ISSN: 1804-1884 (Print) 1805-5014 (Online) Volume 5, 2011, pp. 76-81

THE FEATURES OF THE PHYSICAL DEVELOPMENT, CALCIUM-PHOSPHORUS METABOLISM AND MINERAL DENSITY OF THE BONES IN CHILDREN WITH CHRONIC LUNG DISEASES

OLYA SHARIPOVA

Samarkand Medical Institute
Uzbekistan

We have studied features of physical development, calcium-phosphorus metabolism and mineral density of the bones in children with chronic lung diseases. Comparison of received results with the standards of physical development in children and adolescents has shown the most significant differences in ages of 10, 11 and 15 years old who had the stature level lower than average. The data obtained suggest that children with this pathology undergoes substantial adverse changes in the main somatomertric indicators and bone mineral density, the degree of which depends on the nature of the primary lesion in the bronchopulmonary system, and duration and severity of disease.

Keywords: Children, physical development, stature, adolescents.

UDC: 616.24–007.19–612.612–08.053.4

Introduction

One of the most important problems of medicine is the chronic nonspecific diseases of the broncho-pulmonary system. The epidemiological investigations carried out in the different countries testify about the stable increasing of the amount of diseases of the lower respiratory tract. These diseases attract attention in connection with the wide spreading, disabilities and death rates (Kaganov et al., 2004; Smirnova, 2004). The physical development delay most often leads to the difficulties of the psychological and social adaptation, the consequences of which could be remained when a child is reached the normal physical development. Psychological consequences of short stature can render negative influence to the social integration between children and adolescents, condition limitation of the professional potential (Ahmedova, 2006; Mamedova, 1998; Dautov and Lisenko, 2001; Krans, 2007; Yampolskaya, 2003).

Pathology of different organs and systems of organisms can influence to physical development of children at different ages. It is established that acute and chronic diseases in children could negatively influence the normal development of children's growth. Chronic lung diseases (CLD) could cause more severe pathological changes in the human organism: disorders of microcirculation, arterial hypoxemia, tissue hypoxia and, induced by them pathobiochemical and immunological changes.

It is still not enough studied the problem concerning the influence of exogenous and endogenous risk factors to the physical development of children who live in the district areas of Uzbekistan. Meanwhile this information has a big scientific and practical importance. In CLD the long-term oxygen insufficiency, effect of bacterial toxins and metabolic products, hypovitaminosis and long-term hypodynamia can seriously disturb children's development. The more often we examine recurrence and severity of duration of the disease, and the younger the age of child is by the time of the disease beginning, the more perceptible these disorders are. We repeatedly convinced that the activation of broncho-pulmonary process in the period of accelerated growth can exert aggravating influence to the child's development.

The reviewed literature gives only general information that children with CLD are lacking in the physical development. However, the literature sources do not indicate what

anthropometric indexes change in the most cases, what a relationship of these disorders with the severity of the patient's condition and duration of the disease.

For the last years it was noted that in children with CLD sometimes have associated osteopenia and even osteoporosis which significantly reduce the children's quality of life, and worsen the duration of the basic disease. Osteoporosis is registered in 30-60% of adult patients. There is not any information about the frequency of osteopenia and osteoporosis in children with CLD (DeVries, 2005).

Taking into account from what was abovementioned, it was carried out investigation regarding of study physical development and mineral density of bones in children with nonspecific chronic lung diseases. The aim of investigation was to study the features of physical development, calcium-phosphorus metabolism and mineral density of the bones in children with chronic lung diseases.

Material and methods

It was examined 84 children with chronic bronchitis and multiple bronchiectasis at the age from 10 to 16 years old. In 35 of investigated patients (41.8%) it was determined cylindrical bronchiectasis, in 11 patients (13%) - saccular bronchiectasis, and in 38 patients (45.2%) - chronic bronchitis. Bilateral bronchiectasis was observed in 18 patients (39.3%) and unilateral bronchiectasis - in 28 patients (60.7%). All patients were administered to the clinic with exact diagnosis after bronchographic investigations and computer tomography. Lobectomy was performed in 6 patients (7.1%), pulmonectomy of the right lung was performed in 1 (1.2%) investigated patient. Acquired deformation of the chest was determined in 44 patients (78.6%). By the remoteness of the disease patients were distributed by the following way: 5-6 years old - 18 children (32.1%), 7 years old - 18 children (32.1%), 8 years old and older - 20 (35.8%) children.

The evaluation of the physical development (PD), made up on the basis of the regional standards and worked up by the use of conventional method of regressional analyses was performed by use the method of (Kamilova, 2006) according to the indexes of anthropometric data: weight, height and chest circumference. As a harmonious we considered the PD in which weight corresponded to height or differed from the normal value within $M \pm 1.0_{\sigma R}$. As a disharmonious we consider PD in which weight and height were lagged from the normal value within $1.1–2.0_{\sigma R}$. As a significant disharmonious we considered the PD in which weight and height were lagged from the normal value within $M\text{-}2.1_{\sigma R}$. and lower. Determination of the general calcium, inorganic phosphorus, and alkaline phosphatase in the blood serum were performed by the use of test-kits "BIO - LA - TEST" produced by Laxem firm, Czech Republic.

Mineral density of the bone tissue was measured by use of the osteodensitometric method of the heel bone on the equipment "DPX-MD Plus", supplied by the children's program (South Korea). It was determined bone stiffness index STI (stiffness index), pronounced in percents. The results of US-osteometry in patients with CLD was compared with the indexes of control group of healthy children (n=42). Ultrasound bone densitometry was based on the measurement of the spreading speed of the ultrasound wave on the bone surface and also the measuring of the wave dispersing in the bone. The pointed parameters reflect elasticity, density and stiffness of the bone tissue. Measurement of the bone strength was performed on heel bone. As a criteria of the osteopenia it was considered decreasing of mineral density of the bone tissue (MDBT) from 1 to 2.5 SD due to T-criteria, and decreasing of SD more than 2.5 was evaluated as osteoporosis.

Results and discussion

The results of morphological indexes of the physical development of patients with CLD were presented in Table 1. In children suffering from CLD was noted lag of the physical development: height, body weight and chest circumference in all age groups.

TABLE 1. INDEXES OF HEIGHT, BODY WEIGHT AND CHEST CIRCUMFERENCE IN BOYS WITH CLD

Age (in years)	Height (sm)		Body weight (kg)		Chest circumference (sm)	
	Healthy	CLD	Healthy	CLD	Healthy	CLD
10	135.9±2.2	123.2±1.5**	30.9±1.2	25.8±0.7*	64.3±1.5	58.1±1.7*
11	141.3±2.1	128.6±1.3**	34±1.4	26.6± 0.7*	66.3±1.4	63.7±0.2*
12	146.1±2.7	136.7±2.1*	36.7±1.5	32±0.6*	68.8±1.2	62±0.7**
13	150.8±2.3	142.9±1.2*	39.4±1.4	32.25±1.9*	70.8±1.1	63.4±1.2**
14	158.7±3.5	146.7±1.4*	45.12±1.3	39.2±1.2*	73.9±1.3	66.03±1.03**
15	166.1±2.1	148.8±1.1**	50.3±2.1	41.3±1.1**	78.3±2.3	68.58±0.7**
16	169.2±2.1	157.6±2.2*	56.2±1.2	42.63±1.7**	82.3±2.1	72.35±0.5**

Note: * ** - authenticity of the difference in comparison with the data of the control group (P<0.05; 0.02; P<0.001).

As you can see from table 1 the indexes of height were significantly lower of the such indexes in all age groups (P<0.05; 0.02; P<0.001).

During the comparison of the received results with the standards of the physical development of children and adolescents' (Komilova, 2006), especially the significant changes were noted in children at the age 10, 11 and 15 years old, in whom the height indexes was lower (M-2.1σ and lower). In boys at the age 12, 13, 14 and 16 years old the height indexes were lower than the average parameters (from M-1.1σ till M-2σ). In girls at the age 10 years old the height indexes were lower in comparison of the control group (M-2.1σ and lower), the average index of body height in girls at the age 11, 12, 13 and 14 years old were lower than the average indexes (from M-1.1σ till M-2σ), and in girls at the age 16 years old it was unreliably lower (P>0.1). All these data presented in the Table 2.

TABLE 2. THE INDEXES OF HEIGHT, BODY WEIGHT AND CHEST CIRCUMFERENCE IN GIRLS WITH CLD

Age (in years)	Height (sm)		Body weight (kg)		Chest circumference (sm)	
	Healthy	CLD	Healthy	CLD	Healthy	CLD
10	136.5±2.3	123±0.6**	30.0±1.9	24.6±0.4*	62.3±2.0	60.2±0.6
11	142.3±2.2	133±1.2**	34.4±2.4	27.5±0.8*	65.7±1.2	61±0.4**
12	148.0±2.1	138±2.1*	37.5±2.6	35.2±0.7	68.5±1.4	63±0.6**
13	153.2±2.3	143±0.9**	42.1±1.7	35.2±1.2*	72.3±1.6	69±1.1**
14	157.9±2.4	150±1.1*	47.2±1.2	47±1.4	75.9±1.7	68.2±0.8**
15	158.7±2.9	-	48.2±1.4	-	77.2±1.2	-
16	159.5±2.5	155.7±1.2*	51.1±1.6	41.5±1.2**	79.4±1.3	70.7±0.7**

Note: * ** - authenticity of the difference in comparison with the data of the control group (P<0.05; 0.02; P<0.001).

The average indexes of the body height in boys in all age groups were reliably lower in comparison of the control group. During the comparison with the standards, indexes in boys at the age 10, 11, 15 and 16 years old were in the lower value (M-2.1σ and lower). In patients at the age 12, 13 and 14 years old the deviation was lower than the average indexes. In girls the most significant changes of the body weight were noted at the age of 10 and 16 years old (M - 2.1σ and lower). And in patients at the age of 12, 14 years old unreliably differed in comparison with the control group (P>0.1).

Besides, in all age groups in the patients of both sexes statural-weight index decreased that pointed to the significant deficit of the body weight. So, in the investigated patients at the age of 11, 14 years old the deviation of statural-weight index according to the WHO standards was 1 SD, whereas in patients at the age 12, 13, 15 and 16 years old it was 2 SD.

The negative shifts were determined during the investigation of the chest circumference including in boys and girls at the age from 11 to 16 years old these changes were statistically high reliably (p<0.01; 0,001).

The certain interest represents the study of harmonious development of children with CLD. So during the determination of harmonious development of children with CLD we determined that in boys with CLD at the age of 10, 11, 12 and 14 years old, and in girls at the age of 10, 12 and 14 years old it was determined disharmonious development. In patients at the age of 16 years old in the both sexes it was determined distinctly disharmonious development which were again confirmed the lag of these patients in the physical development.

According to the study objectives we studied the status of the children's physical development depending on the severity and duration of the clinical course of CLD (Table 3).

TABLE 3. STATUS OF PHYSICAL DEVELOPMENT DEPENDING ON THE DURATION OF CLD

Duration of CLD	Until 5 years old	6 years old	7 years old	8 years old	9 years old	10 years old and older	In general
Amount of patients	13	19	14	13	12	13	84
Lag of the physical development %	10 (53.8%)	14 (78.9%)	11 (85.7%)	12 (100%)	12 (100%)	13 (100%)	72 (85.7%)
Boys	6 (60%)	8 (57.1%)	5 (45.5%)	7 (58.3%)	8 (66.7%)	8 (61.5%)	42 (58.3%)
Girls	4 (40%)	6 (42.9%)	6 (54.5%)	5 (41.7%)	4 (33.3%)	5 (38.5%)	30 (41.7%)

During the comparison of data of the children's physical development with the severity and prescription of CLD, we noted the clear relationship among them. The longer and more severe the disease was, the more often the children's physical development was lagged; it could judged by the indexes of height and weight.

Weight is more labile index than height. The weight decrease in the comparison with the average age-sex normative we examined in all children with CLD. Thus, the amount of children with decreased weight was appropriately increased with the increasing of the severity of the disease.

The duration severity of the basic disease was depending on the volume of injure, the character of the changes of the bronchial tree. So, in 25 (65.8%) children with chronic bronchitis and saccular bronchiectasis of the bilateral localization in whom the volume injures were high and exacerbation was taking much severe than in patients with unilateral localization.

As our investigations showed the duration of the disease is one of the most significant factors in the disorders of physical growth and development. So, the duration of CLD in patients with 100% lag of PD was 8-10 years old and older.

The decrease of bone mineral density (BMD) was diagnosed in 72 children with CLD. The frequency of osteopenia was determined in 44 (61.1%) children with CLD, in 28 patients was determined osteoporosis (38.9%).

Thus, the data received testified about the significant negative influence of CLD for the bone mineral density, the cause of which in the most cases depended on the chronic hypoxia which negatively influenced to the harmonious development.

In 28 (38.9%) children with detected osteoporosis differed by the severe duration of the basic disease, early beginning of the clinical manifestations, most frequent exacerbation of the chronic broncho-pulmonary process, persistent hypoxemia and significant disorders of bronchial patency.

Bone mineral density of the sick children with CLD was influenced by severity and remoteness of the disease. The investigations showed that lower and very lower indexes of the bone strength were determined in patients with CD with bronchiectasis ($p<0.001$) who had received systemic steroids and persistently used IH (more than 4-5 years).

During the study of the influence of duration of the disease for the bone mineral density it was determined the relationship between them. When duration of the disease was more than 9 years in the most patients (76%), it was determined osteoporosis of the moderate degree; in children until 5 years from the beginning of the disease it was determined in 8% of patients. During the study depending on the sex the significant changes were not examined.

In general, during the comparison of data of the bone strength index with the severity and duration of CLD we have noted the significant relationship between them. As the disease has long-term and severe duration, the more often it was determined osteopenia and osteoporosis of the bones.

It is known that more than 90% of calcium in the human organism has concentrated in the skeleton. Calcium has formed the base of mineral mass of the bone. Calcium exists in bones as calcium phosphate, calcium hydroxide, calcium hydrogen carbonate, and calcium citrate. Calcium in the child age supplies the accumulation of the bone mass, the growth of skeleton in length and increases the bone volume parameters. Calcium intensively forms in the skeleton in the pubertal period of the leap growth which is important in achieving optimal (peak) bone mass in the adult man.

Taking into account the data about positive influence of calcium for the forming process and mineralization of the skeleton, it was carried out the investigation in order to study the amount of calcium, phosphorus and alkaline phosphatase in the blood.

As the results of the mineral metabolism showed that the amount of calcium in the group of healthy children was 2.5 ± 0.03 mmol/l. In the group of patients with CLD the amount of calcium was reduced 1.77 ± 0.04 mmol/l ($p<0.001$).

The level of inorganic phosphorus in healthy children was 1.25 ± 0.02 mmol/l. During the consideration of the level indexes of the inorganic phosphorus in patients with CLD it was determined the reliably decreasing of this amount 0.8 ± 0.05 mmol/l ($p<0.001$).

It is known that alkaline phosphatase is also a biochemical marker of bone metabolism. In healthy children the amount of alkaline phosphatase was 0.69 ± 0.04 mkM. We determined the reliably increasing of alkaline phosphatase 1.08 ± 0.1 mkM in patients with CLD and the most significant increasing of this amount (1.2 ± 0.05 mkM) in patients with severe status of disease ($p<0.001$).

Received results about the morphological characteristic of FD, particularly about features of calcium-phosphorus metabolism and bone system in children with CLD, have testified that significant negative changes happened in children with CLD in the basic somatometric indexes and mineral density of the bone tissue. Degree of these changes depends on the character of the primary injures in the broncho-pulmonary system, duration and severity of CLD. For supplying the parameters of the normal physical development it is required to diagnose and treat on time, and also to decrease negative influence of risk factors of the disease development. It dictates the necessity of performing secondary prevention which stipulates measures oriented for the early diagnostics, rational treatment with achieving of full remission and then dispanser observation with anti-recurrent therapy for the stabilization of the achieved effect and improvement of the patient's quality of life.

References

Ahmedova, D., Pahimjanov, Sh., 2006. The growth and development of children, Methodic guidance [Rost i razvitie detey. Metodicheskoe rukovodstvo], Tashkent.

Baranov, A., Sheplagina, L., 2006. Physiology of the growth and the development of children and adolescents (theoretical and clinical aspects), [Fiziologiya rosta i razvitiya detey i podrostkov (teoreticheskie i klinicheskie voprosi)], in Russian, Moscow.

Dautov, F., Lisenko, A., Yarullin, A., 2001. "The influence of the environmental factors for the physical development of children of the under school age," Journal of Hygiene and Sanitation [Zhurnal Gigiena i Sanitariya], in Russian, Vol.6, pp.49-55.

De Vries, F., van Staa, T. et al., 2005. "Severity of obstructive airway disease and risk of osteoporotic fracture," Eur. Respir J. Vol. 25, pp.879-84.

Kaganov, S., Rozinova, N., Bogarad, A., 2002. "The lung diseases in the light of International statistic classification of the diseases of the X review," Russian Bulletin of Perinatology and Pediatric [Rossiyskiy Vestnik perinatologii i pediatrii], in Russian, Vol.2, pp.6-9.

Kamilova, R., Iskandarova, G., Alimardonova, M. et al., 2006. The improved method of using screening-tests during the mass medical examinations of children of the school age, Methodic guidance [Usovershenstvovannaya metodika ispolzovaniya skrining testov pri massovih medicinskih osmotrah detey shkolnogo vozrasta, Metodicheskie rekomendacii], in Russian, Tashkent.

Krans, V., 2007. "Physical development of children with kidney pathology," Pediatrics [Pediatria], in Russian, pp.73-80.

Lev, N., 2003. "Bronchiectasis: The old problem is still topical," Russian Bulletin of Perinatology and Pediatric [Zhurnal Rossijskiy Vestnik Perinatologii i Pediatrii], in Russian, Vol.2, pp.21-25.

Smirnova, M., Rozinova, N., 2004. "Chronic bronchitis in children. Determination, clinical types," Russian Bulletin of Perinatology and Pediatric [Zhurnal Rossijskiy Vestnik Perinatologii i Pediatrii], in Russian, Vol.3, pp.14-17.

Yampolskaya, Yu., 2005. "Regional differences and standardized evaluation of the physical development of children and adolescents," in Russian, Pediatrics [Pediatria], in Russian, Vol.6. pp.73-75.