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CARDIO-VASCULAR REACTION AFTER EXERCISE TEST AND SELECTED PARAMETERS OF HEART RATE VARIABILITY

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Abstract

Physical activity makes human body not only physically skilled but also effects efficiency of autonomic cardio-vascular regulation.

The aim of our investigation was to check up the dependence between a type of cardiovascular reaction after exercise test and some selected parameters of heart rate variability (HRV) analysed during orthostatic test.

Materials and Methods. The examination included 33 healthy men aged 19 – 20 years. Martinett exercise test was performed and a type of circulatory reaction was defined on the basis of blood pressure and heart rate measurments. According to the results, the participants of the examination were divided into 3 groups in relation to time of circulatory restitution.

Results. In each group analysis of selected parameters of HRV during orthostatic test was done estimating the index of sympathetic-parasympathetic balance (LF/HF) and the triangular index (TINN).

Conclusions. Our investigations indicate that in healthy men with shorter time of circulatory restitution after physical test more favourable state of autonomic regulation was observed and HRV analysis can be a supplement to estimation of biological renewal in sport.

Key words: cardio-vascular reaction, exercise test, heart rate variability

Introduction

A beneficial effect of physical activity on human physical fitness and also on autonomic cardio-vascular regulation has been commonly known (1-3). An increased general physical efficiency is accompanied by the change in the sympathetic-parasympathetic balance in favour of the parasympathetic component of the autonomic nervous system.

Simple tests based on the analysis of essential circulatory parameters (heart rate, arterial blood pressure measurements) and application of non-invasive methods evaluating heart rate variability (HRV) are often used to assess physical fitness and efficiency of the autonomic mechanisms of cardiovascular regulation (4-6).

HRV is one of the methods used in non-invasive diagnostics of the autonomic system. By evaluating the RR-intervals variability, the frequency analysis of electrocardographic signals can be performed (7,8). In each recording the components of ultra low (ULF), very low (VLF), low (LV) and high frequency (HF) can be distinguished. LF component mainly corresponds to the sympathetic activity, whereas HF to the parasympathetic activity of the autonomic nervous system (5, 9-11). Changes concerning the latter components can be analysed during various functional tests including an orthostatic test.

The aim of the study was to determine interrelationship between the type of cardiovascular reaction after the exercise test and some selected parameters of heart rate variability analysed during the orthostatic test.

Material and methods

The study comprised 33 healthy men aged 19-20 years with a high physical activity, doing different types of sport.

Martinett exercise test was used to initially divide the sample into three particular groups in relation to the dynamics of the circulatory parameters restitution after exercise. Group A (n_A = 8) included subjects in whom restitution occurred after 2 min, group B - those (n_B = 10) with restitution observed after 3 min, and group C (n_C = 12) with restitution after 4 min. In 30 examined subjects with proper arterial blood pressure values at the resting position, a normotonic type of reaction was observed after exercise test. Basic characteristic of examined groups is presented in Table 1.

Tab.1. *Basic characteristic of investigated groups – resting values. SBP, DBP – systolic and diastolic blood pressure respectively. HR – heart rate.*

Parameter	Group A n_A = 8		Group B n_B = 10		Group C n_c = 12	
	mean	SD	mean	SD	mean	SD
Height [cm]	178.5	5.5	180.2	4.0	179.0	6.9
Body mass [kg]	73.4	8.0	69.3	5.8	80.6	7.1
SBP [mmHg]	126.5	7.5	122.7	7.4	125.8	8.2
DBP [mmHg]	73.2	8.2	71.4	9.0	69.4	5.5
HR [$1\cdot min^{-1}$]	71.2	8.4	63.5	10.4	71.9	11.5

In particular groups, the analysis of some selected HRV parameters was performed on the basis of eletrocardiographic records both at rest and during the active orthostatic test. The HRV parameters evaluation was carried out with the use of the Software Fin – Kuopido programme (12). The index of sympathetic-parasympathetic balance (LF/HF) and the triangular index (TINN) were analyzed in each selected group.

The obtained results were analysed by means of t-Student test for paired and unpaired data.

Results

Arterial blood pressure values and heart rate frequency were within the norms in all the groups studied.

In group A at rest (baseline), higher values ($p<0.05$) of the arterial blood pressure, both systolic and diastolic, were diagnosed as compared to groups B and C. This group was characterised by the shorter time of circulatory restitution occurring 2 min after the exercise test.

Similar LF and HF values were found in all the groups at rest, what confirms the sympathetic-parasympathetic balance of the autonomic nervous system. Fig.1A demonstrates an example of the record, tachogram, at rest.

In the standing position, an increase in the spectral LF component values was evident, indicating the balance shift and the sympathetic nervous system activation (Fig.1B)

The sympathetic-parasympathetic balance index during the orthostatic test was evaluated. The changes were demonstrated in Table 2 and Fig.2. In all groups studied an increased tendency for this index was observed. The lowest index values at rest occurred in group A as compared to groups B and C. Group C with the slowest restitution was characterised by the highest index values at rest among all the subjects examined. During the orthostatic test, the highest increments in the index values were recorded in the group with the slowest restitution. In these subjects, a large individual LF/HF index dispersion was noticed. Such a reaction indicates a greater effect of the sympathetic activity.

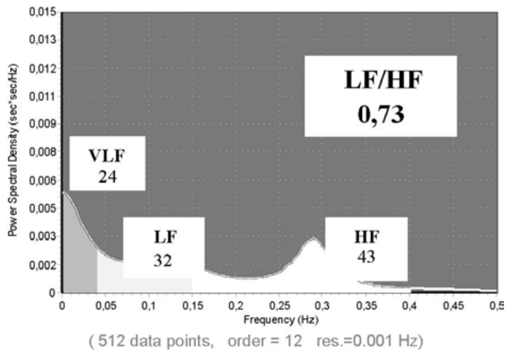
Moreover, the changes in the triangular index (TINN) were also analysed (Table 2 and Fig.3).

Tab.2. *Mean values of some HRV parameters in investigated groups*

Parameter	Position	Group A		Group B		Group C	
		mean	SD	mean	SD	mean	SD
HR [l·min^{-1}]	supine	71.2	8.4	63.5	10.4	71.9	11.5
	orthostatic	91.9	7.9	85.4	14.0	90.9	16.1
TINN [ms]	supine	379	134	337	119	216	130
	orthostatic	217**	65	249*	102	202	84
LF/HF[-]	supine	2.56	2.96	2.39	2.91	5.50	6.55
	orthostatic	11.83**	7.22	14.42	17.82	21.55	22.81

* - $p<0.05$ ** - $p<0.01$

A



B

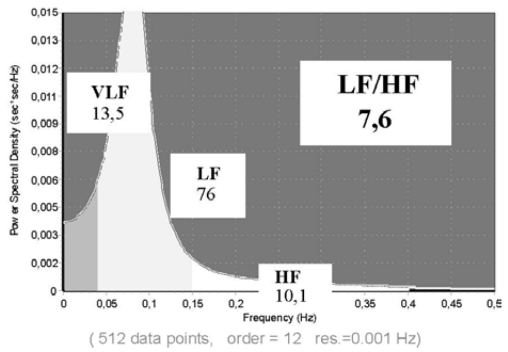


Fig.1. *LF/HF index during orthostatic test in rest /A/ and standing position /B/*

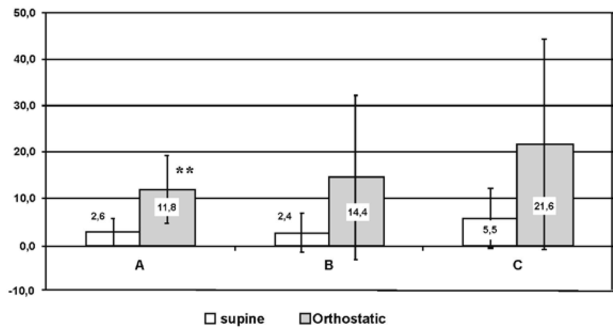


Fig.2. *Changes of LF/HF index in orthostatic test –group A, B and C*

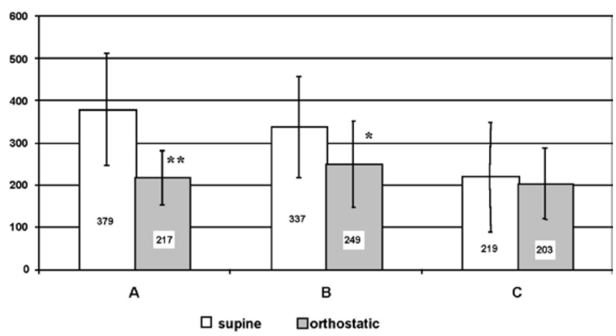


Fig.3. *Changes of TINN index in orthostatic test – group A, B and C*

TINN had the highest values in the group with short time of restitution, which points to high HRV. The lowest TINN values were found in the group with the slowest restitution of heart functioning . In all the groups examined assuming erect position resulted in a significant decrease in TINN index, which was most pronounced in the group A ($p<0.01$) with short time of restitution.

Discussion

The autonomic nervous system with sympathetic and parasympathetic components constitutes an essential part of the central nervous system.

The role of the sympathetic component is to mobilise the organism in stressful situations, which results in breathing and heart rate function enhancement, vasoconstriction and arterial blood pressure increase. Thus it dominates the parasympathetic part which inhibits these reactions. Activation changes in both parts of the autonomic system accompany various diseases including hypertension, diabetes, etc. (13).

The analysis of HRV is one of the methods used for non-invasive diagnosing of the autonomic system function. On evaluating RR-interval variability we can analyse frequency distribution of electrocardiological signals (7,8).

Physical activity favourably affects cardiovascular function and health as well as efficacy of vegetative regulation mechanisms. HRV evaluation during effort and functional tests allows us to indirectly estimate the status of the autonomic system regulating the cardiovascular system (14,15).

Numerous authors have observed that standing position causes changes in the indices determining activity of the vegetative sympathetic part. Similar observations were presented by Daniłowicz-Szymanowicz et al. (4)**.** Orthostatic resulted in a significant increase in the activity of the sympathetic component, what was manifested by the rise in heart rate, as well as in arterial blood pressure. In the HRV analysis, an increase in LF component has been recorded. Our investigations also have revealed LF value increase and HF decrease. The study by Stein et al. also demonstrated that in the course of further exercise test, i.e. prolonging the test, both during the effort and functional tests, HRV evaluation permits indirect assessment of the autonomic system (14,15).

The observed changes indicate adaptation of the organism to exercise test. Raczak et al. in their study have noticed that several month-training of sportsmen can induce changes in the autonomic profile in favour of parasympathetic component (3, 16,17). Piotrowicz considers these changes as one of the elements of primary cardiovascular disease prophylaxis (5).

Conclusions:

1. In subjects with a shorter time of circulatory restitution after exercise test, a more favourable status of the cardiovascular autonomic regulation was observed.
2. HRV analysis may be used as a supplement to fitness examinations and estimation of effectiveness of biological renewal in sport.

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Author's contribution
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection