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Features in the Processes of Left Ventricular Remodeling Depending on the Degree of Renal Dysfunction in Patients with Chronic Heart Failure

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Abstract

Background: The aim of this research was to study the features of changes in the parameters of heart remodeling in patients with coronary heart disease (CHD) and chronic heart failure (CHF), depending on the degree of renal dysfunction (RD).

Methods and Results: The study included 150 CHD patients with NYHA functional class (FC) I-IIII of CHF. All examined patients were subdivided according to the level of eGFR: Group A included 81 patients with CHF FCI-III and eGFR>60 mL/min per 1.73 m^2; Group B included 69 patients with CHF FCI-III and eGFR≤60 mL/min per 1.73 m^2. It was found an increase in left ventricular (LV) mass in Group B by 11.4%, compared to Group A (*P*=0.000). Analysis of LV systolic function showed that in Group B, values of LF ejection fraction and fractional shortening were significantly lower than in Group A (47.64±0.61% vs. 52.7±0.28%, and 25.40±0.46% vs. 28.23±0.25%, respectively, *P*=0.000). Thus, in Group B, we found CHFrEF, compared to Group A with CHFpEF. Analysis of diastolic function revealed that in Group B, the E/A ratio was statistically higher than in Group A (1.12±0.05 vs. 0.81±0.04, respectively, *P*=0.000). At the same time, in Group B, values of IVRT and DT were significantly lower than in Group A (85.01±0.8 ms vs. 91.25±0.99 ms, and 177.8±2.1 ms vs. 197.5±2.07 ms, respectively, *P*=0.000). Thus, the signs of the impaired relaxation (Grade 1 diastolic dysfunction) and the pseudonormal filling pattern (Grade 2 diastolic dysfunction) were found in Group A and Group B, respectively.

Conclusion: RD in patients with CHF is an important factor in the significant deterioration of LV systolic and diastolic functions.(**International Journal of Biomedicine. 2022;12(2):218-221.**)

Key Words: chronic heart failure • left ventricular remodeling • renal dysfunction

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Abbreviations

CHF, chronic heart failure; **CHFrEF**, CHF with reduced ejection fraction; **CHFpEF**, CHF with preserved ejection fraction; **CHD**, heart coronary disease; **CKD**, chronic kidney disease; **DM**, diabetes mellitus; **DT**, deceleration time; **DD**, diastolic dysfunction; **eGFR**, estimated glomerular filtration rate; **EF**, ejection fraction; **FC**, functional class; **Fs**, fractional shortening; **IVST**, interventricular septal thickness; **IVRT**, isovolumic relaxation time; **LV**, left ventricle; **LVEF**, left ventricular ejection fraction; **Ld**, diastolic longitudinal displacement; **Ls,** longitudinal systolic displacement; **LVEDV**, left ventricular end-diastolic volume; **LVESV**, left ventricular end-systolic volume; **LVEDD**, left ventricular end-diastolic dimension; **LVESD**, left ventricular end-systolic dimension; **LVPWT**, left ventricular posterior wall thickness; **LA**, left atrium; **LVM**, left ventricular mass; **LVMI**, left ventricular mass index; **MI**, myocardial infarction; **RD**, renal dysfunction; **RWT**, relative wall thickness; **SV**, stroke volume.

Introduction

Despite significant advances in the treatment of various cardiovascular diseases, the prevalence of chronic heart failure (CHF) continues to grow.[1,2] This disease is the most common reason for hospitalization among people over 65 years of age. Moreover, about 50% of patients with CHF are re-hospitalized within 6 months, 20%-25% of patients - within 30 days after discharge from the hospital, and 70% of re-hospitalizations are associated with decompensated CHF.[2] Features of the course

of CHF against the background of renal dysfunction (RD) are widely discussed. The type of left ventricle (LV) dysfunction more typical for CHF patients in conditions of impaired renal filtration function has not been determined.[3-6] On the other hand, the influence of the structural and functional reorganization of the heart in CHF on the glomerular-tubular relationship of the kidneys has not been sufficiently studied. Features of arterial wall remodeling in conditions of CHF and chronic kidney disease (CKD) have also not been studied enough and are controversial. The presented controversial issues make it difficult to adequately choose the therapy for patients with CHF and CHD, which also requires the provision of a nephroprotective effect of treatment.[7-9] Further research is needed to determine the patterns of CHF and RD in the conditions of the cardiorenal syndrome and to develop pathogenetically substantiated approaches to their treatment.

The aim of this research was to study the features of changes in the parameters of heart remodeling in patients with coronary heart disease (CHD) and chronic heart failure (CHF), depending on the degree of renal dysfunction (RD).

Materials and Methods

We performed a comprehensive examination of 150 patients with CHD and NYHA functional class (FC) I-IIII of CHF.

The non-inclusion criteria were CHF of non-ischemic origin, stroke, severe or insulin-dependent diabetes mellitus, COPD, high-grade arrhythmias, liver disease, severe kidney disease, and other severe somatic pathologies.

All examined patients were divided into groups according to CHF FC: CHF FCI (n=38), CHF FCII (n=62) and CHF FCIII (n=50) (Table 1). Patients were also subdivided according to the level of GFR: Group A included 81 patients with CHF-FCI-III and eGFR>60 mL/min per 1.73 m^2; Group B included 69 patients with CHF-FCI-III and eGFR ≤60 mL/min per 1.73 m^2.

Table 1.

Clinical characteristics of patients

Variable	CHF FCI (n=38)	CHF FCII (n=62)	CHF FCIII (n=50)
Age, yrs	58.77±0.94	61.3±0.68	62.14±0.79
Women	25 (65.8%)	30 (48.4%)	20 (40.0%)
Men	13 (34.2%)	32 (47.1%)	30 (60.0%)
Arterial hypertension	35 (92.1%)	7 (91.9%)	31 (62.0%)
History of MI	7 (18.2%)	17 (27.4%)	27 (54.0%)

The average age of patients was 58.77±0.94 years, 61.3±0.68 years, and 62.14±0.79 years in Groups 1, 2, and 3, respectively. The duration of the disease was 5.81±0.75 years, 6.6±0.63 years, and 16±0.92 years in Groups 1, 2, and 3, respectively.

Conventional 2D echocardiography was carried out according to the recommendations of the American Society of Echocardiography in M- and B-modes using an MEDISON ACCUVIX V20 device (South Korea) equipped with a 3.25 MHz transducer. The following parameters were measured and calculated: IVST, PWT, LVEDD, LVESD, EF, LVEVD, LVESV, Fs, LA size, Ld, and Ls. LVM was calculated using the formula R. Devereux.[10] LVM was indexed to body surface area (LVMI). Left ventricular hypertrophy (LVH) was defined as LVMI of ≥110 g/m^2 (for women) and ≥134 g/m^2 (for men).

Global LV systolic function was assessed by determining linear and volumetric dimensions, wall thicknesses, ventricular volumes. LVEF was calculated by the Simpson method. LV diastolic function was analyzed by measuring peak early diastolic filling (E) and late diastolic filling (A) velocities, E/A ratio, isovolumic relaxation time (IVRT), and deceleration time (DT).[11]

Assessment of the functional state of the kidneys was carried out on the basis of determining the level of serum creatinine, 24-h urinary albumin excretion, eGFR was calculated using the CKD-EPI equation**.** The eGFR was calculated as described by Levey et al.[12] eGFR was expressed in ml per minute per 1.73 m^2.

Statistical analysis was performed using the IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Baseline characteristics were summarized as frequencies and percentages for categorical variables. For descriptive analysis, results are presented as mean ± standard deviation (SD). For data with normal distribution, inter-group comparisons were performed using Student's t-test. Pearson's correlation coefficient (r) was used to determine the strength of the relationship between the two continuous variables. A probability value of $P<0.05$ was considered statistically significant.

The study protocol was approved by the Ethics Committees of the Republican Specialized Scientific and Practical Medical Center for Therapy and Medical Rehabilitation (Tashkent, Uzbekistan). Written informed consent was obtained from each research participant.

Results and Discussion

The analysis of EchoCG indicators found features in the structural and functional state of the left ventricle in CHD patients with CHF-FCI-III, depending on eGFR. It was found that in patients of Group B, there was a moderate increase in the LA size by 11.3% ($P<0.001$), compared to Group A, which amounted to 3.36±0.04 cm versus 3.74 ±0.05 cm (Table 2).

The progression of RD in patients with CHF was characterized by changes in the LV size. The values of LVESD and LVEDD in Group B were significantly higher than in Group A (4.1±0.05 cm vs. 3.72±0.04 cm, and 5.46±0.05 cm vs. 5.23±0.05 cm, respectively, $P=0.000$). These changes were associated with an increase in LVM in Group B by 11.4%, compared to Group A ($P=0.000$).

Analysis of LV systolic function showed that in Group B, values of LFEF and Fs were significantly lower than in Group A (47.64±0.61% vs. 52.7±0.28%, and 25.40±0.46% vs. 28.23±0.25%, respectively, $P=0.000$) (Table 3). Thus, in Group B, we found CHFrEF, compared to Group A with CHFpEF.

Table 2.

Structural and geometric parameters of the LV in CHD patients with CHF depending on eGFR

Indicator	Group A eGFR>60 mL/min per 1.73m^2	*P*-value	Group B eGFR≤60 mL/min per 1.73m^2
LVPWT, cm	1.085±0.01	0.0691	1.088±0.01
IVST, cm	1.126±0.02	0.2241	1.130±0.02
LVEDD, cm	5.23±0.05	0.000	5.46±0.05
LVESD, cm	3.72±0.04	0.000	4.1±0.05
LA, cm	3.36±0.04	0.000	3.74±0.05
AO, cm	3.13±0.03	0.000	3.36±0.045
RWT	0.45±0,005	0.000	0.42±0.006
Ls, cm	38.6±0.69	0.000	42.2±0.67
Ld, cm	48.8±1.05	0.000	51.9±1.38
LVM, g	249.4±5.55	0.000	277.93±5.71
LVMI, g/cm^2	131.5±3.1	0.000	142.4±3.2

Table 3.

Indicators of LV systolic function in CHD patients with CHF depending on eGFR

Indicator	Group A eGFR>60 mL/min per 1.73m^2	P-value	Group B eGFR≤60 mL/min per 1.73m^2
SV, mL	67.4±1.55	0.244	67.1±1.58
LVEF, %	52.7±0.28	0.000	47.64±0.61
LVEDV, mL	131.22±2.73	0.000	145.9±2.93
LVESV, mL	61.4±1.35	0.000	77.43±1.99
Heart rate, bpm	73.84±1.02	0.000	75.81±1.11
Fs, %	28.23±0.25	0.000	25.40±0.46

Analysis of diastolic function (Table 4) revealed that in Group B, the E/A ratio was statistically higher than in Group A (1.12±0.05 vs. 0.81±0.04, respectively, *P*=0.000). At the same time, in Group B, values of IVRT and DT were significantly lower than in Group A (85.01±0.8ms vs. 91.25±0.99ms, and 177.8±2.1ms vs. 197.5±2.07ms, respectively, *P*=0.000). Thus, the signs of the impaired relaxation (Grade 1 DD) and the pseudonormal filling pattern (Grade 2 DD) were found in Group A and Group B, respectively.

Table 4.

Indicators of LV diastolic function in CHD patients with CHF depending on eGFR

Indicator	Group A GFR>60 mL/min per 1.73m^2 EF≥50%	*P*-value	Group B GFR≤60 mL/min per 1.73m^2 EF<50%
E, m/s	0.58±0.01	0.000	0.76±0.017
A, m/s	0.71±0.017	0.000	0.68±0.02
E/A	0.81±0.04	0.000	1.12±0.05
IVRT, ms	91.25±0.99	0.000	85.01±0.8
DT, ms	197.5±2.07	0.000	177.8±2.1

Thus, the results of these studies have established that RD in patients with CHF is an important factor in worsening the clinical manifestations of the disease, reducing physical performance and quality of life. All this is based on more pronounced damage to the cardiovascular system: the progression of post-infarction heart remodeling with a further deterioration in cardiovascular relationships, as well as a decrease in kidney function with a worsening in cardiorenal relationships. These negative processes develop against the background of complex disorders of autonomic and neurohumoral regulation. All this indicates the need to mitigate and, if possible, eliminate the influence of individual metabolic syndrome components on the body and, first of all, on the cardiovascular system. In this regard, our further research was aimed at studying the effectiveness of standard CHF therapy in patients with and without manifestations of RD.

More pronounced structural changes in the heart, and their further progression, in patients with CHF developing against the background of the cardiorenal syndrome are associated with the activation of the neurohumoral system, which contributes to the activation of a number of pathogenetic mechanisms.[1,2] As a result of activation of the SAS, cardiac output increases, and vasoconstriction of peripheral blood vessels is stimulated. Sympathetic stimulation of the kidneys triggers a powerful mechanism for the development of arterial hypertension - RAAS. Angiotensin II, the main active component of the RAAS, directly and indirectly (indirectly through the activation of the sympathetic nervous system) causes hypertrophy of cardiomyocytes.[2] The combined effect of the components is accompanied by a more powerful activation of the SAS and RAAS. The aggravating effect of RD on the development and prognosis of CHF is due to a number of closely related mechanisms. The impact on the stressed endothelium or stimulation of angiogenesis in patients with CHF can help preserve the function of target organs and slow down the progression of pathology.[11]

Conclusions

1. The analysis of the dimensions of the LV and LA cavities, as well as the LV walls, revealed the peculiarity in structural and functional changes in LF in CHD patients with CHF FCI-III and eGFR >60 mL/min per 1.73 m^2 or GFR<60 mL/min per 1.73 m^2

2. Compared to eGFR>60 mL/min per 1.73m^2, eGFR≤60 mL/min per 1.73 m^2 in CHD patients with CHF FCI-III provides evidence of the role of the severity of RD in reducing systolic function in patients with CHF.

3. Compared to eGFR>60 mL/min per 1.73m^2, eGFR≤60 mL/min per 1.73 m^2 in CHD patients with CHF FCI-III impairs diastolic function of LF.

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Competing Interests

The authors declare that they have no competing interests.

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