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SHORT COMMUNICATION

A SHORT DURATION OF PHYSICAL TRAINING BENEFITS CARDIOVASCULAR PERFORMANCE

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Abstract : The present study explored the possibility of short duration of supervised physical training on cardiovascular performance and attempted to look into the changes in the autonomic tone as assessed by heart rate variability (HRV), if any. The study was conducted on 25 healthy adult male subjects (mean age: 32.08±8.32 years) who underwent 15 days of moderate physical training on bicycle ergometer. Heart rate and blood pressure response to exercise and during recovery was monitored as well as autonomic activity (tone) was assessed by heart rate variability in resting condition and all the parameters were compared before and after physical training of 15 days. Heart rate response to graded exercise on bicycle ergometer showed a significant decrease at 2^{nd} minute, 3^{rd} minute, 5^{th} minute and 6^{th} minute during exercise after physical training, and systolic blood pressure response also showed a significant decrease at 4^{th} minute, 5^{th} minute and 6^{th} minute during exercise after physical training. Physical training resulted in quick recovery during the 1^{st} minute after cessation of exercise (percentage drop 21.03±7.93 vs. 23.50±6.97, $P<0.05$). Although there was no significant change in the HRV parameters, there was a trend reflecting an increase in parasympathetic tone and a decrease in sympathetic tone after physical training. We conclude from the present study that even a short duration of physical training results in favorable cardiovascular performance and it may be ascribed to autonomic modulation.

Key words : physical training, cardiovascular performance, HRV, autonomic modulation

INTRODUCTION

It is a well-known fact that physical training results in favorable cardiovascular changes and that autonomic nervous system is the prime mediator of these changes. Physiologically both sympathetic and parasympathetic nervous systems undergo changes with regular physical training with the result that a well trained person performs the same work with greater skill, speed, strength and endurance. Recovery from exercise i.e. return of cardiovascular and other variables to resting levels is also

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more rapid in such individuals. Changes in cardiovascular variables such as heart rate and blood pressure during exercise as well as recovery are regulated by changes in the activity of sympathetic and parasympathetic nervous system. Fluctuations in the heart rate at the onset of a light dynamic exercise is due to a rapid vagal withdrawal (1). An increased sympathetic activity contributes to increase in heart rate during the later part of the exercise (2). Recovery of the heart rate at the cessation of the exercise is also modulated by the appropriate changes in the autonomic nervous system such that initial rapid recovery in heart rate is caused by vagal stimulation followed by sympathetic withdrawal during later part of the recovery phase (3). There are studies showing cardiovascular exercise and recovery changes with long duration of physical training, but studies showing the effect of a short duration of physical training are lacking, except one study from our lab (4). The present study was conducted to test the hypothesis that a short duration of supervised physical training may result in improved cardiovascular recovery profile in humans.

METHODS

Subjects and physical training schedule

The study was conducted on 25 healthy adult male human volunteers (mean age: 32.08±8.32 years). Subjects were screened and a detailed medical history was taken to exclude any disorder, which can interfere in the autonomic responses or with a contraindication for exercise, as per the guidelines laid down by the American College of Sports Medicine. Informed consent was obtained from the volunteers before the start of the study and the study was approved by the ethics committee of All India Institute of Medical Sciences.

All the subjects underwent supervised physical exercise on stationary bicycle. Bicycle ergometry was chosen as the form of physical exercise because it has been shown that aerobic exercise with repetitive iso-rhythmic activities such as brisk walking, jogging, cycling, and involving major muscles gives better cardiovascular effects. For cardiovascular benefit these activities should take place at a minimum intensity of 60–70% of maximum achievable heart rate for duration of 15–30 minutes or more, and at a minimum frequency of three times a week (American College of Sports Medicine, 1980). The training programme consisted of bicycling 15 minutes per day, 6 days a week for 15 days, which conforms to the guidelines, laid down by the American College of Sports Medicine. Everyday the exercise was started with 3–5 minutes of warming up. A bicycle ergometer (Ergo Zimmer Electormedzin, Germany) was used to assess the cardiac performance of the volunteers. The increment in resistance (in watts) was automatic. The equipment could indicate revolutions per minute (RPM), load taken, and time taken from the beginning of exercise. The increment in the load was of the magnitude of 25 watts after every 2 minutes.

Recording of physical performance parameters and autonomic activity (tone)

Cardiovascular physical performance parameters were measured in terms of heart

rate and blood pressure during the physical exercise (bicycle ergometry) as well as during post exercise period (recovery). Exercise duration was kept as 6 minutes for the recording of these cardiovascular parameters. Continuous ECG was recorded for the entire duration of the exercise (6 minutes) as well as during the time course of the recovery. Blood pressure was measured at the interval of 1 minute during exercise as well as recovery. Apart from these cardiovascular exercise parameters autonomic activity (tone) was also measured by heart rate variability (HRV) before the start of the exercise from the resting ECG acquired for a duration of 5 minutes in standard test conditions.

Statistical analysis

All the parameters were measured and analyzed before and after the physical training programme. Student's t-test was applied to analyze the changes in cardiovascular parameters during exercise and recovery, and non-parametric Wilcoxon signed rank test was applied to analyze the changes in HRV parameters because of non-normal distribution of the data.

RESULTS AND DISCUSSION

The effect of physical training on physical performance measurements

Heart rate response to graded exercise test

The heart rate response to graded exercise on bicycle ergometer showed a significant decrease at 2nd minute, 3rd minute, 4th minute, 5th minute and 6th minute after physical training (Table I). Physical training resulted in quick recovery during the 1st minute after cessation of exercise (percentage drop 21.03±7.93 vs 23.50±6.97, $P<0.05$).

Systolic blood pressure response to graded exercise test

The systolic blood pressure response to graded exercise on bicycle ergometer showed a significant decrease at 4th minute, 5th minute and 6th minute after physical training (Table I).

TABLE I: Effect of two weeks of physical training on heart rate and systolic blood pressure response to graded exercise load.

	(n)	*1st min*	*2nd min*	*3rd min*	*4th min*	*5th min*	*6th min*
Heart Rate (HR) (beats per minute)	Pre-training (25)	98.64±10.96	104.48±11.6	111.6±11.70	117.28±11.40	124.76±12.90	129.96±12.70
	Post-training (25)	96.0±10.38	101.96±11.6*	108.48±11.0	114.44±11.20*	120.84±11.20*	126.44±10.90*
	(n)	*1st min*	*2nd min*	*3rd min*	*4th min*	*5th min*	*6th min*
Systolic blood Pressure (SBP) (mm of Hg)	Pre-training (25)	122.60±12.72	127.40±11.8	132.16±13.52	137.6±14.0	140.9±13.60	150.0±25.40
	Post-training (25)	116.50±23.37	125.52±1061	130.56±11.59	134.3±12.57*	138.64±13.430*	142.08±13.07*

[The values are expressed as mean & S.D. *-$P<0.05$]

Effect of physical training on autonomic activity

Although there was no significant change in post training values of time and frequency domain measures of HRV the trend in both these domains reflected an increase in parasympathetic tone. As for frequency domain parameters, total power (TP) and high frequency power (normalized) showed an increasing trend. Similarly time domain measures of HRV showed an increasing trend in mean RR interval, SDNN, RMSSD, CV, NN50 and pNN50 (Table II) after physical training.

TABLE II: Effect of two weeks of physical training on autonomic drive to the myocardium.

	Time domain measures of Heart Rate Variability (HRV)	
	Pre-training Median (range)	*Post-training Median (range)*
Mean R-R	843.70 (641–1071.04)	882.37 (714.64–1120)
SDNN	42.19 (18.84–49.82)	44.30 (19.92–76.09)
SDSD	141.91 (22.31–350.75)	134.29 (23.96–323.79)
RMSSD	29.39 (14.91–80.11)	32.62 (4.25–64.38)
CV	5.02 (2.25–23.13)	5.10 (3.24–26.29)
NN50	8 (1–85)	10 (1–84)
PNN50	3.57 (0.95–28.78)	4.09 (1–24.94)
	Frequency domain measures of Heart Rate Variability (HRV)	
	Pre-training Median (range)	*Post-training Median (range)*
TP	977.31 (351.55–4008.97)	963.68 (401.32–4108.3)
VLF	519.56 (129.20–1565.59)	600.34 (135.35–1653.25)
LF	412.11 (83.17–1568.51)	400.59 (92.24–1627.33)
HF	134.08 (42.9–1874.87)	137.29 (24.36–1764.26)
LF: HF ratio	2.72 (0.82–8.27)	2.43 (0.93–6.28)
LFnu	87.08 (44.12–102.97)	68.34 (19.20–86.27)
HFnu	16.08 (7.47–55.84)	16.64 (6.85–52.27)

[The data are expressed as median (range) for pre training (n = 25) and post training (n = 25). Abbreviations: Mean R-R – median value of mean R-R interval; SDNN – standard deviation of R-R intervals; SDSD – standard deviation of successive R-R interval differences; CV – coefficient of variation of R-R intervals = (100 × SD)/ mean; NN50 – number of R-R interval differences equal or more than 50 milliseconds; pNN50 – percentage of NN50TP – total power of entire frequency spectrum of heart rate variability; VLF – power of very low frequency band; LF – power of low frequency band; HF – power of high frequency band; LF:HF ratio –ratio between LF and HF; LF_{nu} – low frequency in normalized units; HF_{nu} – high frequency in normalized units.]

There are many studies in which duration of physical training is long and the training programmes are different. We were interested in finding out training effects of a short duration of physical training, because previously it has been shown that even 3 weeks of training results in a decrease in catecholamine response to heart rate after an acute bout of exercise (5). Not only in healthy state but also in certain diseases it has been found that short duration of physical training affects the cardio respiratory parameters in a favourable way. In case of hypertension a short duration of physical training results in decrease in blood pressure, and in case of depressive patients 3 weeks of sub maximal exercise training showed improvement in aerobic capacity of the patients (6). Documentation of both short-term effects of exercise and its physiological mechanism is important from clinical point of view. The implication is two fold,

1) the duration of stay (especially post operative period), which is important for socio economic reasons, and

2) in certain diseases the duration of acquisition of physical fitness may be altered.

There may be interaction between the biochemical profile and initial autonomic parameters of patients. Earlier we have reported that initial autonomic parameters appear to be significant in predicting the training outcome (7). The increase in heart rate at a low to moderate level of exercise is due to vagal withdrawal and at severe exercise is due to sympathetic activation (8, 9). In physically trained individuals less increase in heart rate during exercise could be due to autonomic modulation, circulating catecholamines, or change in the integrity

of the central nervous system. Out of all these factors change in the autonomic control seems to be most responsible for the observed effects. In fact earlier studies involving long duration of physical training have shown such effects and have ascribed such changes to the autonomic modulation. In our present study although we could not find a statistically significant change in the parameters of autonomic activity (tone), but there was a trend indicating an increase in parasympathetic (vagal) tone and a decrease in sympathetic tone. A short duration of training is unlikely to produce significant change in autonomic tone (10), but we have shown in our earlier study (4) that a short duration of physical training of 15 days results in a decrease in sympathetic reactivity without having effects on parasympathetic reactivity and autonomic tone. A favourable trend of change in autonomic tone seen in this study wherein there is an increase in parasympathetic tone and a decrease in sympathetic tone can be a forerunner of autonomic modulation seen in trained individuals. Whatever training effects we have observed may be caused by the observed autonomic modulation resulting in favorable cardiovascular status.

Thus the results of our present study show that even a short duration of moderate intensity of physical training results in improvement in the cardiovascular status in humans. We conclude from our present study that even a short duration of physical training results in favourable cardiovascular performance and it may be ascribed to autonomic modulation.

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