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ASSESSMENT OF THE STATE OF INTRACARDIAC HEMODYNAMICS AND MYOCARDIAL REMODELING IN WOMEN WITH GONARTHRITIS, HYPERTENSION AND OVERWEIGHT

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Abstract. The problem of comorbidity is one of the most pressing problems of modern medicine. The presence of arterial hypertension and overweight in patients with gonarthritis is associated with an earlier development of target organ damage and subsequent cardiovascular accidents. In order to assess intracardiac hemodynamics and types of myocardial remodeling in women with gonarthritis, hypertension and overweight, depending on their combinations, from 2018 to 2021, a prospective study of 198 patients of the rheumatology department of the «City Hospital № 10» (Zaporizhzhia) was carried out. According to the results of the study, it was found that the presence of comorbid pathology in the form of arterial hypertension and overweight in female patients with gonarthritis negatively affects the contractile function of the heart, which is confirmed by a decrease in the main indicators of systolic function of the left ventricle; the specified combination of diseases leads to the formation of prognostically unfavorable types of left ventricular remodeling.

Key words: **arthritis; arterial hypertension; overweight; comorbidity; intracardiac hemodynamics.**

Background. The problem of comorbidity is one of the most pressing problems of modern medicine. The presence of arterial hypertension (AH) and overweight (OW) – one of the most common diseases in the world, in patients with gonarthritis (GA), is associated with the earlier development of target organ damage and subsequent cardiovascular accidents [1, 2].

Essential AH is one of the most common diseases in Europe,it affects about 30% of the general population [3]. In addition, OW is diagnosed in 50-80% of patients with AH, which significantly increases the risk of developing cardiovascular complications (CVC) [4]. High blood pressure (BP) is found in 65-80% of patients with OW. In 50-70% of patients with OW, disorders of carbohydrate metabolism develop on the background of already existing AH [5]. Over the past few decades, obesity has become a global epidemic. OW with AH are among the three most common diseases in the world [6].

It was found that an increase in systolic BP for every 10 mm Hg in patients with OW, increases the risk of CVD by 20% [7].

In addition, the combination of AH and OW is considered as the most aggressive in the context of mortality, which is associated with the earlier development of target organ damage and attackable by cardiovascular catastrophes [8].

Thus, the relevance of the research is due to the need for a comprehensive study of the comorbid pathology development mechanisms in gonarthritis using modern technologies available for practical health care, to search for rational and effective methods of its prevention and pharmacological correction, taking into account the course of the underlying pathology.

The purpose: to assess the state of internal cardiac hemodynamics and myocardial remodeling in women with GA, AH and OW, depending on their combinations.

Materials and methods. At the first stage of the study (2018 - 2020), on the basis of the rheumatology in - patient department of the «City Hospital № 10» (Zaporizhzhia), a prospective examination of 198 women with deferent combinations of GA, AH and OW was conducted.

The second stage of the study–catamnestic– was carried out in 2019 - 2021 on the basis of the out - patient department of the «Primary Health Care Center №9» (Zaporizhzhia).

At the first diagnostic stage, 198 women with GA and combinations of GA with AH and OW were examined at the age from 40 to 70 years (62.6 ± 1.9 on average) with an average duration of the disease 13.4±3.8 years. According to clinical forms and predominant localization of joint lesions, patients were divided into two groups: 89 (44.94%) women with polyosteoarthritis and 109 (55.06%) women with GA. Of these 82.8% cases of combinations of GA with osteochondrosis of the lumbar, thoracic and cervical spine and 27.2% cases – with other joints.

The diagnosis of GA was established according to the ICD-10 criteria, recommendations of the Ukrainian Rheumatologists Association. The diagnosis of AH was verified according to the order of the Ministry of Health of Ukraine № 384 dated 24.06.2012. The presence of OW was established according to the WHO recommendations (1998). Body mass index (BMI) was calculated using the formula: BMI = body weight (kg) / height^2 (m). If BMI was within 24-30, then OW was diagnosed, if within 30-34.9 – obesity of the 1st degree. Patients with the fourth radiological stage of GA, third stage of AH, and 2-3 degrees of obesity were not included in the study.

In order to analyze the effect of comorbid pathology on the course of the underlying disease, all examined women were divided into three groups. The first group (G1) included 59 women with symptoms of GA without concomitant pathology, the second group (G2) – 74 women with GA and AH, and the third group (G3) – 65 women with GA and AH and OW.

All patients underwent a standard general clinical examination, including physical examination, history taking, and instrumental laboratory tests.

Ultrasound examination of the heart was performed on the ULTIMA PA apparatus (Radmir, Ukraine), according to the standard method with the recommendations of the American Echocardiographic Society. The presence of left ventricular hypertrophy (LVH) was established according to the recommendations of the European Society of Cardiology and the European Society of Hypertension (2018).

The results obtained were processed statistically using the Microsoft Excel software package and the Biostatistics 7.0 software.

Results and discussion

In accordance with the purpose of the study, the assessment of indicators characterizing the systolic and diastolic function of the heart was carried out in G1, G2 and G3. Analysis of structural and geometric indicators characterizing the size and volume of the atria showed that G2 and G3 patients was characterized by an increasing in the volumes of the left (LA) and right atria (RA), as well as the diameters of the left atria (LA-D), with a reliability of p <0.001 it differs from G1patients. At the same time, the diameter and volume of the LA in G3 patients were significantly bigger (p <0.001) compared with those in G2. In G3 and G2patients, there were significantly larger end-systolic (LVESD) and end-diastolic diameters and volumes of the left ventricle (LVEDD) compared to G1 (p <0.001), with significantly higher values (Table 1) of these indicators in the presence of comorbidity (p <0.001).

Table 1

Structural and functional disorders of the myocardium in women with GA

Indicators	G1 n=59	G2 n=74	G3 n=65
LA, ml	39.50 ± 0.77	47.27 ± 0.41	54.12 ± 0.33
RA, ml	20.90 ± 0.90	38,85 ± 0,46	39,02 ± 0,25
LA-D, mm	32.30 ± 0.59	36,13 ± 0,38	40,44 ± 0,32
LVEDD, cm	4.50 ± 0.04	4,82 ± 0,02	4,98 ± 0,02
LVESD, cm	2.84 ± 0.03	3,13 ± 0,01	3,28 ± 0,02
EDV, ml	93.08 ± 2.08	109,27 ± 1,41	118,59 ± 1,23
ESV, ml	30.88 ± 0.88	39,20 ± 0,59	44,48 ± 0,66
SV, ml	62.19 ± 1.67	70,07 ± 0,94	74,10 ± 0,63
EF,%	66.71 ± 0.74	64,13 ± 0,26	62,91 ± 0,21
MFS, %	36.85 ± 0.59	35,01 ± 0,20	34,22 ± 0,14
CMFSS %/c	1.08 ± 0.01	1,04 ± 0,01	1,001 ± 0,01
ST(D), cm	0.79 ± 0.02	1,11 ± 0,01	1,16 ± 0,01
ST(S), cm	0.93 ± 0.02	1,48 ± 0,01	1,46 ± 0,01
PWT(D), cm	0.83 ± 0.02	1,12 ± 0,01	1,17 ± 0,01
PWT(S), cm	0.98 ± 0.02	1,58 ± 0,02	1,60 ± 0,02
RWT, c.u.	0.36 ± 0.00	0,46 ± 0,01	0,47 ± 0,01
LVM, g	132.61 ± 4,02	237,39 ± 3,99	272,34 ± 4,29
LVMI, g/m^2	74.43 ± 2.33	124.67 ± 1.85	140,45 ± 2,05

Evaluation of ejection fraction (EF) – The main indicator of LV systolic function showed that despite the fact that the study included patients exclusively with preserved systolic function, the EF of patients with G2 was significantly lower than in G1 (p <0.001). Moreover, patients with G3 had significantly lower EF than patients with G2 (p <0.01). The degree of anteroposterior shortening of myocardial fibers (MFS) and the rate of circular myocardial fibers shortening (CMFSS), which were used to assess LV myocardial contractility, were lower in patients with both G2 and G3 compared to G1 (p <0.001). The presence of OW negatively influenced the contractility of the myocardium, as evidenced by the significantly lower values of MFS and CMFSS compared with G2 (p <0.01).

Patients of both groups also had an increase of posterior wall thickness (PWT) and interventricular septum thickness (ST) compared to G1 (p <0.001). At the same time, in the presence of OW, these indicators were large, as evidenced by the reliability of differences in indicators in G1 and G2 ($p < 0.001$). In addition, the relative wall thickness (RWT) of patients with G2 acquired significantly higher values ($p < 0.001$) compared with those for G1.

When examining patients, it was found that left ventricular mass (LVM) and left ventricular mass index (LVMI) in both groups of patients were significantly higher than in G1 ($p < 0.001$). The presence of OW led to a further increase in LVM and LVMI in patients with AH, which is confirmed by significantly higher levels of these indicators in G1 compared with patients in G2 ($p < 0.001$).

In order to assess how OW influenced changes in indicators characterizing the structural and functional state of the myocardium, a comparative assessment of the indicators of G3 and G1 patients was carried out (Table 2).

Table2

Comparison of systolic heart function indicators in G1 and G3

Indicators	G1 N=59	G3 n=65
LA, ml	52.02 ± 0.50	55.03 ± 0.41*
RA, ml	40.89 ± 0.54	43.21 ± 0.25*
LA-D, mm	39.10 ± 0.,37	41.03 ± 0.43*
LVEDD, cm	4.89 ± 0.03	5.02 ± 0.02*
LVESD, cm	3.20 ± 0.03	3.32 ± 0.02*
EDV, ml	113.40 ± 1.95	120.85 ± 1.52*
ESV, ml	41.62 ± 1.03	45.73 ± 0.83*
SV, ml	71.77 ± 1.04	75.11 ± 0.77*
EF,%	63.59 ± 0.33	62.62 ± 0.26*
MFS, %	34.66 ± 0.23	31.03 ± 0.18*
CMFSS %/c	1.00 ± 0.01	1.001 ± 0.008
ST(D), cm	1.13 ± 0.01	1.18 ± 0.009*
ST(S), cm	1.40 ± 0.01	1.48 ± 0.009*
PWT(D), cm	1.17 ± 0.01	1.17 ± 0.01
PWT(S), cm	1.52 ± 0.02	1.63 ± 0.02*
RWT, c.u.	0.47 ± 0.005	0.47 ± 0.003
LVM, g	254.77 ± 4.63	279.98 ± 5.75*
LVMI, g/m^2	141.55 ± 2.46	139.98 ± 2.75

Note: * - statistically significant differences between G1 and G3

As shown in Table 2, G3 patients had significantly larger values of the size and volume of the atria than those with normal body weight ($p < 0.001$). This group of patients was also characterized by larger LVEDD, LVESD, EDV and ESV ($p < 0.01$) with a lower EF ($p < 0.05$) compared with patients with normal body weight. The degree of MFS decreased with an increase in BMI, as evidenced by the significant differences in the indicator between both groups of patients ($p < 0.05$).

G3 patients were characterized by significantly bigger ST and the PWT of the LV ($p < 0.01$), however, LVM in both subgroups of patients did not acquire significant differences. LVMI in G3 was significantly higher ($p < 0.01$) than in the case of normal body weight, however, LVMI did not differ significantly in both groups.

To assess the effect of AH on changes in indicators characterizing LV systolic function, patients with G2 were also compared with G1 (Table 3).

Table 3

Comparison of systolic heart function indicators in G1 and G2

Indicators	Г1 n=59	Г2 n=74
LA, ml	45.95 ± 0.66	48.33 ± 0.48*
RA, ml	38.81 ± 0.48	38.88 ± 0.75
LA-D, mm	34.40 ± 0.37	37.52 ± 0.55*
LVEDD, cm	4.75 ± 0.03	4.88 ± 0.03*
LVESD, cm	3.07 ± 0.02	3.18 ± 0.02*
EDV, ml	105.24 ± 1.66	112.49 ± 2.07º
ESV, ml	37.41 ± 0.70	40.62 ± 0.86*
SV, ml	67.83 ± 1.10	71.86 ± 1.40*
EF,%	64.46 ± 0.32	63.87 ± 0.40
MFS, %	35.20 ± 0.24	34.862 ± 0.30
CMFSS %/c	1.05 ± 0.01	1.039 ± 0.015
ST(D), cm	1.09 ± 0.01	1.131 ± 0.012
ST(S), cm	1.51 ± 0.02	1.462 ± 0.017
PWT(D), cm	1.12 ± 0.01	1.124 ± 0.016
PWT(S), cm	1.66 ± 0.04	1.517 ± 0.03*
RWT, c.u.	0.47 ± 0.01	0.462 ± 0.004
LVM, g	227.15 ± 4.94	245.590 ± 5.79*
LVMI, g/m^2	127.53 ± 2.92	122.388 ± 2.36

Note: * - statistically significant differences between G1 and G2

G2 patients were characterized by significantly larger LA size and volume ($p < 0.01$), as well as LVEDD, LVESD and ESV ($p < 0.05$), than patients with G1. In addition, the specified group of patients had high values of PWT(S) ($p < 0.01$) and LVM ($p < 0.05$) in the absence of significant differences in RWT and LVMI.

At the next stage of the study, the types of LV remodeling in G2 and G3 patients were assessed. It was found that the vast majority of patients with OW (77.54%) and more than half of G2patients (53.42%) had left ventricular hypertrophy (LVH), which was not present in G1. All patients of G3 had impaired LV geometry; 2 patients (2.22%) of G2 and 48 patients

(81.26%) of G1 had normal LV geometry. The predominant types of remodeling in G2 were concentric hypertrophy (45.56%) and concentric remodeling (42.22%). At the same time, in the vast majority of cases in G3, hypertrophic variants of LV remodeling prevailed – concentric (64.06%) and eccentric (16.88%) hypertrophy, which are regarded as prognostically unfavorable types of remodeling.

Comparative assessment of the types of remodeling in G2patients showed significant differences in the variants of remodeling between G1 and G3. As for groups of patients as a whole, and when subgroups were identified depending on BMI, the distribution of types of remodeling in patients remained: the prevalence of hypertrophic variants in the presence of OW and almost the same percentage of cases of concentric hypertrophy and concentric remodeling at normal weight.

For the completeness of the clinical and prognostic picture, and the development of corrective approaches, we investigated the diastolic function of the heart, which is an important sign of the myocardial damage possibility in patients with OW.

It was found that in G2 and G3 patients the pulmonary artery diastolic pressure (PAD) was significantly higher ($p < 0.001$) than in G1 (Table 4). At the same time, patients with G3 had a significantly higher ($p < 0.001$) level of this indicator than patients with G2, which indicates a greater expressiveness of diastolic dysfunction in the presence of NS.

Analyzing the data of Table 4, it was found that the maximum speed of early filling (E) in G2 was significantly ($p < 0.001$) less (66.47±0.64 cm/s and 67.35±1.06 cm/s, respectively) than in G1 (79.27±1.47 cm/s).

Table 4

The state of diastolic function in the examined patients with GA

Indicators	G1 n=59	G2 n=74	G3 n=65
PAD, mm Hg	11.46 ± 0.37	13.52 ± 0.23	17.79 ± 0.26
E, cm/s	79.27 ± 1.47	67.35 ± 1.06	66.47 ± 0.64
A, cm/s	68.95 ± 1.48	77.39 ± 1.23	73.79 ± 0.64
E/A	1.15 ± 0.01	0.88 ± 0.018	0.92 ± 0.01
IVRT, s	0.08 ± 0.002	0.10 ± 0.002	0.11 ± 0.001
DT, s	0.17 ± 0.004	0.19 ± 0.024	0.15 ± 0.005

At the same time, there were no significant differences in the value of E between patients G3 and G2. The maximum late atrial filling rate (A) in patients G2 was significantly ($p < 0.001$) higher than in patients G1. The high A values found in patients G3 significantly differed from those in G2 ($p < 0.01$). According to the ratio of these indicators (E / A) G3 and G2, significantly ($p < 0.01$) differed from G1.

According to the indicator of isovolumic relaxation time (IVRT), Г2 and Г3 significantly ($p<0.001$) differed from G1. At the same time, the IVRT value in patients with G3 was higher than in G2 and G1 (0.115±0.001 versus 0.109±0.002 and 0.085±0.002, respectively), which significantly distinguished G3 from the other two groups ($p < 0.05$).

The deceleration time of the early diastolic flow rate (DT) in G2patients was significantly ($p<0.01$) longer than in G3patients. In G3, this indicator tended to decrease, however, there was no significant difference in DT levels between G3 and G1 patients.

Thus, summarizing the research, the following results can be determined: the presence of OW in patients with GA and AH negatively affects the contractile function of the heart. In G3 patients EF – the main indicator of LV systolic function, was significantly lower than in G1 ($p<0.001$) and G2 ($p<0.01$), which led to a further increase in LVM and LVMI in G3patients.

Patients with OW and with comorbid GA and AH had significantly larger values of the size and volume of the atria ($p<0.001$), larger values of PWT(S) ($p<0.01$) and LVM ($p<0.05$), as well as larger LVEDD, LVESD, EDV and ESV ($p<0.01$) with a lower EF ($p<0.05$) compared with patients with normal body weight. The degree of MFS decreased with an increase in BMI ($p < 0.05$).

While maintaining LV systolic function in the vast majority of patients G3, hypertrophic variants of LV remodeling were established – concentric (64.06%) and eccentric (16.88%) hypertrophy, which are prognostically unfavorable types of remodeling. At the same time, hypertrophic and non-hypertrophic variants of LV remodeling are almost equally encountered in G2 patients.

G3 patients had more pronounced diastolic dysfunction compared to patients of G2, where it was represented by initial changes in the form of impaired relaxation, while in 14.38% of patients G3, diastolic dysfunction progressed in the form of pseudo normalization of blood flow. These changes confirm the high values of the mean pressure in the pulmonary artery and the level of the integral indicator of diastolic function in patients with OW. The severity of diastolic dysfunction in patients is determined by an BMI increase, confirming the reliability of the differences in most indicators of diastolic function in patient subgroups G1 and G3. Confirmation of the association of diastolic dysfunction and OW is the revealed pattern: the second stage of diastolic dysfunction took place in a significantly greater ($p<0.05$) number of patients with OW compared with patients with normal body weight.

Conclusions

1. It was found that the presence of comorbid pathology in the form of AH and OW in patients with GA negatively affects the contractile function of the heart, which is confirmed by a decrease in the main indicators of LV systolic function. In addition, they have significantly larger values of the size and volume of the atria than patients with normal weight, as well as larger end-systolic and end-diastolic sizes and volumes of the LV with a lower ejection fraction.

2. Normal LV geometry was established in 81.26% of patients with GA without comorbid pathology. The predominant types of remodeling in the group of patients with GA combined with AH were concentric hypertrophy in 45.56% of cases, and concentric remodeling in 42.22% of cases. In patients with GA combined with AH and OW, hypertrophic variants of LV remodeling prevailed, concentric and eccentric hypertrophy in 16.88% and 64.06% of cases, respectively.

3. Comorbidity of GA with AH and OW, which leads to a decrease in LV systolic function in combination with an increase in end-systolic and end-diastolic sizes and volumes and the formation of prognostically unfavorable types of LV remodeling, should be taken into account when prescribing treatment and rehabilitation measures for this contingent of patients.

Prospects for further research will be presented in the formation of an improved algorithm for the diagnosis of GA in women in combination with AH and OW and optimization of schemes for the complex treatment of this contingent of patients in the conditions of a family doctor.

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