

How to Cite:

Ishankulova, D. K. (2022). The formation of mucociliary insufficiency in the bronches in respiratory viral infection. *International Journal of Health Sciences*, 6(S3), 4846–4851. <https://doi.org/10.53730/ijhs.v6nS3.6968>

The formation of mucociliary insufficiency in the bronches in respiratory viral infection

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Abstract---Viral infectious inflammatory processes of the respiratory organs account for half of the total morbidity of children and one third of the morbidity of adolescents. One of the most important protective mechanisms of the respiratory system is the mucociliary transport system. There are studies of the mucociliary system in children with various bronchopulmonary diseases. In case of respiratory viral infection, the study of mucociliary transport is presented in single studies.

Keywords---mucociliary insufficiency, bronchopulmonary pathology, viral infection.

Introduction

According to modern concepts, bronchial obstruction syndrome is a clinical symptom complex, the leading sign of which is expiratory dyspnea, which occurs due to restriction of air flow in the bronchial tree, mainly on exhalation, due to bronchospasm, edema of the bronchial mucosa and dyscrinia [1, 2]. The latter term refers to the increased production of pathological bronchial secretions with altered properties (primarily increased viscosity), which violates mucociliary clearance and clogs the lumen of the bronchi. Bronchial obstruction syndrome in the vast majority of cases is the result of degenerative dystrophic changes and/or an inflammatory process in the mucous membrane of the bronchial tree, more often its distal parts, due to various causes of exo - and endogenous origin [3, 4]. Bronchial obstruction can be a manifestation of acute respiratory viral infection. Often manifestations of bronchial obstruction occur in bronchiectatic disease, cystic fibrosis, pulmonary tuberculosis, cystic hypoplasia of the lungs and a number of other diseases [5].

The development of persistent bronchial obstruction syndrome is caused by a complex morphofunctional restructuring of the bronchial tree wall under prolonged exposure to repeated viral respiratory infections with the development

of persistent inflammation in it [6]. The damaging effect of these pathological factors leads to thickening (initially reversible) of the bronchial wall due to swelling of the submucosal layer and hyperplasia of the bronchial glands, hypertrophy of smooth muscles, fibrous changes [7]. Already at the early stages of the development of the pathological process, an increase in the secretory activity of goblet cells is determined, an increase in their number, which is accompanied by an increase in the production of mucosal secretions with a large molecular weight. These changes are accompanied by a decrease in the functional activity of microvilli of the ciliated epithelium, dystrophic changes in epitheliocytes with loss of micro-villi, as well as disturbances in the surfactant system [8, 9]. The consequence of all the above changes is mucociliary insufficiency, narrowing of the lumen of the airways and an increase in bronchial resistance. It should be noted that bronchial obstruction and mucociliary insufficiency are links (or rather stages) of one pathological process. In the first stage, mucociliary insufficiency is mainly observed, and in the second, bronchial obstruction joins [10].

Aim of the study

To study the role of a respiratory viral infection in the formation of mucociliary insufficiency.

Material and methods of the research

We observed 100 children with acute respiratory viral infection, who were divided into three age groups: group I (3-6 years) – 30 children, group II (7-11 years) – 35 children, group III (12-16 years) – 35 children. mucociliary transport (MCT) studies were conducted using a test to determine the time of movement of the indicator substance from the moment it was applied to the mucous membrane of the nasal cavity to its appearance in the oropharynx. The studies were carried out in the dynamics of the development of acute respiratory viral infection – during the period of pronounced clinical manifestations and during the period of convalescence. Statistical processing of data from clinical and experimental studies was carried out using standard methods of variational statistics – SPSS Statistica 5.0. The presence of connections and the strength between the studied values was studied using the Pearson correlation coefficient.

Research results

The results of our study indicate that in the acute period of the disease, 69% of children had a violation of mucociliary transport. The average MCT time in the acute period of respiratory viral infection was 34.1 ± 1.0 min. Normal MCT indicators occurred in children with different morphological forms of pneumonia in 31% of cases. The clinical picture of the disease in them was characterized by mild catarrhal phenomena in the nasopharynx, moderate symptoms of intoxication, unexpressed respiratory failure, local small-bubbly wheezing in the lungs. Comparative analysis of MCT data for various morphological forms of pneumonia did not reveal significant differences between them, although there was a less pronounced violation of MCT in focal pneumonia (33.9 ± 1.2 min.), the greatest deviation from the norm occurred in segmental pneumonia (35.4 ± 2.2 min.). This fact may indicate that a larger volume of lung tissue damage leads to a

more pronounced violation of mucociliary function. There was no significant dependence of the time of MCT on the age of children.

During the convalescence period, there was a significant decrease in the MCT time to 29.6 ± 0.9 min. ($p < 0.001$), i.e., an improvement in mucociliary function. At the same time, against the background of ongoing treatment, 40% of convalescents retained impaired mucociliary function. The study of the effect on this indicator of the presence of chronic diseases of the nasopharynx, the one- or two-sided nature of lung tissue damage, the frequency of respiratory viral infection, did not reveal a significant dependence on the studied indicators.

Clinical case

A 5-year-old boy was admitted to the hospital due to rapidly progressive respiratory failure, with symptoms of fever – 39.2°C , rhinorrhea and cough, respiratory rate 30 breaths / min, oxygen saturation 90% and weakened breathing in the left lung. Pneumonia was diagnosed on a chest x-ray showing an infiltrative shadow in the left inferior field of the lung, atelectasis of the entire left lung, and deviation of the trachea to the left (Fig. 1). The left upper and lower bronchi were blocked by dense mucous casts. The patient was intubated and underwent bronchoscopy. (Fig.2, 3). Immediately after removing the bronchial casts (Fig. 4), his respiratory condition improved and after 2 days he was extubated. The polymerase chain reaction was positive for influenza A (H₁N₁pdm09).

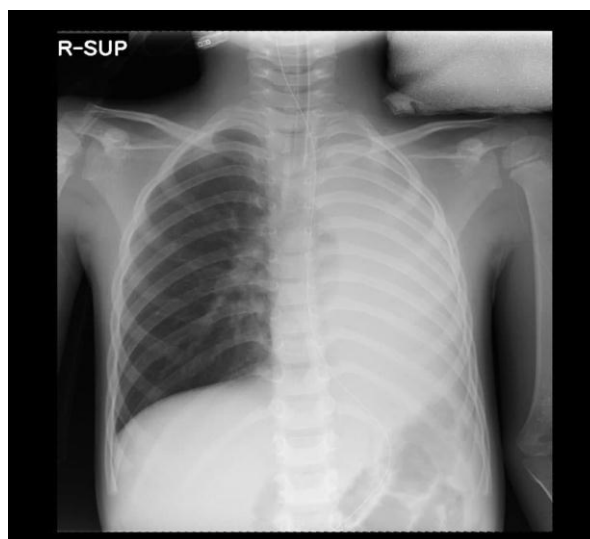


Fig 1. Result of chest X-ray before bronchoscopy: an infiltrative shadow in the left inferior field of the lung, atelectasis of the entire left lung, and deviation of the trachea to the left



Fig 2. Result of chest X-ray after bronchoscopy: The pulmonary pattern has returned to normal



Fig 3. Removal of dense mucous casts using bronchoscopy



Fig 4. Bronchial casts

Conclusions

Thus, in acute respiratory viral infection, a violation of mucociliary function was observed, depending on the period of the clinical course of the disease. During the period of reconvalescence, mucociliary purification was restored. However, almost half of the patients had a violation of the MCT.

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