UDC 616-085.33: 617.751.9

THE AUTONOMIC REGULATION OF HEART RATE IN YOUNG INDIVIDUALS WITH VISUAL DYSFUNCTIONS

I. V. Redka

V. N. Karazin Kharkiv National University, 4, Svobody Sq., Kharkiv 61022, Ukraine
e-mail: iredka@yandex.ru

Visual dysfunctions may cause changes in the autonomic regulation of heart rate due chronic social and emotional stress and because of direct influence of reduction visual inputs on higher autonomic centres. In this article the comparative analysis of the heart rate variability was performed in young people with congenital (n = 32) and obtained (n = 38) visual dysfunctions compared to sighted (n = 34). The results were interpreted with double-contour model for the heart rate autonomic regulation which was proposed by R.M. Baevsky (1968). Visual dysfunctions were characterized by changes in the autonomic regulation of heart rate, which are more pronounced in congenital pathology. It found that higher sensitivity to changes of autonomic regulation of heart rate in the presence of visual dysfunctions was observed in men. Young men with visual dysfunctions have the tension of heart rate regulation mechanisms due to an increased activity of the central regulation and the shift vegetative balance towards the sympathetic nervous system activity. Young women with visual dysfunctions have the tendency to increased activity of autonomous regulation and the shift vegetative balance towards the parasympathetic nervous system activity. In boys with congenital visual dysfunctions objective physiological signs of emotional stress were detected.

Keywords: autonomic regulation, heart rate variability, vision disfunctions.

INTRODUCTION

Psychological studies show that 50–90 % of visually impaired adults had signs of psychological distress that have been caused mainly psychological, social and domestic factors. Among these factors are prevalent such as frustration personality; incertitude in the safety; feeling of inferiority; fear of losing independence; ignoring the need for communication; stay in bounded space; excessive demands on oneself [3; 19; 24]. Other studies were demonstrated a higher values of personal and reactive anxiety in people with visual dysfunctions [3; 25].

It is well known that emotional stress causes to an excessive activation limbic and neocortical structures and the hypothalamic-pituitary-adrenal axis. However, chronic emotional stress causes to depletion of hypothalamic-pituitary-adrenal axis. Indeed, decrease the weight of the pituitary was found in rats with visual deprivation [21]. Moreover, a reduction in the concentration of adrenocorticotropic hormone and cortisol and slowing their metabolism were detected in patients with cataract [6; 13].

The cardiovascular system can be considered as a sensitive indicator of adaptive reactions of the whole organism. In particular, the heart rate variability (HRV) reflects a degree of regulatory systems activation during any stress influences or changes in the hypothalamic-pituitary-adrenal axis' activity. In fact, social [22] and psychological [26] stress causes lower HRV, decrease parasympathetic nervous system activity and increase of sympathetic nervous system activity.

Thus, we can anticipate changes of autonomic regulation of heart rate in people with visual dysfunctions because of chronic emotional stress.

Please note that respectively to modern data visual dysfunctions also can affect an autonomic regulation of heart rate via reduce visual inputs on higher autonomic centers through polysynaptic pathways. Traditionally, the light effects on heart are associated with a regulation of circadian oscillations of heart rate via hypothalamic suprachiasmatic nucleus [5]. However in recent years there is growing evidence that physiological light effects can be realized via mechanisms independent of the circadian synchronization processes [14; 23].

In simplified form, non-circadian physiological effects of light on the autonomic regulation of heart rate realized through polysynaptic excitation glutamate-ergic projection from the retina to (1) the "pre-autonomic" [7] hypothalamic neurons that affect the autonomic centers of the brain stem and spinal cord, as well as (2) neuroendocrine hypothalamic centers responsible for the hormones secretion [5]. The first pathway is associated with projections from the suprahiazmatic nucleus to the parvocellular GABA-ergic neurons of paraventricular nucleus in hypothalamus. These cells project to the sympathetic regulation centers in medulla oblongata and the intermediolateralis of the spinal cord where rising preganglionic fibers to the heart [7; 23]. The second pathway is associated with projections from the intergeniculate leaflet to the neuroendocrine cells of paraventricular nucleus in hypothalamus. These neuroendocrine cells secrete dopamine and have direct access to fenestrated capillaries and thus affect the secretion of hormones adenohypophysis [7; 14]. The adrenocorticotropic hormone secretion cause changes of catecholamine secretion that can affect the heart via adrenergic receptors.

As stated previously, HRV can be used as an accurate indicator of the balance of autonomic regulatory influences on the heart and autonomic responses to stress. Given this we have defined the aim of our study which was to detect physiological markers of emotional stress and features of autonomic regulation of heart rate in young people with visual dysfunctions.

MATERIALS AND METHODS

104 young people were involved in the study. They were divided into three groups: 1) sighted (control); 2) congenital bilateral visual dysfunctions; 3) obtained bilateral visual dysfunctions (Table 1).

The study was carried out in accordance with the national bioethics norms and statements of the Helsinki declaration (re-edited in 2008, 2013). Verbal and written informed consents were obtained from all participants and their parents respectively after a complete description of the study.

In order to standardize conditions of visual stimulation studies were conducted in a darkened room. The participants were in a sitting position during resting-state with eyes closed. ECG was recording in appropriate channel computer electroencephalograph

”DX-5000” (SPE ”DX-system”, Kharkiv) for 2.5 min. The analysis of HRV parameters was implemented in software module ”NeuroResearcher®-Cardio-Tension-Test® Innovation Suite“ (Institute of Medical Informatics and Telemedicine, Kharkiv) according to recommendations [2].

Table 1. **Groups' characteristics of the research participants**

Таблиця 1. **Характеристика груп учасників дослідження**

Group	Gender	Age, years	Noncorrected visual acuity		Corrected visual acuity	
			left eye	right eye	left eye	right eye
Congenital visiual disfunctions	men (n=14)	18.14±0.28	0.05±0.02	0.06±0.02	0.09±0.03	0.09±0.03
	women (n=18)	17.35±0.51	0.06±0.02	0.05±0.02	0.11±0.03	0.10±0.03
Obtained visual disfunctions	men (n=12)	17.28±0.27	0.75±0.07	0.72±0.09	0.85±0.09	0.82±0.08
	women (n=26)	17.30±0.24	0.30±0.04	0.38±0.05	0.48±0.05	0.60±0.06
Control	men (n=12)	17.50±0.18	1.00±0.00	1.00±0.00	1.00±0.00	1.00±0.00
	women (n=22)	16.59±0.17	1.00±0.00	1.00±0.00	1.00±0.00	1.00±0.00

The average duration of cardiac cycle (Mean), the mode (Mo), the amplitude mode (AMo), the spread of variations (ΔX), the variation coefficient (CVr), percents of cardio intervals pairs with a difference of duration more than 50 ms (pNN50), the total spectral power (TP), the absolute spectral power of very low frequency (VLF), low frequency (LF) and high frequency (HF) components and its relative spectral power (according VLF %, LF %, HF %), its normalized spectral power (LFn, HFn), the sympathetic-vagal balance index (LF/HF), the time of response period higher vegetative centers (VLFt), the time of baroreflex response (LFt), the centralization index (IC), the index of subcortical centers activity (IASC), the stress index (SI), the index of vegetative balance (IVB), the vegetative index of rate (VIR), the indicator of the adequacy of the regulation processes (IARP), the coefficient of correlation after the first shift (CC1), the number of landslides autocorrelation functions to achieve value correlation coefficient equal to 0 (SS0), the first value of the spectral function (S0) were analyzed in this research [2].

Additionally, we calculated two indices proposed by O. Mayorov: the “anxiety” index (IA), the “anxiety reaction type” index (ART_{index}) [16].

Intergroup comparison of subjects with different state of the visual functions was performed using the nonparametric Wilcoxon–Mann–Whitney *U*-test.

RESULTS AND DISCUSSION

We noted that the interpretation of HRV parameters was carried out with double-contour model of regulation of heart rate that was proposed R.M. Baevsky (1968). This model based on the concept of HRV as a result of effects on the cardiovascular system of numerous regulatory mechanisms (neural, humoral, reflex). In this model there are two interrelated contours of autonomic regulation of heart rate. A central regulation contour represented the limbic and neocortical structures (cortical regulatory level A), higher autonomic centers videlicet hypothalamic-pituitary axis (intersystem regulatory level B) and subcortical cardiovascular center (intrasystem level C). An autonomous regulation contour represented the sinoatrial node, the vagus nerve and its nuclei in the medulla oblongata. This contour reflects the activity of the parasympathetic nervous system [2].

Central contour regulation of heart rate (by R.M. Baevsky) corresponds to a central autonomic network [4] and autonomous contour (by R.M. Baevsky) corresponds to the parasympathetic autonomic nervous system in English-language publication. Given this, in our article we use the terms "central" and "autonomous" regulation of heart rate, respectively.

The increasing activity of the highest levels of central regulation of heart rate corresponds to a stress (tension) state of autonomic regulation. This fact is indicating reduction functional reserves of the organism [2].

Based on the research [10], we not expected any significant gender differences in autonomic regulation of heart rate in young people. Indeed, the results of our study confirmed the validity of this assumption for sighted people, while among those with visual dysfunctions the significant gender differences in HRV were found. Therefore, to determine the characteristics of autonomic regulation of heart rate in people with visual dysfunctions we conducted further analysis of HRV parameters for men and women separately.

It was established that the HRV parameters values within gender groups versus control were changed unidirectional (except AMo, pNN50, HF %, LF/HF, IC) or multidirectional in people with congenital or obtained visual dysfunctions respectively. Significant changes in autonomic regulation of heart rate versus control were found only in men with visual dysfunctions.

The analysis of HRV time parameters (Table 2) showed a significant increase of functioning level in sinus node in men with congenital and obtained visual dysfunctions (Mean by 15.9 %, $P \leq 0.001$, and 10.1 %, $P \leq 0.05$; Mo by 15.9 %, $P \leq 0.001$, and 11.7 %, $P=0.08$, respectively). Other HRV time parameters indicated an increase of sympathetic nervous system activity (lower values of SDNN by 46.1 %, $P \leq 0.001$; CVr by 36.4 %, $P \leq 0.05$; AMo by 33.0 %, $P \leq 0.01$) and a decrease of parasympathetic activity (lower values of ΔX by 33.1 %, $P \leq 0.01$; pNN50 by 72.7 % $R \leq 0.001$). The similar trend was observed in men with obtained visual dysfunction, but only decreasing values of pNN50 (41.7 %) has approached to statistical significance level ($P=0,052$). This indicated a lower parasympathetic nervous system activity in men with obtained visual dysfunction.

The HRV time parameters have indicated an opposed trend ($P>0.05$) to a lower value of AMo (24.5 %) and greater value pNN50 (18.5 %) there was in women with congenital visual dysfunctions versus sighted (Table 2). These facts indicated an increased activity of autonomous regulation of heart rate. Major changes were found in values of SDNN, ΔX, CVr (greater by 29.0, 25.3 and 21.9 %, respectively, $P> 0.05$) in women with obtained visual dysfunction. These results indicated a tendency to slightly higher level of parasympathetic nervous system activity in women with obtained visual dysfunctions.

It found that HRV in young people with visual dysfunctions characterized by a tendency to lower values of absolute activity of regulatory systems. This trend has gained significance level of men with congenital visual dysfunctions (Table 3), reaching 59–80 % decline ($P \leq 0.05$) versus control. We can argue that visual dysfunctions in young people causes to tension of autonomic regulation of heart rate. Moreover, formation of vegetative dysfunctions was found in men with congenital visual dysfunction.

Table 2. **HRV time parameters in young people with visual dysfunctions**

Таблиця 2. **Часові параметри ВСР у осіб юнацького віку з зоровими дисфункціями**

Parameters	Congenital visual dysfunctions	Obtained visual dysfunctions	Control
Men			
Mean, sec	0.75±0.03***	0.80±0.04*	0.89±0.02
Mo, sec	0.74±0.03***	0.78±0.05	0.88±0.04
AMo, %	12.67±1.19**	10.32±0.89	9.53±0.89
∆X, sec	0.24±0.04**	0.32±0.06	0.36±0.03
CVr, %	5.35±0.44*	7.67±1.21	8.41±0.95
SDNN, sec	0.04±0.00***	0.06±0.01	0.07±0.01
pNN50, %	11.40±4.49***	24.37±7.66	41.78±6.64
Women			
Mean, sec	0.84±0.02	0.83±0.04	0.85±0.03
Mo, sec	0.85±0.02	0.88±0.07	0.86±0.03
AMo, %	9.85±0.85	12.07±1.77	13.04±3.16
∆X, sec	0.30±0.02	0.38±0.08	0.30±0.03
CVr, %	7.08±0.57	9.16±2.19	7.51±0.69
SDNN, sec	0.06±0.01	0.08±0.03	0.06±0.01
pNN50, %	37.34±7.04	36.36±6.48	31.52±4.32

Comment (here in after): significant differences from the control indicated by asterisks at the next P-levels: * – P ≤ 0.05; ** – P ≤ 0.01; *** – P ≤ 0.001.

Примітка (тут і далі): зірочками позначені достовірні відмінності з контролем у таких Р-рівнях: * – P ≤ 0,05; ** – P ≤ 0,01; *** – P ≤ 0,001.

Table 3. **The level of regulatory systems activity in young people with visual dysfunctions**

Таблиця 3. **Рівень активності регуляторних систем у осіб юнацького віку з зоровими дисфункціями**

Parameters	Congenital visual dysfunctions	Obtained visual dysfunctions	Control
Men			
TP, ms²	826.86±178.69**	1987.00±619.19	3204.33±701.98
VLF, ms²	110.00±18.63***	378.67±140.05	467.08±117.89
LF, ms²	343.00±99.84*	736.33±210.83	838.33±160.53
HF, ms²	373.86±68.74**	872.00±276.88	1899.00±509.22
Fameles			
TP, ms²	1768.56±319.96	1730.08±349.11	2643.05±607.79
VLF, ms²	223.22±26.86	291.42±71.99	383.45±111.32
LF, ms²	513.89±66.89	500.42±97.91	772.23±174.39
HF, ms²	1031.56±267.66	938.50±220.53	1487.41±401.23

A spectral structure of cardio intervals and a normalized spectral power provides valuable information on an activity of various aspects of the heart rate autonomic regulation. We observed greater values of relative (by 32.5 %, P≤0.05, and 29.3 % P≤0.01, respectively) and normalized low frequency power spectrum (by 28.5 %, P≤0.05, and 32.7 %, P≤0.01, respectively) and lower values of relative (by 14.2 %, P>0.05, and 20.3 %, P≤0.05, respectively) and normalized (by 15.5 %, P≤0.05, and 17.7%, P≤0.01, respectively) high frequency power spectrum at range in boys with congenital and obtained visual dysfunctions (Fig. 1, *A*). We can state that in men with visual dysfunctions versus control a significant effect on heart rate regulation provides intra-system level (vasomotor) of the central regulation amid reducing effects of the parasympathetic nervous system. This thesis confirmed in the significantly greater values of sympathetic-vagal balance index in men with congenital and obtained visual dysfunctions (by 53.4 % P≤0.05, and 55.3 % R≤0.01, respectively) versus control.

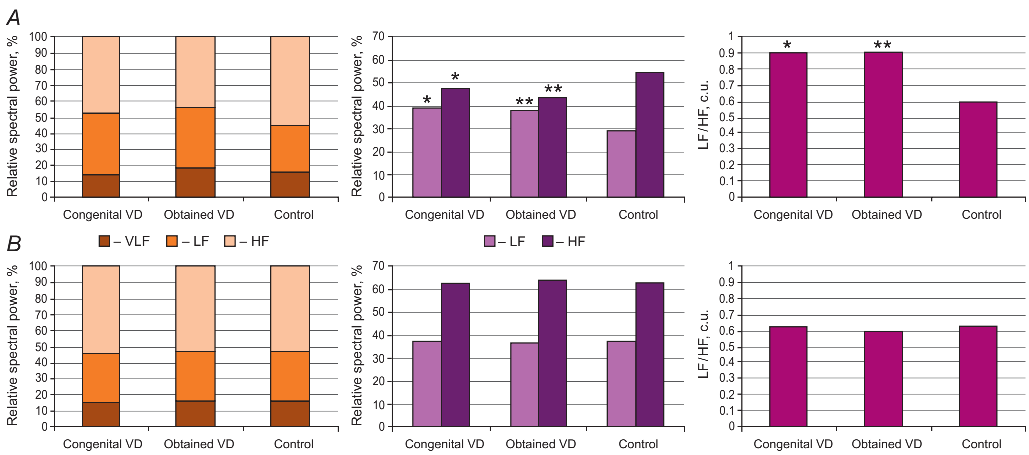

Fig. 1. HRV spectrum structure and the value of sympatethic-vagal balance in young people with visual dysfunctions: *A* – men; *B* – women; VD – visual dysfunctions

Рис. 1. Структура спектра ВСР і значення симпато-вагального балансу осіб юнацького віку з зоровими дисфункціями: *A* – юнаки; *B* – дівчата; VD – зорові дисфункції

It was noted that significant changes in relative very low frequency spectral power not been established in men with visual dysfunctions versus sighted, but they were multidirectional character in men with congenital and obtained visual dysfunctions. Thus, lower value of relative very low frequency spectral power was found in men with congenital visual dysfunctions and its greater value was detected in men with obtained visual dysfunctions. These data indicates a trend to decreasing or increasing of the central regulation effects on intersystem level respectively. Thus, men with obtained visual dysfunctions characterized by most activation of highest levels of central regulation of heart rate than men with congenital visual dysfunctions versus control. These effects confirmed in the values of the centralization index (Table 4): its significant greater value versus control was found in men with obtained visual dysfunctions (by 49.6 %, P≤0.05).

Significant differences in HRV spectral structure were not found in women with visual dysfunctions (Fig. 1, *B*). We can note that HRV in women with congenital visual dysfunctions reflects a tendency to reduce regulatory effects of intersystem level in central regulation HRV.

Table 4. **HRV Integrative indices in young men with visual dysfunctions**
Таблиця 4. **Інтегративні показники ВСР у юнаків із зоровими дисфункціями**

Parameters	Congenital visual dysfunctions	Obtained visual dysfunctions	Control
Spectral index			
IC, c.u	1.22±0.18	1.36±0.19*	0.91±0.13
IASC, c.u	0.39±0.05	0.49±0.05	0.57±0.08
VLFt, ms	597.14±13.44	393.35±71.86	432.38± 108.29
LFt, ms	24.79±4.15	34.15±4.75	29.19±6.15
Autocorrelation analysis parameters			
CC1, c.u.	0.70±0.04*	0.67±0.09	0.54±0.06
CC0, c.u.	4.57±0.57	10.00±3.15	6.58±1.92
S_0, c.u.	0.001±0.001*	0.010±0.004	0.015±0.005
Indexes by R.M. Bayevsky			
SI, c.u.	42.75±9.09**	27.15±7.59	16.70±2.21
IVR, c.u.	61.11±11.76**	42.17±12.25	29.47±3.85
VPR, c.u.	6.36±0.89**	4.86±0.96	3.49±0.35
PAPR, c.u.	17.43±2.06***	13.50±1.42*	10.65±0.72
Indexes by O.Yu. Mayorov			
IA, c.u.	358.00±78.95***	207.50±51.08	155.42±25.69
ARTindex, c.u.	500.71±120.08***	267.33±62.93	175.67±28.94

Values of spectral indices (Table 4) revealed the tended to decreasing activity of subcortical cardiovascular center and deceleration of its reflex response in men with visual dysfunctions. This tendency was pronounced in men with congenital pathology (by 30.5 %, P=0.067 and 51.8 %, P=0.095 respectively). Values of the spectral indices didn't differ in women groups.

Values of autocorrelation analysis parameters (Table 4) also indicated lower activity of autonomous regulation (CC1 greater by 29.6 %, P≤0.05) and intersystem level (S0 less on 90.5 %, P≤0.05) of heart rate regulation in men with congenital visual dysfunctions. Only a trend to decreasing activity of autonomous regulation (CC1 greater by 24.2 %, P=0.089) was observed in men with obtained visual dysfunctions.

It was found that significantly (P≤0.01) higher values of all indexes by R.M. Baevsky were observed only in men with congenital visual dysfunction. This fact indicated a higher total value of sympathetic regulatory effects on HRV and increasing a contribution of humoral factors in the formation of stress state. Given this, we can say that men with visual dysfunctions have a stress (tense) state of the autonomic regulation of the heart rate, which may be a manifestation of non-specific mechanisms of general adaptation process.

The trend to a greater values of all indexes by R.M. Baevsky versus sighted also was observed in young men with obtained visual dysfunction, although significant changes were detected only on parameters of adequacy regulation processes (greater by 26.7% P≤0.05), vegetative index rate (greater by 39.1%, P = 0.068) and stress index (greater by 62.6%, P=0.089). These data reflects the shift of vegetative balance in autonomous regulation toward sympathetic activity and enhance of humoral factors contribution in the heart rate regulation.

When calculating indices by R.M. Baevsky we must take into spread variation of cardio intervals times, making them susceptible to „emissions". In order to address shortcomings of these indexes O.Yu Mayorov proposed the indexes of „anxiety" and „anxiety reaction type". Formulas of these indexes are similar to indexes by R.M. Baevsky but we must use the standard deviation of cardio interval times for their calculation [16].

It was established that men with congenital visual dysfunctions had significantly greater values of indices of „anxiety" (by 130.3 %, P≤0.001) and „anxiety reaction type" (by 185.0 %, P≤0.001) while men with obtained visual dysfunctions had only significantly greater value of „type of anxiety reaction" index (52.2 %, P=0.089). These results reaffirmed our conclusions above enhance contribution of humoral factors in the heart rate regulation in men with visual dysfunctions. Also, the total value of sympathetic regulatory influences was increased in men with congenital visual dysfunctions.

Significant differences in the values of HRV integrative indicators versus sighted were not found in women with visual dysfunctions. However, a tendency (P> 0.05) to decrease values of CC0 (by 33.2 %), S_0 (by 31.6 %), IVB (by 23.8 %), IAPR (by 18.2 %), SI (21.1 %), IA (19.2%), ART_{index} (17.6 %) versus control was observed in women with congenital visual dysfunctions. Given this we can state to presence of tendency to higher values of parasympathetic regulatory influences and nervous regulatory influences against the lower activity of central regulation by decreasing of influences from intersystem regulation level to heart rhythm.

It was found that women with obtained visual dysfunctions had a tendency (P> 0.05) to a decreased value of CC1 (by 14.1 %) and increasing values of S_0 (by 76.0 %), ART_{index} (13.1 %) versus sighted. These facts indicates to trend of higher activity of autonomous regulation, intersystem regulation level and humoral factors contribution in heart rate regulation in women with obtained visual dysfunctions.

Thus, features of heart rate autonomic regulation in young people with visual dysfunctions were detected in our research. These features were characterized for men (versus women) and congenital (versus obtained) pathology clearly. Our data on the activation of highest levels of central regulation of heart rate and sympathetic activity in men with visual dysfunctions are consistent with other research of visually impaired children [16; 18]. At the same time, our data to reduce the absolute activity of autonomic regulatory systems in young men with visual dysfunctions conflict with dates by M.S. Goncharenko et al. (2012) [13]. May be the reason of the conflict are absence of dates of visual acuity, age and gender.

In our opinion, revealed changes in the heart rate autonomic regulation in young people with visual dysfunctions were caused by reduction of visual inputs to cerebral structures. Direct retino-hypothalamic, geniculo-hypothalamic and retino-pituitary tracts is structural preconditions for effects implementation of reduce visual inputs on higher vegetative centers activity. This supposition is confirmed by the detected decrease in intersystem level activity of heart rate regulation (lower S0, VLF, IASC) in men with congenital visual dysfunctions versus sighted. Higher vegetative centers, i.e. the hypothalamic-pituitary system, are structural elements of the intersystem level of heart rate regulation.

Thus, the negative effect of visual deprivation (congenital cataract) on the state of the hypothalamic-pituitary-adrenal system in children is based on reducing cortisol reserve [6; 13]. A decreasing of pituitary weight during visual deprivation in rats was reported [19].

We found greater sensitivity of physiological systems to sensory dysfunction in men that also were detected by others authors [16; 18]. Results of experiments on rats showed greater resistance to adverse factors in women [9].

These results may explain from the positions of evolutionary theory of sex by S.V. Geodakyan (2011), according to which evolutionary women mission is to preservation of genetic information accumulated in the phylogeny [11]. At the same time evolutionary men mission is connectivity with the environment and the transfer new information from the environment to the population, i.e. a genetic information change [11]. This causes a broader reaction norm in women and its narrowing in men that can be explained of cyclical sex hormones fluctuations in women. However, our previous study [18] found a gender effects of visual dysfunctions in the vegetative heart rate regulation in the childhood (4–6 ages), when hormonal cyclist is not expressed. Therefore, we can assume that these effects are associated with differences in the effects of sex hormones on neurotransmitter systems of the brain.

It is already known that estrogens have a higher effect of the regulation ascending cholinergic projections from the forebrain base to the cerebral cortex and neuroprotective and neurotrophic activity [1]. These data may be able to explain of less sensitivity in women to visual inputs reduction.

Experimental data [17; 27] showed that stress reduces dopamine activity in the frontal cortex in men, but not women. As is well known dopamine inhibits nerve transmission in the sympathetic nervous system. This may be one reason for the activated of highest levels of central contour regulation of heart rate and increased sympathetic nervous system activity in young men with visual dysfunction.

CONCLUSION

Visual dysfunctions were characterized by changes in the autonomic regulation of heart rate, which are more pronounced in congenital pathology. It found that higher sensitivity to changes of autonomic regulation of heart rate in the presence of visual dysfunctions was observed in men.

Young men with visual dysfunctions have the tension of heart rate regulation mechanisms due to increased activity of the central regulation and the shift vegetative balance towards the sympathetic nervous system activity. In young men with congenital visual dysfunctions detected objective physiological signs of emotional stress such as lower HRV, greater values of sympathetic-vagal balance index, “anxiety” index and “anxiety reaction type” index.

Young women with visual dysfunctions have a tendency to increased activity of autonomous regulation and the shift vegetative balance towards the parasympathetic nervous system activity.

1. *Arushanyan E.B.* Influence of the hypothalamic-pituitary and ovarian hormonal drugs on cognitive brain activity. **Russian J. of Psychiatry**, 2005; 2: 56-61. (In Russian).
2. *Baevsky R.M., Ivanov G.G., Chireykin L.V.* et al. Analysis of heart rate variability using different electrocardiographic systems (guidelines). **Bulletin Arrhythmology**, 2001, 24: 65–87. (In Russian).
3. *Belinsky A.V., Momot V.A.* **Psychological features of the visually impaired.** Moscow: RRC M.A. Sholokhov MSOPU, 2006. 184 p. (In Russian).
4. *Benarroch E.* The central autonomic network: functional organization, dysfunction, and perspective. **Mayo Clin. Proc**, 1993; 68: 988–1001.
5. *Buijs R.M., van Eden C.G., Goncharuk V.D., Kalsbeek A.* The biological clock tunes the organs of the body: timing by hormones and the autonomic nervous system. **J. Endocrinology**, 2003; 177: 17–26.
6. *Balacco-Gabrieli C., Mastrandea G., Acquafredda A.* et al. Congenital cataract and evolutive myopia. Relationship with hypophyseal-adrenal cortical axis function. **Ophthalmic Paediatr Genet**, 1986; 7(1): 63–67.
7. *Feetham C.H., Barrett-Jolley R.* NK1-receptor-expressing paraventricular nucleus neurones modulate daily variation in heart rate and stress-induced changes in heart rate variability. **Physiol. Rep**, 2014; 2(12), pii: e12207, 9.
8. *Fu Y., Liao H.-W., Tri M., Do H., Yau K.-W.* Non-image-forming ocular photoreception in vertebrates. **Current Opinion in Neurobiology**, 2005; 15(4): 415–422.
9. *Gagliano H., Nadal R., Armario A.* Sex differences in the long-lasting effects of a single exposure to immobilization stress in rats. **Horm. Behav**, 2014; 66(5): 793–801.
10. *Galeev A.R., Igisheva L.N., Kazin E.M.* Healthy children from 6 to 16 years' heart rate variability. **Bulletin of V.N. Karazin Kharkiv National University. Series Medicine**, 2002; 3(545): 35–40. (In Russian).
11. *Geodakyan S.V.* **Two sexes. And why? Evolutionary Theory of Sex**. Moscow, 2011. 230 p. (In Russian).
12. *Goncharenko M.S., Martynenko I.G., Nosov K.V., Martynenko V.V.* Methodical approaches to the estimation of adaptation of students with visual impairments. **Bulletin of V.N. Karazin Kharkiv National University. Series Biology**, 2012; 16(1035): 159–164. (In Russian).
13. *Hollwich F.*, *Dieckhues B.* Effect of light on the eye on metabolism and hormones. **Klin. Monbl. Augenhelkd**, 1989; 195(5): 284–290. (In German).
14. *Horvath T.L.* An Alternate Pathway for Visual Signal Integration into the Hypothalamo-Pituitary Axis: Retinorecipient Intergeniculate Neurons Project to Various Regions of the Hypothalamus and Innervate Neuroendocrine Cells Including Those Producing Dopamine. **J. Neurosci**, 1998; 18(4):1546–1558.
15. *Kokoreva E.G.* Age features of heart rate regulation in preschool and early school age with visual impairment. **Bulletin of the South Ural State University: Education, health, physical education and sport**, 2003; 5(b): 99–102. (In Russian).
16. *Mayorov O.* Some methodical and methodological approaches to the mathematical analysis of heart rate in a emotionally intense activity and emotional stress. In: **Health Diagnostics**. Voronezh Univ. VSU, 1990: 142–143. (In Russian).
17. *Murray H.E., Pillai A.V., McArthur S.R.* et al. Dose- and sex-dependent effects of the neurotoxin 6-hydroxydopamine on the nigrostriatal dopaminergic pathway of adult rats: differential actions of estrogen in men and women. **Neuroscience**, 2003; 116(1): 213–222.
18. *Red'ka I.V.* **The functional state of cardiorespiratory system of visually impaired children.** Kherson: Ailant, 2011. 172 p. (In Ukrainian).
19. *Rees G., Saw C.L., Lamoureux E.L., Keffe J.E.* Self-management programs for adults with low vision: needs and challenges. **Patient Educ. Couns**, 2007; 69(1–3): 39–46.
20. *Ross M.J., Guthrie P., Dumont J.C.* The impact of modulated, colored light on the autonomic nervous system. **Adv. Mind. Body Med**, 2013; 27(4): 7–16.

21. *Sánchez-Barceló E.J., Mediavilla M.D., Sánchez-Criado J.E.* et al. Antigonadal actions of olfactory and light deprivation. I. Effects of blindness combined with olfactory bulb deafferentation, transection of vomeronasal nerves, or bulbectomy. **J. Pineal Res**, 1985; 2(2): 177–190.
22. *Shahrestani S., Stewart E.M., Quintana D.S.* et al. Heart rate variability during adolescent and adult social interactions: A meta-analysis. **Biol. Psychol**, 2015; 105C: 43–50.
23. *Scheer F.A.J.L., Ter Horst G.J, Van Der Vliet J., Buijs R.M.* Physiological and anatomic evidence for regulation of the heart by suprachiasmatic nucleus in rats. **Am. J. Physiol. Heart Circ. Physiol**, 2001; 280: 1391–1399.
24. *Scott I.U., Schein O.D., Feufer W.J.* et al. Emotional distress in patients with retinal disease. **Am. J. Ophtalm**, 2001; 131: 584–589.
25. *Shimgaeva A.N.* The phenomenon of anxiety and correction emotional sphere disorders in the visually impaired teenagers. **Defectology**, 2007; 2: 31–37. (In Russian).
26. *Visnovcova Z., Mestanik M., Javorka M.* et al. Complexity and time asymmetry of heart rate variability are altered in acute mental stress. **Physiol. Meas**, 2014; 35(7): 1319–1334.
27. *Zhou W., Cunningham K.A., Thomas M.L.* Estrogen regulation of gene expression in the brain: a possible mechanism altering the response to psychostimulants in women rats. **Brain Res. Mol. Brain Res,** 2002; 100(1–2): 75–83.

ВЕГЕТАТИВНА РЕГУЛЯЦІЯ СЕРЦЕВОГО РИТМУ В ОСІБ ЮНАЦЬКОГО ВІКУ З ЗОРОВИМИ ДИСФУНКЦІЯМИ

І. В. Редька

Харківський національний університет імені В. Н. Каразіна
Майдан Свободи, 4, Харків 61022, Україна
e-mail: iredka@yandex.ru

Зорові дисфункції можуть призводити до змін вегетативної регуляції серцевого ритму внаслідок створення передумов для хронічного психоемоційного напруження та безпосереднього впливу обмеженої зорової аферентації на вищі вегетативні центри. У статті наведено результати порівняльного аналізу варіабельності серцевого ритму осіб юнацького віку з вродженими (n=32) і набутими (n=38) зоровими дисфункціями та нормальним зором (n=34). Отримані результати інтерпретувалися з позиції двоконтурної моделі вегетативної регуляції серцевого ритму за Р.М. Баєвським (1968). Встановлено, що зорові дисфункції призводять до змін у вегетативній регуляції серцевого ритму, які більш виразні при вродженій патології. Виявлена вища чутливість осіб чоловічої статі до змін вегетативної регуляції під впливом зорових дисфункцій. Зорові дисфункції у юнаків супроводжуються напруженням механізмів регуляції серцевого ритму внаслідок посилення центральних регуляторних впливів і зміщення балансу в бік активності симпатичної нервової системи. Дівчатам із зоровими дисфункціями притаманна тенденція до посилення автономних регуляторних впливів і зміщення балансу в бік активності парасимпатичної нервової системи. У юнаків із вродженими зоровими дисфункціями виявлено об'єктивні фізіологічні ознаки психоемоційного стресу.

Ключові слова: вегетативна регуляція, варіабельність серцевого ритму, зорові дисфункції.

ВЕГЕТАТИВНАЯ РЕГУЛЯЦИЯ СЕРДЕЧНОГО РИТМА У ЛИЦ ЮНОШЕСКОГО ВОЗРАСТА СО ЗРИТЕЛЬНЫМИ ДИСФУНКЦИЯМИ

И. В. Редька
Харьковский национальный университет имени В.Н. Каразина
Площадь Свободы, 4, Харьков 61022, Украина
e-mail: iredka@yandex.ru

Зрительные дисфункции могут приводить к изменениям вегетативной регуляции сердечного ритма вследствие создания предпосылок для хронического психоэмоционального напряжения и непосредственного воздействия ограниченной зрительной афферентации на высшие вегетативные центры. В статье представлены результаты сравнительного анализа вариабельности сердечного ритма лиц юношеского возраста с врожденными (n=32) и приобретенными (n=38) зрительными дисфункциями и нормальным зрением (n=34). Полученные результаты интерпретировались с позиции двухконтурной модели вегетативной регуляции сердечного ритма по Р. М. Баевскому (1968). Установлено, что зрительные дисфункции приводят к изменениям в вегетативной регуляции сердечного ритма, которые более выражены при врожденной патологии. Обнаружена высокая чувствительность лиц мужского пола к изменениям вегетативной регуляции под влиянием зрительных дисфункций. Зрительные дисфункции у юношей сопровождаются напряжением механизмов регуляции сердечного ритма вследствие усиления центральных регуляторных влияний и смещением баланса в сторону активности симпатической нервной системы. Девушкам со зрительными дисфункциями присуща тенденция к усилению автономных регуляторных влияний и смещению баланса в сторону активности парасимпатической нервной системы. У юношей с врожденными зрительными дисфункциями обнаружены объективные физиологические признаки психоэмоционального стресса.

Ключевые слова: вегетативная регуляция, вариабельность сердечного ритма, зрительные дисфункции.

Одержано: 11.02.2015