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Functional Disorders in the Respiratory System in Adolescents with Bronchial Asthma

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ABSTRACT

Currently, bronchial asthma is one of the most common diseases in childhood and adolescence, capable of consistently worsening the quality of life of patients, and in severe cases it leads to disability. Despite the fairly widespread prevalence of bronchial asthma in adolescents, the specifics of disorders in them in the external respiration system require clarification. For this reason, an additional examination of patients in this category was conducted. The aim of the work is to assess the impairment of the functional state of the respiratory system in adolescents suffering from bronchial asthma. The study involved 38 adolescents aged 13–14 years suffering from at least 5 years of moderate bronchial asthma without signs of respiratory failure. At the time of the examination, the disease in the examined adolescents was in a state of unstable remission. The control group consisted of 20 adolescents of the same age, clinically completely healthy. For adolescents with asthma is characterized by a decrease in lung capacity and bronchial diameter of any caliber. This inevitably leads even in adolescents suffering from at least 5 years of bronchial asthma, to a marked decrease in the functional capabilities of the respiratory apparatus. It became clear that early in this disease, resistance of the respiratory center to hypoxia and weakening of the adaptive capacity of the entire respiratory system occurs. In adolescents with bronchial asthma, all the identified disorders lead to an increase in the functional weakness of their respiratory and circulatory systems, and, consequently, they form a low resistance to hypoxia even at a young age.

Keywords: *respiratory system, bronchi, lungs, bronchial asthma, adolescents.*

Introduction

The course of ontogeny of any organism implies its continuous interaction with the environment, which does not always have a beneficial effect[1,2]. All external influences on the organism cause in it sometimes a whole series of genetically determined reactions[3,4] aimed at adapting to the current conditions of existence[5,6]. Due to the severity of adverse environmental effects and the presence in some cases of imperfect adaptation mechanisms and responses in the body, various dysfunctions can occur, and sometimes pathological processes[7,8].

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Observations show that the cardiovascular system, the blood system and the respiratory system are very vulnerable in the human body[9]. Being life support systems, they largely support the overall viability of the mammalian organism[10,11]. At the same time, in recent years there has been a marked increase in the number of various lung diseases, especially at young and young age[12,13].

Bronchial asthma is currently one of the most common diseases in childhood and adolescence, capable of consistently worsening the quality of life of patients and their families, and in severe pathology leading to disability. It is precisely established that bronchial asthma is a chronic disease of predominantly inflammatory and allergic etiology. It often develops against the background of a hereditary predisposition to allergic processes[14].

The total number of patients with bronchial asthma in the modern world is more than 150 million people. In

Russia now there are about 8 million people (about 9% among children and adolescents and about 5% among adults), and 1 million of them have a severe course of the disease. However, there is reason to believe that the true prevalence of bronchial asthma is several times higher, since it is officially registered only in 1 out of 4-5 patients[15].

Despite the fairly widespread prevalence of bronchial asthma in adolescents, the specifics of disorders in them in the external respiration system require clarification. For this reason, it was necessary to conduct additional examinations of patients in this category.

The purpose of the study is to assess the impairment of the functional state of the respiratory system in adolescents suffering from bronchial asthma.

Materials and Research Method

The study was approved by the local ethics committee of the Russian State Social University on September 15, 2017 (protocol №11). The study was conducted on the basis of the Moscow Children's City Polyclinic No. 38 and the Russian State Social University, Moscow, Russia. The study involved 38 adolescents aged 13–14 years suffering from at least 5 years of moderate bronchial asthma without signs of respiratory failure. At the time of the examination, the disease was in all adolescents in a state of unstable remission. The control group consisted of 20 adolescents of the same age, clinically completely healthy.

Studies were conducted on the spirograph SMP-21/01-"P-D" produced by the Scientific-Production Enterprise "Monitor" (Russia). According to the spirogram, a number of indicators were evaluated: minute respiratory volume, lung capacity, maximum lung ventilation, inspiratory reserve volume, expiratory reserve volume, forced vital capacity, forced expiratory volume in 1 second, peak volume rate, maximum volume rate at 25%, 50% and 75% of the forced vital capacity.

All examined were subjected to a functional test of the Post by determining the maximum possible breath-holding time after a deep breath. It was performed in all cases after resting in a sitting position. The subject took a full breath and then exhale, and then again inhale (80-90% of the maximum) and held his breath for the maximum time possible for him[16].

Also, all Genchi's functional tests were carried out to all those taken under observation, determining the maximum possible breath-hold time on exhalation. After 3-5 minutes of rest in the sitting position, the patient was asked to take a full exhalation and inhale, and then exhale again and hold the breath[16].

For a holistic and objective assessment of the functional state of the cardiorespiratory system in the examined, the Skibinsky index was calculated. This indicator characterizes the overall functional state of the respiratory system and its resistance to hypoxia. The calculation of the Skibinsky index was carried out in the following way: vital capacity of the lungs/100 × barbell test, s/heart rate. The results obtained during the calculation were evaluated on the following scale: less than 5 - very bad; 5-10 - unsatisfactory; 10-30 - satisfactory; 30-60 - good; 60 or more - very good.

The size of the chest excursion was measured with a centimeter tape, which was applied to the back at the corners of the shoulder blades and in front over the mammary glands (in girls), then the difference between the maximum inhalation and exhalation was calculated[16].

The obtained results were processed by the methods of mathematical statistics using the statistical software packages Microsoft Excel.

Research Results and Discussion

In adolescents suffering from bronchial asthma, there was a significant violation of indicators of respiratory function (Table 1).

Table 1: Indicators of respiratory function in adolescents with bronchial asthma

Estimated indicators	Group of sick teenagers, n = 38, M ± m	Group of control, n = 20, M ± m
Lung capacity, l	2.0 ± 0.09	2.4 ± 0.12 p<0.05
Forced vital capacity, l	1.8 ± 0.08	2.3 ± 0.17 p<0.01
Forced expiratory volume in 1 second, l	1.7 ± 0.11	2.2 ± 0.15 p<0.01
Minute respiratory volume, l/min	12.5 ± 0.38	10.1 ± 0.45 p<0.05
Maximum ventilation, l/min	48.9 ± 0.43	57.9 ± 0.82 p<0.05

Conted…

Peak volumetric rate, l/s	2.6 ± 0.29	4.2 ± 0.32 p<0.01
Maximum volume velocity of $_{25}$, l/s	3.2 ± 0.26	4.3 ± 0.27 p<0.05
Maximum volume velocity $_{50}$, l/s	2.3 ± 0.28	3.0 ± 0.20 p<0.05
Maximum volume velocity of $_{75}$, l/s	1.5 ± 0.11	1.8 ± 0.16 p<0.05
The result of the test Stange, s	42.3 ± 0.56	61.2 ± 0.48 p<0.01
The result of the test Gencha, s	25.5 ± 0.67	32.6 ± 0.42 p<0.05
Excursion of the chest, cm	2.9 ± 0.32	5.8 ± 0.39 p<0.01
Skibinsky index, usl. units	26.6 ± 0.85	61.3 ± 0.71 p<0.01

Legend: p-confidence of differences in performance between patients and the control group.

It was found that the values of lung capacity in adolescents with asthma were lower than the control group by 20.0%. The magnitude of the forced vital capacity of the lungs was below the control level by 27.0%. At the same time, in terms of the forced expiratory volume in 1 second, the control group exceeded the same indicator in sick adolescents by 29.4%.

When comparing the indices of the minute volume of respiration, it was possible to establish its increase in adolescents with asthma compared with the control group by 23.8%. In addition, in the group of patients, the maximum ventilation rate was reduced by 18.4%.

In the group of adolescents with asthma, the peak volume rate was reduced by 73.1%. This was accompanied by their reduction by 34.4% of the average value of the maximum volumetric flow rate at 25% of the value of the forced vital capacity of the lungs. Their maximum space velocity, at the level of 50% and 75% of the forced vital capacity, was reduced by 30.4% and 20.0%, respectively. In addition, in adolescents with bronchial asthma, the indices of hypoxic samples and the level of chest excursion were significantly lower than those in the control group. The average Skibinsky index in adolescent patients was significantly lower than in the control group (2.3 times).

Discussion

Currently, asthma in adolescents is a very common pathology. Often, it manifests itself already in childhood and progresses rapidly, sometimes leading to disability in young and mature age[17,18].

It was shown that a significant decrease in lung capacity is characteristic of this group of patients[19,20]. In addition, they have an average indicator of forced vital capacity of the lungs also significantly inferior to the level of control. Increasing their bronchial obstruction inevitably leads to a decrease in the forced expiratory volume in 1 second. This was confirmed by the study. The authors found a decrease in the maximum ventilation index in adolescents with asthma[21,22]. These changes should be considered as evidence of the low functional capacity of the respiratory apparatus in adolescents suffering from bronchial asthma, as well as in their ability to mobilize reserves of respiratory function[23,24,25].

A comparison of the indices of the minute volume of respiration in both groups of observations showed an increase in adolescents with bronchial asthma[26,27]. At the same time, the found decrease in peak volumetric rate in the group with bronchial asthma proved for them the presence of low functionality of the respiratory muscles and reduced patency of large-caliber bronchi. The reduced values of the maximal volumetric rate at 25% of the forced vital capacity of the lungs confirmed the development in adolescents with bronchial asthma and the progressive deterioration in patency at the level of the large bronchi[25,29]. The found decrease in bronchial asthma of the average values of the maximum volumetric rate at 50% and 75% of the forced vital capacity of the lungs also proved in patients with adolescents a decrease in the patency of their bronchi of medium and small caliber. Negative changes in their indices of hypoxic tests and a reduction in the volume of the chest excursion proved the possibility of developing already in adolescence with this pathology of a pronounced resistance of the respiratory center to hypoxia and weakening the adaptive capacity of the entire respiratory system[30,31,32]. The decrease in the Skibinsky index found in the observation group should be regarded as a manifestation of functional weakness of the respiratory and circulatory organs against the background of bronchial asthma, and, consequently, their body's low resistance to any hypoxic conditions[33,34,35].

Conclusion

Currently, asthma remains one of the most common diseases of the respiratory system. The presence in this pathology of changes in the sensitivity of the walls of the bronchi to external influences and the development of their hyperresponsiveness creates the basis for respiratory dysfunction. These disorders occur already in adolescence and sometimes manifest significant impaired respiratory function. These patients are characterized by a decrease in lung capacity and bronchial diameter of any caliber. Already in adolescents suffering from bronchial asthma, this leads to a marked decrease in the functional capabilities of the respiratory apparatus, as well as to a weakening of the ability to mobilize the reserves of the respiratory apparatus.

Conflict of Interest: No conflict of interest is declared.

Sources of Funding: The study was conducted at the expense of the authors.

Ethical Clearance: The study was approved by the local ethics committee of the Russian State Social University on September 15, 2017 (protocol №11).

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