



## Analysis of Heart Rate Variability by High-resolution Rhythmocardiography in Chronic Obstructive Pulmonary Disease

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### Abstract

The article describes the features of the heart rate variability in patients with COPD during remission. 78 male patients with COPD aged 45-74 years and 48 participants without COPD were enrolled in the study. We analyzed the following parameters of heart rate variability: RR, SDNN, ARA,  $\sigma_m$ ,  $\sigma_s$ ,  $\sigma_l$ , VLF %, LF %, HF %. We found that parasympathetic influences reduced and humoral-metabolic regulation of the activity of the sinus node increased. We detected low frequency wave with a deviation up from the other waves of the rhythmocardiogram corresponding to the bronchoobstructive syndrome in patients with COPD.

**Keywords:** COPD, autonomic nervous system, heart rate variability, power spectral analysis

## 1. Introduction

Chronic obstructive pulmonary disease (COPD) remains a major public health problem and it is currently the fourth leading cause of mortality in the world. Not all patients with COPD are correctly diagnosed, and more than 90% of those patients who are diagnosed with the disease do not receive treatment provided by modern recommendations [1]. The assessment of the autonomous nervous system is important for various diseases, as the autonomous nervous system is involved in the pathological process at the earliest stages. Heart rate variability (HRV) can be used to estimate of autonomic nervous system dysfunction. The HRV indices have prognostic value in patients with COPD [2]. The increase in some indexes of HRV may have prognostic value in patients with acute exacerbation of chronic obstructive pulmonary disease [3]. However, it is proved that HRV determined by 24-hour monitoring has many factors contributing to measurement inaccuracies (changes in breathing, body position during the day) [4]. Thus, the assessment of heart rate variability using the method of high-resolution rhythmocardiography (RCG), devoid of the above disadvantages may be the most promising method of identifying violations of the regulation of pacemaker activity of the sinoatrial node of the heart. It is a method of computer registration and analysis of changes in inter-systolic time intervals with sampling of  $1000 \pm 3$  Hz [5].

## 2. Objective

The study was performed to evaluate the features of wave heart rate variability in patients with COPD using the method of high-resolution rhythmocardiography.

### 3. Materials and Methods

We enrolled 78 male patients with COPD aged 45-74 years. The diagnosis of COPD is established according to the criteria of GOLD 2016. 48 participants without COPD, comparable to the study group by gender and age, were recruited into the study too. We excluded persons with severe comorbid pathologies, can distort the parameters of rhythmocardiography. In addition to the standard methods of examination all participants of the study to assess the wave structure of the heart rate was carried out high-resolution rhythmocardiography using hardware and software complex “MICOR”. Rhythmocardiography was performed at rest and during autonomic mixed incentives: Valsalva maneuver, Aschner-Dagnini test, active orthostatic test, loading test. We evaluated the following indicators: the average value of RR; the standard deviation of all wave – SDNN; ARA – the amplitude of respiratory arrhythmia; the standard deviation for the sympathetic, parasympathetic and humoral-metabolic fluctuations:  $\sigma_m$ ,  $\sigma_s$  and  $\sigma_l$ ; the ratio of the effects of parasympathetic, sympathetic and humoral factors regulating the pacemaker activity of the sinus node – VLF %, LF %, HF %.

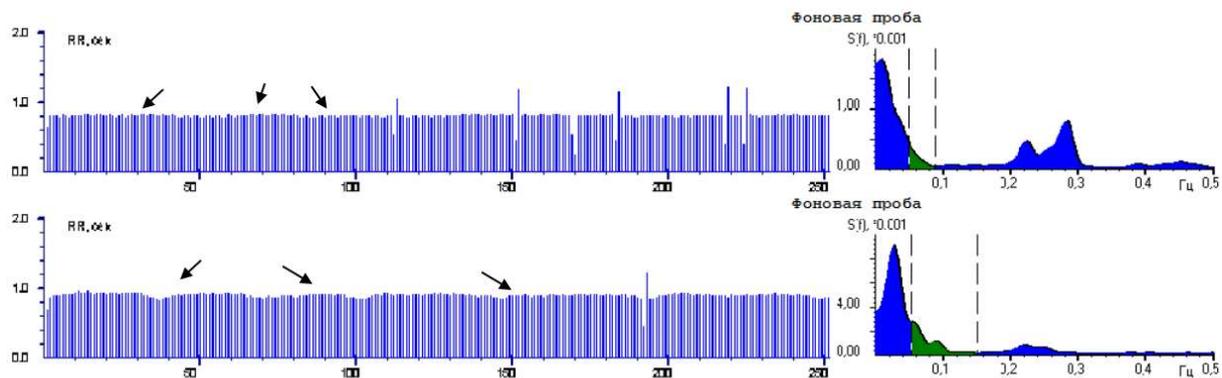
### 4. Results

The results are presented in table 1.

**Table 1. Parameters of heart rate variability in patients with COPD and participants of control group.**

Group	Tests	RR	SDNN	ARA	VLF%	LF%	HF%
COPD	AOP	0,68	0,01	0,01	54,28	24,46	21,24
	PA	0,78	0,02	0,02	49,21	19,24	30,77
	Ph	0,80	0,02	0,03	49,34	18,90	31,76
	PWC	0,82	0,02	0,03	42,99	19,84	37,16
	Vm	0,81	0,02	0,03	48,09	20,56	31,34
Control	AOP	0,74	0,04	0,04	38,22	36,70	25,07
	PA	0,96	0,05	0,08	31,27	24,97	43,76
	Ph	0,97	0,05	0,09	23,08	22,92	53,99
	PWC	0,92	0,05	0,09	27,77	18,93	53,31
	Vm	0,92	0,05	0,09	25,03	22,54	52,42

Reduction of heart rate variability (SDNN index) by half, predominance of humoral-metabolic regulation of pacemaker activity of sinus node (this regulation factor should make a minimum contribution in healthy individuals) were found in patients with COPD compared with participants without COPD. Very low-frequency waves with upward deviation from the main RCG waves corresponding to the bronchoobstructive syndrome according to clinical data and spirometry parameters were recorded in COPD (figure 1).



**Figure 1. Very low-frequency waves with upward deviation from the main RCG waves in patient with COPD is marked with arrows.**

Changing reactions heart rhythm when performing tests for stimulation of autonomic nervous system were registered in patients with COPD compared with the control group. There is a slower achievement of maximum reactions to multidirectional stimuli and a longer recovery of the heart rate after the test.

## 5. Conclusion

Changes in the regulation of pacemaker activity of sinoatrial node with the oppression of peripheral autonomic regulation of chronotropic function of sinus node and the predominance of humoral-metabolic regulation factor found in patients with COPD. We also found low-frequency waves with upward deviation from the main waves of the RCG, corresponding to the bronchoobstructive syndrome.

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