FATTY ACID COMPOSITION OF EXHALED MOISTURE VAPORS IN CHILDREN WITH BRONCHIAL ASTHMA

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The article is devoted to the fatty acid composition of exhaled moisture vapors in children with bronchial asthma. The problem of bronchopulmonary pathology in children living in the sharply continental climate of Transbaikalia is discussed in the article. Numerous factors that contribute to the development of bronchial asthma are indicated. A special role among these factors belongs to the intensification of lipid peroxidation and antiradical protection in "the large biological membrane of the lungs". The parameters of the processes of lipid peroxidation in the vapor of exhaled air and blood serum in children suffering from bronchial asthma are studied [8, 9]. Particular attention is paid to the study of the values of saturated and unsaturated fatty acids and also total lipids in these biological fluids without exacerbation and at the height of the disease. The main attention is focused on new methods of diagnosis. It is recommended to use a simple, atraumatic and non-invasive method – a condensate of exhaled moisture vapors. Studies of the condensate of exhaled air vapors as a medium reflecting metabolism in the respiratory tract and in the body as a whole are widely used in clinical practice including pediatrics [2,11]. That's why the spectrum of fatty acids in blood plasma and expirate in children with bronchial asthma (BA) is studied. It was revealed that changes in the vapor condensate are more specific in comparison with blood plasma [4, 5, 6].

Keywords: condensate of exhaled air vapors, lipid peroxidation, spectrum of fatty acids, bronchial asthma

Over the past decades the urgency of the problem of bronchial asthma as one of the most frequent and severe allergic diseases has increased significantly. In recent years there is a tendency to the increase morbidity of children with bronchial asthma and its more severe course all over the world including Russia. The number of young children suffering from bronchial asthma is increasing rapidly.

Bronchial asthma (BA) is a chronic disease that causes a significant limitation of life activity and decrease in social and physical activity. The constant attention to the problem of BA is due to the fact that insufficiently effective treatment and frequent exacerbations of the disease may lead to the reduced quality of patients' life and their limited vital activity. Severe forms of bronchial asthma are accompanied by dysfunctions of the respiratory system and other body systems. Disability develops in 7% of officially registered patients with bronchial asthma. Nowadays this problem has not only medical but also socio-economic importance.

At present scientists of most countries in the world have the same views on the main problems of bronchial asthma. For example the Russian national program "Bronchial asthma in children: A treatment strategy and prevention" (1997, 2006) was based on the official WHO report "Bronchial asthma. Global strategy" (GINA project).

Bronchial asthma is a chronic disease mostly based on allergic inflammation. In children with bronchial asthma in the vast majority of cases the development of allergic inflammation is due to atopy. Allergic inflammation is a factor largely determining the relapsing and chronic course of bronchial asthma. Inflamed tissues have an increased sensitivity of bronchial receptors not only to allergens but also to external influences including viral infection and pollutants which may significantly increase bronchospasm development.

The inflammation in bronchial asthma is the main pathogenetic link in the development of bronchial obstruction mechanisms such as bronchospasm, hypersecretion of viscous mucus and edema of the bronchial mucosa. Modern pathologic physiology is based on the key role of intensification of lipid peroxidation processes.

Various environmental factors and inflammation stimulate the activation of lipid peroxidation processes and antiradical protection in the surface-active substances of the lungs. The lung surfactant is a "large biological membrane" including a bilipid layer with phospholipids and cholesterol. Structural components of phospholipids are saturated and unsaturated fatty acids. The role of these structures increases in the pathogenesis of the development of bronchial asthma because polyunsaturated fatty acids of phospholipids of the lung surfactant serve as substrates for peroxide oxidation of lipids.

At the same time the regulation of bronchial tonus is controlled by several physiological mechanisms including complex interactions of the receptor-cell link and the mediator system. These include cholinergic, adrenergic and neuro-humoral systems of regulation.

Respiratory tract injuries are the main causes of childhood morbidity. This pathology has a particular prevalence and frequency

of manifestations especially for Transbaikal region due to its natural and climatic factors. The direct contact of the respiratory mucous membrane and the environment with a large number of damaging factors stimulates the development of various reactions – inflammatory, allergic, irritative, etc.

Based on the pathogenesis of bronchial asthma modern therapy is aimed at eliminating allergic inflammation of the bronchial mucosa, reducing hyper-reactivity of the bronchi, restoring bronchial patency and preventing structural rearrangement of the bronchial wall. Untimely diagnosis and inadequate therapy are the main causes of severe illness and mortality in patients with bronchial asthma.

Materials and methods of research

We examined 168 children with nonspecific respiratory diseases at the age of 3 to 15 years (there were no significant differences in age groups). 28 children had bronchial asthma. The control group consisted of 49 children with the same age, sex and without respiratory disorders.

Materials of the study were expirate and blood serum. The collection of CEAV was performed by method of G.I. Sidorenko [3]. The methyl esters analysis of fatty acids (FA) condensate and blood serum was carried out in general lipid extract of the corresponding samples [4] by means of gas-liquid chromatography (gas chromatograph "Chrom-4") with a flame ionization detector. The instrument was calibrated with the standard mixtures of methyl esters of FA. The FA content was estimated by area peaks. The processing of the results was carried out by the method of variational statistics with the determination of the reliability of the differences by the Student's criterion.

In the blood serum the composition of FA and total lipids were studied by means of "Bio-Lachema-Test".

Results of research and their discussion

The presence of non-respiratory functions in the lungs proves their intensive involvement in the processes of lipid metabolism. We established the discharge of total lipids with the exhaled air vapors in bronchial asthma to be increased by 88.0% ($p < 0.001$) in comparison with the control findings. It means that the activation of the destruction processes in the surface-active phospholipids in the alveolar lining takes place.

The fatty acid composition analysis of the expirate and blood serum in children with BA is presented in Table.

The pathochemical essence of inflammation which is the key link in the pathogenesis of infectious but allergic diseases is largely determined by the mechanisms of mediation. Nowadays a significant role is assigned to highly active substances – lipid mediators such as leukotrienes. Their synthesis processes are associated with activation of phospholipase A2 releasing arachidonic acid from the β-position of glycerophosphatides with the following metabolization along the lipoxygenase pathway. Reduction of the concentration of unsaturated fatty acids is due to the intensification of free radical processes. These representatives of lipids are believed to have a high metabolic activity, energy intensity and a short half-life in comparison with other classes of fatty acids. But hypoxia accompanying all forms of respiratory diseases aggravates their utilization in this direction [1, 6, 7].

The content of fatty acids of total lipids of CEAV and blood serum in children with bronchial asthma (in rel. %, M ± m)

FA call number	Condensate		Blood serum	
	Control	BA	Control	BA
C 14:0	9,52±0,48	11,08±0,83	1,74 ± 0,15	1,27 ± 0,09
C 15:0	8,45 ± 0,59	9,44 ± 0,61	-	-
C 16:0	24,66 ± 0,89	26,10 ± 1,84	26,10 ± 0,72	25,59 ± 0,75
C 16:1	2,94 ± 0,38	3,78 ± 0,82	5,17 ± 0,32	5,40 ± 0,46
C 17:0	8,82 ± 0,50	7,61 ± 0,59	-	-
C 18:0	14,19 ± 0,72	9,08 ± 1,93	10,07 ± 0,30	9,90 ± 0,43
C 18:1	10,13 ± 1,05	10,53 ± 1,87	22,77 ± 0,61	27,97 ± 1,41*
C 18:2	7,72 ± 0,57	9,14 ± 1,53	27,75 ± 0,80	26,85 ± 0,85
C 18:3	4,34 ± 0,61	6,09 ± 1,01	0,64 ± 0,23	0,88 ± 0,29
C 20:0	3,71 ± 0,50	4,10 ± 0,68	-	-
C 20:4	5,55 ± 0,69	3,05 ± 1,82	5,76 ± 0,28	2,14 ± 0,55

Note: an asterisk means significant differences compared to the control. When analyzing the fatty acid composition of blood serum the class of limiting FA was unchanged. The increase of monoenoic acids (19.4%) due to C 18: 1 and the decrease of polyene acids (87.5%) relatively to healthy children were found.

A detailed review of higher fatty acids revealed an unreliable decrease in the concentrations of palmitate (C 16:0) and linoleate (C 18:2) on the background of increasing linolenate values (C 18: 3). It testifies to deep system rearrangements of lipid metabolism and free radical processes both at the level of the whole organism and in the surfactant membrane. It confirms the transition of metabolic pathways to a new level.

Studies of the condensation of exhaled moisture in patients with bronchial asthma were allowed to estimate (indirectly) the fatty acid composition of the surface active substances of the lungs at the height of the disease. The values of the saturated FA decreased to 93.4%. On the background of the relative growth of unsaturated FA they decreased to 14.2% in comparison with the control. The apparent decrease in the amount of stearate (C 18:0) in spite of unreliable increase in the figures of palmitate (C 16: 0) led to a general decrease in the level of saturated FA in children with bronchial asthma. Such fatty acids as C 14:0 and C 15:0 had multidirectional deviations with the unreliable decrease of C 17:0 levels and the increase of C 20:0. C 16:1 tended to the increase while the pool of monoenic compounds was relatively unchanged (C 18:1). There was a relative increase in the content of linoleate (C 18:2) which led to a corresponding trend of unsaturated FA. The imbalance in the ratio of the spectrum of fatty acids and the content of total lipids determines the functional and structural rearrangement of the mucous membrane of the bronchial in case of progression of this pathology.

Conclusions

Thus we can conclude that there is a decrease in the concentration of unsaturated fatty acids in children with a long course of bronchial asthma indicating an imbalance in the surfactants of the lungs. The interpretation of the received data proves the fact that prolonged respiratory failure and long-term infectious stress aggravate the state of the peroxide status of children suffering from chronic bronchopulmonary disease. The manifested deficit of antiradical protective factors testifies to their depletion in the alveolar lining. The deviations from the norm of metabolic parameters in the exhaled moisture are more significant and have a specific character. They can be widely used as a diagnostic criterion in future.

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