AN INTERPRETATION OF CERTAIN PECULIARITIES OF THE ARTERIAL OSCILLOGRAM OF CHILDREN*

L. I. Abrosimova

From the Department of Physiology (Head—N. N. Goncharov, Candidate in Medical Sciences; Scientific Director Assistant Prof. — Z. I. Biryukov), of the Central Scientific Research Institute of Physical Culture (Director—N. G. Ozolin, Candidate in Pedagogical Sciences), Moscow

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One of the most marked characteristics of children's arterial oscillograms is the magnitude of vascular fluctuations, which is less than that found among adults. The oscillographic index is also smaller.

The results of processing 359 oscillograms, which we recorded among 164 individuals 12 to 25 years of age in a state of rest, show that a small magnitude of oscillations (up to 10 mm) until the age of 16 is encountered in more than to 50% of cases, while among adults it is encountered in only 4%. High oscillograms (over 20 mm) prior to 16 years of age are rarely encountered; among adults they are found in more than half of the cases.

The oscillographic index (OI) changes not only with age, but also under the influence of physical stress. The physiological interpretation of the changes resulting from athletic training, the stress of training persuits, presents considerable difficulties.

No definite opinion is to be found in the literature relative to the causes of the change in OI. In the opinion of some authors [15, 18] the oscillographic index characterizes predominantly the work of the heart. Others consider the oscillographic index to be an indication of the tonus of the arterial wall. A third group suggests that the oscillographic index depends to the same degree both on the work of the heart and on the state of the arterial wall [12, 14, 22].

The conclusions drawn by the author were made on the basis of clinical observations, model experiments (with rubber tubing) or the results of the use of vasoconstricting and vasodilating substances. The amount of experimental work in this area in comparison with the number of clinical observations is very slight.

The aim of the present work is to establish whether it is possible by the change in a young individual's OI after physical exertion to judge the change in functional state of the heart.

EXPERIMENTAL METHODS AND RESULTS

We studied the relationship of the OI, determined by means of a Serkin-Kudenko arterial oscillograph, and the diastolic-systolic difference in heart area calculated by the planimetric method in conformance with a roentgenokymogram (RKG) in direct projection. We did not succeed in finding similar examinations in the literature.

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The planimetric method of computing heart area in diastole and systole according to an RKG makes it possible to judge the contractile capcity of the heart [1] and the magnitude of its pulsatile volume [2, 5, 8].

Eighteen young individuals were examined: 12 aged 12-14 and 6 aged 15-16. All of the youths were healthy and were engaged in light athletics in a juvenile school of sports.

Oscillograms and RKGs were made simultaneously, at rest and 20 seconds after 40 deep knee-bends.

No clear-cut relationship was found between the magnitude of the OI and the diastolic-systolic difference in heart area in the state of muscular rest; as is shown by the data listed below (Table 1), along with the same value of OI both small and large values of the diastolic-systolic difference in heart area were observed.

TABLE 1

Values of the Oscillographic Index and Diastolic-Systolic Difference in Heart Areas at Rest

Number of observations	Value of oscillographic index (in mm)	Value of diastolic-systolic difference in heart areas (in cm^2)
1	20	10
2	17	13
3	16	12
4	14	17
5	14	12
6	12	12
7	12	3
8	11	9
9	11	8
10	10	10
11	8	6
12	8	7
13	8	11
14	8	7
15	7	9
16	7	4
17	7	13
18	6	11

The absence of a relationship between the changes in these two values was especially clearly evident after physical exertion (Figure 1). Among the majority the oscillographic index increased after exertion, while the

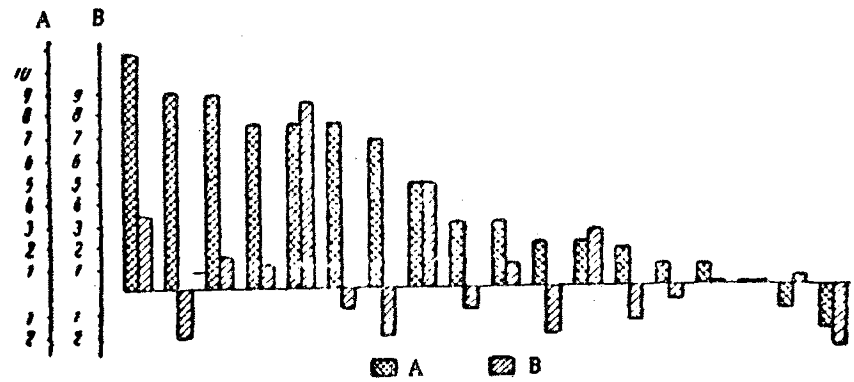

Fig. 1. Change in oscillographic index in mm (A) and in diastolic-systolic difference in heart areas in cm^2 (B) after 40 deep knee-bends. The zero line is the resting level. The columns located below the zero line designate a decrease in the indices. The two contiguous columns represent changes in the same individual.

difference in diastolic-systolic heart areas was reduced in almost 50% of the cases. Thus one cannot judge the work of the heart by the change in oscillographic index.

The large values of pulsatile volume of blood [13, 20, 21], as well as the comparatively large heart sizes among youths [1, 4, 6], indirectly confirm our conclusion.

A comparison of the values of the oscillographic index with the other characteristics of an oscillogram furnishes an identical trend in their changes.

After comparing the changes in oscillographic index following 40 deep knee-bends with the changes of the third phase (the right portion of the oscillogram from the largest peak to a sudden fall-off of oscillations according to M. V. Kudenko), and with the change in length of the entire oscillogram, it is evident that the direction of the changes of the third phase (Figure 2) and of the length of the oscillogram (Figure 3) in the majority of cases corresponds with the direction of the change in oscillographic index. Lack of correspondence is observed in the case of extreme changes in oscillographic index, both of the largest and the smallest changes.

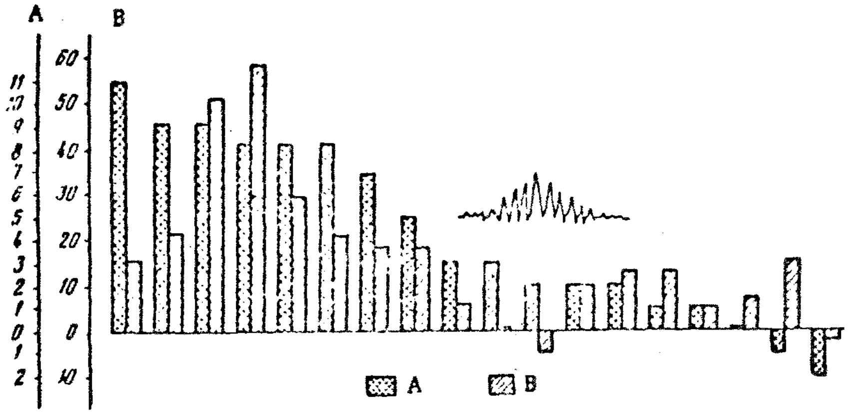

Fig. 2. Change in oscillographic index in mm (A) and in the third phase of the oscillogram in mm of mercury (B) after 40 deep knee-bends. The other designations are the same as in Figure 1.

It was assumed that the third phase and the length of the oscillogram are indications of vascular tonus [7, 18]. A comparison of the changes in oscillographic index, length of the oscillogram and the third phase provides grounds for the assumption that the change in the magnitude of OI after physical exertion is determined to a large extent by the state of the arterial wall.

Many investigators [3, 17, 19] consider a small oscillographic index among adults to be a sign of increased vascular tonus. In a young person, to all appearances, this is not the case. According to our data, the short length of the third phase and of the entire oscillographic curve, as well as a small value of A. S. Lebedev's index (the difference between maximal pressure values, determined by oscillographic and ausculatory methods [10, 11]) are rather an indication of reduced arterial tonus at this age. Our data on the value of A. S. Lebedev's index at different ages are presented in Table 2.

Thus the number of cases with a positive value of A. S. Lebedev's index grows with age, increasing suddenly toward 16 years of age. A zero value of this index is encountered in almost 50% of all cases between ages 12 to 14. Negative values of A. S. Lebedev's index are not encountered at all above age 16.

Simultaneous use of the methods of arterial oscillography and RKG made it possible to obtain new data which indirectly attest to the presence of complex neuro-humoral regulation of the vascular system. If the latter were a simple physical system of tubes, then with an increase in the pulse wave characterizing the work of the heart there would be an increase in the stretching of the vascular wall, its fluctuations and, consequently, in the oscillographic index. This, however, does not occur, inasmuch as, to all appearances, each change in the work of the heart reflexly (chiefly through the system of pressoreceptors of the sinocarotid zone) produces a corresponding change in vascular tonus, a fact which makes it impossible to judge the state of the heart by the oscillographic index.

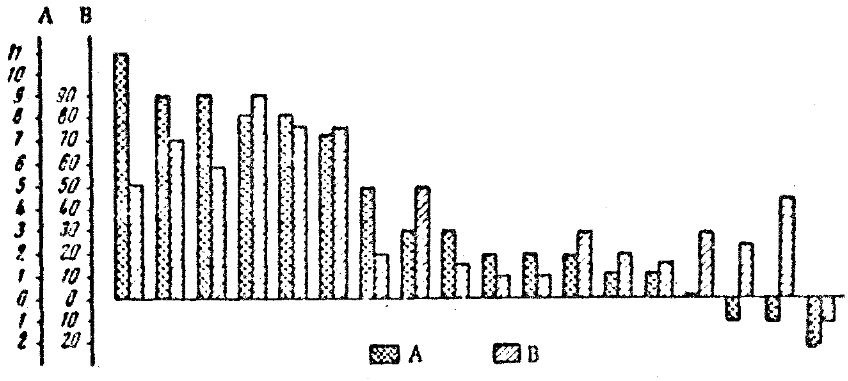

Fig. 3. Change in oscillographic index in mm (A) and in length of oscillogram in mm of mercury (B) after 40 deep knee-bends. The other designations are the same as in Figure 1.

TABLE 2

A. S. Lebedev's Index in Relation to Age

Value of Lebedev's Index	12 yrs.		13 yrs.		14 yrs.		15 yrs.		16 yrs.		17 yrs.		18 yrs.		20-25 years	
	Number of cases	in %	Number of cases	in %	Number of cases	in %	Number of cases	in %	Number of cases	in %	Number of cases	in %	Number of cases	in %	Number of cases	in %
Negative	4	12	9	15	7	8	5	20	—	—	—	—	—	—	—	—
Zero	17	51	25	40	38	45	6	24	1	7	1	9	1	10	7	23
Positive	12	37	27	45	40	47	14	56	13	93	10	91	8	90	19	77
Total number of cases	33		61		85		25		14		11		9		26	

Consequently the small OI typical among juveniles does not indicate slight contractile capacity of the heart or a small pulsatile blood volume at this age, either at rest or after physical exertion.

SUMMARY

Simultaneously recorded values of oscillographic index (O. I.) and diastole-systole difference in heart area were determined planimetrically on kymograms in the state of muscle relaxation and after physical change in different directions. This leads us to assume that: 1) change of O. I. does not adequately show functional conditions of the heart in connection with physical exertion; 2) low O. I. in juveniles does not necessarily imply insufficient functioning of the heart; 3) lack of correspondence in the change of O. I.-values and of diastole-systole difference in heart area reveals complex relations in the realm of neurohumoral regulation of blood circulation.

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