MORPHOMETRIC ANALYSIS OF THE EFFECT OF NANOPARTICLES ON LUNG TISSUE

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Annotation. Analyzing the impact of nanomaterials on cells is critical to assessing their potential risks. One key aspect is studying the ability of aluminum oxide nanoparticles to accumulate in cellular structures such as organelles and cytoplasm, and their effects on cellular morphology and viability, including induction of cytotoxicity and changes in metabolomic and proteomic profiles.

Keywords: nanoparticle, titanium dioxide,TiO_2, Al_2O_3, alveolus, cytoplasm

Aim of the study. To study morphological and functional changes in lung tissue in normal and pathological conditions.

Introduction. Studies of the specific and delayed toxic effects of aluminum oxide nanoparticles indicate their possible carcinogenic and immunotoxic effects. According to the International Agency for Research on Cancer, people working in aluminum production have an increased risk of developing lung and bladder cancer. The nanoparticles were also found to suppress the immune response in human lung lymphoblast cells and human alveolar basal cell adenocarcinoma cells, as shown by in vitro studies.

Studies aimed at studying the permeability of the intestinal mucosa for TiO_2 nano- and microparticles remain rather limited. Some studies have used in vitro models of intestinal epithelium using monolayers of cells morphologically and functionally similar to enterocytes, as in the case of Caco-2 cells. In a study by Z.M. Song et al., it was shown that TiO_2 nanoparticles at concentrations of 10–100 μg/ml (equivalent to 1–10 mg/kg human body weight) penetrate the epithelial cell layer using both transcytosis and paracellular pathways, thereby disrupting the structure of γ-catenin.

Materials and methods. The animals were divided into control and experimental groups. In the control group, consisting of 10 individuals, the morphology and morphometry of the lungs were studied before any damage was inflicted. For this purpose, a humane method of euthanasia was used - decapitation under anesthesia using ether at a dosage of 3-4 ml/kg. During the study, one lung tissue sample was extracted from each individual for micromorphological and immunohistochemical analysis.

The first experimental group (n=50) included 50 rats, which were administered intragastrically every day at the same time for 90 days a dispersion of titanium dioxide nanoparticles TiO_2, which is part of the dye E171, at doses of 1 and 100 mg/kg of body weight. The second experimental group (n=50) also included 50 individuals, which were administered a solution of the dispersion of aluminum oxide nanoparticles Al_2O_3, contained in the dye E173, in similar dosages. The third experimental group (n=50) of 50 rats received a combination of both dispersions in the same dosages. On the 90th day of the experiment, 35 animals from each group were decapitated under anesthesia to assess the effect of the administered substances on the lung tissue. These animals were designated as group 1A, group 2A, group 3A. The remaining 15 rats from each group underwent phytocorrection using spirulina for 30 days, after which they were killed by the same method for subsequent analysis of lung tissue. These animals were designated as group 1B, group 2B, group 3B. During the experiment, the rats' weight was monitored using electronic scales with an accuracy of ±0.5 g, which allowed tracking the dynamics of body weight gain. The total duration of the experiment was 90 days.

Results of the study. At the beginning of the experiment, the average weight of the rats was 180.6±3.7 grams. During the 90-day experiment, the body weight of the rats increased to 241.7±6.2 grams, indicating normal development of the animals under control conditions. At the same time, there was an increase in lung weight: from 1.4±0.03 g to 2.4±0.05 g. If we consider the proportion of lung mass to body mass, then at the beginning of the experiment it was from 0.66% to 0.78%, and by the end it increased to 0.66%–0.95%. The increase in body mass is accompanied by a corresponding increase in lung mass, which is necessary to maintain an adequate level of gas exchange in the body. In this case, lung tissue developed proportionally to the growth of body weight, which indicates the absence of pathological changes and the normal functional state of the respiratory system.

The fact that the increase in lung weight was proportional to the increase in body weight confirms the absence of toxic effects and the maintenance of normal physiological conditions in the control group rats. The data obtained indicate normal adaptation of the body, where the lungs retain their ability to provide adequate gas exchange under conditions of increased metabolism.

The results of the study showed that titanium dioxide and aluminum oxide nanoparticles cause significant inflammatory and fibrotic changes in the lung tissue of experimental animals. The combined effect of these nanoparticles leads

to a more pronounced inflammatory response, which indicates the high toxicity of these substances for lung tissue. Morphometric parameters of the lung tissue of the rat from the control group: Average alveolar diameter - 148.3±3.4 μm, average interalveolar septum thickness - 1.9±0.2 μm, alveolar duct diameter - 36.8±1.9 μm. Morphometric parameters of arterioles and venules under the combined effect of TiO_2 and Al_2O_3: arteriole diameter - 33.0±2.7 μm, arteriole wall thickness - 4.8±0.5 μm, venule diameter - 39.4±3.1 μm

Conclusion. As part of the study, morphological and histological assessments were carried out, the results of which confirm both the presence of inflammatory processes and regenerative changes caused by the correction.

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