Specifics of Left Ventricular Remodeling and Daily Blood Pressure Profiles in Young and Middle-Aged Servicemembers Dealing with Arterial Hypertension

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Abstract

Objective: Investigating structural and geometrical parameters, specifics of LV remodeling, as well as daily BP profiles in young and middle-aged service members dealing with hypertension Stage 1 and Stage 2. A group of 86 male subjects has been researched, including 52 young (26-44 y/o) and 34 middle-aged (45-55 y/o) subjects with AH. The cardiac function has been evaluated through echo cardiography, and daily BP monitoring has been carried out. The ***results*** of the study have shown that young and middle-aged servicemen with AH have a normal LV geometry (59.6% of young subjects (31), 55.9% of middle-aged subjects (19)), and concentric LV remodeling has been observed in 40.4% of young subjects (21) and in 22.1% of middle-aged (15) subjects with AH. According to data obtained during 24-hr BPM,as compared to the normal LV geometry group, in the concentric LV remodeling groups the occurrence of the dipper AH profile has decreased both in young (28.5% vs. 39%) and middle-aged (40% vs. 47.7%) subjects.

Keywords: *Arterial hypertension; echo cardiography, left ventricular remodeling, 24-hr arterial blood pressure monitoring.*

Introduction

Arterial hypertension (AH) is a leading mortality and disability risk factor among CVDs, being far ahead of other risk factors. It has been confirmed by many authors, as they note that in 2015, AH was the most common cause of premature death, killing 10 million and disabling more than 200 million people (5).

An important morphological and functional change, which characterizes thetarget organ's state, is left ventricular (LV) myocardial remodeling. This and other changes consist in LVH (left ventricular hypertrophy), which results from structural and functional modification of the heart, which adapts to increased hemodynamic load and neurohumoral activation.

Echo cardiography of the heart and vessels is still the most advanced non-invasive methodof diagnosing left ventricular remodeling. The diagnostics plays an important role in evaluation of left ventricular myocardium mass, which is an important life expectancy prognostic factor for AH and other patients [Mancia, G.]. The most common method used to classify types of LV remodeling in AH patients is the A[1]. Ganau classification (1992), according to the 2013 ESC/ESH Guidelines, which relies on LVMMI and left ventricular wall thickness[6]. A gradual increase in the LV wall thickness and progressing concentric LV hypertrophy lead to an increased risk of cardiovascular complications[12].

AH in service members attracts closer attention, because high blood pressure (BP) can affect contract servicemen's ability to properly carry out their professional duties and therefore undermine national security and defense capability[8].

Materials and Method

A group of 86 male AH patients, who are service members, have been examined. Group 1 comprises 52 young servicemen aged 26 to 44 y/o (median age – 36.25±5.1 y/o); Group 2 consists of 34 middle-aged servicemen with AH aged 45 to 55 y/o. median age of the group is 47.5±2.6 y/o. Age distribution was made

according to the WHO classification pattern, which deems the age of 18 through 44 as young and the age of 45 through 59 - as middle age. Also, the subjects were divided into subgroups according to the type of LV remodeling.

Male subjects aged 20 through 60 years old and suffering arterial hypertension Stage 1 and Stage 2 have had all inclusion criteria[2]. Non-inclusion criteria are: female gender, old and senile age, non-sinusoid heartbeat, symptomatic AH, diabetes type 1 and/or type 2, IHD, malignant neoplasms, cardiac insufficiency, acquired or inborn cardiac defects, hepatic, renal and/or respiratory insufficiency.

The structural/functional state of the heart has been evaluated through echocardiography with the use of a Neusoft ultrasound system (made in China) in the B- and M modes while relying on the standard method. Left ventricular mass (LVM) has been calculated according to a cubic formula recommended by ASE experts (2015): LVM (g) = 0.8 × (1.04 × ((LV EDD + 3CLV + IVS)^3 – (LV EDD)^3)) + 0.6. [11]. The LVM (LVMMI) index has been calculated as a ratio between LVMMI and TBSA (total body surface area)[4]. LV geometry has been evaluated as recommended by experts from the American Society of Echocardiography Association and from the European Association of Cardiovascular Imaging, as the method help calculate LVMMI and relative left ventricular myocardial thickness (RLVMT, unit = (2x3C LV)/(LV EDD)).

Based on LVMMI and RLVMTIvalues, the following LV remodeling types have been specified: normal geometry LV remodeling (NGLVR): LVMMI is within the normal range with TBSA less than 0.42; concentric LV remodeling (CLVR): LVMMI is within the normal range with TBSA more than 0.42; concentric LV hypertrophy (CLVH): LVMMI exceeding the normal value with TBSA more than 0,42; eccentric LV hypertrophy (ELVH): LVMMI exceeding the normal value with TBSA less than 0.42 [9].

The 24-hr blood pressure monitoring procedure has been conducted with the help of a Shiller BP-102 system and according to the generally accepted method, and it has continued for 24±1.5 hours on average. Based on nighttime BP decreases, four daily BP profiles have been specified: *dippers* (DI>10%<20%), *non-dippers* (DI<10%), *over-dippers* (DI>20%) and *night-peakers* (DI<0).

Data obtained during research has been processed for statistical purposes on a Pentium-4 computer with the help of the Microsoft office Excel-2012 package and integrated statistical processing functions. Parametric and non-parametric variation statistics method have been used with calculation of the mean indicator being studied (M), standard deviation, relative values (frequency, %), statistical significance of measured values, with mean values compared, has been measuredthrough the use of Student's-t test with calculation of error probability (P).

Results and Discussion

The analysis of the study has shown that young and middle-aged servicemen with AH had normal LV geometry and concentric LV remodeling. Particularly, 59.6% of young subjects (31) and 55.9% of middle-aged subjects (19) with AH have had normal LV geometry, while 40.4% of young subjects (21) and 44.1% of middle-aged subjects (15) with AH have had concentric LV remodeling. No cases of eccentric or concentric LV hypertrophy have been revealed.

Meanwhile, LVM in young subjects with AH and normal LV geometry is 151.2±10.1g, in young subjects with concentric LV remodeling – 165.7g±11.4g ($P<0.01$), and LVMMI is 73.5±5.6g/$m^2$and 80.2±6.1g/m^2respectively ($P<0.05$).

Middle-aged AH patients with normal LV geometry have shown a LVM of 154.7±9.9 g, those with concentric LV remodeling – 166.6g±11.3g ($P<0.01$).

Middle-aged subjects with concentric LV remodeling have demonstrated the highest left ventricular posterior wall thickness (LVPWT) – 1.18±0.06cm, in young subjects, LVPET has been 1.11cm±0.03cm ($P<0.05$). Young and middle-aged subjects with normal LV geometry have shown a LVPWT of 1.08±0.05cmand 1.09cm±0.04cm respectively.

As to inter ventricular septum thickness (IVST), geometry changes have not caused any increase; on the contrary, a slight increase has been observed in patients with normal LV geometry: respectively, the normal LV geometry and concentric LV geometry young-age groups have had an IVST of 1.04±0.06cm and 1.02±0,07cm. In middle-aged subjects, it has been 1.07±0.0cm and 1.05±0.07cm respectively. The insignificant increase in these characteristics in subjects with normal LV geometry may be due to the septum's anatomic features,

as it has a convex shape, and depends on what part of the septum these indicators refer to.

Thus, LVM, LVMMI, and LVPWT tend to increase in patients with LV remodeling. There is a direct correlation between left ventricular mass and occurrence of cardiovascular events[15].

Concurrently, ejection fraction (EF), which reflects cardiac contractility, has been similar in all study groups (P>0.05) (Table 1).

Table 1: Echo cardiography test results in young and middle-aged service members diagnosed with AH

Indicators	Young		Middle-aged	
	Normal LVG(31)	Concentric LVR (21)	Normal LVG(19)	Concentric LVR(15)
EDD, cm	4.69±0.22	4.6±0.16	4.7±0.19	4.67±0.21
ESD, cm	2.89±0.24	4.03±5.3	3.03±0.23	2.9±0.2
EDV, ml	100.8±20.89	97.6±8.35	108.4±10.1	104.1±24.4
ESV, ml	33.45±6.47	32±5.2	37.2±6.5	32.6±5.4
SV, ml	69.4±7.5	65.5±7.8	70.0±6.08	71.5±23.7
EF%	67.5±4.4	66.6±4.9	65.4±4.08	66.1±4.2
IVST, cm	1.03±0.06	1.02±0.07	1.07±0.05	1.05±0.07
LVPWT, cm	1.08±0.05	1.11±0.03	1.09±0.04	1.18±0.06**•
LVM, g	151.2±10.1	165.7±11.4**	154.7±11.9	166.6±10.3**
LVMMI, g/m^2	73.5±5.6	80.2±6.1	76.03±7.4	84.42±10.5
RWT, units	0.39±0.022	0.44±0.01	0.39±0.021	0.44±0.021

Note: * P<0.05, ** P<.01 differences between the subgroups, • P<0.05, •• P<0.01 differences between Group 1 and Group 2.

Concentric remodeling (normal LVM with an increased relative wall thickness) is characterized by peripheral vascular resistance, low cardiac index and high arterial stiffness[14]. Concentric LV remodeling is believed to be the earliest stage of the pathologic process that precedes left ventricular hypertension[13].

The results justify the necessity of early AH diagnostics and administration of strict and effective anti-hypertension therapy to servicemen. In turn, these measures help stabilize the left ventricle's state and stop the progress of the disease in patients dealing with the process of LV remodeling.

Table 2: 24-hr blood pressure monitoring indicators in young and middle-aged servicemen with AH

BP (mmHg)	Young		Middle-aged	
	Normal LVG (31)	Concentric LVR (21)	Normal LVG(19)	Concentric LVR(15)
SBP, daytime	152.4±6.1	160.9±5.95**	153.3±5.4	165.9±5.4**
DBP,daytime	85.1±5.12	92.8±5.9**	86.0±5.58	93.2±4.47**
SBP, nighttime	132.9±6.2	147.8±8.5**	139.3±3.04	149.4±8.3***
DBP,nighttime	77.12±5.2	85.7±6.4**	79.8±4.5	88.5±6.4**
SBP, 24-hr	142.5±8.3	155.1±8.8**	148.5±7.9	157.7±4.4***
DBP, 24-hr	83.4±8.4	89.5±8.1	84.3±4.5	87.4±5.9
Mean pulse pressure	66.4±3.5	78.4±4.9**	66.6±6.9	77.87±5.33**

Note: * P<0.05, ** P<0.01 are differences between the groups

Hemodynamics indicators (SBP, DBP, MAP, HR) have been studied in all the groups, and the results are shown in Table 2. BP checks in service members dealing with AH, based on the type of LV remodeling, have helped reveal the following specific features: all groups of AH subjects with concentric LV remodeling have shown an increase in SBP, DBP, MAP, and HR (P<0.01) (except 24-hr HR in the middle-age group relative to AH with normal LV geometry). These indicators were relevant in the young age group (P<0.01).

Also, the analysis of SBP, DBP and mean hemodynamic pressure in the middle-age group of servicemen has revealed a transition from normal LV geometry to concentric LV geometry, but the results have not shown any relevant differences. Based on the above, it is possible to track the relationship between the indicators and the LV geometry; i. e., as these indicators grow, the LV geometry shifts toward remodeling, which is a primary precursor to hypertrophy in itself.

24-hr blood pressure monitoring of servicemen with AHis necessary not only for analysis of prognostically important indicators and daily BP profiles, but also for adequate AH control, because it gravely affects military capacity.

Table 3: Distribution of AH patients according to daily BP profile types

24-hr BP monitoring	Young		Middle-aged	
	Normal LVG (31)	Concentric LVR (21)	Normal LVG(19)	Concentric LVR (15)
Dipper	12 Patients – 39 %	6 Patients – 28.5%	9 Patients – 47.4%	6 Patients – 40%
Non-dipper	18 Patients – 58%	13 Patients – 62%	9 Patients – 47.4%	9 Patients – 60%
OVer-dipper	1 Patient – 3 %	0	1 Patient – 5.2%	0
Night-peaker	0	2 Patients – 9.5%		0

It has been observed that compared to subjects with normal LV geometry, concentric LV remodeling groups, both young (28.5% vs. 39%) and middle-aged (40% vs. 47.7%), have shown a lower occurrence of the *dipper* profile. And vice versa, the occurrence of the *non-dipper* profile has increased in subjects with concentric LV remodeling in both the middle-age (62% vs. 58%) and young (60% vs. 47.7%) groups. Finally, 9.5% of young subjects with concentric LV remodeling have had the *night-peaker* profile (see Table 3).

The results of the study show that a shift from the normal LV geometry changes the daily AH profile, increasing in the number of *non-dippers* and generating *night-peaker* profile cases[7]. In turn, these indicators lay ground for unfavorable prognoses, because they are associated with cardiovascular complications (myocardial infarction, CVA, cardiac insufficiency)[3].

Thus, early diagnostics of AH and effective treatment of servicemen can help keep the LV in a healthy state. However, absence of concentric and eccentric hypertrophy signifies an appropriate pharmacological control of AH indicators in service members. It is known that most scientists consider insufficient lowering of BP during sleep and its dramatic increase in the morning to be an independent risk factor of left ventricular hypertrophy and consequently, cardiovascular complications.

That is exactly why it is important to evaluate nighttime BP levels. Daily BP profile changes accompanied by increased *non-dipper* profile occurrence should be regarded as unfavorable factors, which should also be taken into account when administering a drug therapy. The goal of the treatment, which is part of arterial pressure control therapy, is reversal of the remodeled left ventricular myocardium in this group of patients to reduce the risk of cardiovascular complications.

Conclusion

1. Ithasbeenfoundthatsomeyoungandmiddle-agedservicemenwith AHhaveanormalLVgeometry (59.6% (31) ofyoungand 55.9% (19) ofmiddle-agedsubjects), andconcentricLVremodelinghasbeenobservedin 40.4% (21) of youngand 44.1% (15) of middle-aged subjects.

2.ComparedtothenormalLVgeometrygroup, inc on

centric LV remodeling groups the occurrence of the *dipper* AH profile has decreased both in young (28.5% vs. 39%) and middle-aged (40% vs. 47.7%) subjects.

3. The occurrence of the *non-dipper* AH profile has increased in middle-aged subjects with concentric LV remodeling (62% vs. 58%), as well as in young subjects (60% vs. 47.7%). In 9.5% of the subjects with concentric LV remodeling, the *night-peaker* profile has been observed.

4. 24-hr blood pressure monitoring has revealed at rend of increasing BP along with a change in LV geometry from normal tore modeling.

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