UDC: 616.127-007.61-02:616.12-008.331.1:616.12-018.74

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STRUCTURAL-GEOMETRIC REMODELING OF THE LEFT VENTRICULAR AND ENDOTHELIAL VASCULAR FUNCTION IN CASE OF ARTHERIAL HYPERTENSION AND DIFFERENT BODY WEIGHT OF PATIENTS

Abstract. *This investigation deals with changes of structural-morphologic, geometric, systolic-diastolic indices of remodeling of the left ventricular and endothelial vascular function parameters in patients with arterial hypertension with normal body weight, obesity and low body weight.*
Key words: *arterial hypertension, obesity, deficiency of body weight, structural-geometric remodeling of left ventricular, systolic-diastolic parameters, endothelial dysfunction.*

Introduction. When precautionary methods are applied to prevent the impact on development of cardiovascular complications the main attention is drawn to obesity that more frequently is estimated by means of Quetelet index, that is, the body weight (kg) to body height (m) ratio. Among the mechanisms through which pathological impact of obesity is implemented, arterial hypertension (AH), hypercholesterolemia and glucose intolerance play a critical role, increasing prevalence among overweight individuals.

However, as numerous epidemiological research studies state, among other 32-year observations in Framingham, the increased mortality from IHD and other non-infectious diseases is observed among patients with incomplete body-weight index in comparison to average body-weight index patients. It is essential, that this interdependence has self-sufficient effect and is not influenced by smoking and hidden diseases. In the studies of native scientists the range of minimal mortality is observed when Quetelet index is 24-27 kg/m².

Whereas Quetelet index decrease is accompanied by decrease of systolic and diastolic arterial pressure, total cholesterol and low density lipoprotein and by increase of high density lipoprotein cholesterol, glucose intolerance, individuals with low weight of body probably should have favorable cardiovascular disease risk profile. Increase of mortality caused by cardiovascular system disease among them is seemed more paradoxically in comparison with average Quetelet index individuals.

In fact, when AH and abdominal obesity (AO), specific target lesions occur which afterwards can appear as independent risk factors of cardiovascular sequelae [2,5,6]. Characteristics of myocardial and endothelial dysfunction of patients with AH and deficiency of body weight remain incompletely studied. We did not find convincing data pertaining to this issue in the native literature.

Determination of special aspects of structural-geometric, systolic-diastolic remodeling of left ventricular (LV) and endothelial dysfunction of vessels as early markers of atherosclerosis among patients with AH and different body weight was the target of our research.

Materials and methods. 69 male patients with hypertensive disease (HD) stage II, in accordance to Ukrainian Association of Cardiology (2008), at the ages from 60 to 85, in an average – 75±5,9 years old were enrolled in the study. 25 patients with AH had concomitant AO, 15 – deficiency of body weight, 29 patients – normal body weight.

Duration of the disease was less than 10 years. Abdominal obesity type was determined when waist circumference to thighs circumference ratio was ≥ 0,95 and body mass index (BMI)>25 kg/m², deficiency weight of body – when BMI<18,5 kg/m².

Echocardiography was performed with the use of M – modal, two-dimensional regime, pulsed wave and permanent wave Doppler regime with a help of ”LOGIQ 500” (General Electric, USA) 2,5 – 3,5 MHz sensor machine with phased array. The thickness of cardiac walls and the size of cardiac cavity were determined by means of through Penn convention method and by formula of L. Teichholtz. Myocardium mass of the left ventricule of the heart (MMLVH) was calculated by formula of Devereux R.B. with subsequent indexation to

body surface square. MMLVH criteria that exceeded 134g/m2 for males, was taken as LV hypertrophy (LVH) level. Doppler sonography of the carotid and brachial arteries (BA) was conducted using supersonic diagnostic scanner "LOGIQ 500" (General Electric, USA). The endothelial function was studied using samples with reactive hyperemia (endothelium-dependent vasodilation, EDVD) and nitroglycerin (endothelium-independent vasodilation, EIVD).

Dilation of the brachial artery against the background of reactive hyperemia that exceeds more than 10% of intact diameter is conditionally commonly believed as normal reaction, lower indicator or vasoconstriction is considered to be pathological.

Statistical data processing, provided in M+m form, was conducted by means of variation statistics methods with the use of Student t-test on PC on the basis of Microsoft Excel program of statistical analysis. Difference was considered as adequate when $p<0,05$.

Results and discussion. Characteristics of myocardial function in investigated patients are presented in table 1.

In our investigation patients with HD and AO had adequately higher SWT and PWT, ESD and EDD, and also LVMMI in comparison with the group of patients with HD but without AO that was indicative of liability to predominantly concentric LVH progression. These data matche with the results of majority of investigations [1,3,4,7]. In fact, eccentric LVH typical for gynoid (gluteofemoral) obesity type is connected with left ventricular afterload and dilation increase. In other words, preload by volume causes compensatory myocardium hypertrophy. Concentric LVH, as the most unfavorable remodeling type, is more often diagnosed in patients with AH and android (abdominal) obesity type, in pathogenesis of which neurohumoral component plays a leading role [8]. Hyperinsulinemia directly or via activation of mediators of sympathetic activity and hormones of renin–angiotensin–aldosterone system causes to cellular growth increase and rebuilding of collagen matrix inside myocardium. In some investigations there was revealed the adequate LVMM association with levels of immunoreactive insulin, C-reactive protein and renin activation; it was found that this coherence did not depend on the degree of obesity, duration of AH.

Alterations detected when analyzing transmitral flow have the same trend in all the groups of patients and reflect the formation of hypertrophic type of diastolic function abnormality.

However, intergroup analysis of changes in diastolic function of patients with normal body weight and with AO revealed that abnormality of LV diastolic filling was more often detected in patients with associated AO. Only 1,8 % of patients with AO (14 % without AO) did not have abnormality of LV diastolic filling, and detection frequency of hypertrophic type was 86 % (76 % in patients without AO). Pseudonormal type of diastolic dysfunction also more often was detected in patients with associated AO (12,2 and 10 % respectively), predominantly when eccentric LVH that could be explained by pressure increase in the left atrium (LA) and, thus, increase of blood flow inside early diastole. Restrictive type of diastolic function abnormality was not observed in any patient. When analyzing echocardiographic indices of patients with deficiency of body weight there was detected the tendency to formation of concentric LVH and diastolic function abnormality stage I. In the group of patients with deficiency of body weight when comparison to the group of patients with adequate nutritional status the firm LVMM decrease was observed, that was indicative of mildly less LVH grade and DT decrease associated with myocardium stiffness that negatively affected the heart contractility.

Characteristic of endothelial function of vessels in the examined groups of patients is presented in table 2. To compare the results of BA Doppler sonography and to avoid any doubt we compared foregoing groups of patients with one more group, - control group, which consisted of 20 virtually healthy individuals with an adequate nutritional status.

Outlet diameter of the brachial artery in examined groups did not vary adequately. However in patients with hypertensive disease stage II according to data of investigation there were detected firm pathological EDVD BA decrease and decrease of BA sensation to shear stress, regardless body weight, however it was well-marked in patients with deficiency weight of body and in patients with associated AO. Wherein, EIVD was retained in response to nitrates.

Interaction between LVH stage and endothelial dysfunction was also determined by a variety of experimental and clinical investigations.

Coherence between myocardium remodeling and endothelial dysfunction may be explained by NO synthesis decrease, as a result of induction of proliferative processes inside the heart and vessels and formation of predominantly

Table 1.

Indices of echocardiogram in patients affected by HD stage II and with different body weight

Indices	Indice values (M±m) in groups of patients					
	HD with stand. body weight,29 patients (1 group)	HD with AO 25 patients (2 group)	p1-2	HD with deficiency of body weight, 15 patients (3 group)	p1-3	p2-3
Size of LA, см	3,67 ± 0,1	3,8 ± 0,1		3,59 ± 0,1		
EDD, cm	4,87 ± 0,1	5,76 ± 0,1	<0,001	4,84 ± 0,1		<0,001
ESD, cm	3,15 ± 0,1	3,76 ± 0,1	<0,001	3,10 ± 0,1		<0,001
SWTd ,cm	1,19 ± 0,01	1,27±0,01	<0,001	1,18 ± 0,1		<0,001
PWTd ,cm	1,24 ± 0,01	1,38±0,01	<0,001	1,22 ± 0,1		<0,001
RWT	0,46± 0,02	0,49±0,02		0,42±0,02		<0,05
EF , %	63,4 ± 1,1	55,8 ± 2,2	<0,001	64,4 ± 2,1		<0,001
LVED , ml	118,26±4,8	144,8 ± 4,9	<0,05	116,18±4,1		<0,05
LVES , ml	43,18 ± 2,2	49,9 ± 2,4	<0,05	42,16 ± 2,1		<0,05
SD , ml	76,4 ± 1,8	84,4 ± 2,1	<0,001	74,4 ± 2,1		<0,001
MCO, l/min.	5,4 ± 0,2	6,28 ± 0,4		5,2 ± 0,4		
LVMM , g.	258,4 ± 7,4	300,8 ± 5,1	<0,001	230,8 ± 6,1	<0,001	<0,001
LVMMI ,g/m²	136,7 ± 4,1	148,8 ± 4,4	<0,05	135,8 ± 4,1		<0,05
PVR ,dyn.s.cm-5	1642,4±60,0	1704±58,2		1582±59,1		
E/A $_{TF}$	0,95 ± 0,06	0,82 ± 0,05		0,99 ± 0,05		<0,05
E_{TF}, m/s	0,52 ± 0,02	0,54±0,027		0,50±0,024		
A_{TF}, m/s	0,65 ± 0,02	0,56±0,028	<0,05	0,63±0,026		<0,05
IVRT, s	0,12 ± 0,02	0,13 ± 0,02		0,11± 0,02		
DT, s	0,238±0,002	0,230±0,002	<0,05	0,220±0,002	<0,01	<0,001

Notes (used in Table 1): LA – left atrium, EDD – end-diastolic dimension, ESD – end-systolic dimension, SWTd – septum wall thickness, diastole, PWTd – Posterior wall thickness, diastole, RWT – relative wall thickness, EF – ejection fraction, LVED – left ventricular end diastolic, LVES – left ventricular end systolic, SD – systolic discharge, CO – cardiac output, LVMM – Left Ventricular Myocardium Mass, LVMMI – Left Ventricular Myocardium Mass Index, PVR – peripheral vascular resistance, ETMK – peak early filling velocity of transmitral flow, ATMK –peak atrial systole velocity, IVRT – Isovolumetric (Isovolemic) relaxation time, DT – Deceleration time (DT) of the early filling velocity.

Table 2

Alterations of endothelial function of vessels in patients with HD and different body weight.

Indices	Indices value (M±m) in groups of patients			
	Control n = 20	HD n = 29	HD + AO n = 25	HD with deficiency of body weight n = 15
outlet diameter of BA, mm	3,9 ± 0,2	4,1 ± 0,2	4,4 ± 0,2	3,9 ± 0,3
EDVD , %	10,3 ± 0,6	8,4 ± 0,2*	4,6 ± 0,8**	4,0 ± 0,4**
EIVD , %	17,6 ± 1,3	14,0 ± 1,5	13,5 ± 2,1	12,8 ± 2,1

Notes: * - p <0,01; ** - p <0,001 (in comparison with control group)

concentric LVH in response to peripheral vascular resistance and SD appears. If NO synthesis remains high, the absence of LV walls thickening becomes the consequence of antiproliferative NO parameters, that jointly with dilation of the heart chambers acts as prerequisite of formation of eccentric LVH.

Presence of endothelial dysfunction in patients with HD and AO may be a marker of atherosclerosis. ”Mute” behavior of atherosclerosis in individuals with AH granting insulin resistance makes obvious the necessity of early detection of the abnormality of vasodilation in actual patients category.

Endothelial dysfunction in individuals with HD and deficiency of body weight is pathogenetically related with progression of atherosclerosis in them. It should be admited, that when analyzing lipid metabolism in forgoing category the levels of total cholesterol and triglycerids were in reference range. Collected results indicate the necessity of further investigation of pathophysiological characteristics of AH and their impact on target organs in patients with deficiency of body weight. Perhaps, when conducting large population studies and acknowledgment of cardiovascular risk there would appear the necessity in remodeling of optimal parameters of lipid profile for actual category of patients in order to enhance their medical treatment and preventive measures of development of cardiovascular complications.

Determination of endothelial function of vessels in patients with HD and deficiency of body weight may be also an actual cardiovascular risk marker in current category of patients. Unfortunately, deficiency of body weight issue is neglected in modern preventive cardiology, however continuous increase of cardiovascular mortality requires redouble attention to all the patients, which may be in potential high-risk group. That is why, further investigation of endothelial function of vessels is absolutely necessary for development of clear criteria of preclinical disease diagnostics, determination of process intensity and development of pathogenetically sound tactics of medical treatment.

Conclusions: 1. In group of patients with HD and associated AO there the tendency to development of predominantly concentric LVH was detected.

2. In patients with associated AO abnormality of diastolic LV filling jointly with formation of hypertrophic type of diastolic dysfunction was frequently detected.

3. Abnormality of vasodilation as response to compression is typical for all the patients with HD regardless of body weight, however it was well-marked in patients with deficiency weight of body and in patients with associated AO.

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