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Research Article

# CHARACTERISTICS OF ARTERIAL WALL STIFFNESS IN PATIENTS WITH CHRONIC HEART FAILURE WITH PRESERVED SYSTOLIC FUNCTION OF THE LEFT VENTRICLE

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## ABSTRACT

Modern methods of acute myocardial infarction (AMI) treatment allow to avoid early postinfarction remodeling, but increase the number of patients with chronic heart failure (CHF) and preserved systolic heart function. The stiffness of the main arteries in patients with CHF and preserved left ventricular (LV) ejection fraction (EF) after AMI has been found to be increased. The severity of CHF depends on the increase in pulse wave velocity. The relationship between increased arterial stiffness and BNP and NT-pro BNP levels in patients with CHF with preserved LV EF 1 year after AMI was revealed.

## KEYWORDS

Chronic heart failure, arterial stiffness, central hemodynamic parameters, natriuretic peptide.

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## INTRODUCTION

Epidemiological studies indicate that systolic dysfunction is no longer a prerequisite for CHF syndrome. The number of patients with symptoms and signs of CHF with normal or slightly reduced LV systolic function is increasing. This is associated both with the aging of the population, and with a higher survival rate of patients as a result of the obvious advances in cardiology. It is important to note, that the presence of preserved LV LV EF in CHF does not allow to think about a favorable prognosis of patients. The pathophysiological mechanisms of CHF formation in preserved LV EF. LV EF have been largely clarified, but are far from being fully understood. Apparently, it is connected with the absence of optimal and generally accepted approaches in therapy of such patients. Increased arterial stiffness is increasingly recognized as a surrogate endpoint in cardiovascular disease. A number of studies consider arterial stiffness as a predictor of future major adverse cardiovascular events - myocardial infarction (MI), stroke, revascularization - and mortality. One of the new and developing directions in pathophysiology of CHF syndrome is to determine the significance of vascular wall elasticity in its pathogenesis. It seems relevant to characterize pulse wave velocity (PWV), central aortic pressure and augmentation index (IA), reflecting the stiffness of main arteries in patients with CHF and preserved LV systolic function.

## OBJECTIVE

Characterization of arterial wall stiffness in patients with chronic heart failure with preserved left ventricular systolic function

## MATERIAL AND METHODS

40 patients with signs and clinical symptoms of CHF of ischemic genesis and LVEF of 50% and more (CHFsFV) were included in the investigation. The mean age of the patients was 64.2±6.1 years, 28 of them were men (70%) and 12 women (30%). The study included clinical examination of the patients, ECG registration, EchoCG on ultrasound system SONO-SCAPE-5000 (China). To determine the functional class (FC) of CHF, all the patients underwent 6-minute walking test.

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To estimate structural-functional state of large vessels wall and central hemodynamic parameters we used photo-plethysmography method using "Angioscan-01" hardware-software system (Russia). Automatic contour analysis of pulse wave assessed the following parameters: assessment of vascular stiffness - by reflection index (RI) and stiffness index (SI); assessment of central hemodynamic parameters - by central aortic pressure, augmentation index (AIx) and systolic pressure value in proximal aorta (SPa).

The level of brain natriuretic peptide precursor NT-proBNP was also determined by enzyme immunoassay.

The analysis of clinical and instrumental data was performed depending on CHF class: class I - the 1st group, class II - the 2nd group, class III - the 3rd group of patients (Table 1).

Statistical processing was performed using the STATISTIKA-6 software package. Significance of differences in the mean values was assessed using parametric Student's test for dependent and independent samples in the case of their normal distribution, otherwise nonparametric Wilcoxon's test. Significance of differences was assessed at $p<0.05$. Correlational single-factor and multifactor analysis of variance and regression were used to determine the strength of the relationship between the indices.

## RESULTS OF THE STUDY

Among the patients studied there were 28 men (70%) and 12 women (30%). 20 patients (50%) had myocardial infarction (MI), 11 patients (27,5%) underwent coronary angiography with PCI, of them 3 vascular lesions of the channel were found in 65% of patients. Complete revascularization after thrombolytic therapy (TLT) was observed in 6 (15%) patients (Table 1). Acute cerebral circulation disorder (ACHD) was observed in 7 (17.5%) patients. During the elapsed period after MI, exacerbation of CHD in the form of postinfarction angina was observed in 16 (40%) patients.

The functional class of CHF was reliably confirmed by 6-min walk test. The most part of all 40 patients corresponded to CHF class II - 20 patients (50%). And the severity of CHF was proportional to the patients' age - CHF class I - 54,14,5 years, CHF class II - 66,46,9 years, and CHF class III - 72,36,8 years.

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The leading symptom of CHF was dyspnea, and echocardiography showed cardiomegaly. Edema was detected in30% of patients, and cardiac asthma attacks at night were detected in 60% of patients (Table 1). The symptoms of fluid retention were more pronounced in CCFIII patients, in addition, they more often had various clinically pronounced heart rhythm disorders (20%) - atrial fibrillation, extrasystole.

**Table 1**

**Clinical characteristics of the examined CHF patients**

| **Показатели** | **CHF patients** | | | | **P** |
|---|---|---|---|---|---|
| | **CHF patients** (P=40) | **CHF FK I** (P=8) | **CHF FK II** (P=20) | **CHF FK III** (P=12) | |
| Age, years | 64,2±6,1 | 54,1±4,5 | 66,4±6,9 | 72,3±6,8 | < 0,05 |
| Gender - husband | 28 (70%)<br>12 (30%) | 8(100%)<br>- | 12(60%)<br>8(40%) | 8(66,7%)<br>4(33,3%) | < 0,05<br>< 0,05 |
| wives | 28,3±4,7 | 25,0±2,4 | 28,2±4,3 | 28,8±5,7 | н/д |
| BMI, kg/m2 | 13(32,5%) | 2(25%) | 7(35%) | 4(33,3%) | н/д |
| DM | 7 (17,5%) | - | 3 (15%) | 4 (33,3%) | н/д |
| history of STEMI | 20 (50%) | 4(50%) | 9 (45%) | 7 (58,3%) | < 0,05 |
| MI history | 8 (20%) | - | 3 (15%) | 5 (41,7%) | н/д |
| Arrhythmias | 11 (27,5%) | 4 (50%) | 3 (15%) | 4 (33%) | н/д |

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| | | | | | |
|---|---|---|---|---|---|
| PCI | 6 (15%) | 1 (12,5%) | 4 (20%) | 1 (8,3%) | < 0,05 |
| Thrombolysis | 16 (40%) | 2 (25%) | 8 (40%) | 6 (50%) | < 0,05 |
| Postinfarction angina pectoris | 16,6±9,6 | 11,2±6,8 | 14,5±7,9 | 24,1±14,2 | < 0,05 |
| Orthopnea | 12 (30%) | - | 4 (20%) | 8 (66,7%) | < 0,05 |
| Edema | 8 (20%) | - | 3 (15%) | 5 (41,7%) | < 0,05 |
| Pulmonary congestion | 6 (15%) | - | 2 (10%) | 4 (33,3%) | < 0,01 |
| Cardiomegaly | 9 (22,5%) | - | 3 (15%) | 6(50%) | < 0,01 |
| Dyspnea | 24 (60%) | 2 (25%) | 10 (50%) | 12 (100%) | < 0,05 |
| Nocturnal dyspnea | 40 (100%)<br>341±32 | 8 (100%)<br>432±20 | 20 (100%)<br>352±33 | 12 (100%)<br>248±42 | н/д<br>< 0,01 |

The state of arterial wall stiffness was characterized by the following parameters. Thus, increased stiffness led to increased vascular stiffness and central hemodynamic parameters - central aortic pressure and augmentation index, although there were no differences in other hemodynamic parameters. In patients with signs of CHF FK II and CHF FK III, vascular stiffness was significantly elevated: thus, RI index increased by 22.1% in CHF FK II and by 35.1% in CHF FK III; SI index increased by 33.3% and 49.3%, respectively. The parameters of central hemodynamics increased: AIx index - by 65% and 80%, respectively

## DISCUSSION

The results of the study showed that CHF develops in CHF patients despite the preservation of LV systolic function. These abnormalities are also confirmed by laboratory and instrumental parameters - increase of biochemical markers of CHF.

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It is known that in the long-term course of CHD and especially after MI, most patients have LV systole and diastole disturbances, but systolic CHF does not develop in all patients. The results of our study showed that in patients with different functional classes of CHF, all other conditions being equal, the parameters of LV systolic and diastolic dysfunction were generally comparable.

Increased stiffness of the main vessels was found in CHF patients. Moreover, the degree of increased stiffness depended on the severity degree and functional class of CHF syndrome. This is confirmed by positive correlations between the values of natriuretic peptide and the stiffness index of the vascular wall. Also in CHF patients with increased arterial wall stiffness, we found an increase in the parameters of central hemodynamics - augmentation index and systolic pressure value in the proximal aorta. Apparently, increased vascular stiffness led to pathological overload of the heart due to increased pulse volume and worsened ventricular relaxation.

As a consequence of the pathological impact of impaired cardiovascular interaction is relative coronary insufficiency due to decreased coronary perfusion pressure during diastole in patients with stiff arteries. This is also confirmed by clinical data, i.e., the frequency of angina in CHF patients with various functional classes.It can be assumed that exactly the combination of impaired LV diastole, moderate decrease in LV systolic function and increased arterial stiffness are those important components, leading to the development of CHF with preserved LV ejection fraction.

Thus, aggravation of intravascular hemodynamics due to LV-vessel interaction disorder as a result of pulse volume change is one of the reasons of insufficient treatment effect in patients with CHF of ischemic genesis.

## CONCLUSIONS

1. In CHF patients with preserved LVEF of ischemic genesis, the stiffness of the vascular wall is increased.
2. Increased central aortic pressure and augmentation index in CHF patients with preserved LVEF and increased arterial stiffness were revealed.
3. Positive correlations between central aortic pressure, augmentation index and natriuretic hormone indices in CHF

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patients with preserved LVEF have been established.

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