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FEATURES OF THE HEART RATE VARIABILITY OF POWERLIFTERS UNDER THE INFLUENCE OF THE TRAINING PROCESS

ABSTRACT

Objective. To study the peculiarities of heart rate variability in powerlifters depending on the initial type of vegetative regulation under the influence of the training process and the performance of active orthotropic tests.

Material and methods. The study involved 38 men aged 18-25 years, involved in powerlifting. Registration of the cardiorhythmogram was performed using a vegetotester «VNS-Micro», and the treatment was carried out on the basis of the software package «Poly Spectrum» of Neurosoft Company (Ivanovo). The study included several stages: 1) recording the ECG (rhythmogram) in the initial state; 2) after performing the orthotropic test; 3) performing strength training with about maximal anaerobic power; 4) ECG (rhythmogram) recording after training; 5) performing an orthotropic test with subsequent registration of the rhythmogram.

Results. In response to the training load, the powerlifters with normovagotonic regulation have a shift in the vegetative balance toward the predominance of sympathetic activity. In powerlifters with this type of autonomic regulation in response to an orthostatic test before training, there is an increase in sympathetic and a decrease in parasympathetic activity, which indicates a high reactivity of regulatory mechanisms and reliable functional capabilities of the body liftlifters. In powerlifters with normosympathicotonic type of autonomic regulation in response to an orthostatic test before training, the time indices (SDNN, rMSSD, AMo, SI) do not change significantly, which indicates a low reactivity of the autonomic nervous system. At the same time there is an increase in VLF, which indicates the connection of the central department to regulate the rhythm of the heart. High voltage regulatory mechanisms before training, low reactivity of the autonomic nervous system, high centralization in the management of the heart rhythm indicate a low functional capacity of the body powerlifters with normosympotonic type of autonomic regulation.

The conclusion. The peculiarities of temporal and spectral parameters of heart rhythm in athletes engaged in powerlifting are revealed depending on the dominant type of vegetative regulation. It is shown that the same training load leads to different stresses of the regulatory mechanisms (according to the heart rate), depending on the dominance of the VNS department.

Keywords: variability of heart rhythm, type of vegetative regulation, orthostatic test, powerlifting, adaptation.

INTRODUCTION

Intense strength exercises require from the athlete's organism rapid changes in the heart rate (HR) and blood pressure (BP) required to support the metabolic needs of the motor apparatus. The cardiovascular system is given a special role, since it provides the oxygen needs of working muscles and the whole organism.

Despite numerous studies, the interaction between the functioning of the cardiovascular system, autonomic regulation mechanisms and physical activity requires further study. One of the available highly informative methods for studying the cardiovascular system is an orthostatic test [1].

Based on the concept of a two-loop model of cardiac rhythm control, four types of autonomic regulation of the heart rhythm were singled out: two with predominance of central regulation [moderate (type I) and pronounced (type II)] and two with predominance of autonomic regulation [moderate (type III) and expressed (type IV)] [2]. Taking as a basis classification not the divisions of the vegetative nervous system (sympathetic and parasympathetic), but the central and autonomous contours of the vegetative control of physiological functions, thereby confirmed participation in the processes of vegetative regulation of many links of a single regulatory mechanism.

This is a systematic approach to considering the most complex mechanism of regulation of physiological functions, which can be judged from the analysis of HRV. For the rapid assessment of the predominant type of vegetative regulation, quantitative criteria for the HRV parameters SI and VLF [3].

Material and methods of investigation

The study involved 38 men aged 18-25 years, involved in powerlifting. Registration of the cardiorhythmogram was performed using a vegetotester «VNS-Micro», and the treatment was carried out on the basis of the software package «Poly Spectrum» of Neurosoft Company (Ivanovo). The study included several stages: 1) recording the ECG (rhythmogram) in the initial state; 2) after performing the orthotropic test; 3) performing strength training with about maximal anaerobic power; 4) ECG (rhythmogram) recording after training; 5) performing an orthotropic test with subsequent registration of the rhythmogram.

Further, the temporal parameters of the heart rate were calculated and analyzed: heart rate (heart rate, beats / min); rms deviation of successive R-R intervals (SDNN, ms); standard deviation of the

Table 1

Evaluation of autonomic regulation of blood circulation

Moderate predominance of central regulation (Type I - normosympathicotonia)	SI >100 у.е., VLF >240 $мс^2$
Expressed predominance of central regulation (Type II hypersympathicotonia)	SI >100 у.е., VLF <240 $мс^2$
Moderate predominance of autonomous regulation (III type - normovagonotony)	20 >SI <100 у.е., VLF >240 $мс^2$
Expressed predominance of autonomous regulation (Type IV - hypervagonia) (disruption of the sinus node)	SI < 20 у.е., TP > 16000 $мс^2$, VLF > 500 $мс^2$

Table 2

Background HRV indices before and after training in normovagotonics (M ± m)

Try	Background (n=22)		p
	Before training	After training	
RRNN	871,10±18,26	688,2±32,39	0,001
SDNN	55,40±4,28	28,1±4,59	0,002
rMSSD	43,80±4,33	17,5±3,95	0,002
pNN50	22,95±4,34	3,23±1,51	0,001
TP	3607,6±605,52	1265,3±356,5	0,005
VLF	1421,5±237,60	449,03±108,14	0,002
LF	1086,7±202,48	511,02±140,29	0,028
HF	1099,6±292,22	305,02±121,04	0,013
LF norm	52,85±4,82	73,34±4,63	0,008
HF norm	47,15±4,82	26,65±4,63	0,008
LF/HF	1,38±0,30	4,99±1,67	0,009
%VLF	41,09±4,65	44,76±6,90	0,880
%LF	31,26±3,48	38,65±4,82	0,273
%HF	27,63±3,63	16,60±3,49	0,076
Mo	0,87±0,02	0,68±0,03	0,001
AMo	36,18±2,53	65,72±6,88	0,001
SI	63,08±7,42	528,71±171,90	0,001

Table 3

HRV indices in performing an orthostatic test before training in normovagotonics (M±m)

Try	Before training (n=22)		p
	Background	Orthotest	
RRNN	871,10±18,26	679,8±13,03	0,001
SDNN	55,40±4,28	46,9±3,11	0,150
rMSSD	43,80±4,33	21,9±2,85	0,001
pNN50	22,95±4,34	3,19±0,87	0,001
TP	3607,6±605,52	3209,9±402,73	0,940
VLF	1421,5±237,60	1099,3±134,98	0,364
LF	1086,7±202,48	1660,1±217,92	0,070
HF	1099,6±292,22	450,6±120,39	0,049
LF norm	52,85±4,82	80,64±3,16	0,001
HF norm	47,15±4,82	19,35±3,16	0,001
LF/HF	1,38±0,30	5,81±1,26	0,001
%VLF	41,09±4,65	36,15±3,66	0,406
%LF	31,26±3,48	51,12±3,01	0,001
%HF	27,63±3,63	12,74±2,60	0,007
Mo	0,87±0,02	0,68±0,02	0,000
AMo	36,18±2,53	45,03±1,62	0,013
SI	63,08±7,42	124,03±15,26	0,001

difference of consecutive R-R intervals (rMSSD, ms); frequency of consecutive R-R intervals with a difference of more than 50 ms (pNN50,%); amplitude of the mode (AMo,%); stress index (SI, condition unit).

The conventional notations for heart rate variability (HRV) indicators are presented in accordance with international HRV assessment standards and the applicable guideline standards. Based on the spectral analysis of HRV, the frequency parameters were calculated and analyzed: the total power of the spectrum (TR), the power in the high-frequency (HF, 0.16-0.4 Hz), low-frequency (LF, 0.05-0.15 Hz) and very low-frequency (VLF, <0.05 Hz) ranges. In addition, the LF / HF coefficient was calculated, reflecting the balance of sympathetic and parasympathetic regulatory influences on the heart. To assess the predominant type of vegetative regulation, quantitative criteria for HRV parameters were taken as the basis: SI and VLF [2].

For statistical processing of the obtained data and presentation of the results, the package «SPSS Statistics v.20» was used. With the normal distribution of the analyzed features, the average value (M) and the standard error of the mean (m) were calculated. When estimating the characteristics of spectral analysis of HRV having a distribution different from normal, nonparametric statistics methods were used. The reliability of the differences was assessed by the criteria of Mann-Whitney and Wilcoxon.

Results of the study and discussion

In response to the training load, the powerlifters with normovagotonic regulation have a shift in the vegetative balance toward a predominance of sympathetic activity, as indicated by a decrease in rMSSD, an increase in AMo and SI, and a shift in the LF / HF balance (Table 1). Characteristic is a significant reduction in power in all frequency ranges (VLF, LF, HF).

In powerlifters with this type of autonomic regulation in response to an orthostatic test before training (Table 2), there is an increase in sympathetic (increase in AMO, p = 0,013; SI, p = 0,001) and a decrease in parasympathetic activity (decrease in rMSSD, p = 0,001; HF, p = 0,049). This indicates a high reactivity of regulatory mechanisms and reliable functional capabilities of the body powerlifters.

Comparison of response rates to orthostatic effects before and after training showed the following. After training the results were significantly different (Table 3). Time indicators (rMSSD, p=0,010; AMo, p=0,008; SI, p=0,004), and spectral indicators (VLF, p=0,013; LF, p=0,005; HF, p=0,019) indicated the continuing tension of the regulatory mechanisms. This may demonstrate a sufficiently pronounced training load.

In normosymphathonics the training load was also accompanied by an increase in sympathetic activity (increase AMo, p=0,046; SI, p=0,024) and decrease parasymphatetic (decrease HF, p=0,016).). In this case equity contributions of VLF and LF don't change (Table 4). Also equity contributions of VLF and LF before training were more HF, which indicates a violation of regulatory mechanisms.

For powerlifters with normosymphathonics type of vegetative regulation in response to an orthostatic test before training. The time indices

Table 4

Background HRV indices before and after training in normovagotonics (M±m)

Try (n=22)	Orthotest		p
	Before training	After training	
RRNN	679,8±13,03	559,9±20,28	0,001
SDNN	46,9±3,11	27,1±3,60	0,003
rMSSD	21,9±2,85	11,6±2,76	0,010
pNN50	3,19±0,87	0,43±0,18	0,005
TP	3209,9±402,73	1359,9±323,12	0,007
VLF	1099,3±134,98	525,6±128,95	0,013
LF	1660,1±217,92	667,6±177,40	0,005
HF	450,6±120,39	166,57±67,96	0,019
LF norm	80,64±3,16	83,18±3,80	0,427
HF norm	19,35±3,16	16,82±3,80	0,427
LF/HF	5,81±1,26	8,67±2,55	0,427
%VLF	36,15±3,66	38,98±3,55	0,597
%LF	51,12±3,01	50,26±3,04	0,880
%HF	12,74±2,60	10,79±2,91	0,496
Mo	0,68±0,02	0,56±0,02	0,001
AMo	45,03±1,62	62,58±5,74	0,008
SI	124,03±15,26	440,95±123,73	0,004

Table 5

Background indicators before and after training in normosymphathonics (M±m))

Try	Background (n=16)		p
	Before training	After training	
RRNN	817,5±37,42	672,38±29,86	0,009
SDNN	35,63±2,22	23,38±3,18	0,012
rMSSD	24,86±2,22	12,63±2,98	0,016
pNN50	5,18±1,71	1,07±0,79	0,021
TP	1555,1±157,43	852,38±208,33	0,016
VLF	516,38±70,10	317,25±55,93	0,021
LF	671,5±101,79	380,98±134,85	0,021
HF	367,25±58,12	154,07±65,50	0,016
LF norm	64,33±3,68	75,23±4,48	0,074
HF norm	35,68±3,68	24,78±4,48	0,074
LF/HF	2,05±0,35	6,20±3,08	0,074
%VLF	33,85±4,33	45,54±6,40	0,074
%LF	42,29±3,26	40,75±4,99	0,834
%HF	23,88±2,92	13,71±3,08	0,036
Mo	0,81±0,04	0,67±0,03	0,027
AMo	48,09±3,06	61,86±5,57	0,046
SI	158,00±30,02	438,00±99,48	0,024

Table 6

Indicators of HRV during orthostatic test execution before training in normosymphathonics (M±m)

Try	Before training (n=16)		p
	Background	Orthotest	
RRNN	817,50±37,42	673,38±39,20	0,036
SDNN	35,63±2,22	42,38±5,86	0,430
rMSSD	24,86±2,22	17,38±2,87	0,092
pNN50	5,18±1,71	2,31±0,99	0,206
TP	1555,1±157,43	2840,3±640,70	0,208
VLF	516,38±70,10	1499,6±373,65	0,046
LF	671,5±101,79	1042,5±266,55	0,294
HF	367,25±58,12	297,93±81,21	0,345
LF norm	64,33±3,68	78,79±2,89	0,009
HF norm	35,68±3,68	21,21±2,89	0,009
LF/HF	2,05±0,35	4,19±0,54	0,009
%VLF	33,85±4,33	51,00±3,45	0,021
%LF	42,29±3,26	38,89±3,46	0,345
%HF	23,88±2,92	10,10±1,17	0,005
Mo	0,81±0,04	0,67±0,04	0,027
AMo	48,09±3,06	46,69±5,05	0,875
SI	158,00±30,02	190,15±49,65	0,916

Table 7

Indicators of HRV during the orthostatic test before training in normosymphathonics (M±m)

Try	Orthotest (n=16)		p
	Before training	After training	
RRNN	673,38±39,20	559,9±20,28	0,001
SDNN	42,38±5,86	27,1±3,60	0,003
rMSSD	17,38±2,87	11,6±2,76	0,010
pNN50	2,31±0,99	0,43±0,18	0,005
TP	2840,3±640,70	1359,9±323,12	0,007
VLF	1499,6±373,65	525,6±128,95	0,013
LF	1042,5±266,55	667,6±177,40	0,005
HF	297,93±81,21	166,57±67,96	0,019
LF norm	78,79±2,89	83,18±3,80	0,427
HF norm	21,21±2,89	16,82±3,80	0,427
LF/HF	4,19±0,54	8,67±2,55	0,427
%VLF	51,00±3,45	38,98±3,55	0,597
%LF	38,89±3,46	50,26±3,04	0,880
%HF	10,10±1,17	10,79±2,91	0,496
Mo	0,67±0,04	0,56±0,02	0,001
AMo	46,69±5,05	62,58±5,74	0,008
SI	190,15±49,65	440,95±123,73	0,004

(SDNN, rMSSD, AMo, SI) don’t change reliably (Table 5). This indicates a low reactivity of the autonomic nervous system. At the same time there is an increase of VLF domain (p=0,021), which indicates the connection of the central department for regulation of HR.

Comparison of HRV parameters of orthostatic effect before and after showed the following. A marked decrease of VLF (p=0,016), increase of LF norm (p=0,009), shift balance of LF/HF (p=0,009) towards sympathetic department of ANS (Table 6). High tension of regulatory mechanisms before training low reactivity of autonomic nervous system, high centralization in the management of the heart rhythm indicate a low functional capacity of powerlifter’s organism with this type of autonomic regulation.

Conclusion

The most informative method of studying the regulatory systems of the human body at the present time is the analysis of heart rate variability. Holding an orthostatic test before training allows to determine the functional state of sportsmen, and after training to assess the adaptive capabilities of the body. The intensity and severity of reaction of regulatory systems of powerlifter’s is determined by the initial vegetative tone.

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