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RHEOVASOGRAPHIC ASSESSMENT OF THE MICROCIRCULATION IN CHILDREN WITH FLAT FEET: EXPERIMENTAL RESEARCH

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ABSTRACT — The aim of this work is to study the regional blood circulation in schoolchildren, taking into account the musculoskeletal system. Indicators of microcirculation in healthy children correspond to the *norm* relative to the standards. To assess arterial and venous blood flow in the vessels of the lower extremities in the feet, we used rheovasography performed with rheographic complex *REO-spectrum*. If there is a deviation of the mutual position of the bones of the feet and the configuration of the joints, the presence of changes in the microcirculation of the lower extremities preceding the initial stages of the formation of flat feet is established. There was a disruption of local hemodynamics in children over 12 years, including the decrease of pulse blood filling and maximum blood flow through the arteries at 24–55% in the lower leg and at 60–71% — in the foot with an increase of arterial tone by 1.2–1.5 times to the healthy level.

KEYWORDS — children, microcirculation, rheovasography, flat feet.

In modern society there has been a tendency to increase the prevalence of chronic pathology, including dystrophic diseases of the musculoskeletal system. This trend is fully observed in children, most clearly manifested in schoolchildren [1, 3, 5]. A large number of studies have been devoted to the diagnosis and treatment of musculoskeletal disorders in children [3–5]. At the same time, the main attention is paid to the study of the etiology, pathomorphology of deformities, development and improvement of techniques for correction of scoliosis and flat feet of 3–4 degrees [1, 5]. On the other hand, there is almost no information about the features of regional blood flow of the lower extremities in flat feet of the first degree.

The aim of this work
is to study the regional blood circulation in schoolchildren, taking into account the state of the musculoskeletal system.

MATERIAL AND METHODS

A group of children with flat feet (n=175) was examined. The second group included 242 healthy schoolchildren of the same age. The level of physical development of schoolchildren was determined by a standard set of anthropometric tools that passed metric control. To assess arterial and venous blood flow in the vessels of the lower extremities (lower leg-foot) in flat feet, we used the rheovasography of lower extremities performed on the rheographic complex *REO-spectrum* with subsequent computer processing of data [2]. The following rheographic characteristics were used for quantitative assessment of arterial blood filling of extremities, arterial tone, venous outflow and collateral circulation: rheographic index (RI, rel. ed.), maximum speed of blood filling of large-caliber arteries (Vmax, Om/s), dicrotic index (DIK,%), diastolic index (DIA,%), pulse wave propagation time (Q-x, sec.) [2]. All patients (his parents) signed an information letters for inclusion in this study.

The data were processed in the software package Statistica 6.1 for Windows.

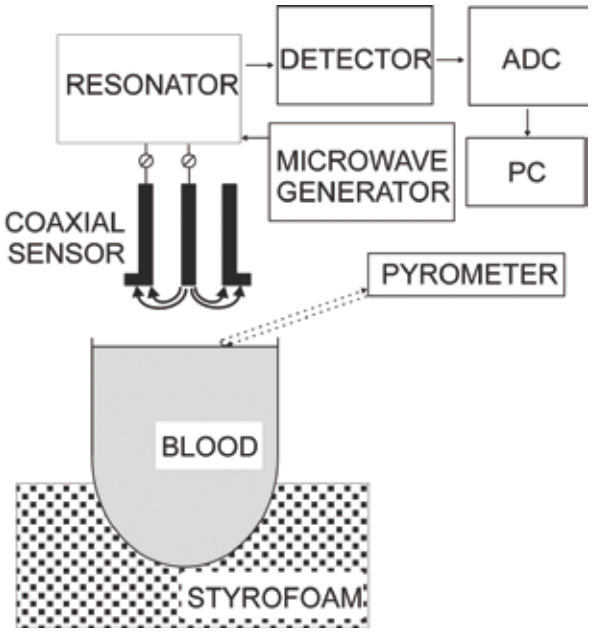

Fig. 1.

Table 1. *Dymanics of rheovasography in healthy children and in flat feet*

			RI, rel. un. (norm for leg - 0,65-1,0; norm for foot - 0,9-1,5)		Vmax, Om/s (norm - 1,3-2,3)		Q-x, sec. (norm - 0,25-0,33)	
			Right	Left	Right	Left	Right	Left
7-8 years old	Leg	1	2.1±0,04	2,1±0,04	2,3±0,02	2,4±0,02	0,18±0,05	0,18±0,04
		2	1,87±0,04	2,3±0,02	2,39±0,01	2,47±0,02	0,21±0,04	0,2±0,04
	Foot	1	0,7±0,03	0,8±0,03	1,07±0,02	1,35±0,01	0,21±0,06	0,21±0,06
		2	0,9±0,03	**1,42±0,02***	1,08±0,02	1,74±0,01	0,22±0,05	0,21±0,01
9 years old	Leg	1	2,0±0,04	1,9±0,01	2,4±0,01	2,39±0,04	0,23±0,03	0,24±0,03
		2	1,8±0,01	1,9±0,02	2,4±,0,01	2,47±0,01	0,21±0,04	**0,21±0,04***
	Foot	1	0,82±0,03	0,82±0,03	0,97±0,04	1,0±0,05	0,26±0,05	0,26±0,02
		2	0,93±0,04	0,86±0,05	1,0±0,03	1,19±0,07	0,25±0,05	0,23±0,03
10 years old	Leg	1	1,82±0,02	1,73±0,02	2,27±0,01	1,96±0,02	0,23±0,03	0,19±0,01
		2	1,79±0,03	1,84±0,03	2,3±0,04	2,24±0,05	0,22±0,03	0,21±0,02
	Foot	1	0,99±0,03	0,64±0,02	1,3±0,01	0,75±0,02	0,22±0,01	0,21±0,01
		2	0,78±0,02	0,97±0,01	0,82±0,03	1,13±0,01	0,22±0,01	0,20±0,02
11 years old	Leg	1	1,89±0,02	1,8±0,01	2,5±0,01	2,25±0,03	0,21±0,03	0,20±0,03
		2	1,53±0,04	1,9±0,07	1,9±0,04	1,96±0,09	0,18±0,04	0,22±0,04
	Foot	1	1,0±0,03	1,24±0,01	1,1±0,05	1,5±0,02	0,25±0,05	0,20±0,01
		2	0,79±0,04	0,85±0,04	0,84±0,02	1,09±0,01	0,21±0,05	0,23±0,01
12 years old	Leg	1	3,26±0,03	2,8±0,03	2,6±0,05	2,5±0,04	0,18±0,07	0,18±0,01
		2	**1,45±0,05***	**1,44±0,03***	**1,9±0,06***	**1,89±0,05***	**0,25±0,02***	**0,26±0,02***
	Foot	1	2,16±0,03	1,76±0,08	2,34±0,02	2,04±0,01	0,18±0,07	0,18±0,04
		2	**0,62±0,02***	**0,45±0,02***	**0,78±0,03***	**0,63±0,01***	**0,24±0,03***	**0,22±0,02***
13 years old	Leg	1	2,6±0,02	2,48±0,02	3,4±0,03	2,2±0,02	0,24±0,06	0,23±0,04
		2	**1,6±0,03***	**1,74±0,01***	**1,97±0,06***	1,7±0,02	0,22±0,04	0,19±0,06
	Foot	1	2,4±0,05	0,56±0,03	2,3±0,02	1,8±0,02	0,25±0,04	0,24±0,05
		2	**1,3±0,04***	**0,9±0,02***	**1,38±0,07***	0,99±0,03	0,22±0,05	0,20±0,08
14 years old	Leg	1	2,03±0,03	1,4±0,01	2,37±0,06	1,58±0,05	0,26±0,03	0,26±0,06
		2	1,3±0,02	1,1±0,02	1,89±0,05	1,39±0,04	0,20±0,05	0,26±0,04
	Foot	1	1,14±0,01	1,08±0,01	1,75±0,02	1,17±0,07	0,25±0,03	0,24±0,05
		2	1,03±0,01	0,9±0,03	1,38±0,04	0,88±0,06	0,19±0,04	0,28±0,06
15 years old	Leg	1	1,53±0,02	0,97±0,01	1,37±0,02	1,3±0,04	0,23±0,01	0,23±0,02
		2	1,43±0,03	**1,63±0,06***	**1,97±0,02***	**2,10±0,02***	0,21±0,06	0,24±0,03
	Foot	1	1,02±0,01	0,81±0,04	1,3±0,01	1,51±0,02	0,23±0,05	0,27±0,02
		2	1,1±0,01	0,85±0,05	1,5±0,05	1,43±0,04	**0,18±0,03***	**0,17±0,01***

Note: *RI — rheographic index, Vmax — maximal speed of filling of large arteries, Q-x — pulse wave propagation time. Groups indication: 1 — healthy children, 2 — children with flat feet. * — statistical differences between groups are significant, p<0.05*

RESULTS

We registered that the severity of regional muscular circulatory abnormalities in children with flat feet is directly related to the age, while no gender differences were found. A number of indicators of rheovasography (such as wave propagation time or dicrotic index) in schoolchildren of 7–11 years old change slightly and do not differ in healthy children and children with flat feet. High correlation of the dicrotic index with the respiratory component of the spectrum in the feet (r=0.8) was revealed in 8-year-old children. Full picture of age dynamics of rheographic parameters is shown in table. Based on these data, it can be concluded that the most active functional rearrangements of the microcirculatory bed in children occur at the age of 12–13 years. This is implemented for all the main parameters

of reovasography (rheographic index, maximal speed of filling of large arteries and pulse wave propagation time).

CONCLUSION

It was stated, the parameters of microcirculation in most healthy children correspond to the age norm, and only some of them exceed this level. If there is deformation of the mutual position of feet bones and joints reconfiguration, the presence of changes in the microcirculation of the lower extremities preceding the initial stages of the formation of flat feet is established. We identified a disruption of local hemodynamics in children over 12, including the decrease of pulse blood filling and maximum blood flow through the arteries at 24–55% in the lower leg and at 60–71% — in the foot with an increase of arterial tone by 1.2–1.5 times to the healthy level.

CONTRIBUTORS

SBM and IVB collected, analyzed, and interpreted data and made the figures. AKM did the literature review, analyzed and interpreted data and collected data. LRD and YaVK collected data and made the figures. AKM, SBM, LRD, IVB and YaVK prepared the manuscript for submission.

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