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***The heart rhythm variability in students under a nervous - emotional
pressure***

Wpływ sytuacji stresowych na rytm pracy serca u studentów

It is well known, that examinations cause a significant nervous – emotional pressure among the students [5,14]. Therefore studying cardiovascular system reaction during examinations is an actual problem of physiology [7,9,10]. It is proved that parameters of individual rhythm variability allow objective estimation of cardiovascular system during a nervous – emotional pressure. The measurements and the analysis of these parameters are one of the most perspective techniques of evaluating the functional condition of cardiovascular system in humans [3,11,16]. The technique of variational cardiointervalography allows estimating objectively the state of neurohumoral mechanisms, the tone and reactance of vegetative nervous system, its internal and intersystem communications as well as the character and the orientation of cardiovascular system functional changes in the students during an examination. But many studies concerning this important problem are fragmentary. It is caused, firstly, by the definite vagueness of the nervous – emotional pressure as an object of research; secondly, by the use of separate sample statistics of cardiointervalography instead of its prolonged registration. Thirdly, there are technical restrictions limiting performance of cardiovascular system studies during an examination. Therefore the task of the work was to study the cardiovascular system reaction regarding the complex of variational cardiointervalography parameters in the students during their examinations.

MATERIAL AND METHODS

The investigation was carried out in w group of 40 persons aged 22-23. The heart rhythm regulation state and participation of different sections of vegetative nervous system (VNS) in it were defined with the help of variational cardiointervalography [2]. Measurements of the R- R intervals of the ECG were carried out with a method of infra-red beam scanning from lobe of the ear with the help of computer system "Prognoz" which works according to a specially developed program. Such technique of variational cardiointervalography allowed to register 500 R-R intervals in investigated persons in conditions of usual academic occupations (a state of relative rest) and during examination (a state of stress). The mathematical analysis included statistical, variational, autocorrelative and spectral processing of cardiointervals.

The statistical characteristic of dynamic cardiointerval line was carried out according to the parameters: a population mean (M), a root-mean-square deviation (SDNN), an error of average (m). Number characteristics of variational cardiointervalography were: moda (M_0), amplitude of moda (AM_0). An index of stress (IS), an index of vegetative balance (IVB), a vegetative parameter of rhythm (VPR) and the parameter of intimate rhythm pressure (PIR) were calculated [2].

The autocorrelation and spectral analysis were used for studying internal structure and an estimation of sinus rhythm periodic components [2, 8]. The physiological matter of autocorrelation analysis

consisted of an estimation of the degree and character of the central mechanisms influence on processes of individual rhythm self-control. Such parameters were used: CC_1 - correlation factor after the first cardiointervals shift, $CC_{0,3}$ - the amount of shifts to the value of correlation factor less than 0,3 and CC_0 - amount of shifts to the first negative value of correlation factor. Periodic components of individual rhythm fluctuations were studied behind parameters of spectral function (S_0) and ratio LF/HF [2, 12, 16]. Accordingly, S_0 displays participation of the higher brain structures, and LF/HF - balance of sympathetic and parasympathetic HNS sections in regulation of cardiovascular system. The registered parameters were processed with the help of software package Excel - 97.

Results and discussion.

The performed study proved that during a significant nervous – emotional pressure, as e.g. an examination, statistical, variational, autocorrelation and spectral heart rhythm parameters change. According to the data presented in table 1 it is obvious that the students' pulse increased significantly from $89,5 \pm 1,96$ beats/min in the state of relative rest up to $116,5 \pm 2,39$ beats/min during examination ($p < 0,001$).

Table 1. Statistical indexes of cardiac rhythm at the students in a state of relative rest and during an examination

Explored parameters	In a state of relative rest	During an examination	Significance of differences (P)
Pulse (beat/min)	89,5±1,96	116,5±2,39	<0,001
M (msec)	682,85±15,47	525,1±10,59	<0,001
SDNN (msec)	65,5±4,12	55,75±4,42	<0,01
m (msec)	2,92±0,18	2,48±0,19	<0,05

It is obvious, that such changes of heart rate during an examination were caused by activation of heart's vegetative regulation mechanisms. According to table 1 it is also visible, that statistics showings of M, m and SDNN during an examination decreased compared to the similar parameters determined in conditions of usual classes. Besides the variational pulsometer parameters: AM_0 , IVB and VPR ($p < 0,05-0,001$) increased significantly and Mo ($p < 0,001$) decreased simultaneously during an exam compared to the state of relative rest (table 2).

Table 2. Variation indexes of cardiac rhythm in the students in a state of relative rest and during an examination

Explored parameters	In a state of relative rest	During an examination	Significance of differences (P)
MO (msec)	653,0±16,34	490,0±10,0	<0,001
AMO (%)	36,67±2,13	42,12±1,54	<0,01
SI s.u.	94,3±14,71	152,8±17,3	<0,001
IVB s.u.	111,56±14,32	141,77±13,83	<0,05
VPR s.u.	4,41±0,4	6,71±0,57	<0,001
PIR s.u.	736,41±99,6	957,62±87,57	<0,01

Significant decrease of M, m, SDNN and M_0 parameters and simultaneous increase of AM_0 , IVB and VPR indicated the increase in the activity of sympathetic – adrenal system's function and indulgence of cholinergic mechanisms in heart regulation, strengthening of the energy metabolism, increase in oxygen delivery by the cardiovascular system for maintenance of brain intensive work capacity during a significant nervous – emotional pressure [8].

At the same time, we established that during a significant nervous – emotional pressure caused by the procedure of examination the SI parameter also increased. This parameter in a condition of relative rest was on the average $94,3 \pm 14,7$ s.u., and during examination it has significantly increased being $152,8 \pm 17,3$ s.u. ($p < 0,001$). Pressure index increase indicates the activity decrease of an independent contour and activity strengthening of vegetative nervous system higher centers in heart rhythm control. Validity of such an idea is confirmed by the fact that autocorrelation function parameters CC_1 , $CC_{0,3}$ and CC_0 and spectral function S_0 increased significantly compared to the relative rest state in the students during an exam ($p < 0,05-0,001$), (tab. 3).

Table 3. Indexes of autocorrelation and spectral functions of cardiac rhythm in students in a state of relative rest and during an examination

Studied parameters	CC1 s.u.	CC0,3s.u.	CC0 s.u.	S0 s.u.	LF/HF
In the state of relative rest	0,79±0,01	8,87±1,93	32,97±5,05	12,53±1,6	0,72±0,3
During examination	0,87±0,02	15,55±3,5	58,8±7,5	20,3±3,0	4,0±1,7
Significance of differences (P)	<0,01	<0,01	<0,01	<0,001	<0,001

The obtained results indicated participation of sub cortical centers in the heart rhythm regulation amplified during an exam. At the same time, S_0 increase in these conditions suggested increased participation of higher vegetative centers and neurohumoral mechanisms in regulation of the heart sinus functions [7].

According to the results of numerous studies, spectrum capacity parameters in low and high-frequency range display the vegetative centers activity of the medulla oblongata and hypothalamus, sympathetic and parasympathetic departments of HNS [1, 2, 4, 6, 7, 9, 15, 16]. Significant nervous – emotional loads demand activation of higher brain structures to control the heart rhythm. It is visible in strengthening of non-respiratory components of sinus arrhythmia, in appearance of slow waves with higher periods, in increase of their capacity.

Comparison of wave LF/HF correlation calculated for parameters which we have registered among the students in conditions of usual academic loading and during examination pointed to prevalence of NHS sympathetic section activity [7]. In the literature it is also stressed, that the increase in capacity of heart rhythm low-frequency component during emotional stress occurs on the account of heart sympathetic regulation hyperactivity [13]. The increase of low frequency wave capacity and increase of LF/HF factor in our researches can indicate for the benefit of brain cortex-limbic structures activity increase in the regulation of an individual rhythm in students during an examination.

CONCLUSIONS

1. The examination stress was accompanied by essential changes in regulation of cardiovascular system activity.
2. The activation of sympathetic – adrenal and depression of vagal – cholinergic mechanisms of an intimate heart rhythm regulation was established in students during examinations.

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SUMMARY

Cardiovascular system reaction of the students aged 22-23 was investigated according to the complex cardiographical parameters during a set of examinations. The obtained results suggest increasing activity of sympathetic and parasympathetic sections of vegetative nervous system on heart rhythm regulation at students during examinations.

STRESZCZENIE

Autorzy badali reakcję układu krążenia studentów w wieku 22 – 23 lata na stres, jakim były egzaminy sprawdzające wiedzę. Reakcja badanych zapisywana była jako zespół parametrów kardiograficznych. Wyniki badań dowodzą wzrostu aktywności współczulnej i przywspółczulnej w trakcie egzaminów.