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The effect of permanent atrial fibrillation on the course of rheumatic heart disease

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Objective. *To evaluate the effect of permanent AF on the course and manifestation of CHF in patients with rheumatic heart disease (RHD).*

Materials and methods. We examined 167 patients with RHD: 84 (50,3 %) with AF and 83 (49,7 %) with (SR). The groups differed by age (p = 0,001): 55,89±0,79 years (SR) and 61,48 ± 0,081 years (AF). The follow-up was 5 years. Echocardiography was performed using Philips Affinity 50 ultrasound machine, 24-hour ECG monitoring using «Cardiotechnika-04–3P (M)» monitor, pulmonary function testing using Spirolab II. The assessment of the quality of life was determined using the SF-36, KCCQ, MHFLQ questionnaire.

Results. *Patties from AF group initially had lower SMo (by 0,22 cm^2) and 6-minute walk test distance (by 31.11 meters) compared with patients from SR group. During echocardiography patients from AF group had higher atria and right ventricle linear dimensions and tricuspid valve pressure. Pulmonary function testing values were lower in patients from AF group compared with SR group: FVC by 11,35 %, FEV1 by 11,35 % and VC by 22.9 %. The quality of life did not differ according to the KCCQ, SF-36, MHFLQ questionnaires. During 5-year follow-up echocardiography, pulmonary function testing, and quality of life parameters did not change significantly in patients from SR group. Patients from AF group had SMo decrease by 0,18 cm^2, LVES increase by 0,19 cm, right ventricle dimension — by 0,23 cm and left atrium — by 0,35 cm. 6-minute walk test distance decreased by 21,48 meters. The changes may be explained by higher resting heart rate in patients with AF — by 6 beats per minute on average.*

Conclusion. *Permanent AF in patients with RHD affects echocardiographic parameters- dilatation of the heart cavities and progression of mitral stenosis, and decrease the distance of the 6-minute walk test. Pulmonary function testing values and quality of life were not affected during the 5-year follow-up.*

Keywords: *Rheumatic heart disease, atrial fibrillation, mitral stenosis.*

Conflicts of interest: nothing to declare.

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Introduction

Atrial fibrillation (AF) is one of the most common heart rhythm disturbances that the physician can be faced with during clinical practice. The prevalence of AF ranges from 1 % to 2 % in general population and reaches 25 % in people aged over 80 years [1]. The presence of AF leads to left ventricle remodeling, increases the risk of death, stroke and the progression of chronic heart failure (CHF) [2, 3]. AF also affects the results of HF treatment using ACE inhibitors and β-blockers [4].

At the same time, CHF and AF are often seen in the same patients, since they have similar pathogenesis [5]. The risk of AF in patients with CHF increases with both — decreased (less than 40 %) and preserved (over 50 %) ejection fraction (EF) [6]. The frequency of AF increases with functional class (FC) of CHF and can reach 25–40 % in patients with IV functional class (FC) of CHF [7]. On the other hand, AF is a risk factor of CHF development that affects patient's life quality [8].

However, the dynamics of echocardiographic parameters and functional class of CHF are usually obtained in patients with arterial hypertension, coronary artery disease, and less often in patients with cardiomyopathies [9, 10]. There were not enough studies on the dynamics of CHF, especially in patients with AF and acquired valve disease [11]. The studies mainly describe life quality and dynamics of echocardiographic parameters for short period of time before and after the surgery [12]. But there are only a few studies on patients with AF and acquired valve disease with long-term follow-up.

Objective

To evaluate the effect of permanent AF on the course and manifestation of CHF in patients with RHD compared with patients with sinus rhythm (SR).

Materials and methods

The study included 167 patients with RHD who signed written informed consent. We included only patients with RHD and signs of mitral stenosis according to echocardiography. 84 (50.3 %) patients had a permanent AF, 83 (49.7 %) had a sinus rhythm (SR). The exclusion criteria were: paroxysmal atrial fibrillation, the absence of mitral valve, surgical intervention on the valves, AF development during 5-year follow-up and pacemaker insertion.

Groups of patients differed by age (p = 0.001): 55.89 ± 0.79 years (SR) and 61.48 ± 0.081 years (AF). There were no differences between groups by gender (p = 0.526): SR — 68 women and 15 men; AF — 71 women and 13 men. The duration of follow-up was 5 years.

Echocardiography was performed using Philips Affinity 50 apparatus with assessment of linear heart sizes, valves pressure gradients and pathological flows in the heart cavities. Daily ECG monitoring was performed using cardiorespiratory monitor «Cardiotechnics-04–3P (M)» of the «Incart» company. Spirometry was performed using Spirolab II (MIR Medical, Italy) with assessment of lung vital capacity (LVC), expiratory and inspiratory RV (reserve volume), FVC (forced VC), FEV1 (forced expiratory volume in 1 second), FEV1 / FVC ratio, PEF (peak expiratory flow), MLV (maximum lung ventilation).

To assess the life quality, we used total scales of SF-36 v.1 questionnaire (Short Form Medical Outcomes Study): physical and mental health component; KCCQ (The Kansas City Cardiomyopathy Questionnaire) with an assessment of two indicators: functional status and overall clinical score; MLHFQ (The Minnesota Living with Heart Failure Questionnaire). We also used EuroQol Group questionnaire (EQ-5D) to assess the life quality.

To objectify heart failure functional class, we used 6-minute walk test. Additionally, we assessed dyspnea using 100 mm visual analogue scale (VAS).

Statistical analysis of obtained data was performed using IBM SPSS Statistics 23.0 software with the t-test for paired samples and the Mann-Whitney U-test. A p value less than 0.05 was considered significant.

Results

According to the results of the examination, body mass differed significantly between groups (p = 0.007): 79.71 ± 1.41 kg (SR) and 74.25 ± 1.17 kg (AF). Although, we expected larger body mass in the group with AF due to possible fluid retention. Groups did not differ by height (p = 0.109): 161.89 ± 0.64 cm (SR) and 163.92 ± 0.74 cm (AF).

Heart rate (HR) according to Holter ECG monitoring differed initially between patients. Average daily HR: 71.31 ± 0.89 per min (SR) and 77.44 ± 1.36 (AF). The nighttime HR was higher in the AF group, but was not statistically significant: 60.37 ± 0.8 per min (SR) and 63.02 ± 1.23 per min (AF). The distance of 6-minute walk test in patients with AF (299.89 ± 9.93 meters) was lower by 31.11 meters (p = 0.037) compared with patients with SR (330.996 ± 11,07 meters). But the severity of dyspnea, that is very common in patients with CHF, did not differ between groups according to VAS: 50.09 ± 2.71 mm (AF) and 50.68 ± 1.97 mm (CP), and differed only by 0.59 mm (p = 0.86).

The initial results of SF-36 total scales, KCCQ and MHFLQ questionnaires did not differ significantly (Table 1). KCCQ overall summary scores differed only by -1.6 for functional status and 0.26 for the overall clinical score. Results according to SF-36 were similar: the values of physical health differed only by 0.68, and mental health by 2.62. There was no statistically significant difference between the groups according to CHF MHFLQ questionnaire — 0.27. Initially, the quality of life differed only according to EQ-5D scale — in the group with AF (47.02 ± 1.88) it was 6.2 (p = 0.007) lower compared with SR group (53.22 ± 1, 35).

Table 1. **Initial results of total scales of life quality questionnaires**

Life quality questionnaire	M±m (AF)	M±m (SR)	p
SF36 physical health component	34,62±0,83	34,67±0,65	0,51
SF36 mental health component	38,36±0,88	35,78±1,04	0,05
KCCQ functional status	20,04±0,87	21,95±0,77	0,15
KCCQ overall clinical score	48,44±1,9	48,05±1,78	0,92
MHFLQ	47,33±1,56	46,34±2,22	0,90

Some echocardiographic parameters significantly differed between groups (Table 2). The linear dimensions of the left atrium (LA) were 1.68 cm higher, and right atrium — 1.24 cm higher in AF group. The linear dimensions of the right ventricle also different and were 0.23 cm higher and left ventricular end-systolic volume (ESV) — 0.57 cm higher. Left mitral orifice area (SMo) in patients with AF was 0.27 cm^2 smaller compared with patients with SR, and the area of tricuspid valve (TV) — 17.67 mmHg higher.

Table 2. **The difference of echocardiographic parameters in patients with SR and AF**

Echocardiographic parameter	M±m (AF)	M±m (SR)	p
Aorta, cm	3,50±0,26	3,55±0,11	0,007
LA, cm	3,86±0,13	5,54±0,22	0,000
End-diastolic volume, cm	5,23±0,34	5,88±0,27	0,054
End-systolic volume, cm	3,48±0,32	4,05±0,22	0,001
Ejection fraction, %	62,00±2,22	58,00±2,27	0,020
Interventricular septum thickness, cm	1,07±0,09	1,15±0,08	0,740
Left ventricular posterior wall thickness, cm	1,11±0,09	1,09±0,06	0,762
Right ventricle, см	2,48±0,05	2,71±0,10	0,001
Right atrium, см	3,76±0,19	5,00±0,36	0,003
S Mo, $см^2$	1,76±0,04	1,49±0,04	0,001
Pressure LV-Aorta, mmHg	20,63±5,51	33,75±9,11	0,723
TV pressure, mmHg	27,33±1,52	45,00±2,31	0,001

Comparison of spirometry parameters (table 3) in patients with AF revealed statistically significant decrease of restriction parameters: VC by 22.9 %, inspiratory RV by 15.14 % and obstruction parameters: FVC by 11.94 %, FEV1 by 15.46 %, and also MLV. Restriction can be explained by pulmonary edema involving peribronchial space that develops due to mitral stenosis that is common in patients with AF.

Table 3. **The difference between spirometry parameters in patients with SR and AF**

Spirometry parameters	M±m (AF)	M±m (SR)	p
FVC, %	75,99±1,49	64,05±2,11	0,001
FEV1, %	84,65±1,65	69,19±2,20	0,001
FEV1/ FVC	118,88±0,75	116,64±1,41	0,834
PEF, %	110,85±2,23	89,39±2,72	0,001
Inspiratory RV, %	89,65±2,24	74,51±2,41	0,001
Expiratory RV, %	25,66±2,71	22,95±3,29	0,111
Inspiratory capacity, %	117,94±3,06	94,62±3,06	0,001
VC, %	117,52±3,07	94,62±3,06	0,001
Maximum lung ventilation, %	67,94±2,14	56,33±2,23	0,001

During the 5-year follow-up parameters of patients with SR did not change significantly. But there were some exceptions: an increase of aortic valve pressure gradient (in patients with mitral and aortic stenosis) by 6.99 mmHg (p = 0.001): from 21.22 ± 1.52 mmHg to 28.2 ± 1.95 mmHg and an improvement of SF-36 mental health component by -3.64 (p = 0.039): from 37.29 ± 2.07 to 40.93 ± 1.37.

Patients with AF had different pattern. A number of echocardiographic parameters changed significantly (Table 4): the linear dimension of the LA increased by 0.35 cm: from 5.19 ± 0.1 cm to 5.54 ± 0.13 cm, the mitral orifice area (SMo) decreased by 0, 18 cm^2: from 1.66 ± 0.076 cm^2 to 1.48 ± 0.076 cm^2. The linear parameters of the ventricles also significantly changed: LV ESV increased by 0.20 cm: from 3.6 ± 0.09 cm to 3.4 ± 0.09 cm, and the right ventricle decreased by 0.24 cm: from 2.98 ± 0.08 cm to 2.74 ± 0.08 cm. Aortic valve pressure gradient increased by 9.8 mmHg: from 25.33 ± 4.03 mmHg to 35.13 ± 3.87 mmHg. The distance of 6-minute test also decreased by 21.48 me-

Table 4. **The dynamics of echocardiographic parameters during 5-year follow-up in patients with AF**

Echocardiographic parameters	M±m (initially)	M±m (5 years later)	p
Aorta, cm	3,26±0,04	3,26±0,04	0,908
LA, cm	5,19±0,10	5,54±0,13	0,017
S Mo, cm^2	1,66±0,08	1,48±0,08	0,004
End-diastolic volume, cm	5,42±0,08	5,27±0,10	0,100
End-systolic volume, cm	3,6±0,09	3,41±0,09	0,020
Interventricular septum thickness, cm	1,11±0,05	1,32±0,08	0,006
Left ventricular posterior wall thickness, cm	1,02±0,06	1,29±0,06	0,001
Right ventricle, см	2,98±0,08	2,74±0,08	0,017
Right atrium, см	5,53±0,35	5,73±0,57	0,770
S Mo, $см^2$	25,33±4,03	35,13±3,87	0,026
Pressure LV-Aorta, mmHg	40,28±1,85	39,67±2,32	0,820

ters in patients with AF (p = 0.03): from 338.09 ± 12.68 m to 324.19 ± 11.87.

The life quality parameters in patients with AF did not change significantly, although SF-36 and KCCQ parameters decreased and MHFLQ — incased that showed an impairment of life quality (table 5).

Table 5. **The dynamics of total scales of life quality questionnaires during 5-year follow-up in patients with AF**

Total live quality scales	M±m (initially)	M±m (5 years later)	p
SF36 physical health component	35,75±1,14	33,80±1,22	0,05
SF36 mental health component	38,43±1,47	35,89±1,37	0,10
KCCQ functional status	21,90±1,17	20,27±1,22	0,16
KCCQ overall clinical score	48,40±2,90	48,20±2,95	0,95
MHFLQ	45,48±2,51	48,61±2,56	0,25

Spirometry and life quality parameters (table 6) did not change significantly. But there we some exceptions: PEF, that is an indicator of obstruction, significantly decreased in both groups: by 12.38 % (SR) from 110.19 ± 4.41 % to 97, 82 ± 5.38 % and by 7.87 % (AF) from 99.11 ± 2.98 % to 91.25 ± 2.66 %.

Table 6. **The dynamics of spirometry paraments during 5-year follow-up**

Spirometry parameter	M±m (initially)	M±m (5 years later)	p
FVC (SR), %	80,16±3,41	78,91±3,20	0,59
FVC (AF), %	70,83±1,38	70,53±2,99	0,91
FEV1 (SR), %	91,53±3,95	87,09±3,18	0,15
FEV1 (AF), %	77,59±1,82	74,96±2,10	0,18
FEV1/ FVC (SR), %	122,56±0,77	118,40±1,83	0,08
FEV1/ FVC (AF), %	117,65±1,372	114,73±2,09	0,19
PEF (SR), %	110,19±4,41	97,82±5,38	0,04
PEF (AF), %	99,12±2,98	91,25±2,66	0,01

Discussion

Irregular heart rhythm and worsening of left ventricular filling in patients with AF contribute to the course of CHF [5]. Cardiac hemodynamics changes even more in patients with acquired valve diseases, and primarily valve stenosis. This explains why initial echocardiographic parameters in patients with AF had larger linear atria and ventricle dimensions, and higher TV pressure gradient compared with SR group, even though AF also contributes to atrial remodeling [7]. It is also remarkable that patients from AF group were 5,6 years older. Patients with AF initially had 0.22 m^2 smaller mitral stenosis area that could stimulate AF development and affect heart sizes and valve pressure. Higher HR in patients with AF could also affect the severity of mitral stenosis compared with SR group. This proves the believe that the progression of stenosis can be explained by aseptic inflammation due to hemodynamic effect of blood flow on altered heart valves. Greater heart rate also affects the severity of CHF [9] that manifests as the decrease of 6-minute walk test by 31.11 meters in patients with AF.

We saw changes of all spirometry parameters in both groups, for example, FVC was 80 % lower than normal. Parameters of obstruction and restriction were lower in patients with AF compared with SR group: FVC by 11.35 %, FEV1 by 11.35 %, VC by 22.9 % that can be explained by severe CHF and by pulmonary edema involving peribronchial space [13].

The parameters of life quality assessed by non-specific CHF questionnaires (KCCQ, SF-36) and specific MHFLQ, as well as the rate of dyspnea according to VAS did not differ. Only life quality according to EQ-5D scale was higher by 6.2 in the patients with SR. The absence of changes is associated with slow increase of heart linear dimensions during slow progression of mitral stenosis with its size under 1.5 cm^2, that is an indication for surgical tratment. On the other hand, there are studies on adverse effect of AF on life quality, physical activity and mental health [8], especially persistent AF in patients without valvular heart disease. The VAS parameter of dyspnea, that also affects life quality did not differ significantly between groups — 0,59 mm.

During the assessment of echocardiographic and spirometry parameters after 5-year follow-up, the parameters of patients with SR did not differ significantly. The exceptions were: the reduction of PEF by 12.38 % according to spirometry and an increase of aortic pressure gradient by 6.99 mmHg.

SMo decreased by 0.18 cm^2 in patients with AF during 5-year follow-up, although some literature sources found the progression by 0.1–0.3 cm^2 per year [9] that requires additional analysis and a longer observation period. LV ESV increased by 0.19 cm, the right ventricle — by 0.23 cm, the left atrium — by 0.35 cm in patients with AF. The distance of the 6-minute walk test decreased by 21.48 meters and PEF by 7.87 % according to spirometry. Patients with AF also had significantly higher daily HR by 6 beats per minute that could lead to a statistically significant progression of mitral stenosis in these group of patients that could affect echocardiographic, spirometry parameters and the distance of 6-minute test.

Conclusion

Permanent AF in patients with RHD affects echocardiography parameters- dilatation of the heart cavities (compared with SR group), progression of mitral stenosis, and the distance of the 6-minute walk test. Pulmonary function testing values and quality of life were not affected during the 5-year follow-up (excluding PEF).

Conflict of interest: None declared.

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