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# MACRO- AND MICROELEMENT STATUS OF RATS WITH INSULIN RESISTANCE AGAINST THE GROUND OF IODINE DEFICIENCY

***Abstract.*** *Combined endocrine pathology and insulin resistance (IR) against the ground of iodine deficiency (ID) in particular, causes disorders of metabolic processes of the organism and mineral homeostasis. That's why the objective of the research was the examination of changes of macro- and microelements status of rats with IR against the ground of ID. ID and IR were found to lead to the reduction of calcium and magnesium content in the teeth and alveolar processes tissues. During the combination of these experimental conditions the redistribution of macroelements between the examined tissues was observed. In particular, against the ground of hypercalcemia and hypermagnesemia decrease of these elements content in the teeth and alveolar processes occur. Activation of acid phosphatase confirms the increasing of bone resorption processes. Thus, IR against the ground of ID leads to the disruption of the mineral composition of the hard tissues of teeth and bones and is a risk factor for the development of dental pathology.*
***Key words:*** *insulin resistance, iodine deficiency, mineral status, dentomaxillary system.*

**Introduction.** Pathology of the endocrine glands belongs to one of the most spread diseases with a tendency to increase. Combination of several endocrine nosologies is especially dangerous in a prognostic aspect. In particular, cases of insulin resistance syndrome against the ground of iodine deficiency (ID) occur more frequently. It is connected both with genetic peculiarities of the population and deterioration of the ecological situation in the world. Under such conditions humoral homeostasis disorders stipulate changes of the structural-functional state of many organs and systems, and dentomaxillary as well [3]. Depolymerization of the bone organic matrix, disorders of collagen formation, osteoclast activation against osteoblast apoptosis and mineral imbalance occurring under conditions of insulin resistance (IR) promote disorders of the osteosythetic processes [1].

**Objective:** to determine changes of macro- and microelement status of rats with IR against the ground of ID.

**Materials and methods.** The investigation was conducted on 90 male rats with the body weight of 150-180 g, divided into three groups: the rats with ID (the 1st group, n=30); the rats with IR (the 2nd group, n=30); the rats with IR against ID (the 3rd group, n=30). ID condition was simulated by means of keeping the animals on iodine deficiency diet during 45 days [2]. IR was simulated by addition of 10% fructose solution to drinking water every day during 8 weeks [6]. Euthanasia was made by means of decapitation under ketamine narcosis (100 mg/kg of the body weight). Macro- and microelement status of the rats was characterized by the level of calcium, magnesium, zinc, manganese and copper in the packed red cells, teeth and alveolar processes by means of the atom-adsorption spectrophotometry method. The activity of alkali and acid phosphatase were detected in the blood serum. For the sake of comparison similar examinations were performed on 30 intact animals (the control group) kept under conditions of standard diet, usual temperature and light regimen in the vivarium. Quantitative results of the study were analyzed by means of the package of mathematic programs StatisticSoft 7,0.

**Results and discussion.** In the rats with ID the amount of calcium and magnesium was found to be 71,1-97,5% ($p<0,05$) and 81,2-95,5% ($p<0,001$) down respectively in all the examined tissues as compared to the animals from the control group (Table 1).

**Table 1**

**The content of macro- and microelements in the packed red cells, teeth and alveolar processes of rats with iodine deficiency, insulin resistance and insulin resistance against the ground of iodine deficiency (M±m)**

| Groups of animals | Calcium, mg/L | Magnesium, mcg/ml | Zinc, mcg/ml | Manganese, mcg/ml | Copper, mcg/ml |
|---|---|---|---|---|---|
| Packed red cells | | | | | |
| Intact animals (n=30) | 0,8±0,29 | 45,26±14,96 | 5,17±2,40 | 0,14±0,05 | 1,79±0,93 |
| 1st group (ID, n=30) | 0,02±0,01* | 2,06±0,41## | 2,65±0,92 | 0,06±0,03 | 4,25±1,32 |
| 2nd group (IR, n=30) | 0,04±0,02* | 2,08±1,68## | 4,03±1,43 | 0,1±0,07 | 2,13±1,1 |
| 3rd group (IR against ID, n=30) | 0,74±0,28 $p_{1-3}$<0,05 $p_{2-3}$<0,05 | 36,09±2,88## $p_{1-3}$<0,001 $p_{2-3}$<0,001 | 4,19±1,73 | 0,02±0,01* $p_{2-3}$<0,001 | 1,63±0,75 |
| Teeth | | | | | |
| Intact animals (n=30) | 59,75±3,98 | 3195,56±253,23 | 44,46±7,77 | 10,89±2,00 | 3,92±1,33 |
| 1st group (ID, n=30) | 17,28±1,18## | 600,00±44,38## | 67,89±12,98 | 4,22±1,64* | 7,05±2,20 |
| 2nd group (IR, n=30) | 18,20±0,60## | 772,50±68,40## | 64,18±5,76* | 3,18±1,46* | 6,03±0,97 |
| 3rd group (IR against ID, n=30) | 12,19±1,05## $p_{1-3}$<0,01 $p_{2-3}$<0,01 | 375,00±40,20## $p_{1-3}$<0,01 $p_{2-3}$<0,01 | 78,85±6,19# | 1,71±0,69# | 5,94±1,54 |
| Alveolar processes | | | | | |
| Intact animals (n=30) | 61,99±11,63 | 1689,00±241,54 | 122,89±58,57 | 1,21±0,47 | 3,29±1,08 |
| 1st group (ID, n=30) | 17,40±0,64** | 215,21±30,90## | 76,65±11,27 | 5,10±1,27 | 4,32±1,06 |
| 2nd group (IR, n=30) | 16,21±0,70** | 174,40±37,99## | 123,36±31,97 | 3,81±1,43 | 4,40±1,92 |
| 3rd group (IR against ID, n=30) | 10,83±1,76** $p_{1-3}$<0,01 $p_{2-3}$<0,05 | 172,00±30,03 $p_{1-3}$<0,01 | 72,97±11,71 | 2,04±1,52 | 5,57±1,51 |

*Notes: * – p<0,05; ** – p<0,02; # – p<0,01; ## – p<0,01 concerning similar indices in the control group of animals; p – reliable difference between the indices of the appropriate experimental groups.*

Similar tendency was detected in animals with IR which amount of calcium and magnesium became 69,5-95,0% (p<0,05) and 75,8-95,4% (p<0,001) down respectively in comparison with the similar indices of the intact rats (Table 1). In animals with IR against the ground of ID redistribution of macro- and microelements in he examined tissues was found. Thus, in the packed red cells, teeth and alveolar processes of rats from the 3rd group the content of the majority of macro- and microelements became 20,3-88,3% (p<0,05) lower than that of the control. At the same time, the content of zinc in the dental tissues became 44,4% (p<0,05) higher than that of the initial data. It can be indicative of a compensatory supplement of calcium and magnesium content in the structure of the teeth by this element, as zinc is known to participate in cell division forming dentin [5].

In case of comparative analysis of the indices of the 1st and 3rd groups different changes of macro-elements in the examined tissues were found.

Thus, in the packed red cells of animals with IR against the ground of ID a considerable increase of calcium and magnesium concentration was found as concerning the indices of rats with ID. On the contrary, in the tissue of the teeth and alveolar processes the content of these elements became 20,1-37,8% ($p_{1-3}$<0,01) lower as compared to the similar indices of animals from the 1st group (Table 1). Certain literary evidence suggests that under conditions of acidosis occurring in case of hyperglycemia, a relative hypercalcemia is found, as calcium ionization intensifies and the percentage of its active form in the blood increases. At the same time, compensatory elimination of calcium from the teeth and bones increases in exchange for carbon ions [4].

The comparative analysis of indices from the 2nd and 3rd groups detected different changes of the examined parameters. For example, in the packed red cells of rats with IR against ID the content of calcium and magnesium increased in 18,5 times ($p_{2-3}$<0,05) and 17,4 times ($p_{2-3}$<0,001) with simultaneous 80,0% ($p_{2-3}$<0,001) reduction of manganese as concerned the similar indices in the animals of the 2nd group. At the same time, the level of macro-elements in the tissue of the teeth and alveolar processes became 33,02-51,5% ($p_{2-3}$<0,05) lower as compared to the appropriate indices of rats with IR (Table 1).

An increased activity of acid phosphatase (AP) in the blood serum of the experimental animals evidences changes of calcium homeostasis (Table 2). Thus, in rats with ID this index became 37,2% (p<0,05) higher as compared to the control data. In animals of the 2nd group AP activity was twice as much (p<0,01) as compared to the initial indices. Combination of IR and ID was associated with more pronounced activation of the enzyme (in 2,4 times, p<0,001) as compared to the appropriate indices of the intact rats, which is indicative of intensification of osteo-resorptive processes under given experimental conditions. The comparative analysis of AP activity of animals from the 1st and 2nd groups indicates that this index becomes 43,4% ($p_{1-2}$<0,05) up. This tendency is indicative of the fact that under conditions of IR changes of the mineral content of the bone are more pronounced. The similar tendency was detected in the blood serum of rats with IR against ID where AP activity became 69,9% ($p_{1-3}$<0,001) and 18,5% ($p_{2-3}$<0,05) higher as compared to the similar indices of animals from the 1st and 2nd groups.

**Table 2.**

**Activity of alkali and acid phosphatase in the blood serum of rats with iodine deficiency (ID), insulin resistance (IR), and insulin resistance against the ground of iodine deficiency (M±m)**

| Groups of animals | Alkali phosphatase, mcct/L | Acid phosphatase, units/L |
|---|---|---|
| Intact animals (n=30 ) | 4848,89±1622,16 | 2,59±0,30 |
| 1st group (ID, n=30) | 2813,60±488,19 | 3,69±0,71* |
| 2nd group (IR, n=30) | 4174,91±1907,65 | 5,29±0,93# $p_{1-2}$<0,05 |
| 3rd group (IR against ID, n=30) | 4855,50±1549,00 $p_{1-3}$<0,01 | 6,27±1,69## $p_{1-3}$<0,001 $p_{2-3}$<0,05 |

*Notes: * – p<0,05; # – p<0,01; ## – p<0,01 concerning similar indices in animals of the control group; p – reliable difference between the indices of the appropriate experimental groups.*

**Conclusions.** Metabolic changes occurring under conditions of iodine deficiency and hyperglycemia result in disorders of macro- and microelement homeostasis of the body tissues. The structural organization of the teeth and bones reacts to such humoral disorders most of all which is manifested by reduced depot of calcium, magnesium and manganese in them. These changes prove the activation of osteoclasts against the ground of inhibition of osteosynthetic processes. Under conditions of combined IR and ID the mineral status experiences more pronounced changes and are associated with redistribution of macro-elements. This tendency produces a negative effect on metabolism of the hard periodontal tissues, and it can result in the development of degenerative-dystrophic disorders in them.

**Prospects of further studies.** The results obtained can be the basis to conduct clinical observations with the purpose to use the data of the blood serum phosphatase as a marker of diseases of the osseous tissue against the ground of endocrine disorders including dental pathology.

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