



Structure of tooth rudiments and mineral metabolism pattern at vibration effect

Apraksina E.Ju.*, Zalavina S.V., Zhelezny P.A.

Novosibirsk State Medical University

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ABSTRACT

Morphological changes in structure of tooth rudiments and mineral metabolism pattern in Mother – Fetus system are presented at vibration effect. The revealed rearrangements indicate microcirculation violation, development of hypoxia in the tissues of dental rudiments of fetus, and accelerated dentinogenesis. We registered decrease in concentrations of trace essential elements, i.e. Ca, Mg, Fe, followed by increase of concentration of Cu, Cd, Pb.

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Introduction

Vibration is one of the most widespread adverse technogenic factors in which environment many people work and live. Considerable influence on a state of oral cavity is exerted by many social hygiene factors, the nature of the effect, their variability depends on the individual and an ecological situation in the region, social environment of people, and also on their professional activity. An indisputable fact is that production factors exert impact both on somatic health, and on indicators of the dental status [1–4]. Importance of studying of structural changes in oral cavity as initial regions of a digestive tract under the different anthropogenous influences can be explained by these circumstances and including the general industrial vibration. It is essential to consider the signs of the pathological changes caused by vibration effect formed in oral cavity organs even before the development of deviations in other systems of a body [5–7].

Aim of the Research

To study the morphological changes of tooth rudiments and the pattern of mineral metabolism under impact of industrial vibration.

Materials and methods

The object of research were Wistar laboratory rats (females) with the initial body weight of 180–200 g. Vibration effect during pregnancy was performed using the vibrostand modeling vibration of 3A category (the general technology), time of exposure was 60 min during the period from the 9th to the 18th day of pregnancy. On the 20th day of pregnancy the animals were brought out of the experiment. Two groups of fetuses were used for the research: the 1st group included fetuses from intact pregnancy, the 2nd group included fetuses from pregnancy in the conditions of vibration. The research of tooth rudiments was

*Corresponding author. Novosibirsk State Medical University, 52, Krasny Prospekt, Novosibirsk, 630091, Russia.
E-mail address: sdv.ngmu@mail.ru

conducted at the light-optical and electron-microscopic levels using the standard technique.

As the mineral structure of a body is reflection of homeostatic processes in cells, tissues and in organism in general, we carried out the determination of mineral metabolism in experimental animals under conditions of vibration influence. Liver of experimental animals was used as the studied biosubstrate (7–10 samples from each group). The choice of liver as biosubstrate can be explained by the fact that liver is one of the main “depots” organs for many bio-elements, provides processes of detoxication and maintains of homeostasis in female body, i.e. participates in regulation of the major processes including during pregnancy [8].

Analytical researches were carried out by the method of atomic issue spectrometry with inductively coupled argon plasma (ICP-AES) in laboratory of “Centre of Biotic Medicine” (Moscow) under the guidance of Professor A. V. Skalniy. Such trace elements as Ca, Cd, Cu, Fe, Mg, P, Pb, Se, Zn were defined in liver of experimental animals.

Results and Discussion

The morphometry of the epithelial tooth rudiments of fetus indicates to reduction of the relative area of internal cells of enamel organ ($p > 0.05$). Reliable reduction of the relative area of external cells of enamel organ by 43.4% is determined that is followed by increase in the areas of intermediate cells of enamel organs by 34% and pulps of enamel body by 11%. The area of cells of a neck of enamel organ decreases in comparison with control group by 4.7%.

The morphometry of tooth rudiments of mesenchymal origin reveals reduction of the relative area of a tooth sack ($p > 0.05$). Comparative area of tooth pappila remains at reference level, and the area of blood capillaries of a tooth pappila decreases by 51.4% that is followed by reduction of the area of vessel opening and vessel walls by 18.3 and 21.2% respectively. Thinning blood capillaries were revealed with light microscopy.

Measurement of layer of dentine showed the increase in its thickness in comparison with control group for 45%, besides, dentine thickness has unbalanced nature on its extent.

Forming preodontoblasts are observed form at electronic microscopy of control tooth rudiments by 20th day of prenatal development of fetuses on initial stage of development with rounded shape which process only begin to form. Big spaces are defined between cells. Preodontoblasts of branched, extended form located compact ranks are revealed in experienced group of fetuses.

The revealed morphological reorganizations demonstrate violation of microcirculation and development of hypoxia in tissues of tooth rudiment owing to what, in authors' opinion, there was an accelerated exit of preodontoblast from a mitotic cycle which caused

an earlier dentinogenesis in tooth rudiments. Besides, violation of microcirculation and the related tissue hypoxia exert restraining influence on development of the majority of cells of ectodermal origin. The pulp of enamel organ increases in volume.

The area of contact of mesenchyma and outside epithelium increases at the normal course of amelogenesis. The capillaries growing from mesenchyma approach to internal cells of enamel organs, and the pulp of enamel organs dividing them decreases in volume that promotes strengthening of nourishing of a layer of the differentiated enameloblasts from a tooth sack. All morphological changes revealed by authors against the background of vibration influence demonstrate deterioration trophism of cellular elements of tooth rudiment.

The change of quantity and a ratio of the studied mineral substances were revealed at determination of mineral trace elements of pregnant female from experienced group. In particular, reliable reduction of Ca, Fe, Mg concentration in liver was defined that was followed by reliable increase in Cu, Cd, Pb content. Significant differences in P, Se and Zn metabolism are not revealed. Such redistribution of mineral substances in female organism, certainly, will exert impact on processes of mineralization of a bone tissue of a fetus and, in particular, on mineralization of tooth rudiments as calcium, phosphorus and magnesium play the major plastic role in a body, forming a mineral basis of a skeleton, bone tissue and teeth. The stressful factor of vibration influence can be one of the reasons of magnesium deficit. Stresses of the different pattern and including accompanying vibration results in negative balance of magnesium.

It is known that hyposiderosis and possible development of hypochromic anemia cause deterioration in trophic processes in fabrics and cages that, in particular, leads to violations of forming of a bone tissue. Copper is one of the major, irreplaceable microelements which key role in exchange is played by hepatocytes. Concentration of copper in an organism is rather permanent. It is proved that the hypercupremia is possible at a wide range of states. Specific factor of that pathogenesis is the stress.

Many factors and, first of all, the following elements exert impact on metabolism of lead: calcium, copper, magnesium, iron and cadmium. Reduced concentration of calcium, magnesium and iron result in the increased accumulation of plumb in a body. It is known that about 20% of endogenous lead is in the structure of a skeleton, and its concentration in teeth is higher, than in a bone tissue, and this lead is in there in tightly bound form. In the situations leading to demineralization of a bone tissue there is a mobilization of lead from its bone depots that can result in its increased accumulation in liver and forming of lead toxicosis [9].

Relying on the researches which revealed morpho-functional dysfunction of kidneys in system Mother –

Fetus at vibration, it is possible to assume that vibration leads to violation of excretory function of kidneys, including cadmium excretion with the urine decreases in pregnant female. It causes its increased admission in active blood flow and, as a result, the increased accumulation of these toxicants in liver. Arisen Itai-Itai disease negatively influences on mineralization of bone tissue, causing osteoporotic changes in bones. It is revealed that osteomalacia of bones is secondary because of dysfunction of proximal kidney tubules owing to adjournment of cadmium in them that leads to decrease in calcium reabsorption. Besides, during the experiment on rats it was established that cadmium causes acceleration of development of the osteoporosis caused by of calcium deficiency. It can be explained with influence of cadmium on absorption of calcium in intestines and on function of endocrine glands [10].

Conclusions

It stands to reason that observed changes in morphology of tooth rudiments and in mineral metabolism are reflection of the changed homeostasis in Mother – Fetus system, arising under the vibration influence. The revealed deviations are morphofunctional substrate which leads to violation of dentinogenesis and enamelogenesis at fetus, and a basis for forming of dental pathology during the postnatal period of life.

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