in the teeth necks regions.

2. Fluorine level is higher in teeth taken from younger patients, especially in the group of healthy teeth and teeth with wedge defects.

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SUMMARY

The aim of the study was to examine quantitative fluorine content in tooth tissues with the decay process, tissues of teeth without decay and tissues with diseases different than thòse of decay origin. It has been found that in the examined teeth decay process the average fluorine content in hard tissues amounted to 235.6 ppm of fluorine and it was lower than in healthy teeth (304.8 ppm) extracted for orthodontic or periodontological reasons, whereas the highest fluorine content – 383.5 ppm – was found in teeth with diseases of non-decay etiology. Analyzing particular teeth groups depending on the

age of the patients, it was observed that the fluorine level is higher in the teeth received from younger patients, especially in the group of healthy teeth and teeth with wedge defects. Susceptibility of tooth enamel to dissolution was estimated by the CRT test with the use of discs impregnated with crystal violet (hexamethylene-4 hydrochloride of fuchsin) with the range of colour change from yellow and green to violet and blue at ph 0.1–1.5. The lengthening of the time of reaction in this test testified to lower acid sensitivity of tissues and at the same time to harder demineralization of enamel, e.g. in the process of decay. Longer time of reaction was observed in teeth with higher indicated fluorine content.

Porównanie poziomu fluoru w tkankach zębów zdrowych i objętych procesem próchnicowym

Celem pracy było badanie ilościowej zawartości fluoru w tkankach zębów objętych procesem próchnicowym, w tkankach zębów bez próchnicy oraz w tkankach z chorobami innymi niż pochodzenia próchnicowego. Stwierdzono, że w badanych zębach objętych procesem próchnicowym średnia zawartość fluoru w twardych tkankach wynosiła 235,6 ppm fluoru i była niższa niż w zębach zdrowych (304,8 ppm), usuniętych ze wskazań ortodontycznych czy periodontologicznych, zaś najwyższa zawartość fluoru – 383,5 ppm wyróżniała zęby z chorobami o etiologii niepróchnicowej. Analizując poszczególne grupy zębowe w zależności od wieku pacjentów, zauważono, że poziom fluoru jest wyższy dla zębów pobranych od pacjentów młodszych, szczególnie w grupie zębów zdrowych i z ubytkami klinowymi. Podatność szkliwa zębów na rozpuszczanie oceniano przy użyciu testu CRT z wykorzystaniem krążków nasączonych fioletem krystalicznym (chlorowodorek heksametylo-4 rozaniliny) o zakresie zmiany zabarwienia z żółtozielonego na fioletowoniebieski przy pH 0,1-1,5. Wydłużenie czasu reakcji w tym teście świadczyło o mniejszej wrażliwości kwasowej tkanek i tym samym o trudniejszej demineralizacji szkliwa np. w toku procesów próchnicowych. Dłuższy czas reakcji wyróżniał zęby o wyższej oznaczonej zawartości fluoru. Wnioski: 1. Najwyższy poziom fluoru stwierdzono w tkankach zębów z chorobami o etiologii niepróchnicowej. 2. Zęby objęte próchnicą miały najniższy poziom fluoru. 3. Mniejsza podatność na rozpuszczanie w kwasie tkanek bogatych we fluor potwierdza kariostatyczną rolę tego pierwiastka.