PHYSICAL EXERCISE IN REHABILITATION OF ESSENTIAL ARTERIAL HYPERTENSION

V. P. DJURDJEVIC, M.D.

*Republic Community of Pension and Disabled Workers Insurance,
Community Service Institute for Examination and Evaluation of Work Capacity,
Belgrade, Teslina 9, Yugoslavia*

Systematic physical training brings about morpho-functional changes of the cardiovascular system and through these changes enlarges cardiovascular capacity, therefore physical training is included in the means of prevention of "hypokinetic diseases of modern life", and is essential to the rehabilitation from these diseases.

Essential arterial hypertension is connected with organic changes which result in decreasing functional ability of the cardiovascular system. These facts are unquestionably established by a great number of experimental and epidemiological studies.

The question is, if and how much systematic physical training can influence the increase of functional capability of the cardiovascular system in hypertensive patients?

Our examinations were done to determine the effect of physical training on the functional and working ability of hypertensive patients.

Methods

Examinations were carried out upon a relatively homogenous group of 100 male patients, aged 40-54, with essential arterial hypertension. All hypertensive patients selected for the examination had the first and second degree of essential hypertension, according to the criterion of the Committee of WHO Experts (1). All patients were professionally active, but they had a sedentary life. The programme of physical training did not influence the medical therapy they received. All selected subjects were divided in the experimental and the control groups by random sampling. Patients in the experimental groups were further divided into individual subgroups with different programmes of exercise, lasting one year.

At the beginning of the experiment, and at the end of the training programme patients from both the experimental and the control group were submitted to the examination of functional abilities of the cardiopulmonary system with the spiroergometric test of ergostasis type, x-ray determination of the heart volume, and with ECG control during effort. According to the methodology considered and adopted by the

International Seminar of Ergometry in 1966 in Berlin (2) and on the meeting concerning the problem of ergometrics in cardiology in 1967 in Freiburg (3), examinees have turned the pedals of the bicycle ergometer in the lying position with a speed of 60/min. During 5 minutes rest, standard efforts for 6 minutes (with loads of 25 w, 50 w, 75 w, 100 w and 125 w) and in the period of recovery of 5 minutes the following parameters were registered: pulse, ECG, arterial blood pressure, absolute and relative oxygen consumption, absolute and relative oxygen pulse and equivalent of the heart volume. X-ray volume of the heart was determined by the standard methodology of Rhorher-Karhlstorf (modification of Mushoff-Reindell) (4).

According to the adopted definition, it is considered that, if the pulse does not exceed an increase of 8 strokes a minute, from the fourth to the sixth minute of work, and if the oxygen consumption remains unchanged from the third to the sixth minute, the work is done in an ergostatic phase. The programme of physical training with members of two experimental groups (E1 and E2) was organized three times weekly. The group E1 had a mixed and varying training programme, consisting mainly of games such as volleyball, without more physical loading, and with a target of gaining psychophysical relaxation. The group E2 had a training programme to obtain the enlargement of the cardiorespiratory functional abilities. The training hour of this group was divided in the two parts: the programme of running was within the first 30 minutes, and another 30 minutes consisted of swimming. At the end of one-year's training period this group ran approximately 700-2,000 metres, and swam 300-900 metres, weekly. The average pulse values during running and swimming were about 120-125/min.

Results and Discussion

Group E1 showed considerable increase of the functional abilities of the cardiorespiratory system only during the maximal working load. In the second control the members of this group had the maximum working load bigger by 10 w than previously ($p < 0,05$) but arterial blood pressure and pulse remained unchanged. Proportionately the maximal load oxygen consumption and maximal oxygen pulse also increased. X-ray determined heart volume was not changed significantly

in the average of the group.

Group E2 showed significant differences which resulted after the one-year training period. In this group was recorded during the second control, a decrease in blood pressure and resting pulse rate. The signification of these differences is expressed better on the submaximal work loads of 25 w and 50 w. During the maximal working load which is significantly higher on the second control (p 0.001) the values of blood pressure are almost identical as on the first control. In proportion to the maximal work load, the oxygen consumption is significantly higher during the second control, as is the maximal and relative oxygen pulse. Absolute heart volume was enlarged from 876.17 cc to 922.07 cc, but this enlargement is not statistically significant. Meanwhile, because of decrease in the patients' body weight this enlargement appears through VH/BW to be statistically significant. The economy and efficiency of such a heart is considerably improved: the heart equivalent is decreased from 101.77 to 79.74 (p 0.005).

It is of interest that in the control group (C) we find decrease of blood pressure both in rest and during submaximal working loads after a one year control period. In connection with this, the control group had bigger maximal working load with bigger oxygen consumption and maximal and relative oxygen pulse as well. Meanwhile, the working ability of the patients hearts did not change significantly.

It is obvious that within all three groups, existing

decrease of blood pressure at rest during the second control, reflects the values of blood pressure recordings during work loads. This is shown well within the members of the E2 group which had vigorous training. Patients with lower blood pressure can endure the same physical exertions with smaller increase of blood pressure, and so the magnitude of the work load can be enlarged under the same range of blood pressure. The rehabilitation potentials of these patients are enlarged. This phenomenon also is manifested through the changes of such other parameters as maximal and relative oxygen consumption, maximal and relative oxygen pulse and equivalent heart volume.

Conclusions

Systematic physical exercise, depending upon its characteristics, applied to subjects with essential arterial hypertension, brings about a decrease of the arterial tension. However, in estimating the obtained values, the influence of drug therapy has to be taken into consideration, as subjects in the control group have shown on the second control a certain degree of lowering blood tension, although not very significant. Lowering of blood tension during rest is proportional to the abilities of hypertensive patients to endure larger physical efforts, as well as to the increase of tension at such loadings, increasing at the same time rehabilitation potentials of these hypertensive subjects. The increase of functional abilities of hypertensive patients is reflected on the maximum work load in the form of the enlargement of the maximum and relative consumption of oxygen and the maximum and relative oxygen pulse.

REFERENCES

1. "Rehabilitation of patients with cardiovascular diseases", Report of a WHO Expert Committee, *Wld. Hlth. Org. techn. Rep., Ser. 270*, 1964.
2. "International Seminar für Ergometrie", *Sporarzt und Sportmed.*, 4 und 5, 1966, 166 und 208.
3. "L'ergometrie en Cardiologie" — Symposium organisé sous le patronage de la Société Européenne de Cardiologie, *Freiburg, Br. 8-11, 1967*, ed. Denolin, H., König, K., Messin, R., Degré, S., Boehringer, Mannheim, 1968.
4. MUSSHOFF, K., REINDELL, H. "Zür Röntgenuntersuchungen des Herzens in horizontaler und vertikaler Körperstellung. I Mitteilung. Der Einfluss der Körperstellung auf des Herzvolumen", *Dtsch. med. wschr.*, 82, 1957, 1075.

BIBLIOGRAPHY

1. REAB, W. "Fundamentals of heart protection through physical activity", *Med.J.* 65/1, 1069. 1-3.
2. FOX, S. M., SKINNER, J. S. "Physical activity and cardiovascular health", *Am.J. Cardiol.* 14, 1964. 731.
3. FOX, S. M., SKINNER, J. S. "Some planning in the United States for further studies to define the relationship between physical activity and coronary heart disease", in "Physical activity and the heart", Proceedings of a symposium Helsinki, Finland, ed. Karvonen, M. J., Barry, A. J. publ. Charles C. Thomas, Springfield, Illinois, 1967.

4. MOŠKOV, V. N. "Lečebnaja fizkultura v klinike vnutrenih boleznej", Medgiz, Moskva, 1961.
 5. MOŠKOV, V. N. "Obščie osnovi lečebnoj fizkulturi" Medgiz, Moskva, 1963.
 6. MOŠKOV, V. N. "Fizičeskaja kultura v profilaktike i lečenii važnejših zabolevanij serdečno-sosudistoj sistemi", Vopr.kurort.fizioterap. i lečebnoj fiz.kult. 1, 1970. 14-19.
 7. KEYS, A. "Physical activity-promises and problems in regard to cardiovascular disease", in "Physical activity and the heart", ed. Karvonen, M. J., Barry, A. J. publ. Charles C. Thomas, Springfield, Illinois, 1967.
 8. REINDELL, H., KÖNIG, K., ROSKAMM, H. "Funktionsdiagnostik des gesunden und kranken Herzens, Beziehungen zwischen Herzgröße und Leistung", Georg Thieme Verlag, Stuttgart, 1967.
 9. MJASNIKOV, A. L. "Gipertoničeskaja bolezn i ateroskleroz," Medicina, Moskva, 1965.
 10. HALHUBER, M. J. "A longitudinal investigation on hypertensive patients during exercise at 2.000 metres altitude", *Journ. of Sports. Med. and Phys. Fitness*, 8/1, 1068, 12.
 11. SANNERSTEDT, R. "Hemodynamic response to exercise in patients with arterial hypertension", *Acta med.scand.*, suppl. 458, 1966.
 12. LUND-JOHANSON, P. "Hemodynamic pattern in essential hypertension at rest and during exercise", in "Physical activity and the health." Proceedings of Beitostölen Symposium, 1966, ed. Evang, K., Andersen, L. K., Universitetsforlaget, Oslo, 1966.
 13. AMERY, A., JULIUS, S., WHITLOCK, L., CONWAY, J. "Influence of hypertension on the hemodynamic responses to exercise", *Circulation*, 36, 1967, 231.
 14. JULIUS, S., CONWAY, J. "Hemodynamic studies in patients with borderline blood pressure elevation", *Circulation*, 38/2, 1968. 282-288.
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