Research Article

Comparison of hemodynamics in people with hearing loss

Artem M. Golovachev, Raisa G. Biktemirova*, Nafisa I. Ziyatdinova, Igor I. Zakirov, Timur L. Zevfirov

ABSTRACT

Aim: Values of parameters of hemodynamics are informative indicators of a cardiovascular system condition. The exact data obtained in real time with each blow of heart are of value. **Materials and Method:** Diagnostics of work of cardiovascular system are of special importance at the persons having congenital diseases of other systems which could influence normal development of an organism in ontogenesis. The congenital or acquired at early age hearing pathology can be one of such factors. **Results:** When carrying out measurements of parameters of hemodynamics in real time by means of the ultrasonic monitor at young people with various extent of loss of hearing deviations both from norm, and from indicators of control group were revealed. A number of parameters of hemodynamics such as were analyzed: Arterial blood pressure, heart rate, shock volume, index of shock volume, warm emission, warm index, system vascular resistance (SVR), and index of SVR (SVRI). Authentically, higher values of the majority of indicators of hemodynamics and low values of SVR at persons with heavy degree of relative deafness are received. The expressed influence of sympathetic nervous system on hemodynamic parameters at persons with heavy extent of loss of hearing is noted. The assumption of the reason of this phenomenon is made. **Conclusion:** These researches can be used when performing medical examinations at students, persons with limited opportunities of health, primary reception by the cardiologist of persons with associated diseases, and functional diagnostics in sports medicine (at professional athletes, fans, and participants of Paralympic games).

KEY WORDS: Cardiovascular system, Diagnostics, Hemodynamics, Ultrasonic methods of a research, Warm emission

INTRODUCTION

A considerable part of the population has pathology of the acoustic analyzer. According to the data published by the World Health Organization (WHO), more than 5% of world's population - 466 million people (432 million adults and 34 million children) suffers from hearing loss. Understand a hearing disorder in the ear hearing better exceeding 40 dB at adults, as this disease and children have 30 dB.[1] A hearing disorder significantly influences the quality of life. Besides, the congenital or acquired at early age pathology of hearing can exert a negative impact on the development of other systems of an organism. In particular, data on interrelation of loss of hearing and clinical displays of coronary heart disease are provided in literature.[2] Furthermore, researches on identification of risk of cardiovascular diseases at the persons having various hearing disorder[3] were conducted. Earlier, we influence of heavy degree of pathology of hearing on indicators of warm emission and shock volume of blood was revealed.[4] However, receiving fuller picture requires studying of dependence of other indicators of hemodynamics, in particular, of system vascular resistance (SVR), from pathology of the acoustic analyzer. The analysis of indicators both warm emission and vascular resistance will give more total characteristic of a condition of hemodynamics, at the same time, it will be possible to draw a conclusion on such parameters as preloading, post-loading, and rigidity of arterial system.

Access this article online	
Website: jprsolutions.info	ISSN: 0975-7619

According to some authors Teregulov,[5] warm emission, SVR, and rigidity of arterial system - the major factors influencing the level of arterial blood pressure (BP) which fixing of changes are necessary for the assessment of the development of risk of cardiovascular diseases.

In literature available to us data of the analysis of indicators of warm emission and the vascular resistance at healthy people and also having a hypertension are submitted, however, there is no sufficient information on the studied hemodynamic parameters at a hearing disorder.

Department of Man's Health Protection, Institute of Fundamental Medicine and Biology, Kazan Federal University, Kazan 420008, Russia

***Corresponding author:** Raisa G. Biktemirova, Institute of Fundamental Medicine and Biology, Kazan Federal University, 18 Kremlyovskaya Street, Kazan 420008, Russia. E-mail: RGBiktemirova@kpfu.ru

Received on: 12-05-2018; Revised on: 22-07-2018; Accepted on: 19-08-2018

The purpose of our research was the measurement of parameters of hemodynamics at persons with various extent of loss of hearing.

RESEARCH MATERIALS AND METHODS

The research of hemodynamic parameters was conducted at young people of 20–25 years (middle age - 21.5 ± 1.9 [M±σ] years) in number of 50 people. From among the young people who participated in a research, 26 had pathology of hearing of various degree and etiology. Young people with limited opportunities of health during the research were divided into two groups according to the extent of defeat of hearing.

The first group included 15 people with the IV degree of relative deafness and also who are completely deprived of hearing (middle age was 20.7 ± 2.5 [M±σ] years). The second group consisted of 11 persons with the I-III degree of relative deafness (middle age - 21.8 ± 2.2 [M±σ] years). Degree of relative deafness was defined according to data of the audiometrics which is carried out by the specialist E.N.T. specialist. Check of hearing was carried out twice a year, last of which was carried out not later than 2 months before the researches. Ranging on causation sign was not carried out; however, it should be noted that in the majority surveyed the first group had congenital pathology of hearing, the second group - acquired. As control (the 3rd group) 24 young men (middle age made 21.8 ± 1.0 [M±σ] years) who do not have in the anamnesis of the expressed deviations in a cardiovascular system condition and operation of analyzers participated in a research.

We took measurements of parameters of systolic emission from the left ventricle in a gleam of the aortal valve by means of the ultrasonic (OUSE) monitor of the warm emission (USCOM 1-A, Ultrasound Cardiac Output Monitor, Australia) equipped with the sensor with a frequency of 2.2 MHz in the aortic valve mode (AV). All measurements were taken at rest, in a prone position, before measurements surveyed were in horizontal position within 5 min. Furthermore, before carrying out measurements of parameters of hemodynamics, it was required to define some data on which calculated values depend. First, it is diameter of an opening of the aortal valve. For its definition, measurement of anthropometrical indicators (growth and weight) which together with age and sex data were brought in the card of surveyed was taken. Diameter of an opening of the aortal valve at the same time was calculated automatically on the basis of the entered data that call into question the accuracy of the received values. However, data on the acceptable accuracy of measurements by means of this method, in comparison with transesophageal echocardiography and even by invasive methods of a research of warm emission are provided in some references.[6-10] Second, measurement of systolic (SBP) and diastolic (DBP) pressure by means of the sphygmomanometer which values were also entered into memory of the monitor was taken. For implementation of measurements of parameters of hemodynamics in the AV mode, the sensor was positioned in suprasternal situation so that OUSE the waves radiated by the sensor were precisely sent to a gleam of the ascending part of an aorta toward the aortal valve. The correct positioning of the sensor was determined by the value of speed of a stream of blood (Vpk), graphic the image of peak of emission on the monitor screen, and to the sound tone accompanying a systole (according to the description in the instruction to the device). After setup of the sensor and obtaining the required image on the monitor screen, we continued measurements within 1 min with the choice of peaks, almost identical on amplitude, in number from 5 to 8 with an equal interval between them. Average values at the same time were selected for the further analysis. Values of indicators of hemodynamics are received and analyzed: Heart rate (HR), SBP, DBP, pulse pressure (BPp), shock volume of blood (SV), index of the shock volume (SVI), warm emission (CO), warm index (CI), the maximum speed of a stream (Vpk), distance a minute (minute distance [MD]), the SVR, the index of the SVR (SVRI), etc.

Statistical processing of the received results was carried out by means of the computer Biostat program, using Student's t-criterion. All average values in the text are presented in form M±σ. Distinctions were considered as statistically significant at $r < 0.05$.

RESULTS AND DISCUSSION

Average values of indicators of hemodynamics in all groups differed from each other. Hence, indicators of the maximum speed of a stream (Vpk) had the greatest value in the first group (1.7 ± 0.3 m/s). In the second and third groups, this indicator was slightly below (1.5 ± 0.2 m/s and 1.4 ± 0.21 m/s, respectively), however, reliable distinctions at the same time were observed only between indicators of the first and third groups ($P < 0.001$) [Table 1].

Apparently from the table, the similar tendency was observed at a research and other indicators such as MD values of indicators were 27.5 ± 3.72 m/min, 21.0 ± 6.21 m/min, and 19.13 ± 3.66 m/min, respectively (at the same time, reliable distinctions were observed as between indicators of the first and third groups [$P < 0.001$], and the first and second groups [$P = 0.003$]); SBP - 126.2 ± 20.28 mmHg, 120.6 ± 8.73 mmHg, and 118.67 ± 10.96 mmHg, respectively; DBP - 69.3 ± 9.57 mmHg, 65.0 ± 5.08 mmHg, and 67.58 ± 6.77 mmHg, respectively; HR - 85.3 ± 16.15 bpm, 69.5 ± 15.97 bpm, and 69.5 ± 9.34 bpm, respectively (reliable

Table 1: Hemodynamics indicators at persons with hearing pathology

Indicators of hemodynamics	Groups of persons surveyed (M±σ)		
	Group 1 (*n*=15)	Group 2 (*n*=11)	Group 3 (*n*=24)
Vpk, m/s	1.7±0.3 *P*=0.067	1.5±0.2 *P**=0.179	1.4±0.21 *P***<0.001
MD, m/min	27.5±3.72 *P*=0.003	21.0±6.21 *P**=0.271	19.13±3.66 *P***<0.001
SVR, d*s/cm^{-5}	916.6±137.08 *P*=0.004	1192.9±291.18 **P*=0.344	1286.13±254.91 ***P*<0.001
SVRI, d*s/cm^{-5}/m²	1496.0±351.63 *P*<0.001	2122.2±487.82 **P*=0.686	2194.25±481.09 ***P*<0.001
BPsys, mmHg	126.2±20.28 *P*=0.401	120.6±8.73 **P*=0.611	118.67±10.96 ***P*=0.140
BPdia, mmHg	69.3±9.57 *P*=0.189	65.0±5.08 **P*=0.269	67.58±6.77 ***P*=0.515
BPp, mmHg	56.9±14.67 *P*=0.816	55.6±10.19 **P*=0.276	51.08±12.00 ***P*=0.164
HR, bpm	85.3±16.15 *P*=0.021	69.5±15.97 **P*=1	69.5±9.34 ***P*<0.001
SV, mL	93.9±20.72 *P*=0.606	90.1±14.36 **P*=0.105	81.33±14.5 ***P*=0.032
SVI, mL/m²	57.7±9.64 *P*=0.075	50.7±9.23 **P*=0.357	47.88±7.84 **P=0.001
CO, L/min	8.0±1.09 *P*=0.004	6.3±1.61 **P*=0.177	5.64±1.16 ***P*<0.001
CI, L/min/m²	5.0±0.8 *P*<0.001	3.5±0.92 **P*=0.544	3.33±0.68 ***P*<0.001

P - reliability of differences in values of indicators of hemodynamics between the first and second groups, ***P* - reliability of differences in values of indicators of hemodynamics between the second and third groups, ***P* - reliability of differences in values of indicators of hemodynamics between the first and third groups

distinctions were observed between indicators of the first and third groups [$P < 0.001$] and indicators of the first and second groups [$P = 0.021$]); the shock volume of blood (SV) - 93.9 ± 20.72 mL, 90.1 ± 14.36 mL, and 81.33 ± 14.5 mL, respectively (reliable distinctions were observed between indicators of the first and third groups [$r = 0.032$]); the SVI - 57.7 ± 9.64 mL/m², 50.7 ± 9.23 mL/m², and 47.88 ± 7.84 mL/m², respectively (reliable distinctions were observed between indicators of the first and third groups [$P < 0.001$]); warm emission (CO) - 8.0 ± 1.09 L/min, 6.3 ± 1.61 L/min, and 5.64 ± 1.16 L/min, respectively (reliable distinctions were observed between indicators of the first and third groups [$P < 0.001$] and indicators of the first and second groups [$P = 0.004$]); and the warm index (CI) - 5.0 ± 0.8 L/min/m², 3.5 ± 0.92 L/min/m², and 3.33 ± 0.68 L/min/m², respectively (reliable distinctions were observed between indicators of the first and third groups [$P < 0.001$] and indicators of the first and second groups [$P < 0.001$]). Besides, decrease in the majority of indicators (Vpk, MD, BPsys, BPp, SV, SVI, CO, and CI) depending on the extent of defeat of hearing was observed. At the same time at two parameters with high value in the first group (BPdia and HR) of such tendency, it was not observed. The average BPdia value in the third group is higher than in the second, average HR values in the second and third groups absolutely identical. By consideration of results of measurement of indicators of the SVR and SVRI in average values depending on extent of loss of hearing was noted in turn. Average values were SVR 916.6 ± 137.08 d*s/cm^{-5}, 1192.9 ± 291.18 d*s/cm^{-5}, and 1286.13 ± 254.91 d*s/cm^{-5}, respectively (reliable distinctions were observed as between indicators of the first and third groups [$P < 0.001$], and indicators of the first and second groups [$P < 0.001$]).

Thus, between values of parameters of hemodynamics in the second group and control (third) group, reliable differences, it was not revealed. The majority of indicators in Groups 1 and 2 and also in Groups 1 and 3 had reliable distinction, especially it concerns the studied indicators in Groups 1 and 3 where the reliability of high degree was observed ($P < 0.001$). Differences in indicators of warm emission, shock volume, vascular resistance, and also their indexes at doubtful differences in indicators of pressure confirm existence of more expressed sympatholytics effect on hemodynamics at persons with heavy degree of relative deafness. Shows low values of vascular resistance in Group 1 in comparison with indicators in other groups at existence of high values of warm emission about compensatory reaction of a vascular wall and lack of increase in integrated rigidity of arterial system.

Differences in values of indicators of hemodynamics were perhaps caused by the oppressing influence of pathological processes in the carrying out ways of the acoustic analyzer on kernels of the wandering nerve which are in close proximity from each other. As a result of this influence weakening of influence of the wandering nerve on a heart innervation, and, therefore, emergence of stronger sympathetic effect takes place.

SUMMARY

Thus, we revealed authentically higher values of indicators of hemodynamics (Vpk, MD, HR, SV, SVI, CO, and CI) at low values of SVR at persons with heavy degree of relative deafness that demonstrated existence of more expressed effect of sympatholytics system in the absence of influence on hemodynamics of integrated rigidity of arterial system.

CONCLUSION

Proceeding from the data obtained during our research, it is possible to draw a conclusion that persons with heavy extent of loss of hearing need to carry out diagnostics of hemodynamics more carefully. These researches can be used when performing medical examinations at persons with limited opportunities of health, primary reception by the cardiologist of persons with associated diseases, functional diagnostics at athletes, and participants of Paralympic games.

ACKNOWLEDGMENTS

This study was prepared in accordance with the Russian state program of competitive growth of Kazan Federal University.

REFERENCES

1. Deafness and Hearing Loss. 15 March 2018/Materials of the World Health Organization Website. Available from: http://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss. [Last accessed on 2018 Jul 05].
2. Susmano A, Rosenbush SW. Hearing loss and ischemic heart disease. Am J Otolaryngol 1988;9:403-8.
3. Tan HE, Lan NSR, Knuiman MW, Divitini ML, Swanepoel DW, Hunter M, *et al.* Associations between cardiovascular disease and its risk factors with hearing loss-a cross-sectional analysis. Clin Otolaryngol 2018;43:172-81.
4. Golovachev AM, Biktemirova RG, Ziyatdinova NI, Zevfirov TL. The use of modern ultrasound methods in the diagnosis of cardiovascular system. J Pharm Res 2017;11:1205-8.
5. Teregulov YE, Teregulova ET, Khusainova DK, *et al*. Integralstiffness of arterial system in patients with arterial hypertension of different genesis. Kazan Med J 2014;95:781-5.
6. Hodgson LE, Forni LG, Venn R, Samuels TL, Wakeling HG. A comparison of the non-invasive ultrasonic cardiac output monitor (USCOM) with the oesophageal doppler monitor during major abdominal surgery. J Intensive Care Soc 2016;17:103-10.
7. Phillips R, Lichtenthal P, Sloniger J, Burstow D, West M, Copeland J, *et al.* Noninvasive cardiac output measurement in heart failure subjects on circulatory support. Anesth Analg 2009;108:881-6.
8. Su BC, Lin CC, Su CW, Hui YL, Tsai YF, Yang MW, *et al.* Ultrasonic cardiac output monitor provides accurate measurement of cardiac output in recipients after liver transplantation. Acta Anaesthesiol Taiwan 2008;46:171-7.
9. Horster S, Stemmler HJ, Strecker N, Brettner F, Hausmann A, Cnossen J, *et al.* Cardiac output measurements in septic patients: Comparing the accuracy of USCOM to piCCO. Crit Care Res Pract 2012;2012:270631.
10. McNamara H, Barclay P, Sharma V. Accuracy and precision of the ultrasound cardiac output monitor (USCOM 1A) in pregnancy: Comparison with three-dimensional transthoracic echocardiography. Br J Anaesth 2014;113:669-76.

Source of support: Nil; Conflict of interest: None Declared