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Article

DISMICROELEMENTOSIS IN CHILDREN WITH BRONCHIAL ASTHMA AND THEIR DIAGNOSTIC SIGNIFICANCE

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Annotation: The aim of the study was to study the possible pathogenetic mechanisms of the formation of bronchial hyperreactivity in bronchial asthma associated with microelementoses. The study group consisted of 45 children with bronchial asthma. The research methods were the method of neutron activation analysis of the content of trace elements in hair and the method of atomic absorption spectrometry of blood serum. The state of bronchial hyperreactivity was accompanied by a deficiency of essential microelements (69.6%) in severe bronchial asthma, against the background of selenium and zinc deficiency (plasma levels below 0.2 and 0.35 mg/l, respectively), and a decrease in the speed parameters of the function of external respiration.

Key words: bronchial hyperreactivity, microelementoses, bronchial asthma.

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Introduction. Airway reactivity is the most important characteristic of the functional state of the bronchopulmonary apparatus. Bronchial hyperreactivity syndrome (BRS) occurs not only in bronchial asthma (BA) [1, 2], but also in other bronchopulmonary diseases: chronic and recurrent obstructive pulmonary diseases, hay fever [1], allergic rhinitis, atopic dermatitis [3]. Violation of metal-ligand homeostasis can indirectly affect the reactivity of the bronchial tree. In the pathogenesis of the development of bronchial asthma, the leading role belongs to calcium and magnesium ions, which are directly involved in the contraction of the bronchi; such microelements (MEs) as selenium, zinc, and copper affect the processes of lipid peroxidation and the formation of an allergic inflammatory process of the tracheobronchial tree, which is the morphological basis for the development of hyperreactivity [4–9]. Under experimental and clinical conditions, an important role of ME in the regulation of bronchial patency, contractility of the respiratory muscles, sensitization processes, and the intensity of the pathochemical and pathophysiological phases of allergic reactions has been established [10–12].

Purpose of the study: to study the possible pathogenetic mechanisms of the formation of hyperreactivity of the bronchial tree in bronchial asthma associated with microelement disorders in children.

Methods. The study group included 45 children with BA with persistent changes in bronchial tone. The average age of children was 9,1±0,6 years. The control group consisted of 30 children with no history of atopic, chronic bronchopulmonary diseases and who had the last acute respiratory disease for more than 1 month before the study.

When diagnosing BA, the classification adopted by the National Program "Bronchial Asthma in Children. Treatment strategy and prevention", in Russia in 2006, which was supplemented in 2020 by the GINA program. The basis for the diagnosis were: complaints, anamnesis data, results of general clinical, immunological and functional research methods. The trace element status of children was determined at the Institute of

Nuclear Physics of the Academy of Sciences of the Republic of Uzbekistan by studying the content of trace elements in hair by neutron activation analysis and in blood serum by atomic absorption spectrometry. Mild BA was registered in 15 (40,7%) cases, moderate BA - in 22 (48,2%) cases, severe BA - in 8 (11,1%) cases. During the allergological examination, food sensitization prevailed in 36 (82,6%) patients, household sensitization was in second place in 25 (72,4%) patients, and pollen sensitization was in third place in 28 (56,5%) patients. Determination of the ME content was carried out by atomic absorption spectrometry (tested substrate - blood serum) and by neutron activation analysis (tested substrate - hair). Mathematical calculations were performed using the Microsoft Excel statistical analysis package. When working with the database, the arithmetic mean values and standard errors of the arithmetic means (M±m) were determined. The significance of differences in the arithmetic means of ranked tests with a normal distribution was assessed using Student's t-tests. Results were considered significant at a significance level of $p<0,05$.

Results and discussion. Hypomicroelementoses were found in all children. In general, there was a deficiency of calcium, selenium, iodine, manganese, zinc (65 (94,2%), 57 (82,6%), 55 (79,7%), 52 (75,3%), 42 (60,9%) respectively). Deficiencies of molybdenum (24 (34,8%)), chromium (21 (30,4%)), copper (18 (26,1%)), nickel (17 (24,6%)), iron (15 (21,7%)). Deficiency of more than four MEs was noted in 33 (47,8%) cases, four - in 21 (30,4%), three - in 15 (21,7%) cases, none of the children was diagnosed deficiency of one or two MEs. Hypermicroelementoses were observed in the majority of patients with HRD (n=66; 95,7%), more often an increased content of several MEs was recorded: five to seven (n = 27; 40,9%), four (n=15; 21,7%), three (n=13; 18,2%), two (n=13; 18,2%). The predominant variants were intoxication with bromine (n=48; 69,6%) and lead (n=36; 52,2%), rubidium hypermicroelementosis (n=22; 31,9%), zirconium (n=19; 27,5%), arsenic (n=15; 21,7%), nickel (n=14; 20,3%). Taking into account the high frequency of microelement disorders in HRD, we analyzed the sensitivity parameters of the bronchial tree depending on the concentration of essential and toxic MEs. The severity of microelement disorders differed among «hyper-reactor» children with high sensitivity of the bronchi to histamine and methacholine and various gradations of sensitivity (Table 1.).

When studying the correlation interactions of essential and toxic ME contained in the hair tissue, it was found that in the control group, where the indicators of both essential and toxic ME did not differ from the values of the «external standard», a moderate negative correlation dependence was determined between zinc and selenium (r =-0,41), indicating the strength of compensatory reactions. A moderate inverse correlation was observed between zinc and lead (r=-0,51), confirming the competing relationship between these MEs, and a direct In the group of patients with bronchial tree hyperreactivity syndrome, a direct correlation between selenium and zinc (r=0,34) remained, indicating a violation of compensatory reactions; between zinc and lead, a negative correlation relationship remained (r = -0,57), and between selenium and lead, the relationship acquired a direct direction (r = 0,42). Such relationships may reflect a weakening of the controlling role of selenium in protection against toxic MEs.

Table-1.
Concentrations of macro- and microelements in the hair tissue of the examined children (μg/g)

Element	Control group, n = 85	High sensitivity of the bronchi, n = 42	Various gradations of the degree of sensitivity of the bronchi, n = 27	Average group values, n = 69	«External standard» National Institute for Environmental Studies, Japan, 1996
Ca	651,33 ± 277,8	380,94 ± 140,9	460,81 ± 160,4	457,32 ± 138,48	280–900
Fe	164,53 ± 48,51	160,22 ± 68,1	168,36 ± 50,27	165,12 ± 58,20	24–54
Zn	188,67 ± 26,48	96,82 ± 25,81*	180,94 ± 41,32	163,33 ± 40,28	110–170
Cr	1,2 ± 0,15	2,42 ± 0,18	2,58 ± 0,25	2,45 ± 0,16	0,7–1,9
Cu	13,33 ± 4,20	10,0 ± 2,41*	13,8 ± 3,42	13,52 ± 1,95	6,1–12,2
Mn	3,82 ± 0,46	2,65 ± 0,38	2,802 ± 0,66	2,82 ± 0,89	0,6–2,4
Pb	3,56 ± 1,19	4,2 ± 0,84*	1,89 ± 0,89	2,59 ± 1,01	0–2,1
Se	0,68 ± 0,12	0,26 ± 0,12*	0,48 ± 0,14	0,42 ± 0,14#	0,4–1,2
Sr	1,96 ± 0,27	1,50 ± 0,68	1,44 ± 0,55	1,48 ± 0,72	0,7–1,9
Br	34,83 ± 18,63	50,14 ± 21,20	56,28 ± 18,91	52,78 ± 20,61	2–6,4
Rb	0,21 ± 0,04	0,57 ± 0,21	0,59 ± 0,18	0,58 ± 0,17	0,03–0,1

Note: * — at $p < 0.05$ (significance of differences in ME concentrations among patients with high bronchial sensitivity and different gradations of sensitivity); ## — at $p < 0.05$ (significance of differences in ME concentrations among patients with high bronchial sensitivity and the control group)

Thus, a close relationship was found between the studied MEs, the features of which manifest themselves depending on the ratio of essential and toxic MEs. In parallel, the content of zinc and selenium in the blood serum was determined. The choice of these MEs was due, firstly, to the high frequency of their deficiency in the hair tissue of children with HRD, and secondly, to their participation in the processes of lipid peroxidation and the maintenance of a chronic inflammatory process and, as a result, hyperreactivity of the respiratory tract. Among the «hyper-reactor» children, the average content of selenium in the blood serum was 0,228±0,024 mg/l, zinc – 0,561±0,049 mg/l, in the control group – 0,889±0,11 and 0,888±0,13 mg/l, respectively, $p<0,05$.

It has been established that the course of BA is the more unfavorable, the lower the concentration of selenium and zinc in the blood serum. Thus, in patients with a selenium concentration of 0,04-0,2 mg/l and zinc – 0,08-0,35 mg/l, the severity of objective and subjective disorders had significantly significant differences from similar indicators in children with a selenium concentration of 0,21 –0,75 mg/l and zinc 0,36–0,62 mg/l, $p<0,01$.

The frequency of BA exacerbations per year and severe forms of the disease were significantly more common in patients with low levels of selenium, $p<0.01$. Correlation analysis of the SCORAD index with the content of selenium and zinc revealed an average negative correlation of indicators ($r=-0,48$ and $r=-0,42$, respectively, $p<0,05$), the most severe course, with complications, was noted in the group of children with low zinc values ($r=0,54$). In addition to the correlation

ratios of indicators characterizing the severity of dermatitis and selenium content in the blood, a moderate negative dependence of the frequency of exacerbation of BA and the content of selenium in serum (r = -0,50) was established.

Conclusion. The state of hyperreactivity of the bronchial tree in children with combined forms of allergy is accompanied by polymicroelement disorders (deficiency of essential MEs was detected in 69,6%), which are especially pronounced with high sensitivity of the bronchi, against the background of selenium and zinc deficiency (plasma levels below 0,2 and 0,35 mg/l, respectively) and is characterized by a decrease in the speed parameters of the function of external respiration.

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