THE EFFECT OF A 19-DAY VIBRATION PLATFORM TRAINING ON SELECTED BIOCHEMICAL PARAMETERS OF PERIPHERAL BLOOD IN PEOPLE ENDANGERED WITH OSTEOPOROSIS

by

MAŁGORZATA ŻYCHOWSKA* AND MARIAN GAWINEK**

This experiment dealt with examining the effect of low frequency vibrations on biochemical parameters of aerated blood, such as concentration of hemoglobin and acid-base equilibrium. Subjects participating in the experiment were divided into two groups. The experimental group (n=12) was subjected to daily, 15 minute long, 3.5 Hz vibrations on a vibration platform. The number of training sessions equaled 19. The other group, identical in number to the experimental, constituted a control group. Before and after the experiment blood from the fingertip was taken in order to determine the concentration of hemoglobin and parameters of acid-base equilibrium. Then the results were statistically analyzed and evident directions of changes of individual parameters were observed. The average concentration of hemoglobin considerably increased in the experimental group and it decreased in the control group. The lack of statistical significance of these differences is connected with a small number of participants in the test and a high value of standard deviation resulting from that. The parameters of acid-base equilibrium show the following direction of changes: decreasing of concentration of H^+ ions (increase of pH in blood), smaller average deficit of buffering bases, increase of bicarbonate concentration and the decrease of p $C0_2$ and p 0_2. However, these changes were rather small, yet they can be of post-training character and should be considered beneficial.

Key words: low frequency vibrations, training, hemoglobin, acid-base equilibrium of blood.

* Ph.D., Institute of Human Physiology, Department of Physiology and Biochemistry, Academy of Physical Education in Cracow, Al. Jana Pawła II 78
** Ph.D., Chair of Physical Therapy, Academy of Physical Education in Cracow

Introduction

Nowadays, when osteoporosis or disturbances caused by the circulatory system are more and more often considered civilization-related diseases, we urgently look for new methods, which would check the already existing changes or at least diminish them to a considerable degree. While searching for new means of biological regeneration for athletes or new rehabilitation methods, more and more physical stimuli such as: magnetic field, laser radiation and others are implemented. Testing the effect of laser light on peripheral blood, such experiments were carried out - among others - by Berki et al. (1998), Abdulkadyrov, et al. (1992) or Trelles and Mayayo (1992). The above-mentioned generally did not state any negative changes, but they noted the increase of immunity of the organism due to degradation of mastocytes (Trelles and Mayayo 1992). However, there is little number of data on the effects of low frequency vibrations on human organism, especially his skeletal and muscular systems or peripheral blood. It is known from literature that short-lasting low frequency vibrations activate the functioning of muscles (Engel 1993), so they can imitate training.

The undertaken subject is of vital importance due to the fact that vibrations can restore the state of balance of the organism through the regulation of energetic processes and the increase of its immunity. Properly selected frequency of vibrations can imitate physical activity, especially in people in whom it is limited because of health problems. General vibration can probably be used in the rehabilitation of bone fractures or the circulatory system diseases (Damian et al. 2002). On the other hand, there are no data on experiments carried out on people, regarding the influence of low frequency vibrations on such biochemical variables as: hemoglobin concentration or acid-base equilibrium. The only work available deals with tests on rats of Wistar breed in which the researchers stated an increased concentration of calcium in blood plasma of the investigated animals, decreased HDL and LDL cholesterol contents, as well as higher concentration of hemoglobin (Damian et al. 2002) in reply to low frequency vibrations.

Material and methods

The research comprised a group of 12 people, aged 39 to 55, with small or average motor activity due to their health problems, especially the ones concerning the skeletal system. All subjects required rehabilitation procedures because of osteoporosis changes stated in them by an orthopedic surgeon and were subjected to training on a vibration platform for the period of 19 days. The frequency of vibrations was chosen according to the frequency of a slow run (3.5 Hz). The training lasted for 15 minutes and was performed at the same time of the day for each subject. Before and right after training, the blood pressure, speed of reaction (Dietrich test) and body temperature were measured. Before the experiment and on the second day after it, blood samples were drawn for the determination of:

– hemoglobin concentration by means of Drabkin method in aerated blood,
– determination of acid-base equilibrium variables in the aerated blood with the Corning 238 apparatus (H^+ ions concentration, partial pressure of carbon dioxide, oxygen, bicarbonate content, deficit or excess of buffering bases and the total amount of carbon dioxide).

This research was carried out only on subjects from experimental blood, since it aimed at monitoring possible post-training changes in the parameters of acid-base equilibrium.

The average values for all variables, standard deviation (SD) and t-Student test were performed with the use of Statistica v. 5.0 in order to evaluate the significance of statistical differences.

Results and Discussion

1. Changes in hemoglobin concentration

Table l shows statistical characteristics of the parameters under research, while their analysis is presented in Figures 1-7.

Table 1. Statistical characteristics (individual and mean values of investigated parameters)

Subj.	Experimental												Control	
	H+		BE		HCO_3		PCO_2		PO_2		Hb		Hb	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A
1	39,2	37,7	1,3	2,4	25,5	26,4	41	40	72	87	13,5	15,8	14,86	13,61
2	40,4	38,5	-3,9	-2,1	20,1	21,9	33	34	75	57	13,6	12,75	15,93	15,6
3	37,9	38	0	0,8	23,9	25	37	39	79	61	13,5	15,45	15,22	13,25
4	39,3	39,6	-1,4	-4,2	22,7	20,8	37,9	32	85	68	17,8	15,01	18,12	16,8
5	37,6	36,7	-0,5	-0,3	23,3	23,5	36	35	64	68	14,5	14,79	24,3	17,11
6	39,6	40,6	-0,2	-0,9	23,9	23,4	36	39	68	66	9,3	13,42	10,44	11,24
7	41,3	40,3	1,7	0,6	26,3	25	38	41	68	71	13,2	16,8	15,38	13,49
8	39	39,8	2	0,4	26,2	24,7	44	40	62	66	10	14,2	14,18	12,27
9	39,8	38,3	-0,1	0,8	25,3	26,1	42	38,3	59	62	10,4	15,01	14,22	15,05
10	40,7	39,6	-1,8	-1,9	22,4	22,2	39	39,6	72	73	10,04	11,9	13,86	13,66
11	40,5	40,6	-0,1	0,9	24,3	26,9	37	40,6	63	58	10,4	13,49	12,9	12,4
12	40,1	40	0	0	24,3	24	40	40	83	66	12,4	14,3	15,24	14,9
Mean	39,62	39,14	-0,25	-0,21	24,02	24,15	38,4	38,2	70,7	66,9	12,45	14,35	15,39	14,12
SD	1,1	1,27	1,61	1,83	1,76	1,88	3	2,9	8,5	8	2,41	1,26	3,35	1,81
Test T	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

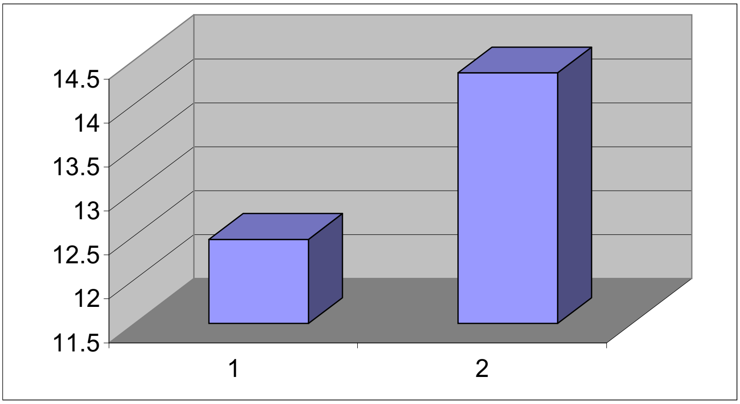

Fig. 1. Changes of average hemoglobin concentration in people in the experimental group before and after the experiment

There is considerable tendency towards increasing the concentration of hemoglobin in subjects of the experimental group. If the average Hb content before the experiment equaled 12.45, then after its termination it amounted to 14.35 (fig. 1). It results from the above data that the average content of hemoglobin before the experiment was below normal (normal value for women equals 14-16 g/dl), and after its termination it was normal. The above results correspond to results obtained in tests with experimental animals in which definite changes were obtained, though statistically insignificant increase of hemoglobin concentration almost by 1/6 of its arithmetic mean. The lack of statistical significance of differences resulted, as mentioned before, from the specific character of the t^0 test, however, just as in the investigated patients, this concentration increased almost in all individuals (Damian et al. 2002). Perhaps the increase of concentration of this parameter is related with the well-known fact of increasing erythropoesis caused by the changes of pressure in the marrow cavity. The above-described dependence has not been stated in the control group, which is illustrated in Figure 2.

As one can see, these changes are characteristic of both different direction and scale. The average Hb value in the first examination equaled to 15.39, and in the other one, after the lapse of 20 days, it amounted to 14.12. The difference between average values is two times lower than in the case of average values for the experimental group. These results confirm the phenomenon of increasing the concentration of hemoglobin under the influence of low frequency vibrations.

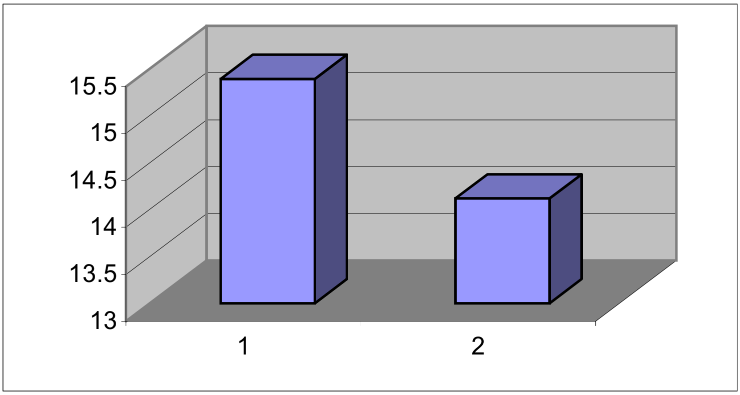

Fig. 2. Changes of average hemoglobin concentration in subjects of the control before (1) and after (2) the experiment

2. The Changes of Acid-Base Equilibrium Parameters After 19 days of Training on a Vibration Platform (3.5 Hz vibration)

The average values of molar concentration of these ions are lower after 19 days of the experiment than before its beginning. The value of blood pH slightly increases. However, these differences are very small since the average value before the experiment equaled 39.62 and after the experiment it amounted to 39.14. The changes of molar concentration of ions are illustrated in Figure 3.

Both, before and after the vibration training, the average values of the parameters point to the deficit of buffering bases. However, they are contained in the physiological norm at rest. This loss, both in the case of experiments carried out before and after the research, was small and equaled respectively: - 0.25 and – 0.20. These differences are rather small, though they seem to be beneficial, especially if one pays attention to simultaneous increase of pH in blood. Despite the fact that these changes are of a small scale, it is worth noticing that the average pH of blood increased with the simultaneous increase of resources of buffering bases, which may be in favor of improving the buffering ability of blood. Figure 4 shows changes of average deficit or excess values of buffering bases (BE). Carbonate buffer as the first one eliminates a probable acidification of blood. Proper concentration of bicarbonate ions constitutes the indispensable condition for the right buffering. The direction of average changes is of increasing character, which would confirm the hypothesis concerning the improvement of buffering ability of blood. However, this change is extremely small and it equals approximately 0.14. Although the direction of changes of parameters of acid-base equilibrium is positive, yet their small scale calls for the necessity of further research, the more so as this tendency has not been confirmed in pilot studies carried out on a group of students. Although in the above-mentioned study the results were statistically insignificant, an increase of concentration of H^+ ions and decrease of bicarbonate were registered (unpublished data).

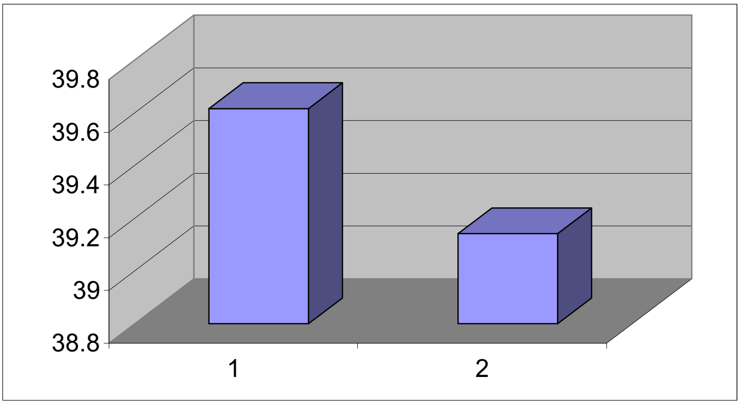

Fig. 3. Changes of average molar concentration of H^+ ions before (1) and after (2) the experiment

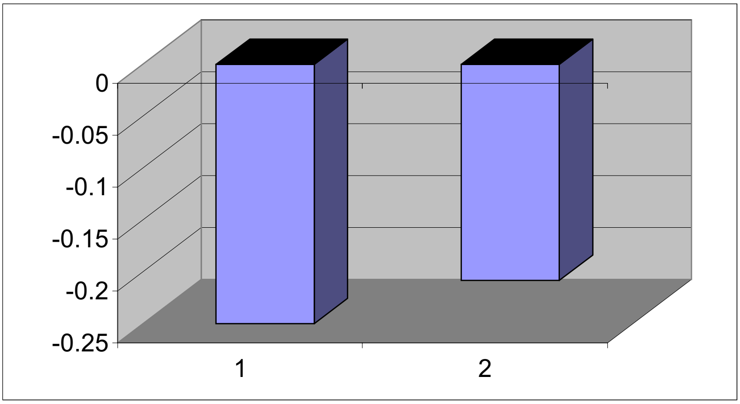

Fig. 4. Changes of average deficit or excess values of buffering bases (BE) before (1) and after (2) the experiment

Finally, we are presenting changes in gas parameters of acid-base equilibrium, i.e. partial pressure of carbon dioxide and oxygen (fig. 6-7).

The average values of partial pressure of carbon dioxide show its very small decrease in the aerated blood (the difference equals 0.20). The decrease of pressure of this gas in blood may result in the increase of pH in blood. While comparing the average partial pressure of oxygen before and after the vibration training, it was noted that the pressure of this gas in blood decreased. The difference was approximately 0.5. Perhaps through the increase of pressure of hemoglobin, a greater part of oxygen has been tied with it.

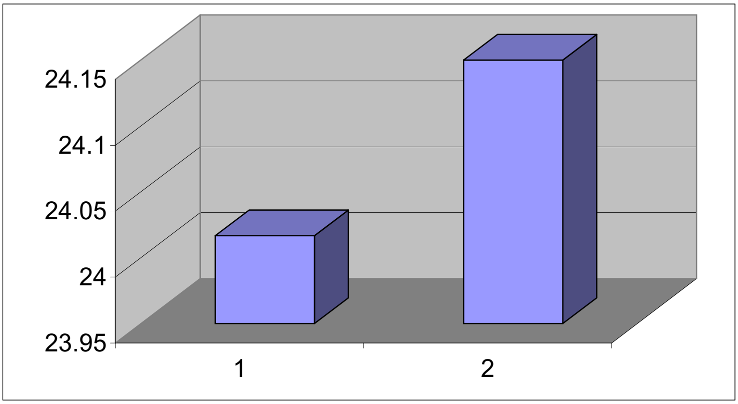

Fig. 5. Changes of mean values of bicarbonate ions concentration before (1) and after (2) the experiment

Due to the lack of published data, which would outline the range or direction of changes of the parameters described, and because of the result of the experiment carried out, which may have more than one meaning, the above mentioned question of the influence of low frequency vibrations on human organism, undoubtedly requires further research, especially on a more numerous research group.

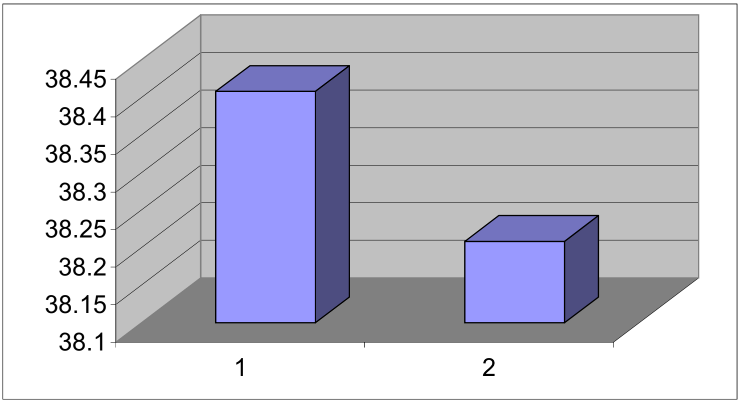

Fig. 6. The average pressure of carbon dioxide in the studied subjects before (1) and after (2) the experiment

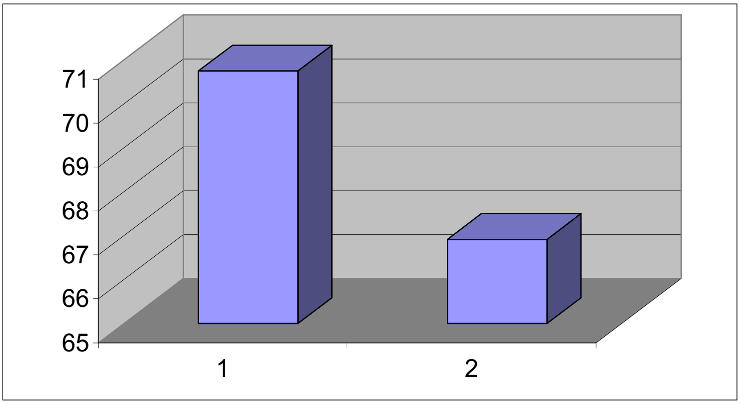

Fig. 7. The average values of oxygen pressure in the studied subjects before (1) and after (2) the experiment

Conclusions

1. The 18-day training on a vibration platform caused:
   – an increase of hemoglobin concentration
   – a decrease of average concentration of hydrogen ions (the increase of pH in blood).
   – inconsiderable increase of average content of buffering bases and bicarbonate
   – a decrease of oxygen and carbon dioxide partial pressure.
2. It seems, that training on the vibration platform induces positive changes in blood parameters.
3. Since the number of investigated subjects was rather small, research projects in this area should be continued

REFERENCES

Abdulkadyrov K.M., Bessmeltsev S.S., Balashova V.A.M., Semenov A.I. 1992. The Use *of Laser adiation and Microwave Emision in the Treatment of Patients with Malignant Diseases ofthe Hemopoietic.* Exp. Oncol. 14: 123-124.

Berki T., Nemeth P., Poto L., Nemeth A. 1991*: The Effect of Photosensitization and Low Power Helium- Neon Laser Irradiation on Liposomes and Cell Membranes.* Scaning Micros. 5: 1157-1164.

Engel Z. *Protection of Natural Environment Before Vibrations* PWN, Warsaw, 1993 (in Polish).

Damian Z., Panuszka R., Majchrzak T., Rumiński M., Żychowska M., Dąbrowski Z. 2002. *Changes of Selected Biochemical Parameters of Rats Under Low Frequency Vibration Structures* - Waves – Biomedical Engineering Kraków 2002, pp. 149-159.

Damian Z., Panuszka R., Żychowska M. *The effect of low- frequency vibration on the human organism*. Unpublished data (in Polish).