



The Functional State of the Special Purpose Detachment Staff in the Active Tilt Test

Elena V. Dyuzheva¹, Sergey B. Ponomarev², Albina A. Burt³, Salikh Kh. Shamsunov^{4*},
Nikolai V. Rumyantsev⁵

¹The Center of Studying of Problems of Management and the Organization Executions of Punishments in Criminally-Executive System, Federal Penal Administration Service Research Institute, Moscow, Russia

²Center for the Study of Problems of the Execution of Criminal Sentences and the Psychological Support of the Professional Activities of Criminal Execution System Employees, Federal Penal Administration Service Research Institute, Moscow, Russia

³Izhevsk Branch, Federal Penal Administration Service Research Institute, Moscow, Russia

⁴The Center of Studying of Problems of Management and the Organization Executions of Punishments in Criminally-Executive System, Federal Penal Administration Service Research Institute, Moscow, Russia

⁵Center for the Study of Security Issues in Penitentiary Institutions, Federal Penal Administration Service Research Institute, Moscow, Russia

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Abstract

The purpose of the article is to study the functional state features of the cardiovascular activity of the special purpose detachment employees when using an active orthostatic test. The main studying approach is to examine the heart rate variability, which allows to identify the risk of overtraining and coronary risk. Most of the employees of special purpose detachment are characterized by the predominance of the autonomous contour of the vegetative regulation. However, in an individual analysis of cardiointervalograms in the orthostatic test, a paradoxical type of reaction was described, during which we observed an inversion of the type of response to an orthostatic test from moderately sympathetic to asympathicotonic and hypersympathicotonic with over-centralization of the vegetative regulation circuit for three days. It has been established that the indices of heart rate variability make it possible to timely detect the state of “overtraining” of an organism under conditions of constant alertness and to carry out optimal planning of the amount of physical training of employees.

Keywords: The Penitentiary System, Special Purpose Detachment, Tilt Test, Heart Rate Variability, Autonomic Regulation.

1 Introduction

In modern conditions, the functioning of the penitentiary system special purpose detachments is carried out by performance of combat missions, due to the need to use force to prevent offenses. In this regard, the physical, combat and psychological preparation of the special purpose detachments staff is subject to increased requirements, both for the unit as a whole and for the readiness of each individual employee (6).

The human body systematically functioning in conditions of increased psycho-emotional and physical exertion is able to perform more significant work in terms of volume and intensity. This is due to the constant activation of physiological and functional systems, the involvement and

growth of their reserve capabilities (2, 10, 11). Significant load intensity requires a significant increase in the function, first of all, of the cardiovascular system and the processes of regulation of its activity. However, when developing training programs for special purpose detachment employees of territorial authority of the Federal Penitentiary Service of Russia, the initial state and adaptive capabilities of regulatory systems are not taken into account. This may cause overtraining of the body and the disruption of its adaptive capacity. Therefore, timely assessment of heart rate variability (HRV) using functional tests can contribute to the timely correction of dysregulatory processes.

The aim of the study was to inspect the peculiarities of the functional state of cardiovascular activity in special purpose detachment employees when using an active orthostatic test.

2 Research Methodologies

The HRV analysis was carried out with 12 employees of the special purpose detachment «Krechët» of government of the Federal Penitentiary Service of Russia in the Udmurt

Corresponding author: Salikh Kh. Shamsunov, The Center of Studying of Problems of Management and the Organization Executions of Punishments in Criminally-Executive System, Federal Penal Administration Service Research Institute, Moscow, Russia. Email: shamsunov46@mail.ru.

Republic of Russia. The registration of HRV indices was carried out during an active orthostatic test (lying down – 5 minutes, standing – 6 minutes). The average age of the subjects was 28 ± 3.5 years. The data was monitored using the «Varicard 2.51» complex in the second standard lead, and the interval cardiogram analysis was performed using the Iskim-6 program. The study was conducted in accordance with the recommendations of the working group of the European Society of Cardiology and the North American Society of Cardiac Stimulation and Electrophysiology (6, 7). The classification of the vegetative regulation types is based on the idea of the presence of central and autonomic contours of heart rhythm control, among which there are four types of vegetative regulation:

- Type I - moderate prevalence of central regulation (MPCR)
- Type II - pronounced predominance of central regulation (PPCR)
- Type III - moderate prevalence of autonomic regulation (MPAR)
- Type IV - pronounced predominance of autonomic regulation (PPAR).

For the rapid assessment of the prevailing type of autonomic regulation, the quantitative criteria for HRV indices - SI and VLF (5) are taken as the basis. Interpretation of the results of an orthostatic test using cardiointervalography was produced in accordance with the assessment of vegetative reactivity proposed by R.M. Baevsky and A.P. Berseneva (1).

Statistical data processing was performed using the Excel 2007 software package. Standard methods of variation statistics were used including the calculation of arithmetic means, standard deviations, and standard error of the mean. The results are presented as $M \pm m$ (M is the arithmetic average, m is the error of the arithmetic average). Taking into account the distribution of indicators close to normal (by Kolmogorov-Smirnov criterion), the assessment of the reliability of differences in averages was carried out using Student's criterion. Used bilateral tests. Differences at significance levels of $p < 0.05$ were considered statistically significant.

3 Results and Discussion

Analysis of HRV indices showed that at rest in the majority of the studied, type III (MPAR) is the predominant type of vegetative regulation – 45.5% (5 people), type II (PPCR) is registered in 36.3% of cases (4 people), Type I (MPCR) and type IV (PPAR) – in 18.2% of cases (1 person each). The average group value of HRV indices testified to the predominance of autonomic regulation of heart rhythm (type III) in the supine position. When performing an orthostatic test, a decrease in parasympathetic activity and tension in the central regulation with activation of sympathetic effects were observed. This was accompanied by a statistically significant decrease in $MxDMn$, $RMSSD$, $pNN50\%$, HF (ms^2), PHF (%) and the prevalence of SI , PLF (%), LF/HF in the standing position (Table 1). In the initial autonomic type of regulation of cardiac activity, the predominance of centralization of heart rhythm control during orthostatic exposure is one of the optimal types of reaction (4).

The data analysis under the study also revealed the paradoxical nature of the vegetative effect, which was expressed in inhibition of the transmission of the nerve impulse of the autonomic nervous system due to the overpotential of the sympathetic channel. For instance, during the three-time execution of an orthostatic test in the morning time of day (08 h 30 min) before physical activity, a paradoxical type of reaction was recorded successively for three days by an employee of the special purpose detachment. During the first test, activation of the central structures of heart rhythm management in response to orthostatic effects is noted, since the values of $MxDM$, TP , LF , VLF , ULF increase and the activity of the sympathetic division of the autonomic nervous system decreases, the value of the stress index decreases. In the second study, an increase in LF , VLF waves and a sharp decrease in ULF waves is recorded, while the activity of HF waves remains almost unchanged. Such a reaction to a change in body position is unfavorable and indicates a decrease in the functional reserves of the body. In the third trial, a special purpose detachment employee responds with a significant increase in $MxDM$, LF and VLF waves.

Table 1. Indicators of heart rate variability in employees of a special purpose detachment in orthostatic test ($M \pm m$) (group mean values)

Indicators of heart rate variability	Lying position	Standing position	Significance p
$MxDMn$, mc	$280,5 \pm 22,9$	$232,2 \pm 20,2$	$<0,01$
$RMSSD$, mc	$48,9 \pm 5,81$	$27,4 \pm 5,5$	$<0,01$
$pNN50\%$	$25,8 \pm 5,3$	$5,0 \pm 1,8$	$<0,001$
$SDNN$, mc	$59,0 \pm 5,6$	$51,5 \pm 5,5$	$>0,05$
CV , %	$6,5 \pm 0,6$	$6,7 \pm 0,6$	$>0,05$
SI , усл.ед.	$89,8 \pm 11,1$	$166,0 \pm 30,5$	$<0,05$
TP , mc^2	$3120,0 \pm 710,0$	$2592,0 \pm 603,9$	$>0,05$
HF , mc^2	$1055,0 \pm 250,6$	$362,0 \pm 146,7$	$<0,05$
LF , mc^2	$1176,3 \pm 366,4$	$1502,0 \pm 467,4$	$>0,05$
VLF , mc^2	$394,0 \pm 100,3$	$327,0 \pm 58,8$	$>0,05$
ULF , mc^2	$495,0 \pm 124,1$	$400,7 \pm 69,1$	$>0,05$
PHF , %	$41,3 \pm 4,7$	$15,4 \pm 3,1$	$<0,001$
PLF , %	$42,2 \pm 4,1$	$66,8 \pm 3,6$	$<0,001$
$PVLF$, %	$16,4 \pm 2,3$	$17,8 \pm 2,3$	$>0,05$
LF/HF	$1,4 \pm 0,3$	$6,9 \pm 1,6$	$<0,01$

Table 2: Individual indicators of heart rate variability in an special purpose detachment employee with orthostatic exposure

Heart rate variability Indicators	Body Position	First Orthostatic Test	Second Orthostatic Test	Third Orthostatic Test
MxDMn	lying position	215	200	143
	standing position	247	171	161
SDNN	lying position	54	37	32
	standing position	55	35	35
SI	lying position	123	152	197
	standing position	106	330	262
TP, mc ²	lying position	1837	1377	780
	standing position	1946	1169	478
HF, mc ²	lying position	815	141	118
	standing position	236	140	44
LF, mc ²	lying position	714	291	235
	standing position	1088	886	248
VLF, mc ²	lying position	196	91	75
	standing position	292	120	95
ULF, mc ²	lying position	111	854	352
	standing position	330	23	92

In this case, the state of overvoltage of the body's regulatory systems is determined, which are sign of pronounced fatigue and indicates the need to relax the training regime (Table 2). However, in an individual analysis of cardiointervalograms in the orthostatic test, a paradoxical type of reaction was described, during which we observed an inversion of the type of response to an orthostatic test from moderately sympathetic to asympathicotonic and hypersympathicotonic with over-centralization of the vegetative regulation circuit for three days.

4 Conclusions

According to the result of the study, it was determined that, in general, the optimal type of autonomic regulation of the heart is characteristic of the whole group of special purpose detachment employees. This fact indicated that they are sufficiently trained and tolerated to physical and psychoemotional loads. However, an individual assessment of HRV indicators showed the presence of a paradoxical autonomic imbalance in one of the employees. This is a predictor of heart overstrain and one of the risk factors for cardiomyopathy in athletes (3, 8, 9). This dictates the need for an individual approach of the coaching staff in developing schemes for training processes and introduction of a preliminary examination using HRV by practitioners of the penitentiary system working with employees.

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