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INFLUENCE OF IMPLANTATION ARTIFICIAL PROSTHESES ON STRUCTURALLY FUNCTIONAL CHANGES LEFT VENTRICULAR AT PATIENTS WITH AORTAL DEFECT

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For last 20 years reached significant progress in surgery of aortal heart diseases. Hundred thousand operations of prosthetics of valves are executed and set of various types of artificial valves of heart are developed, and the number of such operations is enlarged from year to year (Bokerija L.A. from co-workers. 2008; Dzemeshkevich S.L. from co-workers. 2004; Edwards F.H., 1999). However, at all variety of surgical methods of correction of defects of the aortal valve, a problem of a choice of type of a prosthesis for implantation in an aortal position: the bioprosthesis or mechanical (one-cuspidate or two-cuspidate), or pulmonary autographt remains to one of actual [1]. The majority of surgeons prefers implantation to mechanical prostheses [3, 7, 8] whereas the certain part prefers implantation of biological prostheses [2, 9-11]. Now there is no unequivocal approach to a choice of type of prosthesis.

Object of the research was an estimation of influence of implantation of mechanical and biological prostheses on dynamics of indicators of a left ventricle in the postoperative period at patients with aortal insufficiency.

Materials and methods

Total 394 patients with isolated defect of the aortal valve (AV) have been operated, by which prosthetics AV has been executed during 2001-2007. From them men 311, women 83, at the age from 10 till 78 years, middle age has made 36,9±1,3 years. In I FC on NYHA was 14 (3,6%) patients, in II – 42 (10,7%), III – 296 (75,0%), IV – 42 (10,7%). On hemodynamic changes on AV at 229 (58,1%) patients aortal insufficiency and combined aortal defect with prevalence of insufficiency (AI), at 165 (41,9%) patients - an aortal stenosis and combined aortal defect with prevalence of a stenosis (AS) became perceptible. The reasons of aortal defect (AD) were: rheumatic disease in 74,8% of cases, an infectious endocarditis – 16,3%, congenital defect AV – 8,5%, an atherosclerotic degeneration and calcification – 0,4%. Criteria of an exception of research were patients with multivalval defects, AD with combined lesion of coronary arteries, patients with AD and «a prosthesis-patient disharmony». To all patients carried out an electrocardiogram, X-ray inspection, EchoCG, laboratory researches. Results of an electrocardiogram have taped at patients a left ventricle hypertrophy (LV) and disturbance of intraventricular conductivity. At X-ray researches the augmentation of a cardiothoracic index, change of a small circle of a circulation in the form of intensifying and stagnation are taped. Expansion of ascending root of an aorta is noted in all cases. According to EchoCG morphological changes AV at 40,7% of patients were accompanied by valvular and extravalvular a calcification. The calcification 1 type is taped in 5,7% of cases, 2 type – 11,4%, 3 type – 10,7%, 4 type – 12,9% that was the complicating factor of operation. In hemodynamic group AI 208 mechanical prostheses, from which 79 one-cuspidate 129 two-cuspidate, and 21 biological prostheses have been implanted. All comparative estimations were spent among groups of patients authentically not differing on the area of an effective aperture of prosthesis. In all observations isolated prosthetics AV through standard access – a median longitudinal sternotomy has been executed. All operations made in the conditions of an artificial circulation and pharmacold cardioplegias. Average time of an artificial circulation has made 116,5±3,6 minute, aorta occlusions 86,1±2,5 minute. Prostheses «МЕДИНЖ», «SorinBicarbon», «МИКС», «Карбоникс», «КЕМ-АВ-КОМПОЗИТ», «Carpentier-Edwards» have been most often implanted.

Calculations were spent by methods of mathematical statistics under standard programs from a

package of applied programs «STATISTICA for Windows, version 6.0 StatSoft, Inc. 2001» and to original programs developed in a package «Excel-2000» on the built in programming language «Visual Basic for Application». Differences between compared value were considered authentic at $p<0,05$, that corresponds to the criteria accepted in medical-biological researches.

Results

The comparative analysis of the main morph-functional (volume and straight-line characteristics) and hemodynamic indicators of heart at the operated patients in comparison with preoperative data is made for an estimation of dynamics of functional changes LV. The analysis has taped the reduction of cavity LV already in the nearest terms after operation, that is not dependent on types of prostheses (mechanical and biological) and leads to positive changes architronics of the heart at patients with AI becomes perceptible. There was a reduction of linear and volume indicators LV to authentic reduction as end-systolic volume (ESV), and end-diastolic volume (EDV). Thus diastolic indicators LV had considerable dynamics of improvement in relation to initial data. In group with mechanical prostheses authentic depression LVEF has been taped, in comparison with patients to whom biological prostheses (tab. 1) have been implanted.

Table 1.

Dynamics EchoCG of indicators LV at patients with AI at prosthetics by mechanical and biological prostheses

parameters	mechanical (A)				bioprosthesis (B)			
	pre	after	shift %	p	pre	after	shift %	P
EDD, cm	6,5±0,2	5,4±0,1	-17,2	0,0001	7,1±0,8	5,8±0,6	-17,2	0,0025
ESD, cm	4,3±0,2	3,7±0,2	-13,5	0,0001	5±0,8	4,2±0,6	-15,3	0,0085
iEDD, cm/m^2	3,6±0,1	3±0,1	-17,3	0,0001	3,9±0,3	3,3±0,2	-17,2	0,0025
iESD, cm/m^2	2,4±0,1	2,1±0,1	-13,4	0,0001	2,8±0,3	2,4±0,3	-14,8	0,006
EDV, ml	220,8±14,7	143,9±8,6	-34,9	0,0001	267,3±62,7	173,3±41,2	-35,2	0,0018
ESV, ml	89,9±8,8	64,4±6,4	-28,4	0,0001	125,5±42,5	83,5±25,3	-33,5	0,0127
iEDV, ml/m^2	123±8,3	79,9±4,8	-35,1	0,0001	146,7±26,6	95±17,5	-35,3	0,0016
iESV, ml/m^2	50±5	35,9±3,8	-28,1	0,0001	67,9±19,1	45,7±12,1	-32,8	0,0087
SV, ml	131,1±7,8	79,5±4,6	-39,4	0,0001	140,6±31,4	88,5±19,8	-37,1	0,0215
SI, ml/m^2	73,1±4,5	44±2,5	-39,7	0,0001	78±15,6	48,7±8,5	-37,7	0,0166
LVEF	60,5±1,6	56,7±2,2	-6,3	0,0005	54,8±7,3	51,8±5,1	-5,5	0,4917
LVFS	33,4±1,2	30,5±1,6	-8,7	0,0005	29,5±4,4	27,8±3,7	-5,9	0,4871
RF	39,6±1,8	43,6±2,4	10,1	0,0004	45,4±6,9	47±5,6	3,7	0,6587
LVMM, gr	431,9±49,5	318,6±46,2	-26,2	0,0002	534,3±249	381±317	-28,7	1,0
i LVMM, gr/m^2	221,9±22,5	165,7±27,7	-25,3	0,0004	284,3±106	195±126	-31,4	1,0
dPLVWT, cm	1,2±0,1	1,2±0,1	-2,6	0,5	1,2±0,6	1,1±0,2	-7,8	1,0
i dPLVWT, cm/m^2	0,6±0	0,6±0,1	-1,8	0,6	0,6±0,3	0,6±0,1	-8,3	1,0
dIVST, cm	1,2±0,1	1,2±0,1	0,3	0,9	1,5±0	1,1±0	-26,7	1,0
i dIVST , cm/m^2	0,6±0,1	0,6±0,1	2,4	0,7	0,8±0	0,6±0	-26,6	1,0
AVppg, mmHg	30,7±5,3	27,5±2,1	-13,0	0,26	22,02±10,5	19,8±3,3	-11,6	0,58

Stroke work LV in group with mechanical prostheses (A) with 125,6±12,6 U has decreased to 88,7±8,1 U (Shift%-29,4; p <0,00001), SI has decreased with 5,7±0,9 to 3,5±0,5 l/mines/m2 (shift%-37,8; p <0,0001).

In group with biological prostheses (B) stroke work LV with 92,6±67,3 U has decreased to 66,8±4,2 U (Shift%-27,9; p <1,0), SI has decreased with 5,8±2,9 to 3,6±1,1 l/mines/m2 (shift%-38,3; p <1,0). Return pathological dump is not noted on any types of prostheses. The taking place relative regurgitation on the mitral valve (MV) has decreased in group with mechanical prostheses with 1,1±0,2 to 0,7±0,2 item (shift%-27,9, p<0,008) whereas in group with biological prostheses it practically remained without changes – with 0,8±0,5 to 1,0±0,0 item (shift% 33,3, p <0,36). The peak systolic gradient of pressure on AV (AVppg) at implantation of mechanical prostheses with 30,7±5,3 has decreased to 27,5±2,1 mmHg (Shift%-13,0, p <0,26), as well as at bioprosthetics with 22,02±10,5 has decreased to 19,8±3,3 mmHg (Shift%-11,6, p <0,58). Thus transprosthetic AVppg on biological prostheses has appeared authentically lower, than on mechanical (p<0,05). The analysis of dynamics of retrogress of myocardium mass LV (LVMM) and the sizes of back wall LV (dPLVWT) and an interventricular septum (dIVST), has shown, that retrogress of the given indicators in the postoperative period becomes perceptible authentically at prosthetics by mechanical prostheses. Diameter of a fibrous ring (FR) aortas irrespective of type of the implanted prosthesis in dynamics decreased and has made 2,6±0,4 sm (shift%-4,7, p<1,0) whereas ascending department of aorta tended to augmentation to 3,6±0,3 (shift%-2,3, p<0,63). Also reduction of the sizes of the left auricle (LA) with 5,0±0,3 to 4,6±0,2 has been noted sm (shift%-2,2, p<0,68).

Considering positive influence of mechanical prostheses on anatomic-functional indicators of heart, influence on dynamics of indicators LV two-cuspidate (subgroup C) and one-cuspidate (subgroup D) mechanical prostheses (tab. 2) has been investigated.

So the analysis linear and volume absolute and indexed indicators has shown, that already in the nearest postoperative period authentic reduction both ESV and EDV LV becomes perceptible at both types of prostheses. Thus diastolic indicators LV had larger percent of shift. However, authentic depression of ejection fraction (EF) and shortening fractions (FS) LV has been taped in a subgroup of patients with the implanted one-cuspidate valves. Reduction of LV loading in subgroup C occurs already in the nearest terms after operation. So stroke work LV with initially 145,1±36,3 U has decreased authentically to 105±20,3 U (Shift% =-27,65; p <0,0144). The heart index has authentically decreased with 5,6±1,1 to 3,4±0,6 l/mines/m2 (shift% =-38,21; p <0,0007). In subgroup D stroke work LV with initially 119,6±11,8 U has decreased authentically to 83,8±8,0 U (Shift% =-30,0; p <0,0001). The heart index has decreased with 5,9±1,9 to 3,7±1,0 l/mines/m2 (shift% =-37,0; p <0,07). Return dump is not noted on any types of prostheses. The regurgitation taking place in both subgroups on the mitral valve (MV) has decreased with 1±0,2 to 0,8±0,2 item (shift%-21,43, p <0,051), as well as an available regurgitation on tricuspid valve (TV) with 1,1±0,3 to 0,9±0,2 item (shift%-16,67, p <0,12). It is noted that initial peak AVppg in subgroup C with 28,7±7,6 has decreased to 20, ±8,8 mmHg (p <0,95), as well as in subgroup D with 36,5±8,1 has decreased to 30,2±3,5 mmHg (p <0,19). The analysis of dynamics of retrogress of LVMM and the sizes dPLVWT and dIVST, has shown, that retrogress of the given indicators becomes perceptible by 10 days after operation. Thus better retrogress of LVMM and the sizes dPLVWT and dIVST is noted in a subgroup of patients to which have been implanted 2-cuspidate mechanical prostheses of valves of heart. That testifies the best hemodynamic characteristics 2-cuspidate prostheses. The analysis of dynamics FR of an aorta has taped, that irrespective of type of the implanted mechanical prosthesis after operation there is a reduction of a fibrous ring of an aorta: for C (with 3,1±0,7 to 2,8±0,5 sm, shift%-9,2, p<0,13) and for D (with 2,6±0,3 to 2,5±0,2 sm, shift%-2,6, p <1,0) whereas the ascending root of an aorta reacts on a miscellaneous. So if in subgroup C it tends to augmentation (with 3,2±0,3 to 3,4±0,5 sm, shift% 5,2, p<0,53), in subgroup D on the contrary the tendency to reduction (with 3,5±0,6 to 3,1±0,5 sm, shift%-9,2, p<0,13). That is probably more bound to diameter of prosthesis and its design. The prosthesis of adequate diameter allows expecting improvement of anatomic-functional indicators LV and retrogressing of a hypertrophy of a myocardium. At use 2-cuspidate prostheses the augmentation of an ascending aorta occurs at the expense of a good stream whereas, the one-cuspidate prosthesis having a larger

Table 2.
Dynamics EchoCG of indicators LV at patients with AI at prosthetics 2-cuspidate and one-cuspidate prostheses

parameters	2-cuspidate (C)				One-cuspidate (D)			
	pre	after	shift %	P	pre	after	shift %	P
EDD, cm	6,6±0,3	5,5±0,2	-15,6	0,0000	6,4±0,2	5,2±0,2	-18,3	0,0000
ESD, cm	4,4±0,3	3,8±0,2	-13,9	0,0000	4,3±0,2	3,7±0,2	-13,2	0,0000
iEDD, cm/m^2	3,4±0,2	2,8±0,1	-15,4	0,0000	3,8±0,2	3,1±0,1	-18,4	0,0000
iESD, cm/m^2	2,3±0,2	2±0,1	-13,7	0,0000	2,5±0,1	2,2±0,1	-13,2	0,0000
EDV, ml	228,3±24,9	154±11,7	-32,6	0,0000	215,8±18	137±11,8	-36,5	0,0000
ESV, ml	92,7±13,3	67±9,2	-27,7	0,0000	88,1±11,7	62,7±8,8	-28,8	0,0000
iEDV, ml/m^2	116,6±13,6	78,8±6,4	-32,4	0,0000	51,6±6,6	36,9±5,2	-28,6	0,0000
iESV, ml/m^2	47,5±7,7	34,5±5,4	-27,3	0,0001	127,2±10,4	80,6±6,8	-36,7	0,0000
SV, ml	136±13,9	86,9±6,9	-36,1	0,0000	127,7±9,2	74,4±5,7	-41,7	0,0000
SI, ml/m^2	69,2±7	44,2±3,3	-36,1	0,0000	75,6±5,8	43,9±3,5	-41,9	0,0000
LVEF	59,8±2,3	58,6±3,1	-2,1	0,4565	61±2,3	55,4±2,9	-9,2	0,0001
LVFS	32,8±1,8	31,6±2,3	-3,6	0,3905	33,7±1,7	29,7±2,1	-12,0	0,0001
iLVFS	16,9±1	16,2±1,2	-3,9	0,3790	20,2±1,5	17,7±1,5	-12,4	0,0002
RF	39,9±2,2	42,7±3,4	7,0	0,0980	39,4±2,5	44,2±3,2	12,2	0,0015
LVMM, gr	443,1±93	321,3±63,8	-27,48	0,01	423,5±59	316,6±68,3	-25,3	0,01
i LVMM, gr/m^2	213,2±39,5	156,6±34,8	-26,58	0,009	228,3±28,1	172,6±42,2	-24,4	0,02
dPLVWT, cm	1,2±0,2	1,2±0,1	-6,17	0,42	1±0,1	1±0,1	0,0	1,00
i dPLVWT, cm/m^2	0,6±0,1	0,6±0,1	-5,31	0,49	0,6±0,1	0,6±0,1	0,6	0,91
dIVST, cm	1,1±0,2	1,1±0,2	-1,53	0,67	1,3±0,3	1,3±0,2	2,2	0,87
i dIVST, cm/m^2	0,6±0,1	0,6±0,1	-0,89	0,79	0,7±0,1	0,7±0,2	5,6	0,73
AVppg, mmHg	28,7±7,6	20,±8,8	-10,1	0,95	36,5±8,1	30,2±3,5	-8,0	0,19

systolic gradient interferes with an aorta stretching. Basically we have not found description of the given changes in the literature that probably will be useful to consider at a prosthesis choice at replacement AV at patients predisposed to pathology of ascending root of an aorta.

At patients with depression of ejection fraction LV in the postoperative period intravenous injection of 10% of 10 ml (1000 mg/24hours) «RIPRONAT» (3 (2,2,2-trimetylhydrazinum) propionate dehydrate) (ROTAPHARM) by a course №10 has been used. Thus improvement of a clinical condition of patients and gain of ejection fraction LV ($p < 0,05$) have been noted.

Discussion

At the given stage of development cardiosurgery modern criteria characterizing effectiveness of heart artificial prostheses are: mechanical reliability and the durability, adequate hemodynamic parameters (a residual transprosthetic gradient, a return current of blood), tromboresistancy, sterility, absence of a mechanical hemolysis and noise discomfort. Biological prostheses could answer to the given criteria [2]. The carried out research has shown, that in group of patients with aortal insufficiency on hemodynamic indicators biological and mechanical prostheses have shown

good hemodynamic characteristics, and in changes of ejection fraction and shorting LV biological prostheses even surpassed mechanical prostheses. However, limiting factor of application of biological prostheses according to a number of authors [4-6, 11], is the problem of an early degeneration caused by a calcareous infiltration of a bio tissue which amplifies at work of a biological prosthesis in the conditions of high differences of pressure in an aortal position. That causes their fragility and does not allow using them widely in daily cardiosurgical practice, especially at patients of young age. Therefore we also are inclined to opinion, that their application should be basically at patients of the senior age group (more than 60 years) and patients with the complicated current aortal defect (low LVEF, an active infectious endocarditis) at which prognosticated term of a life after operation is expected less term of durability of a prosthesis. Therefore it is more preferable to implant mechanical prostheses. Considering the mechanism and hydrodynamics of ejection LV it is considered, an optimum choice for implantation – a disk (one-cuspidate) prosthesis [3, 7], a systolic stream on which, according to researches Motti-Link S. et al. [7], Nygaard H. et al. [8] corresponds as normal, considering conditions of a coronary blood flow and the mechanism of rotating ejection LV. The maximum amplitude of a disk and optimum gradient on prosthesis favorably affect processes of remodeling LV in the remote period. However in group of patients with aortal insufficiency the best hemodynamic characteristics have shown two-cuspidate prostheses. At all positive influences on anatomic-functional indicators LV of both types of mechanical prostheses, at use of two-cuspidate prostheses there is no authentic depression LVEF and lower transprosthetic gradient, in comparison with disk (one-cuspidate) prostheses becomes perceptible. Thus, prosthetics of the aortal valve by various types of prostheses is one of the basic methods of surgical treatment of aortal defects. At aortal insufficiency or combined aortal defect with prevalence of insufficiency use both mechanical and biological prostheses gives good dynamics of indicators LV. Thus the best dynamics is noted at prosthetics 2-cuspidate mechanical prostheses. At implantation of mechanical prostheses, at patients with aortal insufficiency higher transprosthetic gradient at implantation of one-cuspidate prostheses is taped and authentic depression LVEF after operation, that justifies use and application cardiometabolics. Whereas at implantation of biological prostheses we have not taped authentic depression LVEF and the transprosthetic gradient was authentic lower.

Conclusions

1. At a choice of type of a mechanical prosthesis for correction aortal valve defect the application of modern two-cuspidate mechanical prostheses is more preferable.

2. At prosthetics by one-cuspidate mechanical prostheses authentic depression LVEF (with 61,0±2,3 to 55,4±2,9%, $p<0,05$) and higher transprosthetic gradient (30,5±3,2 mmHg) is taped. In group with implantation of biological prostheses LVEF remains at former level ($p<0,013$).

3. Application of biological prostheses is justified at patients with complicated current of aortal defect (low LVEF, active infectious endocarditis).

THE LITERATURE

1. Использование легочного аутографта при инфекционном эндокардите аортального клапана / Л.А. Бокерия, Р.М. Муратов, Х.Ф. Аль-Хаджабед [и др.] // Анналы хирургии. – 2005. – № 5. – С.10-13.
2. Протезирование аортального клапана ксенопротезом «БиоЛАБ»: промежуточные результаты / Л.А. Бокерия, Р.М. Муратов, С.И. Бабенко [и др.] // Грудная и серд.-сосуд. хир. – 2008. – № 1. – С. 23-28.
3. Дземешкевич С.Л. Болезни аортального клапана. Функция, диагностика, лечение / С.Л. Дземешкевич, Л.У. Стивенсон, В.В. Алексии-Месхишвили. – М.: Гэотар-Мед, 2004. – 328 с.
4. Малиновский И.И. Биологические протезы клапанов сердца / И.И. Малиновский, Б.А. Константинов, С.Л. Дземешкевич. — М.: Медицина, 1988. – 256 с.
5. Edwards M.B. A profile of valve replacement surgery in the UK (1986-1997): a study from the UK heart valve registry / M.B. Edwards, K.M. Taylor // J. Heart Valve Dis. – 1999. – Vol. 8, № 6. – P. 697.
6. Long-term function of cryopreserved aortic homografts. A ten-year study / J.K. Kirklin, D. Smith, W. Nowick [et al.] // J. Thorac. Cardiovasc. Surg. – 1993. – Vol. 106. – P. 154.
7. Non-invasive assessment of differences between bileatlet and tilting disk aortic valve prosthesis by 3D-Doppler profils. / S. Motti-Link, I. Hastcntenfel [et al.] // Interact. Cardiovasc. Thorac. Surg. – 2005. – Vol. 4. – P. 383-387.
8. Quantitation of the turbulent stress distribution downstream of normal, diseased and artifirial aortic valves in humans / H. Nygaard, P.K. Pulsen, J.M. Hasenkan [et al.] // Eur. Cardiothorac. Surg. – 1992. - Vol. 6, № 11. – P. 609-617.
9. Ross operation – modification of technique. Postoperative hemodynamic advantages / V. Sudikien [et al.] // Appl. Cardiopulm. Pathophysiol. – 2002. – Vol. 10. – P. 17.
10. Teijeira F.J. Cardiac valve replacement with mechanical prostheses: current status and trends / F.J. Teijeira, A.A. Mikhail //Advanced in Cardiovascular Engineering / Ed. H.C. Hwang. – N.Y.: Plenum Press, 1992. – 197 p.
11. Westaby S. Stentless aortic bioprostheses: compelling data from the second international symposium / S. Westaby, H.A. Huysmaus, I.E. David // Ann. Thorac. Surg. – 1998. – Vol. 65. – P. 235.

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