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Bioprotective properties of nano-diamond composition at intragastric introduction to rats

N A Lomteva[1], E I Kondratenko[1], S K Kasimova[1], S K Gordeev[2], A F Alykova[3], O M Alykova[1], I N Zavestovskaya[3]

[1]Astrakhan state university, Astrakhan, Russia
[2]FSUE «Central Research Institute for Materials», St. Petersburg, Russia
[3]National Research Nuclear University MEPhI Moscow Engineering Physics Institute), Moscow, Russia
E-mail: saule_kasimova@mail.ru

Abstract. We studied a biocompatibility and a bioprotector property of nanodiamond composites on reduction of the toxic action to cadmium salt. The experimental animal intragastric received with the help of a probe activated carbon and nanodiamond composite. We researched the rate of spontaneous and ascorbate-dependent lipids peroxidation and the reference level of malonic dialdehyde in liver, thyroid and adrenal glands tissues. So this concentration of the nanopore material at intragastric entering did not led to difference of researched parameters of the lipid peroxidation. The solution of cadmium salt developed typical for it toxic action which expressed in increase intensity of the processes of POL in liver and thyroid gland tissues. The nanopore material developed the characteristic which screened the toxic action of cadmium chloride and it was more denominated on some parameters in comparison with the effect of the intragastric entering of the activated carbon.
Keywords: nanodiamond composition, level of free radical oxidation of lipid, biocompatibility, bioprotector property.

1. Introduction

Recent years have led to the rapid development of the synthesis and research of new carbon nanomaterials. In biology and medicine, the use of nanomaterials allows us to tackle a number of problems that can ensure the revolutionary development of almost all basic areas of medicine [14]. And at the same time, more and more questions began to arise about the dangers of these materials to health and the environment. The first results of the study of this topic turned out to be contradictory, and rather did not give an answer to the questions posed, but caused many new ones. The small size and large specific surface of nanomaterials lead to high chemical activity, allow penetration into the body through inhalation (and further into the lungs), through the skin, or even act at the cellular level. Moreover, nanomaterials can affect plants, animals, microorganisms [7]. So the problems of toxicity of substances are quite important, work on the study of the toxic properties of nanomaterials, their distribution in biological systems and metabolism began almost immediately after the materials became available for extensive research [1-6].

The widespread use of nanomaterials in industrial products (goods) from cosmetics to electronics and the enormous potential for developing new products and devices with nanoparticles included in them is of

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concern to scientists, toxicologists, and physicians. Nanoparticles (nanotubes, fullerenes) can cause damage to the respiratory system, skin, and other organs, especially for workers who manufacture and manipulate them [9,13]. The process of nanotechnology development cannot be stopped; therefore, an urgent task is to assess the biocompatibility of nanomaterials and their synthesized modifications, and especially to study the mechanisms of the possible damaging effect [8,10].

2. Materials and methods of research

In our research we used nanocarbon material – nanodiamond composite (NDC). The NDC materials are high-porous carbon composite bodies: a pore volume is ranging from 30 to 60 vol%, and an effective pore size of 7±2 nm. We studied a biocompatibility and a bioprotector property of nanodiamond composites on reduction of the toxic action to cadmium salt.

58 females of the rats used in the experiment. The experimental animal intragastric received with the help of a probe activated carbon and nanodiamond composite, reduced in powdery mass in the manner of water dispersion. Its solution entered for 3 days before chloride cadmium solution injection and entered during 12 days. 0,2 M solution of the crystalogydrate $CdCl_2$ [$CdCl_2 \cdot 2,5\ H_2O$] entered daily and one-short during 9 days for 0,2 ml/100g body weight of the animals. Animals were divided into 6 groups: 1) intact females; 2) animals received activated carbon solution; 3) animals received nanodiamond composite solution; 4) animals received cadmium solution; 5) animals received cadmium and activated carbon solution; 6) animals received cadmium and nanodiamond composite solution. The preliminary entering activated carbon and nanodiamond composite realized for 50-60 minutes before solution of cadmium salt entering. All experiments with animals did in the morning.

Methods. We researched the second products of the lipid peroxidation (POL) – the level of malonic dialdehyde (MDA) for study processes of POL [11, 12]. We researched the rate of spontaneous and ascorbate-dependent lipids peroxidation and the reference level of malonic dialdehyde in liver, thyroid and adrenal glands tissues.

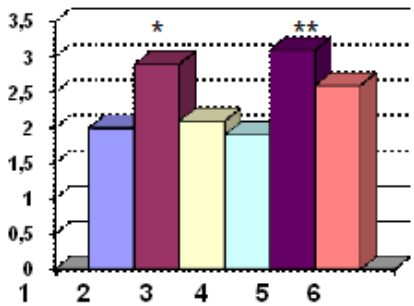

Figure 1. The reference level of MDA in liver tissue. 1 – control; 2 – cadmium; 3 – carbon; 4 – nano; 5 – carbon+cadmium; 6 – nano+ cadmium; * - difference in comparison with control group ,° - difference between animals, received salt cadmium and animal, received salt cadmium+activated carbon or nanomaterial; Δ- difference between animals, received activated carbon or nanomaterial and animal, received salt cadmium+activated carbon or nanomaterial; *(°, Δ) - p<0,05; ** (°°, ΔΔ) - p<0,01; *** (°°°, ΔΔΔ) - p<0,001.

3. Results and discussion

In liver tissues the reference level of MDA (Pic.1) of the female of rats which received salt cadmium injected and cadmium with activated carbon injected was higher than that of the control animals. The reference level of MDA of the rats which received injected salt cadmium with nanodiamond composite did not differ from the control group. This data indicated the probably screening of the toxic effect of the salt cadmium intravitelline injection in liver tissue.

The rate of spontaneous POL (Pic.2.) in liver increased at the animals were received salt of cadmium in comparison with a similar parameter at the control animals (p<0,001). The rate of spontaneous POL also increased at the animals were received the activated carbon with cadmium, in comparison with intact females (p<0,05) and it was higher that the rate of spontaneous POL at the animals were received activated carbon (p<0,001). The rate of spontaneous POL at females were received salt of cadmium and nanopore material did not differ from the parameters of the control animals and it was lower that the rate of spontaneous POL at females were received solution of cadmium salt in comparison with analog parameters of the control animals (p<0,05).

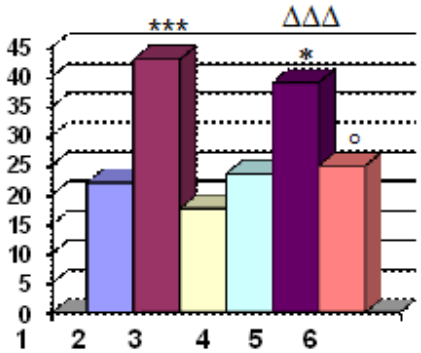

Figure 2. The rate of spontaneous POL in liver. 1 – control; 2 – cadmium; 3 – carbon; 4 – nano; 5 – carbon+cadmium; 6 – nano+ cadmium.

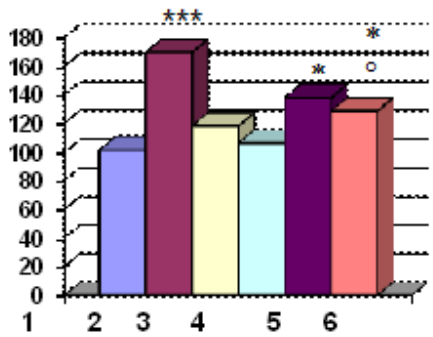

Figure 3. The rate of ascorbate- dependent POL in liver. 1 – control; 2 – cadmium; 3 – carbon; 4 – nano; 5 – carbon+cadmium; 6 – nano+ cadmium.

The rate of ascorbate-dependent POL in liver tissue (Pic.3.) also increased at the females were received salt of cadmium (p<0,001) in comparison with the intact animals. The rate of ascorbate-dependent POL at the animals were received salt of cadmium with activated carbon and nanopore material in comparison with a similar parameter at the control animals (p<0,001). The rate of ascorbate-dependent POL was lower in the group of the animals were received salt cadmium with nanopore material in comparison with animals were received cadmium salt (p<0,05).

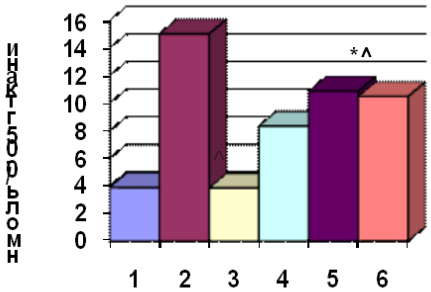

Figure 4. The reference leve lof MDA in thyroid gland . 1 – control; 2 – cadmium; 3 – carbon; 4 – nano; 5 – carbon+cadmium; 6 – nano+ cadmium.

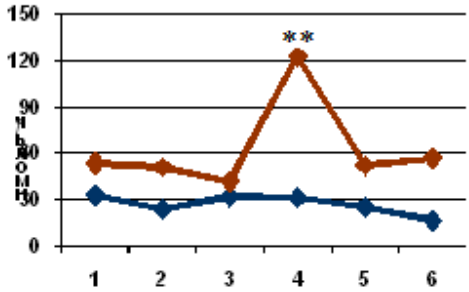

Figure 5. The rate of spontaneous(I) and ascorbate-dependent (II) POL in thyroid gland. 1 – control; 2 – cadmium; 3 – carbon; 4 – nano; 5 – carbon+cadmium; 6 – nano+ cadmium.

The reference level of MDA in thyroid gland tissue (Pic.4) increased at intravitelline entering nanopore material, and cadmium salt in comparison with a similar parameters of the control animals. The entering of the activated carbon and cadmium salt led to increase of the reference level of MDA in comparison with intact animals and the females were received the activated carbon ($p < 0,05$). The rate of ascorbate-dependent POL in thyroid gland tissue (рис.5) increased at intravitelline entering cadmium salt in comparison a similar parameters of the control animals ($p<0,01$).

The intravitelline entering of the activated carbon led to reduction the reference level of MDA in adrenal glands tissue in comparison with the control animals ($p<0,01$) (Pic.6). The rate of ascorbate-dependent POL in adrenal glands tissue (Puc.7) remained low at entering of the activated carbon and cadmium salt in comparison with the intact animals, whereas entering of cadmium salt with nanopore material led to increase of the parameter on comparison with the control animals.

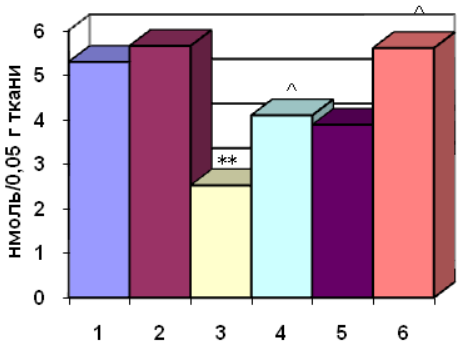

Figure 6. The reference level of MDA in adrenal glands tissue.
1 – control; 2 – cadmium; 3 – carbon; 4 – nano; 5 – carbon+cadmium; 6 – nano+ cadmium.

The rate of spontaneous POL in adrenal glands tissue (Pic. 8) increased at entering the activated carbon and nanopore material and cadmium salt in comparison with a similar parameters at control females. Simultaneous received by animals of the activated carbon and cadmium salt led to reduction the rate of spontaneous POL up to a level, typical for the control animals whereas at simultaneous received cadmium salt and nanopore material the rate of spontaneous POL was higher that it was at the intact animals.

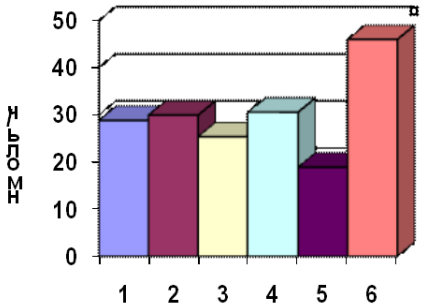

Figure 7. The rate of ascorbate-dependent POL in adrenal glands. 1 – control; 2 – cadmium;3 – carbon; 4 – nano; 5 – carbon+cadmium; 6 – nano+ cadmium.

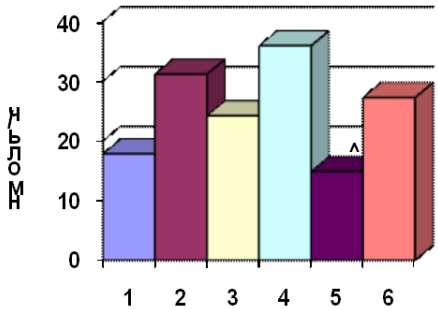

Figure 8. The rate of spontaneous POL in adrenal glands. 1 – control; 2 – cadmium;3 – carbon; 4 – nano; 5 – carbon+cadmium; 6 – nano+ cadmium.

Acknowledgments
So this concentration of the nanopore material at intragastric entering did not led to difference of researched parameters of the POL. The solution of cadmium salt developed typical for it toxic action which expressed in increase intensity of the processes of POL in liver and thyroid gland tissues. The nanopore material developed the characteristic which screened the toxic action of cadmium chloride and it was more denominated on some parameters in comparison with the effect of the intragastric entering of the activated carbon.

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