

Arterial Stiffness and Parameters of Central Hemodynamics in Adolescents with Different Value of Blood Pressure

Anastasia Ledyeva¹, Anastasia Amelina², Mikhail Ledyev³

¹Undergraduate student, Department of Children Diseases, Volgograd State Medical University, Russian Federation. ²PhD-student, Department of Children Diseases, Volgograd State Medical University, Russian Federation. ³Professor, PhD, Department of Children Diseases, Volgograd State Medical University, Russian Federation.

Abstract

Purpose: The aim of the research was to make a correlation analysis of hemodynamic parameters (central aortic pressure and arterial stiffness) in high-school students from boarding school.

Methods: The study included 64 adolescents 15-18 years old. The examination included: 3-times measurement of blood pressure by the method of Korotkov, ambulatory blood pressure monitoring using the device BPLab («Peter TELEGIN», Russia) and applanation tonometry using the unit SphygmoCor («AtCor medical», Australia, Ver.9.0). There were five groups: 1-group – healthy adolescents, 2-group – adolescents with normal BP, but having violence of circadian blood pressure profile, 3-group – adolescents with the «white-coat» hypertension, 4-group – adolescents with arterial hypertension, 5-group – adolescents with «latent hypertension».

Results: In 1-group there is inverse relationship between the aortic systolic blood pressure (SBPao) and heart rate (HR), the HR and aortic pulse pressure (PPao); in 2-group there was direct correlation between PPao and AIXao; in 3-group - between average aortic hemodynamic pressure (BPao) and HR, aortic diastolic blood pressure (DBPao) and duration of left ventricular ejection (ED); in 4 and 5-groups we noted a direct correlation between SBPao and DBPao. The highest values of PWVao were found in the group of adolescents with hypertension – the fourth group. In 1-group there was a negative correlation between AIX and height of the adolescents, in 2-group - the inverse relationship between age and PWVao, PWVao and ED, in 3-group - between PWVao and HR, in 4-group there were no correlations between parameters, in 5-group there were only average correlation links between PWVao and SBPao, and PWVao and average pressure in the aorta.

Conclusion: The results confirmed different relationships between parameters of central hemodynamics and arterial stiffness. Arterial hypertension influences on the value of this parameters. Using this method in pediatric practice helps to optimizing the diagnosis and prevention of hypertension in adolescents.

Keywords: Adolescents, Applanation tonometry, Ambulatory blood pressure monitoring, Arterial stiffness, Central hemodynamics

Introduction:

Numerous studies of arterial hypertension (AH) in adults found that its reasons are to be found in childhood and adolescence. It is known that high stiffness of arteries

in different ways contributes to the increase in aortic systolic blood pressure (SBP) and diastolic blood pressure (DBP), which increases the damaging effect of the pulse wave on the blood vessels of the brain, heart and other

organs, the blood supply is reduced and this increases the load on the myocardium and in the future all this changes contributes to the development of coronary heart disease, heart, kidney failure, stroke. Therefore, the estimation of the parameters of the central aortic pressure (CAP) is important in examining patients with high cardiovascular risk.^{1,2,3} It is known that the main vessels in hypertension are not only the target organ, but it has an independent role in the development and progression of hypertension.^{4,5}

The aim of our research is to make a correlation analysis of hemodynamic parameters (central aortic pressure and arterial stiffness) in high school students from boarding school.

Materials and Methods:

The study included 64 high school students (10-11 classes) from boarding school from 15 to 18 years old (average age – 16,16 years). The examination of them included: three times measurement of blood pressure (BP) by the method of Korotkov, ambulatory blood pressure monitoring (ABPM) using the device BPLab («Peter TELEGIN», Russia) and applanation tonometry using the unit SphygmoCor («AtCor medical», Australia, Ver.9.0). We made a correlation analysis of following central aortic hemodynamic parameters: aortic systolic blood pressure (SBPao), aortic diastolic blood pressure (DBPao), average aortic hemodynamic pressure (BPao), aortic pulse pressure (PPao), aortic augmentation index (AIxao), duration of left ventricular ejection (ED), parameters of arterial stiffness: pulse wave velocity in the aorta (PWVao), augmentation index (AIx). The processing of the data was performed by the program SPSS Statistics 17.0.

Results:

Three times measurement of BP by the method of Korotkov and ABPM were conducted to verify the diagnosis of hypertension and based on the results we made 5 groups of patients. The first group (12,5%) – healthy adolescents, the second group (7,8%) – adolescents with normal BP, but having violence of circadian blood pressure profile. The third group (23,4%) – adolescents with the «white-coat» hypertension. The fourth group (37,5%) – adolescents with arterial hypertension. The fifth group (18,8%) – adolescents with «latent hypertension».

The analysis of the parameters of central hemodynamics in all groups we identified the most significant correlations: in the first group there is inverse relationship between the aortic systolic blood pressure (SBPao) and the heart rate (HR) ($r = -0,70$; $p = 0,004$), the HR and aortic pulse pressure (PPao) ($r = -0,77$; $p < 0,001$); in the second group there was direct correlation between PPao and AIxao ($r = +0,82$; $p < 0,001$); in the third - between average aortic hemodynamic pressure (BPao) and HR ($r = +0,80$; $p = 0,001$), aortic diastolic blood pressure (DBPao) and duration of left ventricular ejection (ED) ($r = +0,76$; $p < 0,001$); in the fourth and fifth groups we noted a direct correlation between SBPao and DBPao ($r = +0,81$; $p < 0,001$ and $r = +0,70$; $p < 0,001$, respectively). Also as a result of applanation tonometry we found average values of PWVao in all groups: the first group - $5,29 \pm 0,24$ m/s, the second group - $4,48 \pm 0,17$ m/s, the third - $5,07 \pm 0,21$ m/s, the fourth - $5,48 \pm 0,13$ m/s, the fifth - $4,88 \pm 0,20$ m/s. All values of PWVao in all groups are in the normal range (5.5 - 8.0 m/s), due to the young age of the participants. However, the highest values of this parameter were found in the group of adolescents with hypertension – the fourth group.

The correlation analysis of the parameters of arterial stiffness showed the following links in groups: in the first group there was a negative correlation between AIx and height of the adolescents ($r = -0,70$; $p < 0,001$) in the second group - the inverse relationship between age and PWVao ($r = -0,88$; $p < 0,001$), PWVao and ED ($r = -0,73$; $p < 0,001$), in the third group - between PWVao and HR ($r = 0,77$; $p < 0,001$), in the fourth group there were no correlations between parameters, in the fifth group there were only average correlation links between PWVao and SBPao ($r = 0,59$; $p < 0,001$), and PWVao and average pressure in the aorta ($r = 0,58$; $p < 0,001$).

Discussion:

The results confirmed that there are different relationships between parameters of central hemodynamics and arterial stiffness, and showed that arterial hypertension influences on the value of this parameters.

Conclusion:

Applanation tonometry can be used to evaluate the parameters of central hemodynamics and arterial stiffness in children of different age groups, the advantage of the method is that it is non-invasive and it helps to highlight the features of the relationships between various hemodynamic parameters. Using this method in pediatric practice contributes to optimizing the diagnosis and prevention of hypertension in adolescents. All these measurements are very popular in general practice, so normal ranges displayed with individual patient results, but this method is new in pediatric practice and there are NO normal ranges for children and adolescents. The prospect of our study is to collect the necessary basis and to determine normal ranges for children and adolescents of all ages.

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Corresponding Author**Anastasia Ledyeva**Russian Federation, 400120 Volgograd,
Eletskaya street, 18\114**Email id:** *a.m.ledyaeva@gmail.com*