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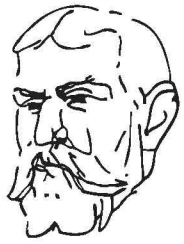

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ORIGINAL ARTICLES

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THE INFLUENCE OF SPELEOTHERAPY ON BRONCHI PASSAGE IN CHILDREN WITH BRONCHIAL ASTHMA USING A PHARMACO-FUNCTIONAL TEST WITH SALBUTAMOL

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ABSTRACT

The aim: To investigate the reaction of the bronchi to inhalation of salbutamol in children with different severity of bronchial asthma under the conditions of speleotherapy.

Materials and methods: 40 children aged 6-15 years were examined, 20 of them had an intermittent course of the disease, 20 had a mild course, and the children were in the inter-relapse period. Determining the function of external respiration (FER) with a pharmaco-functional test (PFT) with salbutamol was carried out in the dynamics of observation before and after treatment and compared with the indicators of 40 healthy children. Speleotherapy was performed based on the children's department of the Ukrainian Allergological Hospital of the village Solotvino.

Results: A decrease in increased bronchial tone and restoration of bronchial patency at all levels of the bronchi in all patients with an intermittent course of the disease and a partial decrease in bronchial hyperreactivity with the improvement of bronchial patency in children with a mild course of bronchial asthma under the influence of speleotherapy was established.

Conclusions: Thus, speleotherapy contributes to a positive reaction of the bronchi to inhalation of salbutamol, which is reflected in the normalization of disturbed bronchial tone and the restoration of bronchial patency at all levels of the bronchi, in all patients with an intermittent course and partially with a mild course of the disease.

KEY WORDS: children, bronchial asthma, bronchial tone, speleotherapy, salbutamol

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INTRODUCTION

The study of bronchial patency using a pharmaco-functional test with the use of a beta2-agonist allows not only to assess of the degree of loss of external breathing function and to determine the reversibility of these disorders but also to investigate the effect of speleotherapy on bronchospasm as one of the pathogenetic mechanisms of bronchial obstruction in children with bronchial asthma. Bronchospasm characterizes the increased reactivity of the bronchi, which can be considered a leading symptom of BA and an important mechanism of disease development, which correlates with the severity of the disease. Bronchial hyperreactivity is manifested by bronchial obstruction – an increased secretion of mucus, swelling of the mucous membrane of the bronchi, and spasm of smooth muscles of the bronchial tree. At the same time, obstruction of the bronchi can be considered a sign of bronchial hyperreactivity and improvement of central bronchial patency – FVC, $FEV_{1.0}$, FEF_{25} [1-3] and patency of small bronchi FEF_{50}, FEF_{75} [4] after inhalation of bronchodilator beta-2 agonist salbutamol [5] confirms this. Speleotherapy is one of the non-medicinal means of influencing a patient with bronchial asthma. The essence of the speleotherapy effect is that as a result of isolation from the external environment, stable microclimate conditions, the absence of usual pollutants and allergens in the air, a low concentration of microorganisms, irritation of the mucous membrane of the respiratory tract is reduced and the activity of chronic allergic inflammation is inhibited [6]. Appropriate diagnosis and correction of bronchial reactivity under the influence of speleotherapy can help reduce the frequency of exacerbations of bronchial asthma and improve disease control. In the studied literature, there are isolated works devoted to the study of the positive impact of speleotherapy [7-9] and its artificial analogs [10] on the course of the disease in children, as for the formation of bronchial reactivity in the conditions of speleotherapy and its analogs in children, these works are single [11], which made it possible to formulate the appropriate goal work.

THE AIM

To investigate the reaction of the bronchi to the inhalation of salbutamol in children with different severity of the course of bronchial asthma under the conditions of speleotherapy.

MATERIALS AND METHODS

40 children aged 6-15 years with bronchial asthma were examined, 20 of them had an intermittent course of the disease, 20 had a mild course, and the children were in the inter-relapse period of the disease. The duration of the disease was 4.9 ± 1.9 years, there were 29 boys and 11 girls. The control group consisted of 40 healthy children who were determined to have bronchial patency and underwent a pharmaco-functional test with salbutamol. Informed consent for the examination was obtained from all parents the studied children. The criterion for including children in the examined group of patients was the absence of use of control therapy and acute respiratory infections for 2 months. The criterion for including children in the control group was the absence of acute respiratory infections during the last month before the examination.

The study of the function of external respiration (FER) was carried out in children in the morning hours on the computer spirograph "Masterscreen" of the company "Jaeger" (Germany). All children complied with the requirements: physical exertion and contact with strong odors (perfumes, household chemicals, etc.) were excluded 2 hours before the test. The examination was performed on an empty stomach or after a light breakfast and 15-20 minutes of rest before spirography. The study was conducted with the patient in a sitting position, the height of the oral tube and the height of the seat were adjusted so that the subject did not have to tilt his head or torso. Before each study, the child was instructed in detail, and the procedure for performing breathing maneuvers was also demonstrated. The obtained absolute values of the indicators were evaluated as a percentage of the appropriate values. For each patient, the value of the individual norm was calculated taking into account age, sex, height, and conditions of the study: temperature, humidity, and atmospheric pressure. The data by Shiryaeva I.S. with coauthors were used to determine the degree of violation of bronchial patency. The following indicators of FER were evaluated: forced vital capacity of the lungs (FVC), forced expiratory volume in 1 second ($FEV_{1.0}$), maximum volumetric velocities at the level of 25, 50 and 70% (FEF_{25}, FEF_{50}, FEF_{75}) FVC. Next, a bronchodilation test was performed. To perform the test, a short-acting beta 2 agonist (salbutamol) was used in a dose of 200 mcg in children under 12 years of age and 400 mcg in children over 12 years of age. Bronchospasm, characterized by increased bronchial tone, was defined as an increase in the flow-volume curve 20 minutes after inhalation. The test was considered positive if the sum of the increase in speed indicators at the level of central (FEF_{25}), medium (FEF_{50}), and small bronchi (FEF_{75}) exceeded the level of reproducibility of the result, which is 37% for these indicators. Determination of FER with PFT was carried out in the dynamics of observation before and after treatment and compared with indicators of 40 healthy children. Speleotherapy in the form of staying in an underground department was carried out based on the children's department of the Ukrainian allergological hospital of the village Solotvino. The microclimate of the underground compartment is characterized by the following parameters: air temperature is 22.5–23.5°C, relative humidity is 30–50%, absolute humidity is 5–10 g/m^3, air velocity is 0.15–0.2 m/sec, atmospheric pressure 760-770 mmHg, aerosol content 2.5-4.0mg/m^3, number of aerosol particles up to 3 μn – 71-81%. Sodium chloride in the aerosol is 99%. The bacterial contamination of the air is 70-100 microorganisms in 1 m^3, which equates to sterile conditions with a complete absence of pathogenic flora and mold. The children got 14 descents into the salt mine.

The results of the research were processed using the package of statistical programs "Exel" with the calculation of the average values of indicators (M), and standard error (m). The probability of differences in mean values (p) was determined using the Student's test. A *p-value* ≤ 0.05 was considered significant.

RESULTS

Before treatment, hidden bronchospasm, which characterizes increased bronchial tone, was observed in 14 (35%) children. Reduced bronchial patency after inhalation of salbutamol remained at the level of central bronchi in 10 (25%) children, and at the level of medium and small bronchi in 16 (40%) and 18 (45%) patients compared to the indicator of the control group of practically healthy children. The obtained data indicate the presence of increased tone mainly in the small bronchi, where it occurs 1.8 times more often ($p < 0.05$) than at the level of the central bronchi.

The study of impaired bronchial tone in children, depending on the severity of BA, revealed that it was observed in 4 (20%) patients with an intermittent course of the disease who were admitted to the speleological clinic for treatment. In children with a mild course of the disease, violation of bronchial tone was observed in every second patient and occurred 2.5 times more often

Table I. Bronchial patency indicators during the salbutamol test with different severity of BA in children

Indicators	Healthy children N = 40	Intermittent BA N = 20	Mild BA N = 20	P
FVC	108,8 ± 1,33	104,6 ± 1,48	96,5 ± 1,31	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 < 0,05$
FEV1.0	107,1 ± 1,22	102,2 ± 1,59	82,2 ± 1,73	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 > 0,05$
FEF25	96,2 ± 1,26	92,8 ± 1,42	72,6 ± 1,56	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 > 0,05$
FEF50	93,8 ± 2,10	87,8 ± 1,60	60,1 ± 1,69	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 < 0,05$
FEF75	92,1 ± 2,15	81,8 ± 1,76	53,9 ± 2,74	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 < 0,05$

P_1 - Healthy - patients with intermittent BA
P_2 - Healthy - patients with a mild course of BA
P_3 - Patients with an intermittent course of BA - patients with a mild course of BA

Table II. Indicators of bronchial patency during a test with salbutamol with different severity of asthma in the dynamics of treatment

Indicators	Healthy children N = 40	Intermittent BA N = 20	Mild BA N = 20	P
FVC	108,8 ± 1,33	114,5 ± 1,79	106,9 ± 1,85	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 < 0,05$
FEV1.0	107,1 ± 1,22	109,8 ± 1,58	104,2 ± 1,65	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 > 0,05$
FEF25	96,2 ± 1,26	97,4 ± 1,79	94,9 ± 1,85	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 > 0,05$
FEF50	93,8 ± 2,10	98,8 ± 1,66	84,3 ± 2,12	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 < 0,05$
FEF75	92,1 ± 2,15	94,5 ± 2,15	86,8 ± 3,29	$P_1 > 0,05$ $P_2 > 0,05$ $P_3 < 0,05$

P_1 - Healthy - patients with intermittent BA
P_2 - Healthy - patients with a mild course of BA
P_3 - patients with an intermittent course of BA - patients with a mild course of BA

compared to the intermittent course of the disease. The most pronounced decrease was the velocity indicators of medium bronchi (FEF_{50}) by 1.6 times ($p<0.01$) and at the level of small bronchi (FEF_{75}) by 1.7 times ($p < 0.001$) (Table I).

After the speleotherapy treatment in children with an intermittent course of the disease, the increased tone of the bronchi disappeared in all patients. Treatment contributed to a significant increase in bronchial patency at all levels of the bronchi by 10-13% ($p < 0.05$) and was accompanied by a tendency to exceed the bronchial patency of healthy children (Tabl II).

In children with a mild course of BA, after a course of treatment, increased bronchial tone decreased in 90% of patients and remained only in 2 (10%) cases. Among patients with a mild course of BA, the normalization of the patency of the large bronchi was observed in all cases, which was accompanied by an increase in the $FEV_{1.0}$ indicator by 22% ($p < 0.05$), and the bronchial patency indicators did not differ from the indicators of sighted children. The study

showed that bronchial patency normalized in children at the level of medium and small bronchi – in 72 and 69%, respectively. Indicators of bronchial patency at the level of the middle bronchi FEF_{50} increased by 1.4 times ($p < 0.01$). The FEF_{75} indicator, which characterizes bronchial patency at the level of small bronchi, increased most significantly by 1.6 ($p < 0.01$) and did not differ from the indicator of the control group of healthy children.

DISCUSSION

The achievements of modern fundamental clinical medicine testify to the growth of the role of universal non-specific mechanisms in the pathogenesis of most diseases, with the violation of the functioning of various organs and systems, which determines the expediency of the use of natural therapeutic factors with a multi-component mechanism of influence. Therefore, the use of natural healing factors is considered an effective and affordable method of achieving control over the course of the disease and forms the basis of restorative treatment technologies. The development of restorative medicine technologies significantly complements the principles of drug treatment, timely correcting and restoring the body's functional reserves. Among the natural healing factors, speleotherapy is one of the «young» methods of treatment, which began to develop thoroughly in the middle of the 20th century. The effectiveness of speleotherapy is quite high, but the mechanisms of its therapeutic effect are still not fully revealed since underground therapeutic objects are very different in terms of their microclimatic characteristics [8].

The general protective mechanisms of speleotherapy include isolation from the external environment, stable and in some cases comfortable microclimatic conditions, and absence of usual pollutants and allergens in the air – these factors reduce irritation of the mucous membrane of the bronchi and inhibit the inflammatory process. In addition, they have a pronounced bactericidal effect, which, together with the improvement of bronchial drainage, leads to a decrease in the inflammatory process in the bronchi and contributes to the restoration of the sensitivity of the receptor apparatus of the bronchi to bronchodilators [12]. The reduction of the inflammatory process in the bronchial tree also leads to the inhibition of bronchial remodeling processes [9], which, together with the improvement of the drainage function and the restoration of sensitivity to bronchodilators, causes a decrease in the phenomena of bronchial obstruction. Therefore, the complex of all the above-mentioned factors in combination with the general mechanisms of influence of speleotherapy and adequate broncholytic and anti-inflammatory drug therapy allows to achieve the maximum possible control over the course of the disease, in particular BA.

CONCLUSIONS

In this way, speleotherapy promotes a positive reaction of the bronchi to the inhalation of salbutamol, which is reflected in the normalization of the disturbed tone and the restoration of bronchi passage at all levels of the bronchi, in all patients with intermittent course and partially with a mild course of the disease

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