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THE PROCESS OF CARDIAC REMODELING IN PATIENTS WITH CHRONIC HEART FAILURE COMPLICATED BY RENAL DYSFUNCTION.

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Chronic heart failure (CHF) remains the most common, severe, and adverse complication of cardiovascular diseases. In all developed countries, the issue of CHF prevalence is becoming increasingly significant every year.
Keywords: chronic heart failure, renal dysfunction, cardiac remodeling

Chronic heart failure (CHF) remains the most common, severe, and adverse complication of cardiovascular diseases. In all developed countries, the issue of CHF prevalence is becoming increasingly significant every year. This condition drastically worsens patients' quality of life and increases mortality rates up to fourfold, with an annual mortality rate ranging from 15% to 50%. The risk of sudden death in CHF patients is five times higher than in those without heart failure [4]. Despite receiving combination therapy, approximately 50% of patients die within five years after the onset of CHF clinical symptoms. CHF is a complex clinical process that develops due to various cardiovascular diseases and manifests as systolic and/or diastolic dysfunction of the ventricular myocardium. Various population studies indicate that the prevalence of CHF among the general adult population is 1.5–2%, while among individuals aged 65 and older, it ranges from 6% to 17%.

Currently, the issue of cardiorenal syndrome (CRS) in patients with chronic heart failure (CHF) is widely discussed. The mutual negative interaction between heart and kidney dysfunction, manifested as worsening CHF symptoms along with the development of renal dysfunction, has been proven [1,2,3]. Early detection of CHF and renal dysfunction, as well as timely initiation of treatment, are key factors in preventing mortality from heart failure [6,8,9].

Diastolic dysfunction typically develops before systolic dysfunction, and in many cases of asymptomatic heart failure, signs of diastolic dysfunction are observed. Therefore, identifying diastolic dysfunction at the early stages of heart failure allows for timely diagnosis and prevention of its progression [7,10].

Objective of the Study. To investigate the process of cardiac remodeling in patients with chronic heart failure (CHF) complicated by renal dysfunction.

Materials and Methods. A total of 95 patients aged 40 to 60 years who had suffered a myocardial infarction and developed CHF as a complication were examined.

Materials and Methods

Patients were divided into two groups according to the **New York Heart Association (NYHA) classification** of CHF functional class (FC). Functional class was determined using the **Clinical Condition Assessment Scale (CCAS)** and the **Six-Minute Walk Test (6MWT)** results.

- **Group 1**: 51 patients with **NYHA class II CHF**
- **Group 2**: 44 patients with **NYHA class III CHF**
- **Control group**: 20 healthy volunteers

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Patients with **diabetes mellitus** were excluded from the study. **Serum creatinine (Cr) levels** were measured, and **glomerular filtration rate (GFR)** was calculated using the **Modification of Diet in Renal Disease (MDRD) formula**.

Echocardiographic Examination

Echocardiographic images were obtained using a **Medison 8000 LIVE (South Korea) system**, equipped with a **dedicated program** for tissue Doppler transthoracic imaging and data processing. The examination followed the recommendations of the **American Society of Echocardiography (ASE)**, with patients in the **supine and left lateral decubitus positions**, using **M-mode and B-mode imaging**.

The following parameters were assessed:

- **Left ventricular end-diastolic and end-systolic dimensions (LVEDD and LVESD)**
- **Diastolic and systolic sphericity indices (D-SI and S-SI)**
- **Myocardial stress (MS)**
- **End-diastolic and end-systolic volumes (EDV and ESV)**
- **Ejection fraction (EF), calculated using the Teichholz formula**

Assessment of Left Ventricular Diastolic Dysfunction

To evaluate **left ventricular diastolic dysfunction**, echocardiographic examination followed the **2005 recommendations of the European Association of Echocardiography and the American Society of Echocardiography**. Pulsed-wave Doppler imaging of **transmitral flow** was used to measure:

- **Peak early diastolic filling velocity (E)**
- **Peak atrial systolic filling velocity (A)**
- **E/A ratio**
- **Isovolumetric relaxation time (IVRT, ms)**
- **Deceleration time of the first filling wave (DT, ms)**

Statistical Analysis

The study data were analyzed using an **IBM PC/AT personal computer and Microsoft Office Excel 6.0 software**. Results were presented as **M±m**. Relationships between parameters were assessed using **Pearson's linear correlation coefficient**, and qualitative and quantitative parameters were evaluated using **Spearman's correlation coefficient**. A significance level of **$r < 0.05$** was considered statistically significant. Qualitative and quantitative parameters were evaluated **using Spearman's correlation coefficient**. A **significance level of $r < 0.05$** was considered statistically significant.

Results and Analysis

The initial **glomerular filtration rate (GFR)** values were as follows:

- In **NYHA class II CHF** patients: **76.4 ± 19.12 ml/min/1.73 m^2**
- In **NYHA class III CHF** patients: **66.3 ± 12.8 ml/min/1.73 m^2**

The proportion of patients with **GFR < 60 ml/min/1.73 m^2** was:

- **29.4%** in **Group 1 (NYHA class II CHF)**
- **61.4%** in **Group 2 (NYHA class III CHF)**

These findings indicate that **as the disease progresses, renal dysfunction becomes more pronounced** [3].

According to the results of the SMWT, tolerance to physical exertion was found to be related to the functional state of the kidneys. In patients with GFR ≥60 ml/min/1.73m^2, the distance covered was 344.6±21.8 meters, while in patients with GFR <60 ml/min/1.73m^2, it

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was 235.0±8.24 meters. This condition was also reflected in the CCAS indicators, where patients with GFR <60 ml/min/1.73m² scored 8.1±0.67 points, whereas those with GFR ≥60 ml/min/1.73m² scored 5.6±0.51 points.

Table 1

Characteristics of Patients with CHF Based on Renal Functional Status (M±SD)

Indicators	**GFR ≥60 ml/min/1.73 m² (n=53)**	**GFR <60 ml/min/1.73 m² (n=42)**
Age (years)	53.42 ± 6.2	55.3 ± 4.8
CHF FC - II - III	36 (70.6%) 17 (38.6%)	15 (29.4%) 27 (61.4%)
Duration of **CHF** (months)	17.8 ± 4.8	19.5 ± 6.9
SMWT (m)	344.6 ± 21.8	237.5 ± 9.4
CCAS (points)	5.6 ± 0.51	8.1 ± 0.67 (r<0.001)
EF (%)	49.4 ± 1.88	44.6 ± 2.54
Creatinine (μmol/l)	88.8 ± 8.4	124.6 ± 11.3 (r<0.001)
Glomerular filtration rate (ml/min/1.73 m²)	75.3 ± 11.7	54.6 ± 5.3 (p<0.001)

The analysis of structural and geometric parameters in the examined groups, including the systolic function and volume indicators of the left ventricle, showed that hemodynamic changes were more prominently manifested in patients with FS III (Table 2). In this group, the degree of left ventricular dilation, as well as increases in EDV and ESV, were observed to rise by 21.5% (R<0.001) and 44.1% (R<0.001), respectively, compared to patients with FC II. Additionally, a 20.1% (R<0.001) decrease in EF, which characterizes the myocardial contractility potential, was also observed.

Table 2

Changes in Cardiac Hemodynamics in Patients with FS II and III (M±m)

Hemodynamic Indicators	**FC II (n=51)**	**FC III (n=44)**	**R**
EDD, ms	5.5 ± 0.1	6.32 ± 0.2	<0.001
ESD, ms	4.3 ± 0.1	5.2 ± 0.11	<0.001
EDV, ml	162.5 ± 4.36	194.2 ± 3.8	<0.001
ESV, ml	88.4 ± 2.6	125.1 ± 9.4	<0.001
EF, %	47.1 ± 3.9	36.1 ± 4.1	<0.001
ISd	0.71 ± 0.01	0.75 ± 0.01	<0.001
ISs	0.71 ± 0.01	0.81 ± 0.01	<0.001
MS, dyn/cm²	151.6 ± 5.5	164.9 ± 4.3	<0.05

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Hemodynamic Indicators	FC II (n=51)	FC III (n=44)	R
E, ms/s	77.21 ± 9.0	69.21 ± 5.0	<0.05
A, ms/s	66.12 ± 6.21	73.22 ± 7.12	<0.05
E/A	1.16 ± 0.05	0.94 ± 0.04	<0.05
DT, ms	198.6 ± 21.45	178.56 ± 19.9	<0.05
IVRT, ms	124.3 ± 14.8	102.4 ± 12.3	<0.05

As a result of myocardial infarction, pathological remodeling processes are observed in the myocardium, leading to the loss of the left ventricle's ellipsoid shape and its transformation into a spherical shape. These changes are more prominently manifested in patients with FC III. The ISd and ISs indices increase by 6.7% (R<0.001) and 12.1% (R<0.001), respectively, compared to patients with FS II. Due to the increase in intramyocardial pressure of the left ventricle, the myocardial systolic stress (MS) indicator, which reflects the tension of the left ventricular wall, increases and is 7.9% (R<0.05) higher in FC III patients compared to FC II patients.

The relationship between renal dysfunction and echocardiographic (EchoCG) parameters is of particular interest in studying the cardiac remodeling process in patients with CHF (Table 3)

Table 3

Relationship Between FC and Renal Dysfunction in CHF Patients Based on EchoCG Parameters (M±m)

Hemodynamic Indicators	GFR ≥60 ml/min/1.73 m² (n=53)	GFR <60 ml/min/1.73 m² (n=42)	R
ODH, ml	172.8 ± 3.6	190.9 ± 4.8	<0.05
OS'H, ml	97.5 ± 3.5	121.7 ± 1.8	<0.001
OF, %	45.8 ± 3.5	42.3 ± 4.7	<0.05
ISd	0.68 ± 0.01	0.73 ± 0.01	<0.05
ISs	0.70 ± 0.01	0.74 ± 0.01	<0.05
MS, dyn/cm²	140.3 ± 4.9	152.1 ± 5.6	<0.05
E, cm/s	73.6 ± 4.4	78.9 ± 5.9	<0.05
A, cm/s	74.9 ± 6.1	65.3 ± 6.4	<0.05
E/A	0.98 ± 0.04	1.2 ± 0.06	<0.05
DT, ms	210 ± 24.6	165.2 ± 31.4	<0.05
IVRT, ms	112.5 ± 8.3	98.6 ± 4.3	<0.05

The obtained results show that the most significant changes were observed in patients with renal dysfunction: a significant increase in EDd and EDs was recorded, rising by 8.5% (R<0.05) and 23.7% (R<0.001), respectively. Additionally, noticeable changes were observed

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in the cardiac geometric parameters such as ISd, ISs, and MS. Specifically, in patients with GFR <60 ml/min/1.73 m², compared to those with GFR ≥60 ml/min/1.73 m², the left ventricular ejection fraction decreased by 14.6% (R<0.05). Moreover, the ISd and ISs indices increased by 4.3% (R<0.05) and 4.2% (R<0.05), respectively, and the myocardial systolic stress (MS) increased by 11.3%.

The assessment of diastolic function reveals that in patients with CHF, indicators of isovolumetric relaxation (IVRT) are elevated, and early diastolic filling time (DT) is prolonged, while normal E/A ratios can still be observed. This condition should be taken into account diagnostically, as diastolic dysfunction of the heart in patients with CHF is considered an unfavorable prognostic factor [5]. Among patients with GFR ≥60 ml/min/1.73 m², 31 had isolated relaxation impairment, 8 had pseudonormalization, and 4 had restrictive filling impairment. Meanwhile, among patients with GFR <60 ml/min/1.73 m², 20 had isolated relaxation impairment, 9 had pseudonormalization, and 5 had restrictive filling impairment.

Thus, in CHF patients with renal dysfunction, diastolic dysfunction of the heart is clearly pronounced as a result of impaired early filling processes.

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