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The Influence of Overweight on the Structural and Geometric Parameters of the Left Ventricular Myocardium and the Daily Blood Pressure Profile in Middle-aged Military Personnel

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Abstract--- *One of the leading risk factors for the development of arterial hypertension is undoubtedly overweight. The purpose of this study was to study the effect of excess body mass index on the structural and geometric parameters of the left ventricular myocardium and the daily blood pressure profile in middle-aged military personnel with arterial hypertension. The study included 73 patients suffering from arterial hypertension (AH) of 1-2 degrees, male aged 20 to 45 years, with stage 1 hypertension. With an increase in the level of body weight in military personnel with hypertension, there is an increase in the incidence of remodeled left ventricular myocardium and an increase in the diagnostic plan of adverse daily blood pressure profiles. Based on the results of complex therapy (hypotensive therapy), it is also necessary to pay attention to actions that are aimed at normalizing body weight.*

Keywords--- *Arterial Hypertension, Overweight, Echocardiography, Left Ventricular Remodeling.*

I. INTRODUCTION

Among the leading risk factors for the development of arterial hypertension (AH), overweight undoubtedly occupies the place. There is a real epidemic in the world — 30% of the world's population is obese, not counting those who are overweight [3, 57-59].

Body mass index (BMI)>30 kg/m^2 affects 400 million adults, and a BMI of 25-30 kg/m^2 is observed in 1.6 billion adults [15, 29-31]. Excessive weight gain is associated with the development of hypertension, and its normalization contributes to a decrease in blood pressure (BP) [12, 991]. There is extensive information about the Association of obesity with increased blood pressure [24, 30:445-8]. According to the Framingham study, a 1 kg weight gain increases blood pressure by 1 mmHg [20, 478–482]. This suggests that there is a causal relationship between obesity and hypertension [14, 157: 2413-2446].

The results of numerous studies indicate the need for early non-drug and drug treatment of abdominal obesity for the prevention of hypertension [6, 263-264]. Both overweight and obesity are associated with an increased risk of cardiovascular disease and overall mortality. Weight loss is recommended for overweight and obese patients with hypertension to control metabolic risk factors. According to the Prospective Study Collaboration [22, 1083–1096],

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the mortality rate is minimal with BMI values in the range of 22.5-25 kg/m^2 [11, 71-82]. Weight loss can also help improve the effectiveness of antihypertensive medications and improve the profile of cardiovascular disease factors.

In patients suffering from hypertension and overweight, the lesion of at least one target organ is significantly higher by 3 times than in patients with hypertension without excess body weight. [7, 1-15].

Thus, the purpose of this study was to study the effect of excess body mass index on the structural and geometric parameters of the left ventricular myocardium and the daily blood pressure profile in middle-aged military personnel with arterial hypertension.

II. THE MAIN FINDINGS AND RESULTS

Materials and Methods

The study included 73 patients suffering from grade 1-2 hypertension, male military personnel aged 20 to 45 years, and stage I hypertension. Depending on the body mass index, patients are divided into 3 groups: patients with normal body weight, overweight and obese I degree. The first group included 10 patients aged 26 to 43 years, with an average age of 34.7±6.1 years. The second group – 37 patients aged 36.7±4.4 years, the age range from 28 to 44 years. The third group included 26 patients aged 28 to 44 years, with an average age of 37.3±5.3 years. Age data did not differ significantly between the groups.

The criteria for exclusion from the study were: female patients, elderly and senile patients, non-sinus rhythm, symptomatic hypertension, the presence of type 1 or 2 diabetes, the presence of IHD, malignant neoplasms, heart failure, acquired or congenital heart defects, liver, kidney, respiratory failure.

The structural and functional state of the heart was determined by echocardiography using a Neusoft ultrasound machine (China), in B - and M - modes according to the standard method. The mass of the left ventricle myocardium (MML) was calculated using a cubic formula recommended by ASE experts (2015): LVM, g = 0,8 × (of 1.04 × ((LV KDR + ZS LV + IVS)^3-CDR LJ^3) + 0,6. [18, 577–605].The MMLF index (LMMLF) was calculated as the ratio of MMLF to body surface area [10, 613-618]. The LV geometry was evaluated according to the recommendations proposed by experts of the American society of echocardiography, as well as experts of the European Association of specialists in cardiovascular imaging techniques, taking into account the calculation of LVML and the relative wall thickness (OTS) of the LV (OTS, ed = (2hzs LV) / CDR LV)).Based on the values of LVMWI and ITS singled out the following types of cardiac remodeling: normal LV geometry (GLI): LVMWI in the normal range and the OTS at least 0,42; concentric left ventricular remodeling (KRLI): LVMWI within normal limits and OTC over 0,42; concentric LV hypertrophy (CGLI): LVMWI more normal values and OTS more of 0.42; eccentric LV hypertrophy (EGLE): LVMWI more than the norm, and the OTS at least 0,42 [17, 28;17(1):915].

The daily monitoring of blood pressure (BPM) was performed using the Shiller BP-102 complex, according to the generally accepted methodology, and lasted an average of 24 ± 1.5 hours. Based on the degree of nighttime decrease in blood pressure, 4 variants of the daily profile of blood pressure are distinguished: with normal nightly decrease in blood pressure (dippers) (Daily Index (SI)> 10 <20%); with insufficient nightly decrease in blood

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pressure (non-dippers) (SI <10%); with an excessive nightly decrease in blood pressure (over-dippers) (SI> 20%); with night hypertension (night-peakers) (SI <0).

The data obtained during the study were subjected to statistical processing on a Pentium-IV personal computer using the Microsoft Office Excel-2012 software package, including the use of built-in statistical processing functions. We used methods of variational parametric and nonparametric statistics with the calculation of the arithmetic mean of the studied indicator (M), standard deviation (SD), relative values (frequency,%), the statistical significance of the measurements obtained by comparing the average values was determined by the Student criterion (t) with the calculation of the error probability (R).

Results and Discussion

One of the important morphological and functional changes that determine the damage to target organs in hypertension is LV remodeling. It is known that one of the markers of the effect of stress on the heart may be myocardial remodeling [1, 3-5].

Studying the types of myocardial remodeling in patients with hypertension, depending on body weight, revealed statistically significant differences between the groups (Table 1).

Moreover, the normal LV geometry in patients with hypertension with normal body weight was more common than in overweight (90% versus 73%, p = <0.05) and obesity of the 1st degree (90% against 65.4%, p = <0.03).

Table 1: Left Ventricular Myocardial Geometry Depending on Body Weight

Bodymass	**Amount73**	**LV geometry**		
		Norm53 (72,6%)	**KR 19 (26%)**	**EG 1 (1,4%)**
Norm	10	9 (90%)	1 (10%)	0
Overweight	37	27 (73%)*	9 (24,3%)	1(2,7)
Obesity 1 tbsp.	26	17(65,4%)**	9 (34,6%)	0

Note: * - significance of the difference between patients with normal body weight and overweight

** - significance of the difference between normal body weight and obesity of 1 degree

The features of hypertension with obesity are marked by an increase in circulating blood volume (BCC) and an increase in stroke volume of the heart. These changes are the result of increased metabolic needs of the body due to an increase in the total mass and surface of the body. With an increase in fat mass, a decrease in peripheral vascular resistance occurs with a gradual deposition of blood, leading to an increase in bcc and stroke volume. In obese patients, there is a change in the functioning of the kidneys with a delay in water and sodium salts, which is also a mechanism for increasing bcc. Chronic overload by volume and pressure leads to the formation of eccentric left ventricular hypertrophy (EHL), enlargement of the heart chambers, its remodeling and the development of heart failure. [8, 93-99]

Concentric LV remodeling in the hypertension group with normal body weight was less common with respect to grade 1 obesity (10% versus 34.6%) and overweight (10% versus 24.3%). In military personnel with hypertension, obesity-related 1st degree obesity was accompanied by a higher frequency of LV concentric remodeling compared to other groups. Only 1 patient - 2.7% of overweight had eccentric LV hypertrophy. Concentric LV hypertrophy was not observed in the examined.

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It is believed that the earliest stage of the pathological process preceding the development of LVH is concentric remodeling of the LV [23, 7: 79-108].

It is possible that the pathological effect of obesity on blood pressure is mediated by elevated levels of leptin, free fatty acids and insulin, which can stimulate the activity of the sympathetic nervous system and thus play a major role in the link between obesity and hypertension [19, 433-439].

Thus, the body weight of a patient with arterial hypertension affects the formation of the type of architectonics of the left ventricle. With increasing body weight, the incidence of LV myocardial remodeling increases.

When analyzing the data on the study of the daily profile of blood pressure (SPAD), significant differences were found in the examined groups, the results are presented in table 2. Thus, the physiological variant of the dippers "Dippers" in military personnel with grade 1 obesity was less frequently recorded compared to overweight (19.2% versus 51.4%) and with normal body weight (19.2% versus 60%).

Table 2: SPAD Data in the Examined Patients

Body mass	**Amount 73**	**BP profile**			
		Dippers 30(41,1)	**Non-dippers 36 (49,3)**	**Over-dippers 1(1,4)**	**Night-pickers6 (8,2)**
Norm	10	6 (60%)	4(40%)	0	0
Overweight	37	19 (51,4%)	15 (40,5)	1 (2,7)	2 (5,4)
Obesity 1 tbsp	26	5 (19,2%)	17(65,4%)	0	4(15,4%)

An insufficient degree of nightly decrease in blood pressure ("non-dippers") prevailed among obese military personnel. Thus, the frequency of the "non-dippers" option in military personnel with 1st degree obesity was higher compared to overweight (65.4% versus 40.5%, and normal body weight (65.4% versus 40%).

As a result of long-term follow-up of hypertensive patients with various types of the daily profile of blood pressure [13, 3-10], it was found that the highest incidence of strokes, microalbuminuria, and LVH is observed in individuals with an insufficient decrease in nighttime blood pressure (the "non-dipper" option).

According to the results of the analysis of SPAD in military personnel with arterial hypertension, depending on body weight with 1st degree obesity in 15.4%, and with overweight in 5.4% of cases, an increase in the frequency of the pathological type of night-pickers was noted relative to military personnel with normal body weight, in the group of patients with normal body weight, the presented option was not identified. In addition, the type of "over-dippers" profile in the groups was found only in 1 patient (2.7%) with overweight.

Hyper-activation of the renin-angiotensin-aldesterone system (RAAS) and sympatho-adrenal system (CAS), the presence of inflammation due to the production of pro-inflammatory adipokines by adipocytes, a tendency to sodium retention due to an increase in its consumption, associated with hyper-sympathicotonia and leptin resistance, are noted with an increase in body weight and severe damage to target organs (heart, kidneys, blood vessels). Due to the fact that the activation of RAAS and inflammation are closely related to the number and size of adipocytes, preference is given to antihypertensive drugs with high lipophilicity, which can reduce the production of atherogenic factors [2, 57].

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Thus, the obesity phenotype of AH is characterized by a high frequency of pathological profiles of non-dippers and night-pickers. The AH phenotype with normal body weight is characterized by a high frequency of occurrence of the "dippers" profile, with an increase in body weight, the proportion of the occurrence of "dippers" among military personnel with AH fits.

A significant predictor of LVH development is an insufficient decrease in SBP and DBP at night (non-dippers and night-pickers) [5, 57], besides these BP profiles, irrespective of other factors, increase the risk of cardiovascular death. [21, 15:357–364] Which requires their tight control of the blood pressure profile?

Table 3: Morphometric Indicators of the Left Ventricle According to Echocardiography in Patients with Hypertension DEPENDING on Body Weight

Indicators	**AH with normal body weight n-10**	**Overweighthypertension n-37**	**AH with obesity of 1 degree n-26**
KDR, cm	4,56±0,33	4,7±0,29	4,8±0,2
DAC, cm	3,04±0,4	2,91±0,28	3,08±0,38
BDO, ml	104,5±10,8	107,05±9,4	108,6±9,1
CSR, ml	35,4±7,8	33,73±7,4	37,9±7,1
UO, ml	72,9±9,1	72,95±8,9	72,4±7,8
PV %	67,8±5,5	67,99±4,7	65,3±5,6
MCP, cm	0,93±0,07	0,986±0,06*	1,02±0,09**
SSLI, cm	0,91±0,08	0,95±0,05*	1,01±0,06**
LVMM, gr	160.1±9,6	167,7±8,8*	173,9±8,9**
LLVMM, gr/m^2	79,8±5,6	85,6±7,4*	90,8±7,1**
IOT, ed	0,388±0,03	0,406±0,02*	0,417±0,03**

Note: * - significance of the difference between patients with normal body weight and overweight

** - significance of the difference between normal body weight and obesity of 1 degree

As a result of studying morphometric parameters by echocardiography in patients with AH, depending on body weight, parameters are presented that characterize changes in the structural and functional parameters of the left ventricle. The condition of the left ventricle in patients with hypertension was characterized by the fact that, with an increase in body weight, there was a tendency to an increase in the thickness of the interventricular septum, posterior wall of the left ventricle and left ventricular mass, and an increase in the left ventricular mass index and the relative myocardial thickness index. In obese soldiers, the left ventricular myocardial mass index (LVMI) and the left ventricular myocardial mass (LVML) were statistically significantly higher than the groups of patients with overweight ($p = 0.007$ and $p = 0.008$) and normal body weight ($p = 0.001$ and $p = 0.001$).

In studies of Avelar E., it was shown that there is a correlation between blood pressure, BMI, and LVMI, which is also observed in our subjects [9, 34-39].

It has been proven that with an increase in body weight, an increase in the volume of circulating blood is noted, which is accompanied by changes in systemic hemodynamics with subsequent hemodynamic load on the LV myocardium and the development of LVH [4, 35-39].

The thickness of the interventricular septum (UTI) in the group of overweight and obese patients exceeded the values of the group with normal body weight and amounted to 0.986 ± 0.06 cm ($p = 0.01$) and 1.02 ± 0.09 cm ($p = 0.008$), respectively, against 0.93 ± 0.07 cm.

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In addition, the highest obesity index was determined in the obese military group, higher than normal body weight (1.01 ± 0.06 cm versus 0.91 ± 0.08 cm, p = 0.001) and overweight employees (1, 01 ± 0.06 cm versus 0.95 ± 0.05 cm, p = 0.001).

Moreover, the ejection fraction index (EF) did not statistically differ in hypertensive patients with overweight and obesity compared with the index of the group with normal body weight.

III. CONCLUSION

Thus, the frequency of left ventricular myocardial remodeling and diagnostic terms of adverse indicators of the daily blood pressure profile increases with an increase in body mass in military personnel with hypertension, which requires not only strict control of blood pressure to prevent possible complications, but also requires strict control of body weight, which is closely related to the aggravation of target organ damage in hypertension. The results of a number of studies show that patients with a smoothed daily pattern of blood pressure, increased risk of hypertension and its complications in the form of left ventricular hypertrophy and cerebrovascular pathology. Conversion to the optimal profile of blood pressure reduction at night is one of the important components of hypotensive therapy of military personnel.

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