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INTERVAL AND CONTINUOUS TRAINING IN PATIENTS AFTER ACUTE MYOCARDIAL INFARCTION

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A b s t r a c t

The purpose of the study was to examine the effect of two modifications of aerobic training (interval and continuous) during 12 weeks of a controlled outpatient cardiovascular rehabilitation program on aerobic capacity and performance on the level of ventilatory anaerobic threshold. Thirty-six males were included in our study. They were divided into two subgroups. Group K (EF 54±7.7 %, n=18) passed the aerobic phase of the program with continuous workload, in group I (EF 47±12.7 %, n=18) interval training was prescribed. The intensity of the training was on the level of ventilatory anaerobic threshold in both groups. The groups did not differ in age. Symptom-limited spiroergometry was provided before and after the rehabilitation program. The rehabilitation program was carried out three times a week for 60 min. Oxygen intake was increased in both groups studied (VO_2ANP was increased in "K" by 13 %, VO_2ANP/kg by about 11 %. VO_2ANP was increased in "I" by 20 %, VO_2ANP/kg by 20 %). The workload on the level of anaerobic threshold improved significantly (WANP was increased by 15 % in "K" and WANP/kg by about 17 % in "K". WANP was increased by about 35 % and WANP/kg by about 37 % in "I"). A statistically significant improvement in aerobic capacity and performance on the level of anaerobic threshold was observed in both groups. Both modifications of aerobic training were well tolerated.

K e y w o r d s

Cardiovascular rehabilitation, Continuous training, Interval training, Myocardial infarction

INTRODUCTION

Cardiovascular rehabilitation is a universally accepted part of the complex care of patients with cardiovascular disease. It starts already during hospitalisation and after the discharge to home care it continues in the form of a controlled outpatient rehabilitation program of individual training at home (*1)*. It increases physical fitness, improves the quality of life (*2–4*), and decreases cardiovascular mortality (*5,6*). Dynamic endurance aerobic activities are the basis of each training unit (*7–9,13,14*). The best known and most widespread type of aerobic training is the training with continuous workload. Interval training (*1,10*) can be an alternative training method for persons with a low tolerance of load, with a lower contractility of left ventricle, or for elderly people.

AIM OF THE STUDY

To evaluate the effect of a 12-week controlled outpatient rehabilitation program with continuous and interval workloads on aerobic capacity and performance on the level of anaerobic threshold in men after acute myocardial infarction (AIM) treated by percutaneous thoracoplasty of coronary artery (PTCI with stent implantation).

SET OF PATIENTS

Thirty-six male patients after AIM were included into the study. According to ejection fraction of the left ventricle (EF) they were divided into two groups. The group with a higher EF (54 ± 7.7 %, group K, n=18) went in the aerobic phase through the training with continuous workload, the second group with a lower EF (47 ± 12.7 %, group I, n=18) went in the aerobic phase through the interval training.

Controlled outpatient rehabilitation was started within 12 weeks after AIM. AIM diagnosis was identified at 1st Dept. of Internal Medicine – Cardioangiology of the Faculty of Medicine, Masaryk University, St. Anne's Faculty Hospital in Brno (treated by PTCI with stent implantation). During rehabilitation all patients were symptomatically stable and their medication was not changed.

The groups did not differ in age, their characteristics are given in *Table 1*.

Table 1
Characteristics of the set

	Group K	Group I
Number (n)	18	18
Age (years)	57 ± 12	60 ± 7
Ejection fraction (%)	54 ± 7,7	47 ± 12.7
Starting RHB (weeks after AIM)	6 ± 2.5	5 ± 3.4

METHODOLOGY

Methods of examination

Before the beginning of the rehabilitation (RHB) program and after its completion we made a spiroergometric examination up to a symptom-limited maximum (Pulmonary Function System 1070, MedGraphics, USA). The examination was started by monitoring resting EKG in lying and sitting position (Schiller CS 100), followed by 3-minute adaptation in sitting position on an ergometer. The workload was increased every 2 minutes by 20 W to the symptom-limited maximum. The anaerobic threshold was determined from the course of changes of ventilatory-respiratory parameters. For the use of RHB it was expressed in watts, heart rate, and degrees of RPE (Borg scale).

Before the beginning of resistance training (i.e. in the 3rd week of RHB program) we made an isometric test ("handgrip", DHG-SY3, Recens) to verify blood pressure response to isometric load. In the case of a normal response the entrance 1-RM test (one repetition maximum test) was made in three exercises of resistance training. The test was repeated in the 6th week and in the 12th week of the RHB program.

Rehabilitation program

The controlled outpatient RHB program lasted 12 weeks altogether at a frequency of three times a week. The training unit lasted 60 minutes and consisted of a warm-up phase (10 min), an aerobic phase (1st to 2nd week 40 min; 3rd to 12th week 25 min), a toning phase (3rd to 12th week 15 min), and a relaxation phase (10 min). The patients in the "K" group went in the aerobic phase through continuous training, in the "I" group they went through the interval training. For the interval training the following modification was chosen: 30 s of working phase with the intensity on the level of anaerobic threshold and 60 s of relaxation phase with a minimum workload of 5 watts.

The interval training was indicated by residual ischaemia, low ejection fraction of the left ventricle, generally low tolerance of workload.

The warm-up phase was aimed at preparing the cardiovascular and motoric system for further load, prevention of musculoskeletal lesion. It consisted of dynamic endurance exercises (simple floor gymnastic exercises, exercises with gymnastic apparatus) and stretching of muscle groups with a tendency to shortening.

The aerobic phase was effected on a bicycle ergometer (Ergoline REHA E900) controlled by the program ErgoSoft+ for Windows. The aerobic training intensity was determined on the anaerobic threshold level.

The resistance training was realised on multifunctional muscle conditioning machines TK-HC COMPACT. Four exercises were done (bench press, pull-down, leg extension on the machine and sitting-lying positions). The resistance training intensity was determined by the 1-RM method and the training loads were determined in percents of maximum: 30–60 % 1-RM each week increase by 10 %). The number of sequences was 3–5 with ten repetitions. Before starting the resistance training, the patients were thoroughly informed about proper breathing and the technique of doing exercises.

Modified Schultz autogenic training was used for relaxation.

In the course of the whole training, monitoring of heart rate, blood pressure and degree of RPE, and also of EKG during the aerobic phase, was carried out.

Statistical processing

Statistical processing was made in the programs Microsoft Excel and Statistica, version 8. Distribution was tested by the Lillefors modification of the Kolmogorov-Smirnov test of normality. According to the result either a paired t-test or the Wilcoxon test for dependent specimens were used. The significance level was determined to 0.05, at the statistical significance on this level the testing was made on the level 0.01 (0.001). The results are presented as means with standard deviations.

RESULTS

After the completion of the program a statistically significant increase of oxygen intake on the level of anaerobic threshold was recorded in both groups (*Table 2*). VO_2ANP increased in the "K" group by 13 %, VO_2ANP/kg by 11 %. VO_2ANP increased in the "I" group by 20 %, VO_2ANP/kg also by 20 %.

Table 2
Parameters of aerobic capacity on the level of anaerobic threshold

	Group K		p	Group I		p
	Before RHB	After RHB		Before RHB	After RHB	
VO_2ANP (ml.min^{-1})	1086±190.6	1225±291.5	0.001	995±209.9	1194±242.6	0.05
VO_2ANP/kg (ml.min^{-1}.kg^{-1})	12.9 ± 1.7	14.3 ± 2.5	0.01	11.6 ± 3.30	13.9 ± 3.71	0.05

VO_2ANP = oxygen intake on the level of anaerobic threshold

The tolerance of workload on the level of anaerobic threshold also improved statistically significantly in both groups (*Table 3*). WANP in the "K" group increased by 15 % and WANP/kg by 17 %. In the "I" group WANP increased by 35 % and WANP/kg by 37 %.

Table 3
Performance parameters on the level of anaerobic threshold

	Group K		p	Group I		p
	Before RHB	After RHB		Before RHB	After RHB	
WANP (W)	62 ± 14.2	71 ± 19.4	0.01	52 ± 10.2	70 ± 16.1	0.001
WANP/kg (W.kg^{-1})	0.7 ± 0.17	0.8 ± 0.19	0.05	0.6±0.17	0.8 ± 0.26	0.001

WANP = performance on the level of anaerobic threshold

DISCUSSION

The training with continuous workload and the interval training are used widely not only in sports activities but also in rehabilitation. The interval training in cardiovascular rehabilitation is often recommended and conducted individually with regard to the health and functional state, to the age and gender of the patient. Workload intensity, duration of working and relaxation phases in interval training, and the total number of exercise intervals differ according to the orientation of the training (*10–12*). *Mífková et al.* (*11*) used in her study the following modification of interval training: 30 s of working phase on the level of anaerobic threshold and 60 s of relaxation phase on the level of 5 watts. Thirty-eight men with ischaemic heart disease were monitored in the study. Both groups differed in age and ejection fraction. The total work done by the patients in this interval training modification was 2.5 to 3 times lower than in the group of patients for whom the continuous training was prescribed. In the final spiroergometric examination there was no statistically significant difference between the groups with interval and continuous training either in performance parameters or in parameters of aerobic capacity (evaluated on the level of the highest values achieved). Both in interval and continuous types of the training similar results were obtained at the same training workload intensity.

In our study we used the same modification of interval training: (30 s of working phase with the intensity on the level of anaerobic threshold and 60 s on the level of 5 W). We evaluated selected parameters on the level of anaerobic threshold. The patients in our group did not differ in age, but they differed in ejection fraction. The ejection fraction in the group with interval training was lower than in the group with continuous training (low ejection fraction is one of the indications for interval training). The benefit of interval training lies in the possibility of obtaining improvement even in risk patients (*11*). In our study we verified the method in patients with decreased ejection fraction of the left ventricle and in patients with residual ischaemia and generally low tolerance of workload. In these patients preference should be given to interval training before continuous one, also for safety reasons (*11*).

CONCLUSION

The group with interval training (I) had already before the starting of the program a lower oxygen intake and a lower tolerance of workload than the group with continuous training (K). After the completion of the program the oxygen intake on the level of anaerobic threshold increased statistically significantly in both groups (VO_2ANP increased in the "K" group by 13 %, VO_2ANP/kg by 11 %. VO_2ANP increased in the "I" group by 20 %, VO_2ANP/kg also by 20 %). The tolerance of workload increased statistically significantly on the level of anaerobic threshold in both groups. (WANP increased in the "K" group by 15 % and WANP/kg by 17 %. In the "I" group WANP increased by 35 % and WANP/kg by 37 %.) In both groups a statistically significant improvement of the monitored parameters was recorded after a 12-week rehabilitation program. Both types of the training were well tolerated.

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