Functional Features of External Respiration in School Children of Adolescence, Long Suffering from Chronic Obstructive Bronchitis

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Abstract

Context: In the modern world, chronic bronchitis is one of the most common diseases in childhood and adolescence that can stably degrade their quality of life. In this regard, an additional examination of patients in this category was carried out. The purpose of the work is to assess violations of the functional state of the external respiration system in adolescents suffering from chronic obstructive bronchitis. The study involved 42 adolescents 13-14 years old, suffering from at least 5 years of chronic obstructive bronchitis of moderate severity with no signs of respiratory failure. At the time of the examination, the disease was among the examined adolescents in a state of unstable remission. For adolescents with chronic obstructive bronchitis, a decrease in the vital capacity of the lungs and diameter of the bronchi of any caliber is characteristic. This inevitably leads them to a marked decrease in the functional capabilities of the external respiration apparatus. It became clear that early enough with this disease, the respiratory center becomes resistant to hypoxia and weaken the adaptive capabilities of the entire external respiration system. All identified violations lead in adolescents with chronic obstructive bronchitis to an increase in the functional weakness of their respiratory system and circulatory system, and, therefore, form a low resistance to hypoxia even at a young age.

Keywords: *Respiratory system, bronchi, lungs, obstruction, chronic bronchitis, adolescents.*

Introduction

Ontogenesis of any organism implies its continuous interaction with the environment, which does not always positively affect[1,2]. All external influences on the organism sometimes cause a whole series of genetically determined reactions in it[3,4], aimed at adapting to the current conditions of existence[5,6]. Due to the severity of harmful environmental influences and the frequent imperfection of adaptation mechanisms and responses, various dysfunctions and sometimes pathological processes can occur in the body[7,8].

Often affected by the pathology in the human body are the cardiovascular system, the blood system and the respiratory system[9]. Being life support systems, they significantly support the overall viability of the mammalian organism[10, 11]. Moreover, in recent years there has been a clear increase in the number of various lung diseases, especially at a young and young age[12,13].

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Chronic obstructive bronchitis 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 cases of pathology leading to disability. It is well established that chronic obstructive bronchitis is a chronic disease of predominantly inflammatory etiology. This disease always leads to changes in the sensitivity of the walls of the bronchi and the development of airway hyperresponsiveness[14,15].

Despite the fairly widespread prevalence of chronic obstructive bronchitis in adolescents, the features of disorders in their external respiration system need to be clarified. For this reason, it was necessary to conduct additional examinations of patients in this category.

The purpose of the study was to assess impaired functional state of the external respiration system in adolescents suffering from chronic obstructive bronchitis.

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 City Children's Clinic №38 and the Russian State Social University in Moscow, Russia. The study involved 42 adolescents 13-14 years old, suffering from at least 5 years of chronic obstructive bronchitis of moderate severity with no signs of respiratory failure. At the time of the examination, the disease was in all teenagers in a state of unstable remission. The control group consisted of 20 adolescents of a similar age, clinically completely healthy.

The work was performed on the SMP-21/01- "R-D" spirograph produced by the Monitor scientific-production enterprise (Russia). A number of indicators were estimated from the spirogram: minute respiratory volume, lung vital capacity, maximum lung ventilation, inspiratory reserve volume, expiratory reserve volume, forced expiratory lung capacity, forced expiratory volume in 1 second, peak volumetric rate, maximum volumetric rate of 25%, 50% and 75% of the forced vital capacity of the lungs.

All adolescents underwent a functional test of Stange by determining the maximum possible time for holding the breath after a deep breath[16].

All included in the study underwent a functional test of Genchi, determining the maximum possible time for breath holding on exhalation. After 3-5 minutes of rest in a sitting position, the examinees were offered to exhale and inhale completely, then exhale again and hold their breath[16].

For a comprehensive 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 external respiration system and its resistance to hypoxia. The calculation of the Skibinsky index was carried out in the following way: vital lung capacity/100 × Stange test, s/ heart rate. The results obtained during the calculation were evaluated on the following scale: less than 5 - very poor; 5-10 - unsatisfactory; 10-30 - satisfactory; 30-60 - good; 60 or more is very good.

The value of the chest excursion was measured using a centimeter tape, which was applied posteriorly at the level of the angles of the shoulder blades, and in front, above the mammary glands (in girls), then the difference between the maximum inspiration and expiration was calculated[16].

The results were processed using mathematical statistics method using statistical packages of Microsoft Excel. The statistical processing performed included the calculation of the arithmetic mean value (M) and the error of the arithmetic mean value (m). To identify the statistical difference between the indicators in the group of patients and in the control group, t-student criterion was used.

Research Results and Discussion

In adolescents suffering from chronic obstructive bronchitis, a significant violation of the indices of the function of external respiration was noted (Table 1).

Table 1: Indicators of external respiration function in adolescents with cobstructive bronchitis

Estimated performance	Group of sick teenagers, n=42, M±m	Control group, n=20, M±m
Vitallungcapacity, l	1.9±0.11	2.4±0.12 p<0.05
Forced vital capacity, l	1.7±0.09	2.3±0.17 p<0.01
Forced expiratory volume in 1 second, l	1.6±0.12	2.2±0.15 p<0.01
Minute breathing volume, l/min	12.3±0.43	10.1±0.45 p<0.05
Maximum ventilation, l / min	47.7±0.36	57.9±0.82 p<0.05
Peak space velocity, l/s	2.7±0.25	4.2±0.32 p<0.01
Maximum space velocity $_{25}$, l/s	3.2±0.24	4.3±0.27 p<0.05
Maximum space velocity $_{50}$, l/s	2.4±0.22	3.0±0.20 p<0.05
Maximum space velocity $_{75}$, l/s	1.6±0.10	1.8±0.16 p<0.05
Stange Result, s	41.8±0.41	61.2±0.48 p<0.01
Gencha test result, s	24.9±0.52	32.6±0.42 p<0.05
Chest excursion, sm	2.8±0.36	5.8±0.39 p<0.01
Skibinsky index, conventional units	28.5±0.72	61.3±0.71 p<0.01

Legend: p-significance of differences in indicators between patients and the control group.

Values of lung capacity in adolescents with chronic obstructive bronchitis were lower than the control group by 26.3%. The value of the forced vital capacity of the lungs was 35.3% lower than the control level. Moreover, in terms of forced expiratory volume for 1 second, the control group exceeded the same indicator in sick adolescents by 37.5%.

By comparing the indicators of minute volume of breathing, it was possible to establish its increase in adolescents with chronic obstructive bronchitis compared with the control group by 21.8%. In addition, in the group of patients, the maximum ventilation rate was reduced by 21.4%.

In the group of adolescents with chronic obstructive bronchitis, the peak volumetric rate was reduced by 55.5%. This was accompanied by a decrease of 34.4% in the average value of the maximum volumetric rate indicator at the level of 25% of the value of the forced vital capacity of the lungs. Their maximum volumetric rate, which is at the level of 50% and 75% of the value of the forced vital capacity, was reduced by 25.0% and 12.5%, respectively. In addition, in adolescents with chronic obstructive bronchitis, the indicators of hypoxic tests and the level of chest excursion were significantly lower than those in the control group. Moreover, the average Skibinsky index in sick adolescents was significantly lower than in the control group (2.1 times).

Discussion

Now, chronic obstructive bronchitis in adolescents is a very common pathology. Often, it manifests itself already in childhood and progresses rapidly, sometimes leading to disability in young and adulthood[17, 18].

It is known that the development of the pathological process in the respiratory system at any age has a very negative effect on the parameters of external respiration. Even in adolescence with chronic obstructive bronchitis, significant violations of the external respiration function are noted. It was shown in the work that this contingent of patients is characterized by a significant decrease in lung vital capacity[19,20]. In addition, their average indicator of forced vital capacity of the lungs is also significantly inferior to the level of control. Their growing bronchial obstruction inevitably leads to a decrease in the volume of forced expiration in 1 second. This was confirmed in the study. The authors revealed a decrease in maximum ventilation in adolescents with chronic obstructive bronchitis[21,22]. These changes should be considered as evidence of the low functionality of the external respiration apparatus in adolescents suffering from chronic obstructive bronchitis, as well as their weakening ability to mobilize respiratory function reserves[23,24,25].

A comparison of the indices of minute respiratory volume in both observation groups showed its increase in adolescents with chronic obstructive bronchitis[26,27].

Moreover, the found decrease in peak volume velocity in the group with chronic obstructive bronchitis proved that they had low functional capabilities of the respiratory muscles and reduced patency of the large-caliber bronchi. The reduced values of the maximum volumetric rate index found at 25% of the level of forced vital capacity of the lungs revealed in the work confirmed the development of progressive worsening of patency at the level of large bronchi in adolescents with chronic obstructive bronchitis[28,29]. The found decrease in chronic obstructive bronchitis of the average values of the maximum volumetric rate indicator at the level of 50% and 75% of the forced vital capacity of the lungs also proved in sick teenagers a decrease in the patency of their bronchi of medium and small caliber. Negative changes in their indices of hypoxic tests and a decrease in the volume of chest excursion proved the possibility of developing, in this pathology, a pronounced resistance of the respiratory center to hypoxia and weakening the adaptive capabilities of the entire external respiration system[30,31]. The decrease in the Skibinsky index found in the observation group should be regarded as a manifestation against the background of chronic obstructive bronchitis of functional weakness of the respiratory and circulatory organs, and, consequently, low resistance of their body to any hypoxic conditions[32].

Conclusion

In the modern world, chronic obstructive bronchitis remains one of the most common diseases of the respiratory system. The presence of this pathology changes in the sensitivity of the walls of the bronchi to external influences and the development of their hyperreactivitycreates the basis for dysfunction of external respiration. These disorders occur already in adolescence and are sometimes manifested by significant violations of the function of external respiration. Such patients are characterized by a decrease in vital capacity of the lungs and diameter of the bronchi of any caliber. This leads already in adolescents suffering from chronic obstructive bronchitis to a marked decrease in the functional capabilities of the external respiration apparatus, as well as to a weakening ability to mobilize the reserves of the respiratory apparatus. Quite early in this disease, resistance of the respiratory center to hypoxia and a weakening of the adaptive capabilities of the entire external respiration system arise.

Conflict of Interest: No conflict of interest is declared.

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