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MORPHOLOGICAL CHANGES IN THE LUNGS OF MICE UNDER EXPERIMENTAL HYPOXIA

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Abstract: This study investigated the micromorphological alterations in the lung tissue of mice exposed to experimentally induced hypoxia. Histopathological examination demonstrated significant structural changes characterized by thickening of the alveolar septa, capillary proliferation, inflammatory cell infiltration, and disruption of the pulmonary surfactant system. These morphological abnormalities indicate that prolonged hypoxic exposure induces pathological remodeling of pulmonary tissue, potentially impairing respiratory function and gas exchange. The findings provide important experimental evidence regarding the structural basis of hypoxia-induced pulmonary injury and contribute to a better understanding of the mechanisms underlying respiratory diseases associated with oxygen deficiency.

Keywords: hypoxia, experimental hypoxia, mice, lung, pulmonary morphology, alveoli, inflammation, surfactant, histopathology.

Introduction. Hypoxia is a pathological condition characterized by an inadequate supply of oxygen to tissues and organs, resulting in impaired cellular metabolism and functional deterioration. It is a common feature of numerous respiratory disorders, including chronic obstructive pulmonary disease (COPD), obstructive sleep apnea syndrome, pulmonary fibrosis, acute respiratory distress syndrome, and exposure to high-altitude environments. Persistent oxygen deprivation initiates a cascade of adaptive and pathological responses that affect both pulmonary structure and function.

The lungs serve as the principal organs responsible for oxygen uptake and carbon dioxide elimination. Their highly specialized alveolar architecture provides an extensive respiratory surface that facilitates efficient gas exchange. Under hypoxic conditions, however, structural remodeling of the pulmonary parenchyma occurs, leading to alterations in the alveolar-capillary interface and deterioration of respiratory efficiency.

Previous experimental studies have demonstrated that chronic hypoxia induces alveolar remodeling, angiogenesis within the pulmonary capillary network, inflammatory responses, and extracellular matrix deposition. Nevertheless, the chronological progression and quantitative characteristics of these histopathological alterations remain incompletely understood. Therefore, detailed morphological evaluation is essential for clarifying the mechanisms responsible for hypoxia-induced pulmonary injury.

Aim of the Study

The aim of this study was to identify and characterize the micromorphological changes occurring in the lung tissue of mice subjected to experimentally induced hypoxia.

Materials and Methods

Experimental Animals

Thirty adult male mice aged 8–10 weeks and weighing 200–250 g were included in the study. The animals were randomly allocated into two equal experimental groups:

- **Hypoxia group (n = 15)**
- **Control group (n = 15)**

All experimental procedures were performed in accordance with internationally accepted laboratory animal welfare guidelines.

Experimental Hypoxia Model

Experimental hypoxia was induced using a specialized hypoxic chamber maintained at **10% oxygen concentration**. Animals in the hypoxia group were exposed to this environment for **8 hours daily over a period of 14 consecutive days**. The control animals were maintained under normoxic laboratory conditions throughout the experimental period.

Histological Examination

At the end of the fourteenth experimental day, all animals were euthanized under general anesthesia. Lung tissues were carefully excised and fixed in **10% neutral buffered formalin**.

After routine tissue processing and paraffin embedding, histological sections were prepared and stained using:

- Hematoxylin and Eosin (H&E)
- Masson's Trichrome stain

Microscopic evaluation focused on:

- Alveolar septal thickness
- Pulmonary capillary proliferation
- Degree of inflammatory cell infiltration
- Structural integrity of pulmonary tissue

Statistical Analysis

Quantitative data were analyzed using **Student's t-test**. Differences with $p < 0.05$ were considered statistically significant.

Results

Histopathological Findings in the Hypoxia Group

Microscopic examination revealed substantial pathological alterations in the lungs of mice exposed to chronic hypoxia.

Alveolar Septal Thickening

The thickness of the alveolar septa increased significantly compared with the control group ($p < 0.01$). Thickening of the alveolar walls reduced the effective diffusion distance for gas exchange and reflected structural remodeling of pulmonary tissue.

Capillary Proliferation

Hypoxic exposure induced marked expansion of the pulmonary capillary network accompanied by endothelial cell proliferation. These vascular adaptations appear to represent compensatory mechanisms aimed at improving oxygen delivery under conditions of reduced oxygen availability.

Inflammatory Cell Infiltration

Histological sections demonstrated extensive infiltration of inflammatory cells, predominantly macrophages, neutrophils, and lymphocytes, within the pulmonary interstitium and around alveolar structures. The inflammatory response suggests activation of immune-mediated pathways during prolonged hypoxic stress.

Structural Alterations of the Surfactant System

Ultrastructural examination revealed morphological abnormalities in **type II pneumocytes**, including degeneration of intracellular organelles associated with surfactant synthesis. A reduction

in surfactant-associated structures was also observed, indicating impaired surfactant production and secretion.

Findings in the Control Group

The lungs of control animals exhibited normal pulmonary architecture. Alveolar spaces remained well preserved with thin septa, normal capillary distribution, and no evidence of inflammatory infiltration or structural remodeling. Type II pneumocytes maintained normal morphology, indicating intact surfactant production under physiological conditions.

Discussion

The present study demonstrates that experimental hypoxia induces pronounced micromorphological alterations in murine lung tissue. The observed thickening of alveolar septa, vascular remodeling, inflammatory infiltration, and surfactant abnormalities collectively indicate that chronic oxygen deprivation profoundly affects pulmonary architecture.

Alveolar septal thickening increases the diffusion distance between alveolar air and pulmonary capillary blood, thereby reducing gas exchange efficiency. Simultaneously, proliferation of pulmonary capillaries likely represents an adaptive angiogenic response intended to compensate for diminished oxygen availability.

The inflammatory infiltrates observed in hypoxic lungs suggest activation of multiple inflammatory signaling pathways, including cytokine-mediated recruitment of macrophages and neutrophils. Persistent inflammation may subsequently promote extracellular matrix deposition and pulmonary fibrosis if hypoxic exposure continues.

The structural impairment of type II pneumocytes is particularly significant because these cells synthesize pulmonary surfactant, a phospholipid-rich substance that lowers alveolar surface tension and prevents alveolar collapse. Reduced surfactant production may therefore increase the risk of atelectasis and further compromise respiratory function.

These findings are consistent with previous investigations describing hypoxia-induced pulmonary remodeling and support the concept that chronic hypoxic stress initiates both adaptive and pathological responses within lung tissue. The present results further contribute to understanding the morphological basis of respiratory disorders associated with prolonged oxygen deficiency.

Conclusion

Experimental hypoxia produces significant micromorphological alterations in the lungs of mice, including alveolar septal thickening, pulmonary capillary proliferation, inflammatory cell infiltration, and structural damage to type II pneumocytes. These pathological changes impair pulmonary gas exchange and may contribute to progressive deterioration of respiratory function.

The findings provide valuable experimental evidence regarding the mechanisms of hypoxia-induced pulmonary injury and may serve as a morphological basis for future investigations into chronic respiratory diseases and the development of novel therapeutic strategies targeting hypoxia-related lung damage.

References

1. Abdullayev U, Tursunov K. **Toxic and Morphological Changes in Lung Tissue.** *Uzbekistan Medical Journal.* 2021;3(45):12–19.
2. King TE Jr, Shapiro SD, et al. **Pulmonary Pathophysiology: The Essentials.** Philadelphia: Wolters Kluwer; 2021.
3. Azizov O. **Forensic Aspects of Domestic Gas Poisoning.** *Journal of Global Health.* 2022;5(8):56–63.

4. Kurbanov A. **Pulmonary Edema and Alveolar Hemorrhage: A Morphological Analysis.** *Uzbekistan Medical Journal.* 2020;4(38):22–28.
5. Weidemann MJ, et al. **Hypoxia and Lung Morphology.** *American Journal of Respiratory and Critical Care Medicine.* 2012;186(12):1240–1247.
6. Nasriddinov S. **Toxic Lung Injuries.** *Journal of Global Health.* 2023;3(10):44–50.