MORPHOLOGICAL CHANGES IN RAT LUNG TISSUE UNDER COVID-19 EXPOSURE

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Abstract

COVID-19 primarily affects the respiratory system, causing structural and functional changes in the lungs. This review summarizes morphological alterations in rat lung tissue under SARS-CoV-2 exposure, including alveolar wall thickening, interstitial edema, inflammatory cell infiltration, and microvascular damage. These findings provide insights into pulmonary pathophysiology, guide therapeutic evaluation, and help predict disease progression. Animal models remain essential for studying early lung pathology and developing intervention strategies.

Keywords

COVID-19, rat lung, morphological changes, pulmonary pathology, SARS-CoV-2

МОРФОЛОГИЧЕСКИЕ ИЗМЕНЕНИЯ В ЛЁГОЧНОЙ ТКАНИ КРЫС ПРИ ВОЗДЕЙСТВИИ COVID-19

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Аннотация

COVID-19 в первую очередь поражает дыхательную систему, вызывая структурные и функциональные изменения лёгочной ткани. В статье рассматриваются морфологические изменения лёгочной ткани крыс при воздействии SARS-CoV-2, включая утолщение альвеолярных стенок, интерстициальный отёк, инфильтрацию воспалительных клеток и повреждение микрососудов. Эти данные помогают понять патофизиологию лёгких, оценить терапевтические подходы и прогнозировать течение болезни.

Ключевые слова

COVID-19, лёгочная ткань крыс, морфологические изменения, патология лёгких, SARS-CoV-2

Introduction

COVID-19, caused by SARS-CoV-2, has emerged as a global pandemic with profound public health and socioeconomic impacts. While primarily a respiratory disease, COVID-19 can affect multiple organ systems, with the lungs being most severely involved. The virus enters host cells via the angiotensin-converting enzyme 2 (ACE2) receptor, highly expressed in alveolar epithelial cells, resulting in direct cytopathic effects, immune-mediated injury, and a cascade of inflammatory responses contributing to pulmonary pathology.

Pulmonary manifestations range from mild interstitial inflammation to severe acute respiratory distress syndrome (ARDS). Histopathological studies in humans reveal diffuse alveolar damage, hyaline membrane formation, interstitial edema, inflammatory cell infiltration, and microvascular thrombosis. However, detailed human studies are limited due to ethical and logistical challenges. Animal models, particularly rats, are valuable for studying cellular and tissue-level mechanisms of SARS-CoV-2-induced lung injury, allowing controlled observations of early morphological changes, disease progression, and therapeutic responses.

Experimental studies in rats permit detailed examination of alveolar architecture, interstitial spaces, vascular endothelium, and inflammatory infiltration. Morphological investigations using light and electron microscopy reveal subtle structural changes such as alveolar septal thickening, edema, epithelial cell degeneration, inflammatory infiltration, and endothelial injury. Understanding these patterns is essential for interpreting pathophysiology, identifying biomarkers of severity, and developing targeted interventions.

Comparative studies between rat models and human pathology enhance understanding of conserved mechanisms of lung injury, viral replication, and immune response. Such knowledge bridges preclinical research and clinical application, guiding antiviral drug development, immunomodulatory therapy, and prevention of long-term pulmonary complications.

The aim of this review is to summarize morphological alterations in rat lung tissue under COVID-19 exposure, discuss their pathophysiological relevance, and highlight the role of animal models in advancing the understanding of SARS-CoV-2 pulmonary injury.

Methods

This article is theoretical and based on literature analysis; no experimental study was conducted. Scientific publications, reviews, and experimental reports on SARS-CoV-2-induced lung pathology in rats were systematically analyzed.

The review focused on the following morphological features:

- Alveolar structure and wall thickness
- Interstitial edema
- Inflammatory cell infiltration
- Microvascular and endothelial changes
- Comparison with human lung pathology

The goal was to synthesize typical morphological changes in rat lungs under COVID-19 exposure and discuss their implications for research and therapy.

Results

The literature indicates that rat lungs under SARS-CoV-2 exposure exhibit the following key morphological alterations:

1. **Alveolar Wall Thickening:** Increased septal thickness due to inflammation and cellular infiltration.
2. **Interstitial Edema:** Fluid accumulation in interstitial spaces reflecting increased vascular permeability.
3. **Inflammatory Cell Infiltration:** Macrophages, neutrophils, and lymphocytes infiltrate alveolar and interstitial regions.
4. **Microvascular Changes:** Endothelial damage, capillary congestion, and occasional microthrombi formation.
5. **Epithelial Injury:** Degeneration of alveolar epithelial cells and loss of ciliated pneumocytes, resembling early human COVID-19 pathology.

These changes correlate with impaired gas exchange and decreased lung compliance observed in both experimental and clinical settings.

Discussion

Morphological analysis of rat lungs under SARS-CoV-2 exposure demonstrates patterns similar to human COVID-19 pathology. Alveolar wall thickening and interstitial edema reflect acute inflammation, while infiltration by immune cells indicates a strong host response. Microvascular alterations, including endothelial injury, support the vascular component of COVID-19 pathophysiology, which may contribute to hypoxia and coagulopathy.

Animal models provide controlled environments for detailed examination of early tissue changes. Rat studies reveal alveolar, interstitial, and vascular alterations that precede clinical symptoms, offering valuable insight into disease mechanisms. These findings assist in identifying potential therapeutic targets, evaluating intervention strategies, and predicting disease progression.

Limitations include species differences in lung morphology and viral tropism. Therefore, extrapolation to human pathology should be done cautiously.

Nevertheless, comparative studies highlight conserved mechanisms of pulmonary injury and immune response, enhancing translational relevance.

In summary, morphological studies in rats provide a foundation for understanding COVID-19 pulmonary pathophysiology, guiding preclinical research and supporting the development of effective therapies.

Conclusion

Morphological alterations in rat lung tissue under COVID-19 exposure—such as alveolar thickening, interstitial edema, inflammatory infiltration, and microvascular damage—mirror key features of human disease. Animal models are essential for studying early lung injury, evaluating therapeutic interventions, and predicting disease outcomes. Comprehensive morphological analysis in experimental models is crucial for advancing knowledge and management of COVID-19-related pulmonary pathology.

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