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INFLUENCE OF AORTIC VALVE REPLACEMENT IN PATIENTS WITH CRITICAL AORTIC STENOSIS WITH PRONOUNCED CALCIFICATION ON PROCESSES OF LEFT VENTRICULAR REMODELING

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Abstract

The article presents the results of aortic valve replacement in patients with aortic stenosis complicated by severe calcification, in patients with a preserved and reduced fraction of left ventricular ejection, in 3 months after the operation.

Analysis of the natural history of aortic stenosis showed that after the first symptoms of the disease within 2 years more than 50% of patients die. The main causes of death are coronary insufficiency and cardiac arrhythmia. The only radical treatment for aortic valve defect is surgical correction.

There is a statistically significant reduction in the peak and average pressure gradient on the prosthesis aortic valve, which demonstrates the effectiveness of surgical correction of the defect. Reducing the pressure in the left ventricle resulted in decreasing the degree of mitral regurgitation, which did not exceed the first-second degree in both groups after 3 months.

Thus, the results indicate more severe violations of structural-geometric and functional parameters of the left ventricle before surgery in patients of the first group compared with those of the second group, as well as fairly significant decrease in linear and volumetric parameters of left ventricle, reduction in left ventricular myocardial mass and left ventricular myocardial mass index, increasing ejection fraction 3 months after surgery.

Patients with aortic stenosis complicated by severe calcification, show estimates of structural and geometric and functional parameters of left ventricular function, assessment of mitral valve regurgitation and the degree of the valve before and after surgery by transthoracic echocardiography.

Dynamics of structural-geometric and functional parameters of the left ventricle in patients of both groups in 3 months after prosthesis aortic valve is characterized by a significant decrease of linear and volumetric parameters of left ventrical, left ventricular myocardial mass l, increase of left ventricular ejection fraction, decrease in the degree of regurgitation on mitral valve, which indicates the positive impact of operations on processes of reverse left ventricular remodeling.

Keywords: *aortic valve, stenosis, surgery, echocardiography, remodeling.*

Introduction

Critical aortic stenosis (AS) is currently one of the most common and most commonly operated valvular heart disease. With a preserved left ventricular ejection fraction (LVEF), operations in such patients are widespread and carry a minimal risk of adverse outcome – 0.6-3.2%. A different situation is observed in patients with a critical AS with sharply decreased myocardial contractility [*Otto CM, 2006*]. Because cardiac surgery is so successful in recent years, such patients are increasingly being offered surgical interventions. The incidence of AS with left ventricular systolic dysfunction, according to different authors, makes 4.3 to 13% of the number of patients operated for AS. There is no doubt that for such patients, surgery is the only possible treatment; without surgery, their lethality reaches 90% within 6-12

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months [*Belash S et al., 2017*]. However, the risk of surgical treatment of such patients in comparison with those with a preserved left ventricular ejection fraction, is much higher.

Currently, lethality in aortic valve prosthetics in patients with AS and LVEF is less than 40%, ranging from 9 to 11% [*Rothenburger M et al., 2003; Sharony R et al., 2003*]. That is the reason why the possibility and expediency of surgical treatment cause much discussion. Thus, according to some authors [*Duarte I et al., 1997; McCarthy P, 2002*], aortic prosthetics in patients with critical AS have a high risk of adverse outcome and low long-term survival in the presence of severe LV stethodynamic function and dilatation. The others [*Kvidal P et al., 2000a, b*], in their work, on the contrary, describe a significant improvement in the life quality and the disappearance of the symptoms in patients with severe aortic stenosis and LVEF after correction of the defect. The above facts testify to the need for an in-depth evaluation of the possibilities and results of surgical treatment of patients with a critical AS in the setting of a sharply depressed LVEF, which will eventually provide for treatment to those previously denied it.

Aortic valve prosthetics is currently the only possible and effective method for correcting hemodynamic disorders developing in a critical AS [*McCarthy P, 2002; Chukwuemeka A et al., 2006*]. The risk of a lethal outcome increases with age, associated with ischemic heart disease, a decrease in LVEF, infective endocarditis, renal insufficiency, and excess body weight. Additionally, one of the most significant predictors of mortality are the signs of severe heart failure and its duration [*Cieśla-Dul M et al., 2004; Tjang Y et al., 2007; Vassileva C et al., 2015*]. In the study conducted by C. Vassileva and co-authors in the US in 2015 [*McCarthy P, 2002*], it is shown that if the duration of circulatory decompensation in patients with critical AS and low LVEF is longer than 3 months, the risk of hospital mortality in surgical treatment increases by 50%. That is why earlier studies show that operations in such patients actually show a high risk of death and low survival, and the authors recommend refraining from surgery. Thus, according to N. Connolly, hospital mortality in patients with critical aortic stenosis and LVEF less than 35% is 21%. In the work of D. Powell, this figure reaches 18% [*Connolly H et al., 2000*]. At the same time, describes an extremely high mortality rate – 90% in unoperated patients with severe aortic stenosis (AS) and stromal cell-derived factor-1. It is the unpromising projections and high mortality rates that forces surgeons to operate such patients, despite the extremely high risk associated with the surgery.

In different reports, there is some ambiguity in assessing the severity of LV stethodynamic function. Different authors [*Rothenburger M et al., 2003. Sharony R et al., 2003*] refer to this group less than 40%, less than 45% and even less than 50% of patients with LVEF. At the same time, the lethality figures vary quite widely, and in most cases appear to be high. In a number of studies in patients with LVEF less than 40%, lethality makes 9 to 10.9%. The group of Meshalkin National Medical Research Center authors in their study of the group of patients with critical AS and LVEF less than 50%, reported a hospital mortality rate of 4.9%, while in the group of patients with LVEF less than 40% mortality made already 10.5%. A similar level of lethality is also shown in the studies of patients with initial LVEF less than 35%, the lethality made 5.1 to 8.3% [*Tarantini G et al., 2003*].

Analysis of the natural history of aortic stenosis showed that after the first symptoms of the disease within 2 years more than 50% of patients die [*Ivanov V et al., 2011*]. The main causes of death are coronary insufficiency and cardiac arrhythmia [*Dzemeshkevich S, Stivenson L, 2004*]. The only radical treatment of aortic valve defect is surgical correction [*Frederic V et al., 2007; Grossi E et al., 2008*].

The article presents the results of aortic valve replacement in patients with aortic stenosis complicated by severe calcification, in patients with a preserved and reduced fraction of left ventricular ejection, in 3 months after the operation [*Eynden FV et al.*, 2007].

The study aimed to evaluate the process of left ventricular remodeling in patients with critical aortic stenosis before and 3 months after valve replacement.

Material and methods

The study included 204 patients with cardiac surgery of aortic valve prosthetics performed in Cardiosurgery Center on the basis of Municipal Institution Zaporozhye Regional Clinical Hospital from 2009 till 2017. The average age of the patients was 64.5±5.3 years (ranged 43 to 70 years): 112 men (68.7%) and 51 women (31.3%).

The study involved patients with no coronary pathology.

All patients had heart failure corresponded III-IV functional class NYHA classification. Patients were divided into two groups according to the severity of the defect and ejection fraction of the left ventricle. The first group included 77 (37.8%) patients with left ventricular ejection fraction less than 50%, the second one – 127 (62.2%) patients with left ventricular ejection fraction greater than 50%. Patients in both groups did not differ by age.

Before surgery all patients were performed by the research of intracardiac hemodynamics by transthoracic echocardiography, the state of coronary arteries was assessed by coronarography.

Aortic valve replacement was done for all patients. The double-leaf mechanical prostheses of aortic valve St Jude Medical Regent were used for replacement.

St Jude Medical Regent (St Jude Medical, St Paul, Minnesota, USA) bileaflet mechanical prosthesis has demonstrated excellent early and long-term haemodynamic results. Good outcome after implantation of these valves, even in smaller aortic annuli, has been reported [*Xu R et al., 2017*].

Echocardiography was performed in one-two-dimensional, Doppler mode on the unit: En Visor C, US production. The following parameters: end-diastolic dimension, *cm*; end-diastolic volume, *ml*; end-systolic dimension, *cm*; end-systolic volume, *ml*; stroke volume, *ml*; ejection fraction, %; left ventricular myocardial mass, *g*; left ventricular myocardial mass index, g/m^2; interventricular septum thickness in systole, *mm*; the thickness of left ventricular posterior wall in systole, *mm*; peak and average gradients at the aortic valve, *mm Hg*, were evaluated.

The calculation of ejection fraction by Simpson equation was performed in hardware mode [*Shiller N, Osipov M, 2005; Rybakova M et al., 2008*].

The degree of mitral regurgitation was assessed by the percentage of the jet area and left atrium area. Coronarography was performed according to M. Judkins' method (1967) with fixing images on angiographic complex "Semens" Acuson Artis, US.

Results and discussion

The study included patients without any significant stenotic coronary involvements according to the results of coronarography that did not require additional shunt vessels.

Prior surgical treatment of I group of patients, compared with those of II group of patients, table, there was a significant increase in end-diastolic dimension, end-diastolic volume, end-systolic dimension, end-systolic volume, and stroke volume of 8.5%, 6.1%, 6.8%, 4.6% and 8.4% respectively.

Significant increase in left ventricular myocardial mass and left ventricular myocardial mass index was revealed in patients of I group of 6.7% and 7.0%, respectively.

Also, there was a decrease in LVEF of 6.9% in I group compared to these indicators in II group. Left ventricular posterior wall, interventricular septum thickness had no significant differences in both groups of patients.

By means of the continuous wave Doppler's method maximum high peak and average pressure gradients between the aorta and the left ventricle were recorded in both groups of patients.

In all patients according to transthoracic echocardiography the mitral valve regurgitation was found. In I group mitral regurgitation of II degree – in 23 (29.9%), I degree in 54 patients (70.1%). In II group the second degree of regurgitation was revealed in 44 (34.6%) patients, the first degree – in 83 (65.4%) patients.

Aortic valve replacement was done for all patients. The double-leaf mechanical prostheses of aortic valve St Jude Medical Regent were used for replacement.

In 3 months after the operation, in patients of I and II groups, compared with the data before the operation, there left ventricular myocardial mass index significant decrease in the performance of linear and volumetric LV, reduction of left ventricular myocardial mass and left ventricular myocardial mass index, increase of ejection fraction at 8.1% in I group and 9.2% in patients of II group (Table).

Table 1

Echocardiography in patients of I and II groups before and 3 months after surgery (M±m)

Indicator	before surgery		3 months after surgery	
	I group (n=77)	II group (n=127)	I group (n=77)	II group (n=127)
Left ventricularparameters				
end-diastolic dimension (*cm*)	7.02±0.28	5.62±0.15	6.32±0.15	5.26±0.16
end-diastolic volume (*ml*)	257±24.0	155.0±6.0	202.0±12.0	133.0±9.0
end-systolic dimension (*cm*)	5.63±0.33	3.91±0.15	4.71±0.15	3.51±0.20
end-systolic volume (*ml*)	155.0±22.0	66.5±6.1	103.0±8.0	51.0±7.5
stroke volume (*ml*)	102.0±1.01	88.5±3.3	99.0±4.01	82.0±1.50
ejection fraction (%)	39.6±2.80	57.1±1.30	49.1±1.10	61.6±2.6
interventricular septum (*cm*)	1.56±0.06	1.60±0.05	1.50±0.05	1.50±0.05
posterior wall in systole (*cm*)	1.40±0.05	1.40±0.05	1.35±0.05	1.40±0.05
myocardial mass (*g*)	538.0±65.0	387.0±36.0	434.0±38.0	333.0±15.0
myocardial mass index (g/m^2)	269.0±0.33	188.0±17.0	213.0±19.00	162.0±7.0
Pick gradient on aortic valve (*mmHg*)	95.2±17.2	85.5±18.6	27.6±5.7	18.3±2.5
Average gradient on aortic valve (*mmHg*)	48.8±11.2	43.7±12.1	11.3±2.1	10.1±2.4

There's a statistically significant reduction in the peak and average pressure gradient on the aortic valve prosthesis, which demonstrates the effectiveness of surgical correction of the defect. Reducing the pressure in the left ventricle resulted in decreasing the degree of mitral regurgitation, which did not exceed the first-second degree in both groups after 3 months.

Thus, the results indicate more severe violations of structural-geometric and functional parameters of the left ventricle before surgery in patients of I group compared with those of II second group, as well as fairly significant decrease in linear and volumetric parameters of LV, reduction in left ventricular myocardial mass and left ventricular myocardial mass index, increasing EF 3 months after surgery.

Conclusion

Patients with aortic stenosis complicated by severe calcification, show estimates of structural and geometric and functional parameters of left ventricular function, assessment of mitral valve regurgitation and the degree of the valve before and after surgery by transthoracic echocardiography.

Dynamics of structural-geometric and functional parameters of the left ventricle in patients of both groups in 3 months after aortic valve prosthesis is characterized by a significant decrease of linear and volumetric parameters of LV, LVMM, increase of ejection fraction LV, decrease in the degree of regurgitation on mitral valve, which indicates the positive impact of operations on processes of reverse LV remodeling.

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