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## **Features of the condition of microcirculation in school-age children with arterial hypertension**

**Abstract:** 62 children were examined. 30 children with hypertension were included in the main group, 32 healthy children — in to control. In children with hypertension more often appears symptoms of violation of microcirculation, such as reducing the width of the capillary, the presence of “sludge”, local spasm and slowing of blood flow, changes in shape of the capillary, which is understandable consequence of autonomic dysregulation, which in turn is accompanied by violation of hemodynamic at all levels, including capillary.

**Keywords:** school-age children, microcirculation, arterial hypertension.

Arterial hypertension (AH) — is a disease characterized by recurrent or persistent rise in systolic blood pressure (SBP), sometimes diastolic blood pressure (DBP), occurs on a background of excessive sympathoadrenal activity and/or the renin-angiotensin-aldosterone system, endothelial dysfunction and leads to hypertensive damage to target organs (heart, kidneys, blood vessels of the brain and retina) [1, 5–10]. The diagnosis of hypertension is set in adolescents 16 years and older if primary hypertension persists for 1 year or more earlier (under 16 years) — if damage to target organs. The term “hypertension” is also synonymous with “primary hypertension” and is used traditionally in Russia and Ukraine, as better emphasizes chronic disease and points to the need for adjuvant therapy [3, 202].

For 10 years from the end of 80's to the end of 90's of the past century the index of the average systolic blood pressure in children increased in 1.4 mmHg and diastolic — 3.1 mmHg. According to recent epidemiological studies in Russia, including

4015 children aged 4–16 years in ontogeny formed three peaks of high blood pressure: the girls — in 5 (22.7%), 8 (19.1%) and 13 (15, 1%) years, boys — in 6 (16.7%), 8 (12.3%) and 14 (11.2%) years. According to our study in the population of students ranging from the age of 12 arterial hypertension occurs in virtually every 6<sup>th</sup>, and between boys of 15–16 years old in 8% determined hypertension of the second degree [2, 111–112].

Evaluation of AH is carried out by percentile tables according to gender, age, height of the child. If the SBP and/or DBP  $\geq$  90th but  $\leq$  95th percentile, it was considered high normal blood pressure, but taking into account recommendation JNC7 [5, 289] have been replaced the concept of “high normal pressure” to “before-hypertension”, and if blood pressure exceeds 120/80 mmHg, even if it is  $<$ 90 th percentile, this condition is considered to “before-hypertension”. This is because the cardiovascular risk begins to increase in blood pressure higher than 115/75 mmHg. If the SBP and/or DBP level higher

then 95th percentile according to sex, age, height and is determined during three or more measurements, we can talk of about availability of hypertension in child [3, 202]. Hypertension of 1<sup>st</sup> degree — rate SBP and/or DBP during three or more measurement values higher than 95th percentile, but lower than the value of 95-th percentile + 10 mmHg, arterial hypertension of the second degree — during three or more measurements is determined by the average SBP and/or DBP higher by 10 mmHg the values of 95th percentile according to sex, age, height [1, 5–10].

Microcirculatory link is a subsystem of the vascular bed, which consequently realized by providing transcapillar metabolism and its response to the impact of external factors and internal environment. It is obvious that changes in the microcirculation (MC) of blood are closely correlated with changes in the central hemodynamics, they can be used as criteria to evaluate the overall physical development and health of the subjects. Study MC is important in modern pediatrics, as, at this level of the circulatory system ensured delivery of oxygen to the cells, energy and plastic substrates, removal of tissue carbon dioxide and other decomposition products. MC responsive to the effects of various pathological factors, so its violation can be an early sign, and prolonged exposure — persistent and often the only sign of the disease. It is proved that the changes of microcirculation determined option of hypertension and is quite an early marker of the degree of destruction organs-targets [4, 15–18].

**The purpose of the study.** Examine the condition of microcirculation in school-age children with arterial hypertension.

**Materials and methods.** We examined 62 children of school age with hypertension in rural areas and cities. Value of girls and boys was 1:1. The average age of children was  $13,4 \pm 0,12$  years. 30 children made up the main group, 32 children — control. The main group includes children whose blood pressure was higher than 95<sup>th</sup> percentile.

We used the following methods of examination: anthropometric, clinical, laboratory, and statistical tools. Blood pressure measurement was carried out with automatic tonometers Microlife, Nissei, AND and Little Doctor with removable sleeves in the morning on both hands three times, with an interval of 2 minutes between each measurement. In addition to the children with high blood pressure and arrhythmias additionally performed electrocardiography. Assessment of the peripheral microcirculation was provided using computer

capillaroscopy. Statistical analysis of the data was carried out using non-parametric methods of estimation.

**Results and discussion.** The overall picture of the capillaries in the nail bed children with basic group had the correct architecture structure, standard U-shaped and the same diameter vessels (Fig. 1).



Fig. 1. Capillaroscopic vascular pattern of the nail bed.

At the same time, some children were recorded pathological tortuosity (Fig. 2) and reduction of the number of capillaries per unit area (Fig. 3).



Fig. 2. Pathological capillary tortuosity (Patient D.).



Fig. 3. Reduction of the number of capillaries per unit area

Also in 22 children with a core group observed pronounced local spazmovanist capillaries which are virtually disappeared after the thermal test. (Fig. 4 and Fig. 5)



Fig. 4. Severe local spasm of capillaries before the thermal test



Fig. 5. Severe local spasm of capillaries after the thermal test

Another feature was that in 12 children there was the phenomenon of “sludge” and slowing blood flow (Fig. 6).



Fig. 6. Phenomenon of «sludge» and slowing of blood flow.

In the control group, the above-mentioned features were absent. Only in one child we found a decrease in the number of capillaries per unit area, which is likely the result of innate characteristics, so that this pattern was observed in the child’s father, who we have specially invited for examination. The difference in basic terms, that has been noted between the main and control groups is given in Table 1.

Table 1. – Average values of capillaroscopic research in school age children

Index	Group of surveyed		
	Norma	Main (n=30)	Control (n=30)
Perivascular zone, mkm	93,8±	92,72,4	94,2±
Distance between capillars, mkm	110,1±	97,1±	109,9±
The length of the capillary, mkm	158,7±	153,6±	155,4±
The width of the capillary, mkm	41,3±	36,4±	41,9±
Number of anastomoses (per 10 cap)	1,0±	0,60,9*	1,1±
Linear density, capillary/mm	7,4±	7,8±	8,1±
Changing the shape of the capillary (per 10 cap)	0,9±	2,30,4*	0,5±
The presence of «sludge», points	0	1,2±	0
Transcapillary changes, points	1,1±	1,20,2	1,1±

\* –  $p < 0,05$

Five indicators had significant difference between children from main and control group: the distance between capillaries, capillary width (due to the presence of local spasm in children with hypertension), number of anastomoses (reduced in children in the main group, due to a reduced oxygenation and slow blood flow), change in shape of the capillary and the presence of «sludge» that measured in points.

### Conclusions.

1. Summarize the data presented above it can be concluded that there is a significant difference in microscopic picture of blood vessels of the nail bed between children with hypertension and healthy children
2. In children with hypertension more often present the symptoms of violation of microcirculation, namely — the reduction of the width of the capillary, the presence of “sludge”, local spasm and slowing of blood flow, changes in

shape of the capillary, which is understandable consequence of autonomic dysregulation, which in turn is accompanied by hemodynamics violation at all levels, including capillary.

3. Use the nail bed capillaroscopy can be recommended during screening for arterial hypertension of school-age children because of its ease of use and non-invasivity.

**Prospects for further development.** Based on the obtained results promising is a further more detailed study of the characteristics of microcirculation in the dynamics in school-age children with arterial hypertension.

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