DEVELOPMENT OF INNOVATION TECHNOLOGIES OF FUNCTIONAL DIAGNOSTICS IN THE SYSTEM OF OLYMPIC RESERVE TRAINING

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Special emphasis in the concept of development of physical culture and sport in Russian Federation for the period until 2005 is focused on the application of advanced scientific technologies in the practice of training of top-level sportsmen [1]. It is beyond the question that the technologies of quantum biophysics and medicine are the most modern scientific and technical achievements of the beginning of the XXI century [2, 3].

Based on the knowledge of quantum biophysics and information technologies, in 1999-2003 the complex method of conjugate "substrate" and quantum-field diagnostics of psychophysical potential of the human being and expert-diagnostic system "Quantum-Pro", has been developed.

Complex has passed tests in the scientific institutions of the North-West Olympic Academy of Russia.

Champions of Olympic games and top-level athletes of the Olympic Reserve colleges N 1, 2 and Center of Olympic training of St. Petersburg took part in the research, including 15 masters of sports of international class, 26 masters of sports, and 42 candidates for master of sport (middle age – 18.3±3.5 years). On the whole, more than 630 tests were performed in the sports focusing on endurance: modern pentathlon, triathlon, ski racing, skating, boar-racing, and swimming.

The results of application of GDV bioelectrography indicate that the top-level sportsmen show a number of characteristic features of patterns of induced optoelectronic emission (BEO-grams). First of all, their BEO-grams are distinguished by a relatively high degree of structuredness in comparison with control tested individuals (students of non-sport institutes of higher education of the same age). Maximal structuredness of BEO-grams was registered for the top-level swimmers. It is very important that BEO-gram parameters (area, fractal and entropy characteristics) significantly differed ($p < 0,05 - 0,01$) for the groups of sportsmen with different degree of functional readiness, which was determined basing on the data of tests by standard verifying methods. Multiparameter (correlation and factor) statistical analysis, carried out taking into account expert evaluation of effectiveness of competition activity of sportsmen, proved ($p < 0,05$) differential-diagnostic significance of BEO-gram parameters for the determination of psychophysical endurance of sportsmen.

Secondly, stable connection between BEO-gram parameters and genotypic characteristics of sportsmen, determining their physical endurance, was found in the course of research. In order to assess genotypic differences of sportsmen, the technique of identification of genotypes of angiotensinconverting ferment, developed in St. Petersburg Research Institute of Physical Culture by V.A.

Rogozkin, was used in joint research carried out together with the molecular genetics specialists [4].

The revealed patterns give grounds to suppose that the BEO-gram parameters, reflecting both "conservative" (genetic) and "labile" characteristics (actual functional state of sportsmen), can be applied as markers of prognostic value, characterizing psychophysical potential of sportsman's organism.

Moreover, the research in imitation modeling of conditions of competition activity (induced start state) demonstrates that the top-level athletes, distinguished by a high level of psychical readiness (according to the data of psychological examination), possess an ability to emergency ideomotor modulation of BEO-gram patterns. The discovered phenomenon shows itself in the increase of fragmentation of BEO-grams and in a number of cases in the formation of powerful outbursts of distant emission [5].

Taking into account all the abovementioned, in 2000 – 2001 specialists of the department of computer science of St. Petersburg Technical University developed a test sample of automated complex "Quantum-Pro" for screening assessment of psychophysical potential of top-level athletes.

The complex includes five blocks, enabling to evaluate psycho-physical potential (the level of psycho-physical reserves) of a sportsman:

- Valeometric block – assessment of the quality of health;
- Block of estimation of physical working capability;
- Psychometry block and assessment of psychic working capability;
- Block of assessment of vegetative and humoral regulation on the basis of method of variational cardiometry;
- Block of assessment of bioenergy potential on the basis of GDV bioelectrography technique (in the scale "redundancy of energy – norm – energy deficit").

Block of GDV-diagnostics is provided with two software packages "GDV APPS" and "GDV Pattern", designed for express-analysis of BEO-grams. Processing of data allows receiving individual characteristics of a sportsman's bioenergy potential practically and in real time scale, and further – obtaining of group rating for all the examined individuals, reflecting comparative level of functional readiness of sportsmen for competition.

The results of testing by hardware-software complex "Quantum-Pro" in the colleges of Olympic reserve of St. Petersburg in 2001 – 2002 give grounds to suppose that by synthesizing methods of "substrate" and biophysical diagnostics in "Quantum-Pro" system the possibilities of functional diagnostics in top-level sport are widened significantly.

These possibilities include, first of all, the personified express evaluation of psycho-physical functional reserves of a sportsman taking into account genetic predisposition. The second important factor which determines the significance of the developed technology is a possibility to objectively assess the psychic (mental) readiness of a sportsman and the capability of a sportsman to psycho-energy mobilization for a competition.

Among the approaches to the introduction of the developed complex technology of functional diagnostics into Olympic reserve training are: application in the system of selection of young sportsmen, operational control and monitoring of their psycho-physical state, and prognosis of successfulness of a competition.

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CORRELATION BETWEEN THE PARAMETERS OF INDUCED OPTO-ELECTRON EMISSION AND THE PROCESSES OF CORTICOVISCERAL REGULATION

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The present research aimed at analyzing physiological mechanisms, enabling to identify the peculiarities of patterns of induced opto-electron emission (hereinafter referred to as BEO-grams). The technique of combined study of the parameters of BEO-grams and the characteristics of wave structure of heart rate was used. Corticovisceral regulation of heart rate is quite well studied today, at that (1 – 3).

Methods of research and contingent of examined individuals.

1. Registration and computer analysis of processes of opto-electron emission with the help of hardware-software complexes "Corona TV" and "Compact", applying special programs "GDV APPS" and "Pattern 6" and distinguishing the following three groups of BEO-gram parameters:

a) Initial basic parameters: integral area – (JSR, JSL), fractality – (Fract. R, Fract. L) and entropy (Entr R, Entr);

b) Integral parameters "Pattern 6": general functional-energy index (GFEI), general level of energy deficit (GLED), and index of partial energy deficit (IPE);

c) Integral parameter in "GDV APPS" program – rating of the examined individuals by psycho-physiological potential.

Dynamic registration of BEO-grams in "GDV Video" program with the frame duration of 100 ms and video file duration of not more than 30 frames was performed in a number of research sessions.

2. Registration and determination of the heart rate variability by means of "Polar Electro OY" and "Heart-Tuner" cardio monitors in supine position in the state of relative physiological rest. The obtained results were mathematically processed in "Polar Precision Performance" and "Microsoft Excel" programs. Parameters of time domain, scattergram and histogram parameters were calculated. 0,05 s interval was used to built histograms. Apart from that, absolute and relative values of estimated power of spectrum of periodic fluctuations of heart rate in standard frequency ranges: ≤0.04 Hz – VLF, 0.04-0.1 Hz – LF, 0.1-0.4 Hz – HF were determined. Amplitude of estimated spectrum for all frequencies with 0.01 Hz step was calculated. On the whole, 65 BCP parameters were analyzed. 39 sportsmen of Olympic reserve (St. Petersburg Olympic Reserve College N 1) were examined; average age of the examined – 15.7 years; SD = 2.75 years. All the examined individuals were practically healthy sportsmen training in endurance sports.

Results of research.

About 1000 correlations coefficients were received as a result of correlation analysis. We managed to find out that the majority of BEO-gram parameters had significant correlations with the amplitude of spectral estimate of heart rate by way of filtering the obtained correlation coefficients at the level of significance 0.1, 0.05, and 0.01 consecutively. The most stable and statistically reliable correlation coefficients of basic and integral parameters of BEO-grams were observed in frequency zones 0.1-0.12 Hz and 0.27-0.28 Hz of spectrum of wave structure of the heart rate. However, the closest correlations were found between BEO-gram parameters and ratio of amplitudes of VLF zone and the zones of heart rate variability mentioned above (table N 1).

Table 1. Coefficients of correlation of GDV bioelectrography and BCP parameters (p≤0,01).

Parameters	Valid N	Spearman R	p-level
JS_R & S0,01%	39	0,47	0,0025
JS_R & S0,27%	39	-0,59	0,0001
Fract_L &	39	-0,48	0,0020

S0,01%			
Fract_R & S0,27%	39	0,42	0,0080
GFEI & S0,01%	39	0,51	0,0008
GFEI & S0,27%	39	-0,43	0,0059
GLE & S0,01%	39	-0,45	0,0044
IPE & S0,01%	39	-0,43	0,0062
Rating & S0,01%	39	0,52	0,0007
Rating & S0,27%	39	-0,45	0,0044

The following coefficients were calculated in order to check the correlation between this ration and BEO-gram parameters:

a) K1 = (sum of amplitudes of spectral zone 0-0.08)/(sum of amplitudes of spectral zone 0.09-0.4).

b) K2 = Amplitude 0.01 Hz/(sum of amplitudes 0.1 and 0.27 Hz).

c) K3 = (sum of amplitudes of spectral zone 0-0.08) - (sum of amplitudes of spectral zone 0.09-0.4).

Significant correlation of these coefficients with the majority of BEO-gram parameters was found (table 2).

Table 2. Correlation between GDV parameters and coefficients.

Parameters	Valid N	Spearman R	p-level
JS_L & K2	39	0,35	0,0313
JS_R & K1	39	0,48	0,0019
JS_R & K2	39	0,56	0,0002
JS_R & K3	39	0,49	0,0016
GFEI & K1	39	0,43	0,0064
GFEI & K2	39	0,48	0,0022
GFEI & K3	39	0,42	0,0079
GLE & K1	39	-0,32	0,0486

GLE & K2	39	-0,38	0,0171
GLE & K3	39	-0,32	0,0478
Rating & K1	39	0,39	0,0152
Rating & K2	39	0,46	0,0033
Rating & VLF/dX	39	0,34	0,0301
Rating & Index of Health	38	0,34	0,0391

The factor analysis proved the correlation between BEO-gram parameters and coefficients determining the ratios of power of the marked zones of spectrum of wave structure of heart rate (WSH).

Discussion

The results of research demonstrate that the parameters of opto-electron emission registered in the state of relative rest correlate with the wave structure of heart rate in frequency bands VLF (0.01Hz), and HF (0.27-0.28 Hz). Maximal intensity of relative value of amplitude in VLF spectral zone of wave structure of heart rate and minimal intensity of relative value of amplitudes in HF spectral zone correspond to the maximal values of JSL and JSR, as well as to GFEI and Rating. Inverse ratios are observed with fractality parameters and integral parameters of GLE and IPE.

The obtained data is fully proved by the correlations of K1, K2, and K3 coefficients (see above) with BEO-gram parameters. Dynamic registration of BEO-grams disclosed only periodic component within the range of 0.1 Hz, coinciding with LF frequency range of wave structure of heart rate: 0.1 – 0.12 Hz. There is good reason to believe that BEO-gram parameters are determined by the interaction of the mentioned mechanisms of corticovisceral regulation, taking into account that the correlation between the components of the heart rate spectrum within VLF zone and the processes of humoral-metabolic regulation, as well as between the components in LF and HF zones and processes of reflex sympatho-parasympathetic regulation (1, 2) was experimentally proved.

Summary

1. Basic and integral parameters of opto-electron emission (BEO-graphy) correlate both with the processes of humoral-metabolic regulation and with the processes of reflex regulation at the level of vegetative nervous system.

2. The power of processes of opto-electron emission (JS), stress-tolerance indices and general level of functional index increases (GLE) and energy deficit index (IPE) decreases when the activity of central (neurohumoral) component of autoregulation mechanisms increases.

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