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COMPARATIVE MORPHOLOGICAL AND MORPHOMETRIC INDICATORS OF MAJOR SALIVARY GLANDS UNDER CHRONIC EXPOSURE TO GAS

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Abstract: This scientific study investigates morphological and morphometric changes in the major salivary glands of laboratory animals under chronic exposure to NO_2 and SO_2 gases. The histological structure of the parotid, submandibular, and sublingual salivary glands was analyzed using microscopic and morphometric methods. The results revealed cellular and tissue-level degeneration, inflammation, atrophic changes, and a decrease in secretory activity. These changes reflect the adverse effects of the gas mixture and emphasize the need for preventive measures to ensure environmental safety.

Introduction

In recent years, the increase in industrialization and vehicle emissions has led to a serious problem of atmospheric air pollution. Among the gaseous pollutants, nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) are known to negatively affect the respiratory tract and oral tissues. However, the effects of these gases on the salivary glands—especially the major ones (parotid, submandibular, and sublingual)—at morphological and morphometric levels have not been sufficiently studied.

Salivary glands play a vital role in maintaining oral hygiene and providing immunological protection. Therefore, studying their condition under chronic gas exposure is essential. This study aims to determine the morphological and morphometric changes in major salivary glands under chronic gas exposure and compare them with a control group.

Materials and Methods

Study Subjects

The experiment involved 30 healthy, sexually mature male Wistar rats (weighing 180–220 g), divided into two groups:

- **Control group (n = 15):** Maintained under standard laboratory conditions.
- **Experimental group (n = 15):** Exposed to a mixture of NO_2 and SO_2 gases at 0.2 ppm concentration for 6 hours daily over 90 days.

Sample Collection

At the end of the experiment, the animals were euthanized under anesthesia. The parotid, submandibular, and sublingual salivary glands were harvested and fixed in 10% neutral formalin. The samples were embedded in paraffin, sectioned at 5 μm thickness, and stained with hematoxylin and eosin for microscopic examination.

Morphometric Analysis

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After microscopic imaging, the following parameters were measured using the ImageJ software:

- Acinus diameter (μm)
- Nuclear volume (μm³)
- Number of secretory cells
- Capillary density (per 100 μm²)

For each sample, average values were calculated based on 10 visual fields.

Statistical Analysis

Data were presented as mean ± standard deviation (M ± SD). Differences between groups were analyzed using Student's t-test ($p < 0.05$ was considered statistically significant).

Results

Morphological Changes

Parotid Gland:

In the control group, parotid glands showed a normal architecture with densely packed acini and minimal stromal tissue. In the experimental group, cytoplasmic vacuolization, nuclear pyknosis, and disappearance of secretory granules were observed. Lymphocytic infiltration and partial fibrotic changes were noted in the stroma.

Submandibular Gland:

A reduced number of acini, varying degrees of cellular degeneration, stromal fibrotic growth, and microcirculatory disturbances were seen in the experimental group. This gland showed the highest sensitivity to gas exposure.

Sublingual Gland:
Secretory epithelial cells showed nuclear deformation, vacuolization, and necrotic signs. Inflammatory signs were detected around blood vessels in the stroma.

Morphometric Indicators

Indicator	Control Group (M ± SD)	Experimental Group (M ± SD)	Difference (%)	p-value
Acinus diameter (μm)	56.2 ± 3.1	42.8 ± 2.7	−23.9%	<0.01
Nuclear volume (μm³)	112.5 ± 5.4	89.3 ± 4.9	−20.6%	<0.01
Capillaries (per 100 μm²)	7.4 ± 0.8	5.1 ± 0.7	−31.1%	<0.01
Secretory cells	34.5 ± 2.6	25.2 ± 2.1	−27.0%	<0.01

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Indicator	Control Group (M ± SD)	Experimental Group (M ± SD)	Difference (%)	p-value
count				

These findings demonstrate that chronic exposure to NO_2 and SO_2 gases significantly alters the structural integrity of major salivary glands. The parotid gland showed cytoplasmic vacuolization and granule loss; the submandibular gland exhibited fibrotic overgrowth and degeneration; the sublingual gland showed necrotic changes. These changes are likely due to disruptions in cellular metabolism, oxidative stress, and impaired microcirculation.

Morphometric changes serve as objective markers of functional impairment—reduced secretory cell count and nuclear volume indicate decreased secretory activity. The submandibular gland appeared to be the most sensitive among the three.

Conclusion

Chronic exposure to gas mixtures causes significant morphological and morphometric changes in the major salivary glands. These changes adversely affect the overall health of the organism and oral cavity function. The results emphasize the importance of environmental pollution control and the implementation of preventive public health measures.

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