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Research Article

Results of the Ultrasound Study of Intracardial Hemodynamics in Patients with Ischemic Heart Disease in Combination with Arterial Hypertension and Complicated by Chronic Heart Failure 2A and 2B

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Abstract

Objective. To conduct a comprehensive study of patients with ischemic heart disease (IHD) in combination with arterial hypertension (AH) complicated by chronic heart failure (HF) 2A and 2B, by studying parameters of intracardiac hemodynamics considering the pressure in the pulmonary artery.

Research results. We examined 120 patients with coronary heart disease in combination with hypertension aged 44 to 90 years old (mean age 72.29 $\pm$ 1.66), the majority were men (86.7%). All patients were divided into two groups according to the degree of heart failure: HF 2A - 54 persons, with HF 2B - 66 people. The groups were compared in age, gender, functional class of IHD, severity of AH and HF.

Analysis of heart ultrasound showed the following. In IHD in combination with hypertension, complicated by HF 2A, the pressure in the pulmonary artery rises in an average to 46.46 $\pm$ 3.64 mm Hg and it increases in HF 2B to 57.00 $\pm$ 5.19 mm Hg, that corresponding to the average level of pulmonary hypertension ($p < 0.01$); at the same time, the fraction of ejection of left ventricle in the first patients decreases moderately up to 45.96 $\pm$ 2.01%, in others - to 39.93 $\pm$ 1.99% ($p < 0.01$).

In patients with IHD in combination with hypertension complicated by chronic heart failure the structural and functional changes are formed on the side of the left heart, accompanied by an increase in their size due to hypertrophy, formation of stagnant phenomena, regurgitation, functional state disorders by the restrictive type, progressive systolic and diastolic dysfunction, increased pressure in the pulmonary artery.

Conclusions. Consideration of pulmonary hypertension, along with other parameters of intracardiac hemodynamics, is an important component in determining the degree and nature of heart failure, which requires the selection of adequate and timely therapeutic tactics.

Keywords
IHD in combination with AH; CHF; pulmonary hypertension; heart ultrasound

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Problem statement and analysis of the recent research

In the 21st century, chronic heart failure (CHF) remains one of the most important problem areas of modern medicine and it has great social significance due to the widespread, progressive, prognostically unfavorable, course and high economic losses [1, 2, 8-10].

The European Society of Cardiology in 2016 recommended an algorithm for diagnosis of CHF, which consists of assessing the probability of HF (subjective symptoms, anamnesis data, physical examination, ECG), determination of the plasma concentration of natriuretic peptide (NUP) and / or echocardiography [1].

The echocardiography has the highest sensitivity (from 79 to 100%) and specificity (from 69 to 98%) among non-invasive methods of diagnosis [4, 7, 11, 12]. It directly provides information about the volume of chambers of the heart, systolic and diastolic function, thickness of the myocardial wall, valves and the presence of pulmonary hypertension (PH).

The study of modern possibilities of detect of the CHF in patients with ischemic heart disease in combination with hypertension has shown the following: the heart failure is usually diagnosed in presence of pronounced morpho-functional changes that occur due to hemodynamic overload pressure, rigidity hypertrophied myocardium with increase in connective tissue matrix, interstitial fibrosis which leads to myocardial ischemia, a decrease in the number of myocytes and suppression of the contractile function of the heart and promotes the expansion of cavities, remodeling and the development of heart failure.

At the same time, the presence of secondary pulmonary hypertension, which is formed at the beginning of hemodynamic

disorders and takes place at all stages of CHF, is practically not taken into account [5, 6]. Therefore, the issue of early diagnosis of CHF in patients with ischemic heart disease in combination with hypertension remains relevant.

Objective. To conduct a comprehensive study of patients with ischemic heart disease (IHD) in combination with arterial hypertension (AH) complicated by chronic heart failure (HF) 2A and 2B, by studying parameters of intracardiac hemodynamics considering the pressure in the pulmonary artery.

1. Material and methods

Diagnosis of IHD in combination with hypertension complicated by heart failure 2A and 2B was established in accordance to the requirements of the Protocols of the Ministry of Health of Ukraine [4]. The screening program included: general-clinical, laboratory methods of study, as well as the study of electrocardiographic and echocardioscopic indicators, statistical processing of the data.

2. Results and discussion

We examined 120 patients with ischemic heart disease in combination with hypertension aged 44 to 90 years old (mean age 72.29 $\pm$ 1.66), the majority were men (86.7%) because studies conducted in the cardiology department of the Military Medical Center of the Southern region.

All patients were divided into two groups according to the degree of heart failure: HF 2A - 54 persons, with HF 2B - 66 people. The groups were compared in age, gender, functional class of IHD, severity of AH and HF.

Heart ultrasound was performed in the positions of echocardiography according to the standard protocol [11] with the calculation of size, volume, speed and other characteristics of intracardiac hemodynamics.

In both groups, the aortic root dilatation was determined: in the first group, up to 3.95 $\pm$ 0.10 cm, and the second one to 4.05 $\pm$ 0.11 cm, which indirectly indicated the significant changes in vessels.

Along with this, an increase in the size of the heart in diameter (DSH) was observed, which in patients of the 1st group was in the average 11.91 $\pm$ 0.39 cm, and of the second - 12.69 $\pm$ 0.46 cm ($p<0.05$). This was due to the following changes: first, a significant ($p<0.001$) increase in the systolic size of the left ventricle (SS LV) (with HF 2A up to 4.34 $\pm$ 0.26 cm, with HF 2B up to 4.77 $\pm$ 0.23 cm), and secondly, the enlarge ($p<0.05$) of the diastolic size of the left ventricle (DS LV) (at HF 2A to 5.76 $\pm$ 0.21 cm, and at HF 2B to 6.02 $\pm$ 0.24 cm) (Tab. 1).

In all patients was determined thickening of the walls of the left heart with an increase in the myocardial mass index ($p<0.01$) and hypokinesis of interventricular septum (IVS) ($p<0.05$) with the prevalence of these parameters in patients with HF 2B.

It was noteworthy that the difference in volume changes between diastole and systole in patients of both groups was practically the same (1.25 – 1.26 cm) and differed from normal (1.4 – 2.3) digits. However, this figure was only moderately lower for HF 2A, because LV hypertrophy was not so significant, but significantly differed in the group of patients with HF 2B ($p<0.001$), given the larger size of ESV and EDV of LV in these group. This was explained by a reduced ejection fraction and indicated the formation of restrictive changes in the heart muscle.

Patients with HF 2B had more attenuated movement of interventricular septum ($p<0.05$), significantly ($p<0.001$) lower ejection fraction (FE) of LV relative to norm and group of patients with HF 2A and large parameters of end-systolic ($p<0.001$) and end-diastolic ($p<0.05$) volumes (ESV and EDV), which explained the decrease in the total pumping function of the heart (Tab. 1).

The received data show the presence of moderate systolic dysfunction in patients of the first group and expressive in the second, which was burdened by diastolic dysfunction and restriction myocardial of LV.

Regurgitation at the mitral valve is absent in healthy, however, it has been registered in the subjects in varying degrees. Thus, in the 1st group of observations in 29.6% of patients regurgitation was clinically insignificant or in a state of compensation (I st.), in 24.1% - in the state of subcompensation (II st.), the III st. (left ventricular failure) was in 46.3%. In the 2nd group, similar indicators were distributed as follows: I st. (compensation) was registered in 15.2%; II st. (subcompensation) - in 21.2%; III st. (left ventricular failure) - in 51.5% and IV st. (dystrophy) in 12.1% of the subjects.

Consequently, hemodynamic overload of LV due to hypertension on the background of ischemic phenomena contributed to a decrease in contractile function of the myocardium and regurgitation on the MV, increase in the blood filling of the left atrium, the difficulty of the outflow of blood from a small circle of blood circulation and the formation of pulmonary hypertension (PH).

The pressure in PA in patients with HF 2A (46.46 $\pm$ 3.64 mm Hg) exceeded the norm by 1.8 times, and in patients with HF 2B (57.00 $\pm$ 5.19 mm Hg) – 2.2 times ($p<0.05$). At the same time, the size of the right ventricle (RV) in patients of the 1st group did not differ from normal, and the 2nd - exceeded them, with certain regurgitation on tricuspid valve in 81.8% of cases.

According to the deciphering of the results of the study, conducted on the background of continued high blood pressure in patients with ischemic heart disease in combination with hypertension, structural and functional changes in the heart, remodeling of the myocardium were diagnosed (Tab. 1).

3. Conclusions

Thus, the analysis of heart ultrasound results allowed drawing the following conclusions:

1. In IHD in combination with hypertension, complicated

Table 1. Heart ultrasound parameters in patients with ischemic heart disease in combination with hypertension, depending on the severity of heart failure

TTE parameters	Norm	HF 2A, n=54	HF 2B, n=66	p
DSH, cm	9-10	11.91±0.39*	12.69±0.46*	<0.05
Aortic root diameter, cm	up to 3.4	3.88±0.09*	4.05±0.11*	<0.05
Diastolic size of LV, cm	up to 5.6	5.80±0.18	6.16±0.22*	<0.05
Systolic size of LV, cm	3.3-4.2	4.43±0.19	4.98±0.21*	<0.001
Diastolic thickness of the posterior wall of LV, cm	up to 1.1	1.27±0.03*	1.33±0.05*	<0.05
Systolic thickness of the posterior wall of LV, cm	1.3-1.5	1.42±0.03	1.47±0.03*	<0.05
End-systolic volume (ESV) of LV	62	87.02±8.76*	110.53±9.57*	<0.001
End-diastolic volume (EDV) of LV	160	179.2±11.80*	196.79±11.56*	<0.05
Diastolic thickness of interventricular septum, cm	up to 1.3	1.41±0.05	1.44±0.04*	-
Systolic thickness of interventricular septum, cm	1.2-1.4	1.60±0.04*	1.63±0.03*	-
Movement of interventricular septum, cm	0.4-0.6	0.36±0.03*	0.29±0.03*	<0.05
Regurgitation on the mitral valve (MV)	-	83.4±10.12*	100.0*	<0.05
I st. (compensation)	-	13.0±9.15*	15.2±8.84*	
II st. (subcompensation)	-	24.1±11.64*	21.2±10.06*	
III st. (LV failure)	-	46.3±13.57*	51.5±12.3*	<0.05
IV st. (dystrophic)	-	-	12.1±8.02*	<0.001
Left atrium (LA), cm	up to 3.9	4.48±0.10*	4.81±0.12*	<0.001
Myocardial mass index of LV, g/m^2	71-94	127.5±4.58*	134.17±3.10*	<0.01
Pressure in the pulmonary artery (PA), mm Hg	up to 25	46.46±3.64*	57.00±5.19*	<0.05
EFof LV, %	55-65	45.96±2.01*	39.93±1.99*	<0.001
Right ventricle (RV), cm	up to 3.0	2.80±0.21	3.14±0.12*	<0.05
Regurgitation on the tricuspid valve (TV)	no	no	81.8±9.5*	<0.001
Area of right atrium (RA), cm^2	up to 15	13.56±0.29	17.28±0.37*	<0.001

Notes:

* - the differences compared with the norm are reliable ($p<0.05$);

p - is the reliability of the differences between HF 2A and 2B.

by HF 2A, the pressure in the pulmonary artery rises in an average to 46.46 ± 3.64 mm Hg and it increases in HF 2B to 57.00 ± 5.19 mm Hg., that corresponding to the average level of pulmonary hypertension ($p<0.01$); at the same time, the fraction of ejection of left ventricle in the first patients decreases moderately up to 45.96 ± 2.01%, in others - to 39.93 ± 1.99% ($p<0.01$).

2. In patients with IHD in combination with hypertension complicated by chronic heart failure the structural and functional changes are formed on the side of the left heart, accompanied by an increase in their size due to hypertrophy, formation of stagnant phenomena, regurgitation, functional state disorders by the restrictive type, progressive systolic and diastolic dysfunction, increased pressure in the pulmonary artery.

3. Consideration of pulmonary hypertension, along with other parameters of intracardiac hemodynamics, is an important component in determining the degree and nature of heart failure, which requires the selection of adequate and timely therapeutic tactics.

4. Prospects for further researches

Further research aimed at improving the diagnosis of chronic heart failure, taking into account the degree of pressure in the pulmonary artery and the fraction of ejection, that develops in patients with ischemic heart disease in combination with arterial hypertension, are perspective as they determine not only the diagnostic but also the prognostic role of the severity of CHF, contribute to adequate and timely choice of pharmacological correction.

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