

Review Article

THE HEART CONTRACTILITY OF HEARING-IMPAIRED YOUNG PEOPLE UNDER STATIC LOAD

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Abstract

The contractile function of the heart is controlled by the autonomic nervous system. The reaction of the contractile function of the heart to physical activity clearly demonstrates the features of the regulation of the cardiovascular system. In the modern way of life, the response of the body's systems to static loads is of particular importance. It is necessary to conduct regular diagnostics of the state of the cardiovascular system of hearing-impaired people due to the fact that their body develops under reduced physical activity and is exposed to mainly static loads. Diagnosis of hemodynamic parameters using an ultrasound monitor in young men with varying degrees of hearing loss revealed differences compared with healthy young men. We studied the following hemodynamic parameters at rest and after the static load: stroke volume (SV), cardiac output (CO), stroke work (SW), cardiac power (CPO). Higher values of these indicators were recorded at rest (except for SW) and after the static load. Signs of the predominance of the influence of the sympathetic nervous system on the regulation of hemodynamics in young people with hearing pathology were recorded. The reaction of the contractility of the heart in young people with hearing impairments was evaluated. These studies can be used during medical examinations in people with disabilities; when compiling guides for doctors and specialists in cardiology and functional diagnostics; in the preparation of teaching aids for specialists in age and sports physiology.

Keywords: Diagnosis, cardiovascular system, hemodynamics, heart contractility, ultrasound methods.

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INTRODUCTION

One of the most important functions of the heart is myocardial contractility. It characterizes the performance of the mechanical work of the heart and is regulated by the autonomic nervous system. The parameters of the contractile function of the heart, namely, the volume of ejection for systole and 1 minute, **stroke work**, **cardiac power**, and also the reaction of the myocardium to physical activity clearly demonstrate the features of regulation of the cardiovascular system. The influence of the autonomic nervous system is manifested in an increase or decrease in the values of indicators of systolic ejection. The values of the indicators of the cardiac ejection and, consequently, the shift in regulation depend on the vital activity of the organism, its fitness, and adaptive capabilities. Experts note the presence of a shift in regulation towards sympathetic influences in case of physical inactivity, the predominance of static loads and an increased level of stress [1,2]. That is why it is especially important to conduct regular diagnostics of the state of the cardiovascular system of hearing-impaired persons due to the fact that their body develops in conditions of reduced physical activity, exposure to static loads and permanent stress. Earlier, we found increased indicators of cardiac output and stroke volume in young people with a severe degree of hearing pathology [3,4]. However, it is important to study the effect of physical activity on the regulation of hemodynamics of hearing-impaired people. According to scientific literature [5], cardiac output is one of the most important factors affecting the level of blood pressure, the fixation of changes that is necessary to assess the development of the risk of cardiovascular disease. In this regard, the analysis of indicators of the volume of systolic ejection, mechanical work of the heart and myocardial power after static loading will provide a more complete description of the state of hemodynamics.

The **aim** of our research was to study the hemodynamic parameters in **young men** with varying degrees of hearing loss.

MATERIALS AND METHODS

The study of hemodynamic parameters was conducted in 38 young men aged 17-21 years. 27 of them had a hearing

pathology of various etiologies and severity, 11 had no deviations in the state of the cardiovascular system (CVS) and in the functioning of analyzers.

We investigated the parameters of central hemodynamics using an **ultrasound cardiac** output monitor (USCOM 1-A, Ultrasound Cardiac Output Monitor, Australia) equipped with a 2.2 MHz sensor in AV mode (aortic valve). The accuracy of measurements by this method is confirmed by numerous sources [6,7,8,9,10]. All measurements were carried out at rest (in a prone position, before the measurements the subjects were in a horizontal position for 5 minutes) and after a functional test under static load. As a static load, holding the hand dynamometer with the left hand at a value of 50% of the maximum force (measured in advance to determine muscle strength) for 1 minute was used. The hemodynamic parameters were recorded in the 1st minute after the static load. At the 3rd minute after the static load, the initial values were restored, and therefore we decided not to use them for further analysis. To perform hemodynamic measurements in the AV mode, the sensor was positioned in the suprasternal position so that the ultrasound waves emitted by the sensor were precisely directed into the lumen of the ascending aorta towards the aortic valve. The correct positioning of the sensor was determined by the value of the peak blood flow velocity (Vpk), the graphic image of the peak **ejection** on the monitor screen, the sound tone accompanying the systole (in accordance with the description in the instructions for the device). After adjusting the sensor and obtaining the desired image on the monitor screen, we continued the measurements for the first minute with a choice of practically identical amplitudes of 5 to 8 peaks with an equal interval between them. The average values were selected for further analysis. The hemodynamic parameters were obtained and analyzed: stroke volume (SV), cardiac output (CO), stroke work (SW), and cardiac power (CPO).

Statistical processing of the results was performed by using a Biostat computer program with Student's t-test. All mean values in the text are presented as $M \pm \sigma$. Differences were considered statistically significant at $p < 0.05$.

RESULTS AND DISCUSSION.

The value of the indicator of stroke (systolic) volume (SV) at rest was higher in young men aged 17-21 with impaired activity of the auditory analyzer than in young men without similar disorders in the same age group ($p < 0.05$) (Table 1). After a static load during the 1st minute, we recorded a higher SV value in young men with deviations in the work of the auditory analyzer compared to that in their healthy peers ($p < 0.05$) (Figure 1). Dynamics of changes in SV was practically absent in young men with pathology and without pathology of hearing.

The initial value of the indicator of the cardiac output (CO) in young men with impaired auditory analyzer function was significantly higher than in young men without hearing

impairment ($p < 0.01$). After a static load during the 1st minute, a decrease in the CO indicator in young men aged 17-21 years with hearing pathology by 3.59% was recorded, while healthy young men of a similar age, after a static load, on the contrary, had an increase in this indicator by 3.05%.

Thus, a multidirectional shift of the CO indicator in the compared groups after a static load was recorded, while the absolute values of this indicator remained practically unchanged compared to the initial hearing impairment in young men and without such violations (Figure 2). At the same time, a higher value of the CO indicator was recorded at the 1st minute after the static load in hearing-impaired youths compared to normally hearing ones ($p < 0.01$).

Table 1. Values of indicators of systolic volume, systolic work, and the power of myocardial contractions in young men aged 17-21 years at rest and after a static load ($M \pm \sigma$).

Indicators of hemodynamics	At rest		After a static load in the 1st minute	
	Young men with hearing loss	Healthy young men	Young men with hearing loss	Healthy young men
SV, ml	100,0 \pm 21,51*	84,5 \pm 12,86	98,0 \pm 18,96*	83,0 \pm 14,14
Δ			-2,04%	-1,85%
CO, l/min	7,0 \pm 1,99**	5,1 \pm 0,84	6,7 \pm 1,50**	5,2 \pm 0,99
Δ			-3,59%	3,05%
SW, mJ	1121,0 \pm 301,51	938,3 \pm 143,88	1167,0 \pm 258,7**	911,5 \pm 149,3
Δ			4,10%	-2,86%
CPO, W	1,3 \pm 0,48*	0,9 \pm 0,19	1,3 \pm 0,36*	1,0 \pm 0,19
Δ			1,89%	1,25%

Notes:

Δ - dynamics of the values of indicators in % compared with the value at rest;

* - the significance of differences between the absolute values in **young men** with and without hearing pathology $p \leq 0.05$.

** - the significance of differences between the absolute values in **young men** with and without hearing pathology $p \leq 0.01$.

Figure 1. Change in SV after a static load in hearing-impaired and healthy **young men** ($M \pm \sigma$).

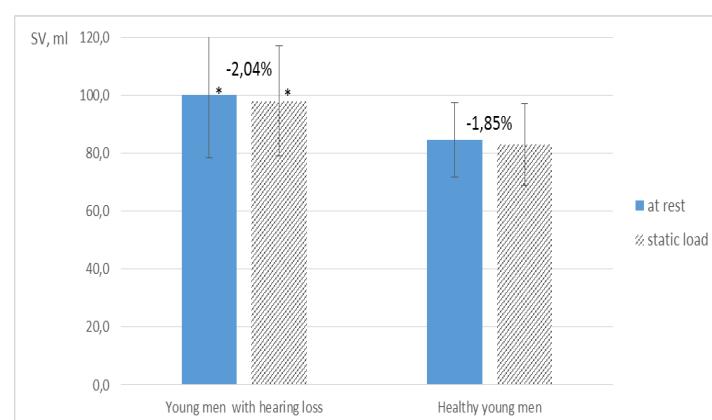


Figure 2. Change in CO after a static load in hearing-impaired and healthy **young men ($M \pm \sigma$).**

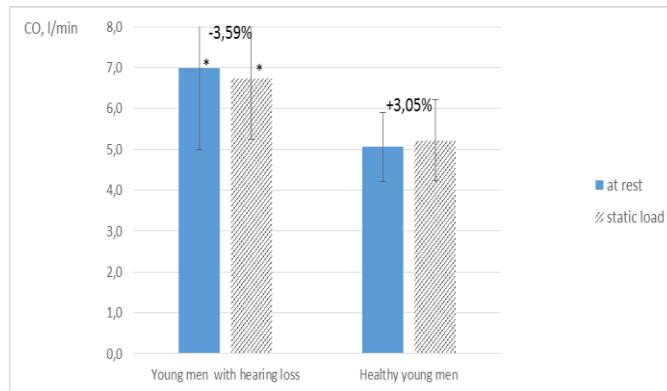


Figure 3. Change in SW after a static load in hearing-impaired and healthy young men ($M \pm \sigma$)

Note:

* - the significance of differences between the absolute values in **young men** with and without hearing pathology $p \leq 0.05$.

At rest, the values of the index of mechanical work of the heart (**SW**) were recorded - 1121.0 ± 301.51 mJ in hearing-impaired youths of 17-21 years old, and in healthy youths of the same age - 938.3 ± 143.88 mJ. During the 1st minute after the static load, the SW value in young men with hearing pathology

increased by 4.10% and amounted to 1167.0 ± 258.7 mJ, while in healthy young men it decreased by 2.86% and amounted to 911.5 ± 149.3 mJ, respectively. Moreover, the value of this indicator in young men with hearing impairment was significantly higher than that in young men of a similar age without the impaired activity of the auditory analyzer ($p < 0.01$) (Figure 3).

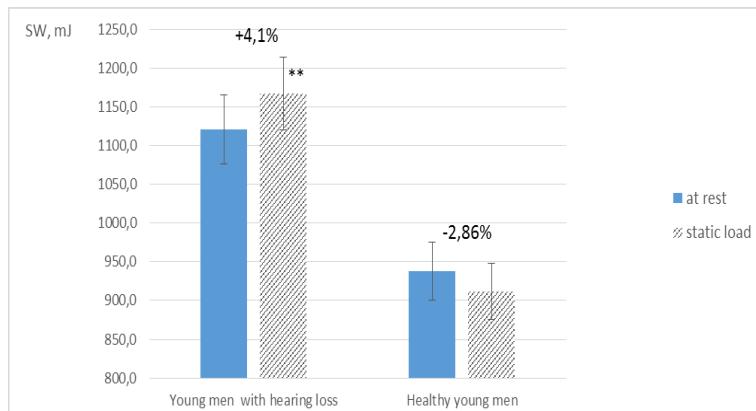


Figure 4. Change in CPO after a static load in hearing-impaired and healthy young men ($M \pm \sigma$)

Note:

** - the significance of differences between the absolute values in **young men** with and without hearing pathology $p \leq 0.01$.

We noted higher values of the cardiac power output CPO at rest among hearing-impaired **young men** of 17-21 years old (1.3 ± 0.48 W) compared with healthy young men of the same age (0.9 ± 0.19 W) ($p < 0.05$). CPO recorded during the 1st minute after the static load in young men with hearing pathology (1.3 ± 0.36 W) was higher than in young men without hearing pathology (1.0 ± 0.19 W) ($p < 0.05$), while the initial CPO value remained almost unchanged in both compared groups of young men (Table 1).

The increased values of the indicators of the mechanical work of the heart (SW) and the power of the myocardial contractions (CPO), indicated a greater tension of the contractile function of the CVS in hard of hearing young people after a static load, which is associated with increased cardiac output. It is important to note that SW at rest was slightly higher in young people with hearing impairment than in healthy young men, while the static load contributed to a significant increase in SW.

It should be noted that high SV and CO, recorded at rest, may indicate the predominance of the influence of the sympathetic system on the contractile function of the heart. Preserving the relationship between the values of stroke volume after a static load in young men with and without hearing pathology confirms the presence of an increased initial sympathetic tone in hearing-impaired people. At the same time, the multidirectional dynamics of changes in CO and SW after a

static load demonstrates the contribution of an increase in heart rate after this type of load in hearing-impaired young people, which also indicates an increase in the influence of the sympathetic nervous system tone on the regulation of hemodynamics. At rest, a higher CPO in young men with hearing impairments once again demonstrates the predominance of sympathetic tonus in the formation of the initial vegetative status.

The data obtained emphasize the importance of studying the above indicators using functional tests, due to the fact that the initial values can not always reveal significant differences in the state of CVS in young men with and without hearing pathology.

SUMMARY

Thus, we revealed significantly higher hemodynamic indices such as SV, CO, and CPO at rest, as well as SV, CO, SW, and CPO after a static load in hearing-impaired young men compared to healthy ones, which indicates the presence of signs of an increased sympathetic effect on the myocardial contractility in young men aged 17-21 years with hearing pathology.

CONCLUSION

Based on the data obtained in the course of our study, it can be concluded that persons with hearing impairments need to more thoroughly diagnose hemodynamics, including using functional tests. The data of the study can be used during medical examinations in people with disabilities; when compiling guides for doctors and specialists in the field of cardiology and functional diagnostics; in the preparation of teaching aids for specialists in age and sports physiology,

teachers and trainers of specialized boarding schools for hearing-impaired and deaf children; functional diagnostics in athletes, participants in the Deaf Olympic Games.

CONFLICT OF INTERESTS

The author declares that the provided information has no conflicts of interest.

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