UDC 616-008.9:[611.314+612.392.69]

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METABOLISM OF HEAVY METALS IN RAT'S ENAMEL DURING EXCESSIVE INFLOW OF HEAVY METALS

With the help of atomic absorption spectrophotometry the character of heavy metals (Fe, Zn, Pb, Cu, Mn, Cr) accumulation in rat's teeth enamel was studied. It was determined that in enamel of animals receiving salts of heavy metals the concentration of Zn potentially increased for 87,5%, Pb for 80,8%. There was a tendency for Fe increasing for 39,1%. At the same time the accumulation of Cu was for 57,8% less compared to control group, Cr content in enamel decreased for 30,9% and Mn for 25,7%. It was concluded that salt mixtures of Fe, Zn, Pb, Cu, Mn, Cr course mineral imbalance in teeth enamel. Dyscrasia of metals in enamel can be a risk factor of hard tooth tissues pathology.

Keywords: salts of heavy metals, teeth enamel, accumulation, metabolism, rats.

Environmental degradation stipulated a number of studies to find the influence on human body the harsh environment with emphasis on salts of heavy metals.

Mineral constituent of teeth and bones of vertebrata has the capacity to accumulate some impurity elements, namely, heavy metals from the environment. Structure and capacity of mineral constituent of teeth tissue in a great measure reflect physiological makers of body functioning, and also can provide important information for monitoring of environmental situation of the local area [4]. In fact, chemical composition of enamel has such "elemental portrait" that reflects the content of those substances in the air, soil, water and food. Especially obviously we can see it in citizens of industrial or environmental unfriendly regions [7, 9, 10].

There are many projects devoted to disclose the mechanism of negative influence and biological effects of heavy metals excess on living organisms, but generally they concern changes in case of monomicroelementosis only, that is why of current interest is the question of chemical elements accumulation in teeth enamel under the influence of heavy metal compounds mixture.

Goal of research. To study accumulation of heavy metals Fe, Zn, Pb, Cu, Mn, Cr in rat's teeth enamel during excessive inflow of its mixture.

Subject and methods of research. The study was carried out on 20 mature outbred white male rats with initial weight ranging 180-200 g during 30 days. All animals were divided into two groups: group I (n = 10) were control rats that were taking potable water. Animals in group II (n = 10) were taking potable water with SHM combined: zinc ($ZnSO_4 \times 7H_2O$) – 5 mg/L, copper ($CuSO_4 \times 5H_2O$) – 1 mg/L, iron (FeSO4) – 10 mg/L, manganese ($MnSO_4 \times 5H_2O$) – 0,1 mg/L, lead ($Pb(NO_3)_2$) – 0,1 mg/L, chrome ($K_2Cr_2O_7$) – 0.1 mg/L. Rats had free access to water. Under ether anaesthesia they were decapitated to take samples of enamel tissue. Enamel samples were de-oiled with alcohol, washed with d water and weight accurate within 0,001g. Then enamel was burned in incinerator at a temperature 450˚C for organic cavity. The ash was dissolved in mixture of chlorohydric acid (2,0 ml) and nitric acid (1,0 ml) and raise to 10ml with bidistilled water. This solution was analyzed with the help of spectrophotometer C115-01 with flaming and electrothermic atomizer.

During the experiment, the laboratory animals were kept in compliance with rules adopted by the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes (Strasbourg, 1986) and "General Ethical Rules for Experiments Using Animals", approved by the First Bioethics National Congress (Kyiv, 2001).

Study Findings and Discussion. Results of research showed that heavy metals do not have the character of absolute accumulation in teeth enamel. In animals receiving heavy metals salts the concentration of Zn potentially increased from 69,66±10,05 mcg/L to 555,00±98,80 that is for 87,5% higher than control (p = 0,0005). Content of Pb increased from 0,14±0,05 to 0,73±0,09 mcg/L, in other words for 80,8% (p = 0,0004). There was a tendency for Fe increasing for 39,1% from 616,48±91,59 to 1013,4±141,60 mcg/L (p = 0,07).

At the same time the accumulation of Cu was for 57,8% less compared to control group – from 35,99±9,25 to 15,18±2,08 mcg/L (p = 0,006), Cr content in enamel decreased from 575,39±70,38 to 397,56±59,75, that is for 30,9% less compared to control group of rats (p = 0,07). Concentration of Mn decreased for 25,7% (from 58,74±4,53 to 43,65±5,15 mcg/L), p = 0,03.

We see that under excessive inflow of heavy metals some metals accumulated in a great measure compared with control group, but others conversely in a lesser degree. Here mineral dyscrasia of metals in teeth enamel – imbalance is present. Analogical result we get in alveolar ridge [8].

Imbalance in accumulation of heavy metals in rat's enamel is caused, to our opinion, by peculiarities of metal interreaction. Microelements have wide range of synergetic and antagonistic interreactions [3]. It was proved that between 15 specified essential elements there are 105 double-sided and 455 three-sided interreactions. Complex inflow of toxic and essential elements increases washout of some elements and accumulation of other elements [5].

Enamel is the hardest tissue in human body that effected by mouth media. It consists of 96% of non-organic and 4% of organic substances and water. Main component of nonorganic part

of enamel are hydroxyapatite crystals able to accumulate metals. Apatites can have a great amount of vacancies and thereby can have some ion replacements, which determine their reactivity and biologivcal properties. As contrasted with other biominerals they have unique adaptiveness to different biological functions. Special mechanisms of charge compensation make possible molecular and ion insertions and replacements that determine properties of apatite crystal surface with relation to chemical (solvability, capacity to ion replacement, ion insertions, adsorbation and molecular insertions) and physical (surface charge of interphase energy) properties [6]. Microelement metabolism is an integral part of mouth homeostasis. Change of element homeostasis leads to anomaly mineral metabolism and as a result to pathology of teeth hard tissue and alveolar ridge [1, 2].

Therefore, on the ground of our research we can make the following **conclusion**: environmental heavy metals, getting into the body, cause anomaly of mineral metabolism in enamel. Mineral imbalance leads to changes of crystals properties whereby the enamel can become exposed to adverse factors of local and general environment.

References:

1. Боровский Е. В. Биология полости рта / Е. В. Боровский, В. К. Леонтьев. Изд. второе, стереотип. М. : Мед. книга; Н. Новгород : Изд-во НГМА, 2001. – 304 с.

2. Вавилова Т. П. Биохимия тканей и жидкостей полости рта / Т. П.Вавилова. – М. : ГЭОТАР-Медиа, 2011. – 257 с.

3. Мікроелементний склад довгих та мішаних кісток скелета в нормі / Є. В. Гусак, М. В. Погорєлов, Г. Ф. Ткач [та ін.] // Український морфологічний альманах. – 2010. – Т. 8., № 4. – С. 51 – 55.

4. Мультиэлементный масс-спектрометрический микроанализ в исследованиях биоминеральных образований / С.Л. Вотяков, Д.В. Киселева, А.Ю. Розанов и др. // Литосфера. – 2007, № 1. – С. 123-137.

5. Скальный А. В. Биоэлементы в медицине / А. В. Скальный, И. А. Рудаков. – М. : Издательский дом «Оникс 21 век» : Мир, 2004. – 272 с.

6. Chemical Diversity of Apatites / C. Rey, C. Combes, Ch. Drouet, H. Sfihi //Advances in Science and Technology. – 2006. – Vol. 49. – P. 27-36.

7. In vivo studies on lead content of deciduous teeth superficial enamel of preschool children / V. E. Gomesa, M. da L. R. Sousa, Fernando Barbosa Jr Jr. [et al.] // Science of The Total Environment. – 2004. – Vol. 320, № 1. – P. 25–35.

8. Lakhtin Yu.V. Accumulation of heavy metals alveolar ridge on rats' jaws during excessive inflow of heavy metals / Yu. Lakhtin // Teoretyczne i praktyczne innowacje w nauce : materiały Miedzynarodowej Naukowi-Praktycznej Konferencji (Gdańsk, 28–30.04 2012). – Gdańsk, 2012. – S. 97-98.

9. Multivariate Statistical Analysis of Metal Concentrations in Teeth of Residents of Silesian Region, Southern Poland / D. Wiechuła, A. Fischer, J. Kwapuliński [et al.] // Archives of Environmental Contamination and Toxicology. – 2006. – Vol. 51, № 2. – P. 314-320.

10. Study of environmental burden of lead in children using teeth as bioindicator / J.D.T. Arruda-Netoa, M.C.C. de Oliveiraa, J.E.S. Sarkis [et al.] // Environment International. – 2009. – Vol. 35, № 3. – P. 614–618.

11. The heavy metal content of the teeth of the bank vole (Clethrionomys glareolus) as an exposure marker of environmental pollution in Poland / J. Appleton, K. M. Lee, K. Sawicka-Kapusta [et al.] // Environ Pollut. – 2000. – Vol. 110, № 3. – P. 441-449.