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Revealing of Initial Factors Defining Results of Operation in Patients with Aortic Valve Replacement and Coronary Artery Disease

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1. Introduction

Moderate aortic valve stenosis is a common condition in patients with coronary heart disease (Gullinov and Garsia, 2005). Recent studies have shown that progression of aortic valve stenosis depends on the degree of valvular leaflets calcification; that aortic valve replacement does not increase mortality after coronary artery bypass grafting (CABG); moreover, valve replacement performed after CABG leads to decreased mortality, it was especially confirmed in patients with severe aortic valve stenosis. However, review of the literature concerning integration of the mathematical approaches in medicine has demonstrated that, the simple prognosis is more significant than an evaluation based on organ and system modeling for choice of treatment method and options for patients with such combined pathology. Repeated intervention is one of the most significant prognostic factors. Thus, after analyzing of 13,346 CABG cases Yap et al (2007) have shown that mortality of repeated interventions is approximately 3 times higher than that of primary interventions (4.8% and 1.8%, respectively). Patient's age is another such a factor. Urso et al. (2007) have established that one-year survival after aortic valve replacement in patients aged over 80 years (86,1%) is significantly less than that in the younger group. Analyzing of 1567 patients after valve replacement combined with CABG, Doenst et al.(2006) have demonstrated patients' gender influence on surgery outcomes, postoperatively women had higher stroke possibility (risk index was 1.52). We believe that various influences of parameters characterizing patient's baseline status on surgery outcome require more complex multivariate statistical analysis to be used. It allows defining rational number of the most significant factors determining the surgery prognosis related both to baseline status of patients with heart defects and immediate postoperative complications caused by interventional injury and heart hemodynamic changes (1, 2, 3, 4, 5, 6). Moreover, one of the authors of the article (Wann and Balkhy, 2009) considers that application of the most modern diagnostics tests (i.e. computed tomography coronary angiography) allows predicting an outcome of the scheduled surgery more accurately.

The objective of this study was to investigate factors affecting the outcomes of combined interventions performed in patients with aortic valve defects and coronary artery lesions and to evaluate anatomical and hemodynamic parameters influencing the prognosis.

2. Material and methods of the study

One hundred twenty eight (128) patients who underwent one-step aortic valve replacement and CABG were enrolled in the study (104 men and 24 women aged from 40 to 73, mean age was 56.4±1.5 years). Aortic valve stenosis was predominant in 82.8% (106) cases; aortic insufficiency was predominant in 17.2% (22) cases. Aortic valve lesions were caused by rheumatic process (65.6%), atherosclerotic degeneration and calcification (15.6%), and infective endocarditis (18.8%). All patients underwent examination including chest X-ray, ECG, EchoCG. Increase in cardiothoracic index and change in pulmonary circulation were observed on X-ray scans. Enlargement of ascending aorta was revealed in all patients. Left ventricle hypertrophy and intraventricular conduction disturbance were observed on ECG. Aortic valve defect was complicated by valvular and extravalvular calcification in 87.1% patients: 3.2% - Grade I, 22.6% -Grade II, 32.3% - Grade III, 29% - Grade IV, absolutely, it was a complicating factor for surgery. Table 1 presents the distribution of patients by chronic heart failure (CHF) and New York Heart Association Functional Class (NYHA FC).

NYHA Functional Class	Number of patients	HF	Number of patients
II	21 (16.1%)	IIA	88 (68.7%)
III	78 (61.3%)	IIB	40 (31.3%)
IV	29 (22.6%)		

Table 1. Distribution by chronic heath failure stage and functional class

All patients were operated using cardiopulmonary bypass and cardioplegia. Mean time of cardiopulmonary bypass was 178.5±7.8 min, time of aortic occlusion was 132.8±5.0 min. One hundred eight (108) mechanical (75 bicuspid, 33 unicuspid) and 20 biological prostheses were implanted. The most common aortic valve prostheses were MEDINZH, SorinBicarbon, EMIKS, KEM-AV-MONO, KEM-AV -COMPOZIT.

All patients who had significant coronary artery lesions (stenosis >50%) underwent coronary artery bypass grafting: one artery – in 56 (43.8%) patients, two arteries – in 42 (32.8%) patients, three arteries – in 30 (23.4%) patients. Concomitant mitral and tricuspid insufficiency was corrected in 25 and 23 patients, respectively. Atrioventricular valve insufficiency was in all cases caused by fibrous annulus dilatation, which was treated with support ring implantation. Patient status at baseline was a landmark to determine all totality of defect pathogenetic disorders, and evaluation of the factors affecting the separate components of complete clinical picture creation permitted to consider specially the causes, conditions and consequences of systemic positions. Calculations were performed using «STATISTICA for Windows», v.6.0 and original programs developed in "Excel - 2000" on "Visual Basic for Application" integrated computer language. Group data were divided into numeral and classification ones; additional tables for deviations (abs. and %) of variables from baseline levels were calculated. Difference significance was evaluated by χ^2 criterion and 2x2 tables by adjusted Fisher test.

Distribution parameters were evaluated by formulas as follows:

$$M = \frac{1}{N} \sum_{i=1}^n X_i; \quad S = \sqrt{\frac{1}{N-1} \sum_{i=1}^n (X_i - M)^2}; \quad m = M \frac{S}{\sqrt{N}}$$

Consistency of numerical data with normal distribution law was assessed with Kolmogorov test. If the numerical data did not correspond to normal distribution law, non-parametric statistical methods were used - Wilcoxon rank test. Power and direction of correlation between the signs were determined by Pearson correlation coefficient (**r**) and Spearman rank correlation, if distribution of the baseline data was not normal. The values of these tests range from -1 to +1. The extreme values are observed in signs associated with linear functional relation. The significance of selected correlation coefficient is assessed by statistics value $r \cdot \sqrt{n-2} / \sqrt{1-r^2} = t_{a,f}$ (1). Expression (1) permits to determine a, i.e. possibility of correlation coefficient difference from zero depending on r and sample size n. This, in turn, allows comparing the correlation of the same signs in the different sample sizes by possibility. Correlation power was assessed by a value of the correlation coefficient: strong, if $r \geq 0.7$, moderate, if $r = 0.3-0.7$, weak, if $r < 0.3$. The differences between compared values were significant if $p < 0.5$, it is consistent with criteria accepted in medical and biological researches. Prognosis model is based on the regression analysis.

Regression analysis was directed to the test of significance of one (dependent) variable Y from set of other ones, so called independent variables $X_j = \{X_1, X_2, \dots, X_p\}$. The values of the prognostic parameter are defined as a result of determination of the risk factors based on analysis of the clinical materials. The purpose of linear regression analysis in this study was to predict the values of the resulted variable Y using the known values of physical parameters, EchoCG parameters and various additional features related to surgery specificity. Parameter of favorable surgery outcome was calculated as an arithmetic mean of risk factors. As a result of these calculations, the model was developed. Based on this model the program was created in "Excel-2000": «Program for outcome prognosis of aortic valve replacement combined with coronary heart disease» (CERTIFICATE SPD RUz № DGU 01380») allowing to calculate a percentage of favorable surgery outcome and dynamics of LV ejection fraction after a surgery with prognostic significance 75-90%.

3. Results and discussion

As a result of the performed analysis the variables pooled in factor groups (**F**) affecting the surgery prognosis were determined: **F1** - blood supply disturbance (HF, NYHA FC), **F2** - physical parameters (gender, age*, weight*, height*, body surface area*, Kettle index*, CTT*), **F3** - hemodynamic parameters (SBP*, DBP*, MBP*, BSV, HR*, BMV*, TPR*, SPR, HI*, LV stroke work*), **F4** - heart parameters (EDD*, ESD*, EDV*, ESV*, SV*, EF*, FS*, RF*, SVE*, RV*, LA*, RA*, PA*), **F5** - myocardial parameters (IVS*, LVPW*, LVMM*, sPLVWT and dPLVWT*, 2HD*), **F6** - valve morphology (calcification degree on AV, regurgitation degree on AV, MV, and TV), **F7** - valve parameters (FA and ascending aorta diameter*, AV gradients*, AO* surface, MO* surface, MV gradients*, Emv, Amv, E/A mv), **F8** - coronary blood supply parameters (blood supply type, percentage of coronary artery occlusion (LAD, DB, CA, RCA), number of planned bypass grafting). Indexed parameters, reverse values and second degree were considered in «*» variables, it has been leading to increase in prognosis efficacy (see Table 2).

No	Variable	Unit	defenition	Variable nomenclature
I Blood supply disturbance (F 1)				
1	HF		I, IIA, IIB, III	Heart failure
2	FC		I , II, III, IV	Functional class
II Physical parameters (F 2)				
1	Gender		1 - man, 2 - woman	Patient gender
2	Age*	years		Age
3	Weighr*	kg		Weight
4	Height*	cm		Height
5	BSA*	m²	$BSA= 0.007184 * Weight^{0.423} * Height^{0.725}$	Body surface area
6	Kettle index*	U	$Kettle\ index = 10000* Weight / Height^2$	Kettle index (body weight index)
7	CTI*	%		Cardiothoracic index
III Central hemodynamic parameters (F 3)				
1	SBP*	mmHg		Systolic blood pressure
2	DBP*	mmHg		Diastolic blood pressure
3	MBP*	mmHg	$MBP = DBP+[(SBP - DBP)/3]$	Mean blood pressure
4	PBP*	mmHg	SBP-DBP	Pulse blood pressure
5	BSV		$BSV = 90,97 + 0,54 * PBP - 0,57 * DBP - 0,61*Age$	Blood stroke volume by Starr (39)
6	HR*	beat per minute		Heart rate
7	CO*	l/min	$CO= SV * HR / 1000$	Cardiac output (blood supply)
8	TPR*	dyne*cm- ₅	$TPR = 79,92*MBP/CO$	Total peripheral resistance (59)
9	RPR		$RPR = TPR / BSA$	Relative peripheral resistance (110)
10	HI*	U	$HI =CO / BSA$	Heart index (109)
11	Asw*	U	$Asw(LV) = SV*1,055*(MBP-5)*0,0136$	LV stroke work (153)
12	LVMW	U	$LVMW = 0,0136 * 1,055 *CO * (MBP-5)$	LV minute work (157)
13	LVWI		$LVWI = 0,0136 * 1,055 * HI * (MBP-5)$	LV work index (160)
14	LVWSI		$LVWSI = 0,0136 * 1,055 * SI * (MBP-5)$	LV work stroke index (161)
15	HFi		$HFi= SBP* HR / LVMM$	Heart functioning index
IV Heart parameters (F4)				
1	EDD*	cm		End-diastolic dimension
2	ESD*	cm		End-systolicdimension
3	EDV*	cm³	$EDV= 7 * EDD^3 / (2.4 + EDD)$	End-diastolic volume
4	ESV*	cm³	$ESV = 7 * ESD^3 / (2.4 + ESD)$	End-systolic volume
5	SV*	cm³	$SV = EDV - ESV$	Stroke volume
6	SI*	u	$SI = SV / BSA$	Stroke index (108)

7	LVEF*	%	$LVEF = 100 \cdot (EDV - ESV) / EDV$	Ejection fraction
8	LVFS*	%	$LVFS = 100 \cdot (EDD - ESD) / EDD$	Fractional shortening
9	RF	%	$RF = ESV / EDV \cdot 100$	Residual fraction (55)
10	SVE*	%	$SVE = EDV / ESV \cdot 100$	Systolic ventricular ejection (56)
11	TC*		$TC = (EDV - ESV) / (EDD - ESD) \cdot 1 / ESV$	Ventricular wall tensility coefficient (57)
12	RV*	cm		Right ventricle
13	LA*	cm		Left atrium
14	RA*	cm		Right atrium
15	PA*	cm		Pulmonary artery
16	PAP	mmHg		Pulmonary artery pressure
17	PA FAD	mm		PA fibrous annulus diameter
V Myocardial function parameters (F5)				
1	dIVST*	cm		Diastolic interventricular septum thickness
2	dPLVWT*	cm		Diastolic posterior LV wall thickness
3	LVMM*	g	$LVMM = 1,04 \cdot ((EDD + VST + PLVWT)^3 - EDD^3) \cdot 13,6$	LV myocardial mass
4	rsPLVWT*	U.	$rsPLVWT = dPLVWT / EDD$	Relative systolic posterior LV wall thickness
5	rdPLVWT*	U.	$rdPLVWT = dPLVWT / ESD$	Relative diastolic posterior LV wall thickness
6	2HD*	U.	$2HD = (dIVST + dPLVWT) / EDD$	Relative double thickness
VI Valve morphology (F 6)				
1	AVca	score	1,2,3,4	AV calcification, degree
2	AVreg	score	1,2,3,4	AV regurgitation, degree
3	MVreg	score	1,2,3,4	MV regurgitation, degree
4	TVreg	score	1,2,3,4	TV regurgitation, degree
VII Valve function parameters (F 7)				
1	ARD*	cm		Aortic root diameter
2	AAD *	cm		Ascending aorta diameter
3	AVppg*	mmHg		AV peak pressure gradient
4	AVmpg*	mmHg		AV mean pressure gradient
5	AVsfs	m/s		AV systolic flow speed
6	AO s*	cm²		Aortic orifice surface area
7	E mv			MV E peak
8	A mv			MV A peak

9	E/ A mv	U.	E/ A mv = E mv / A mv	E/ A ratio
10	MO s*	cm²		Mitral orifice surface area
11	MV ppg	mmHg		MV peak pressure gradient
12	MV mpg	mmHg		MV mean pressure gradient
VIII Coronary blood supply parameters (F8)				
1	CVG		1-right, 2- balanced, 3- left	Blood supply type by CVG
2	LAD	%		Left anterior descending, lesion %
3	DB	%		Diagonal branch, lesion %
4	CA	%		Circumflex artery, lesion %
5	RCA	%		Right coronary artery, lesion %
6	IA	%		Intermediate artery, lesion %
7	No.of grafts	pcs		Number of grafts

Table 1. Risk factors and variables and their components

We determined that a percentage of complex factor influence on surgery prognosis – peak systolic gradient (PSG) and post-operation ejection fraction dynamics were different (Figure 1).

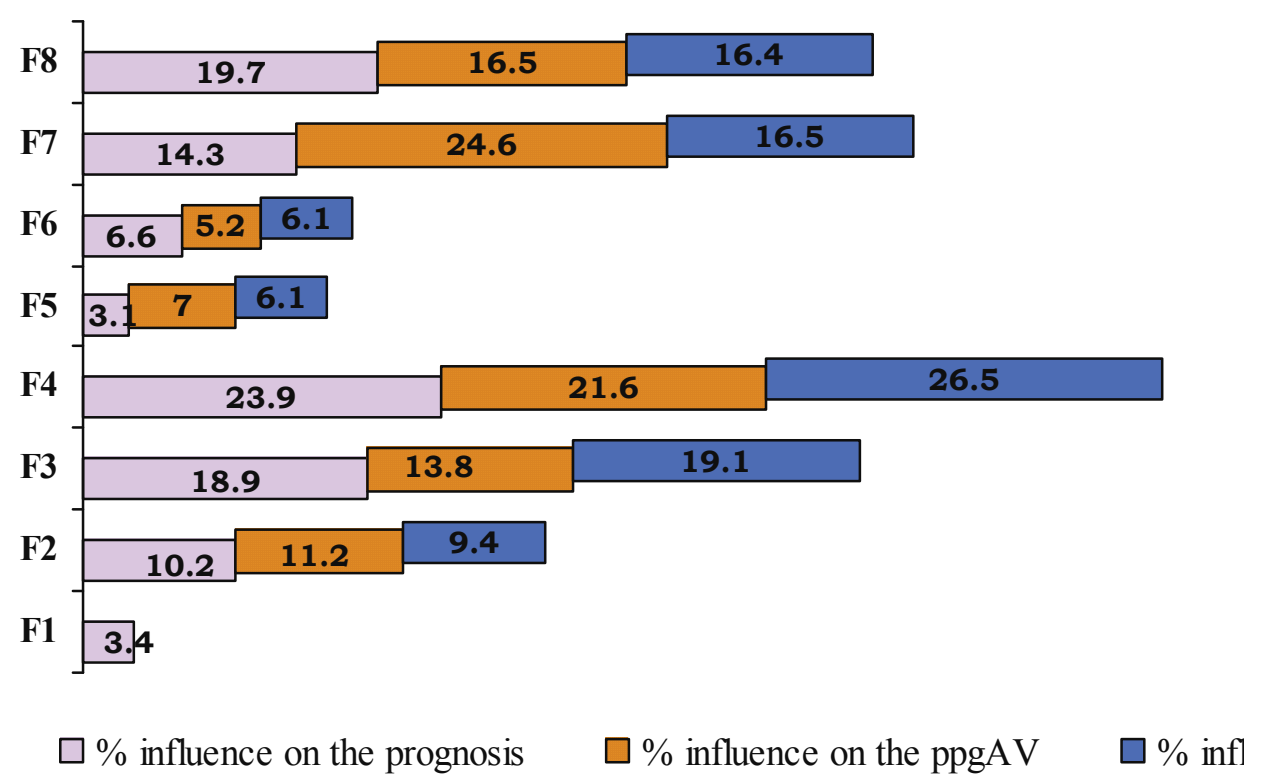


Fig. 1. Percentage of complex factor influence on prognosis, PSG, LVEF in patients suffered from valve defect combined with coronary artery lesions

Thus, heart parameters (F4) ($r=0.320$ $p<0.01$),coronary blood supply parameters (F8) ($r=0.165$ $p<0.05$), F3 ($r=0.330$ $p<0.01$), valve function parameters (F7) ($r=0.183$ $p<0.05$), and physical parameters (F2) ($r=0.223$ $p<0.05$) had greater influence on prognosis. However,

valve functions (F7) ($r=0.320$ $p<0.01$), heart parameters (F4) ($r=0.261$ $p<0.05$), coronary blood supply parameters (F8) ($r=0.046$ $p<0.05$), hemodynamic parameters (F3) ($r=0.284$ $p<0.05$), and myocardial function parameters (F5) ($r=0.589$ $p<0.001$) have played greater role for peak systolic gradient (PSG). The parameters of the following factors affect changes in LV ejection fraction: heart parameters (F4) ($r=0.381$ $p<0.01$), hemodynamic parameters (F3) ($r=0.332$ $p<0.01$), coronary blood supply parameters (F8) ($r=0.322$ $p<0.01$), and valve function parameters (F7) ($r=0.332$ $p<0.01$). The positive surgery prognosis in patients with lower HF ($r=-0.111$) and lower NYHA FC (II, III) ($r=-0.560$) was higher than 80%. However, in operated patients with FC IV the surgery prognosis was less than 80%. It was noted that higher FC corresponded to lower LV EF values ($r=-0.086$). It means that FC IV is a high risk predictor for combined surgeries (Figure2).

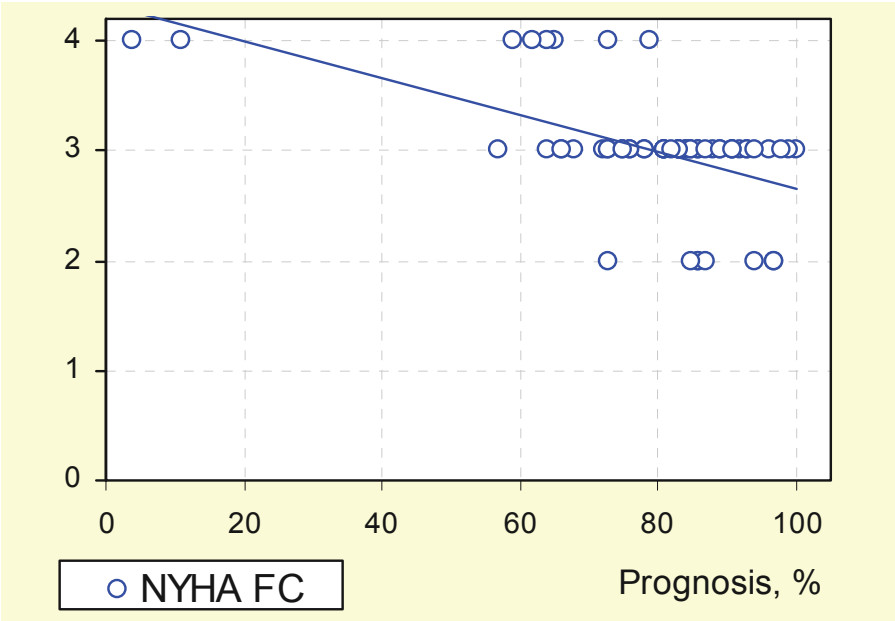


Fig. 2. Correlation between prognosis and functional class

Physical parameters (F2) suggested that PSG on AV had a trend to increase with age ($r=0.264$), i.e. compensated processes are progressing depending on age, although general biological and physiological processes are decreasing. However, age had no significant influence on surgery prognosis ($r=-0.162$). Moderate correlation between prognosis ($r>0.31$) and peak SPG ($r>0.206$) was observed when hemodynamic parameters were analyzed (F3). The correlation was direct for prognosis and reverse for SPG: e.g. in patients with CO more than 4.0 l/min surgery prognosis was higher. This parameter increased not due to HR, but due to minute volume ($r=-0.215$). Such pattern was observed between parameters of LV stroke work (Asw): surgery prognosis was higher if LV Asw was higher ($r=0.468$). But if SPG was increased, decrease in LV Asw was observed ($r=-0.295$). It may be concluded that increase in afterload leads to decrease in LV work efficacy (Figure 3). If peak SPG is more than 60 mmHg, LV Asw becomes less than 100 U, and favorable surgery prognosis does not exceed 80%. If stroke work was more than 100 U, positive surgery prognosis was 80-100%. It means that in patients with coronary artery lesions in combination with aortic defect $SPG \geq 60$ mmHg is one of indications for aortic valve replacement. Heart parameters (F4) had the greatest influence on surgery prognosis. Thus,

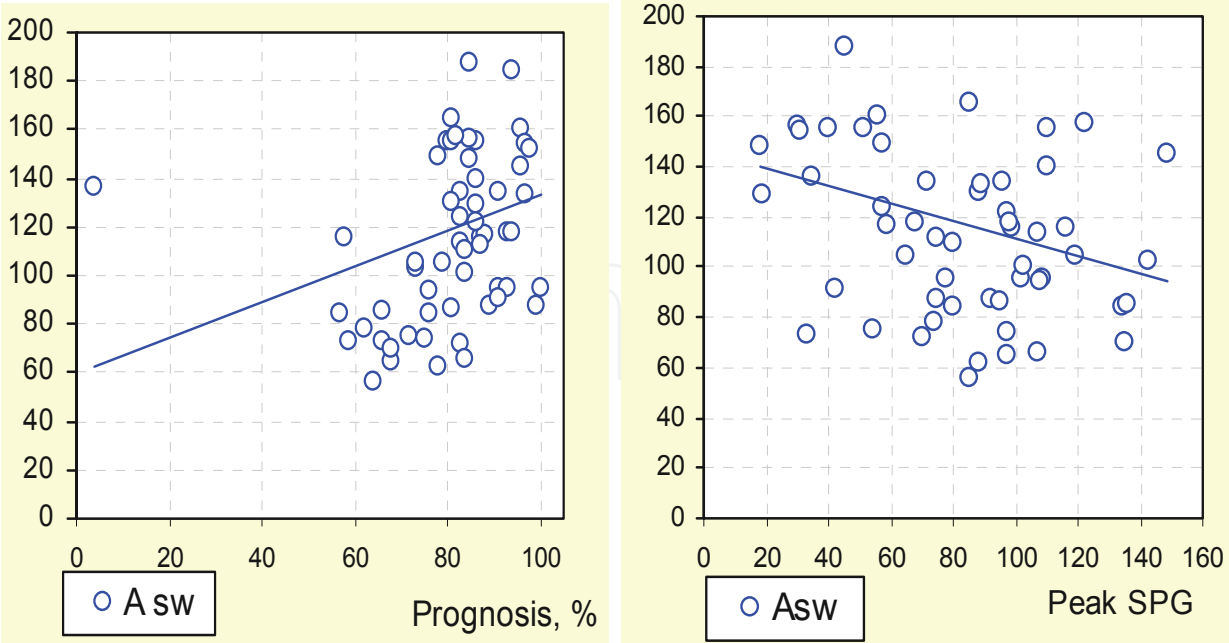


Fig. 3. Correlation between prognosis with SPG and LV stroke work

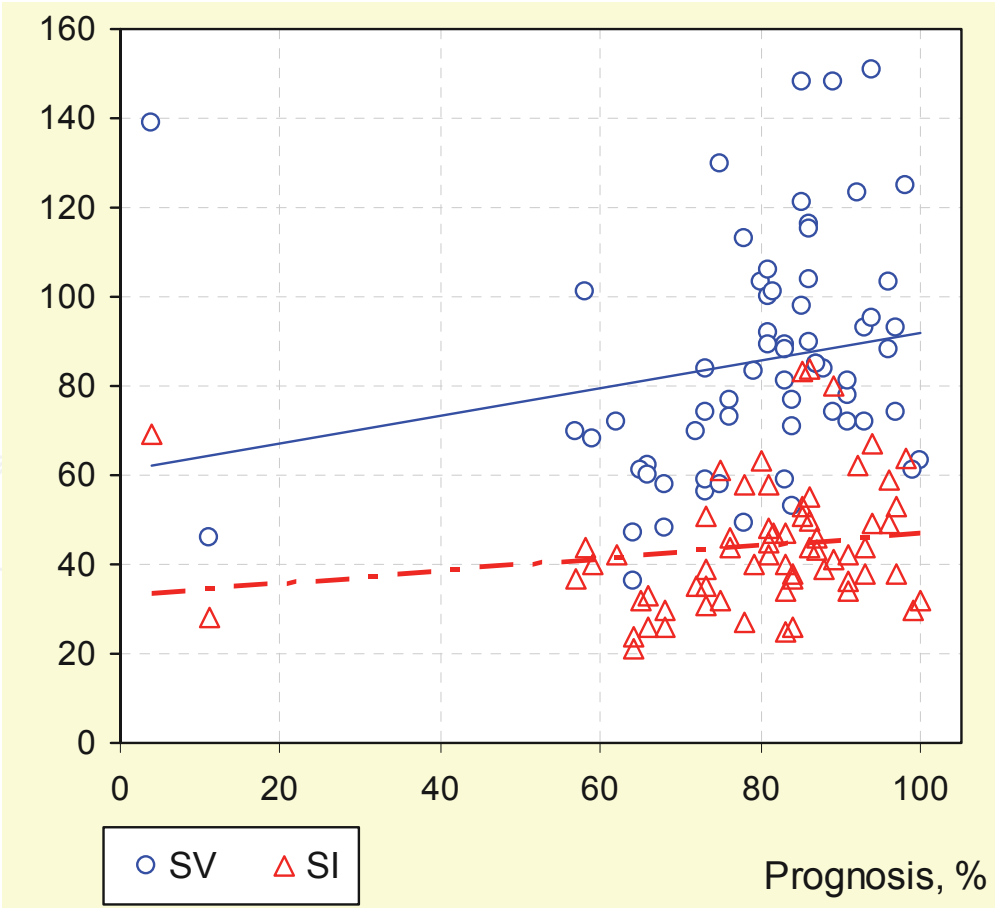


Fig. 4. Correlation between SV and SI with surgery outcome

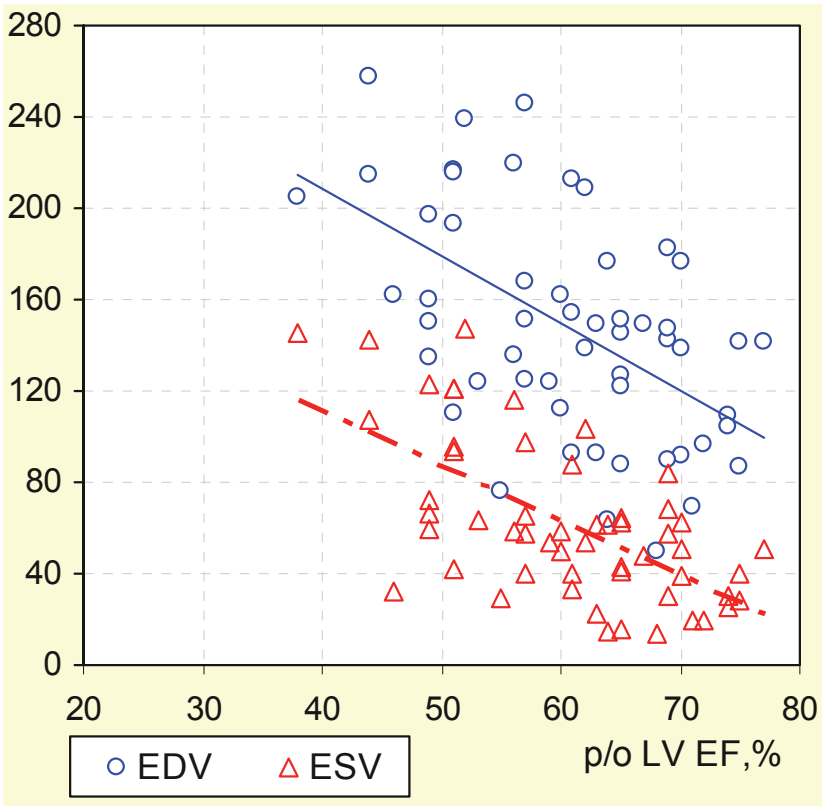


Fig. 5. Influence of EDV and ESV on LV ejection fraction

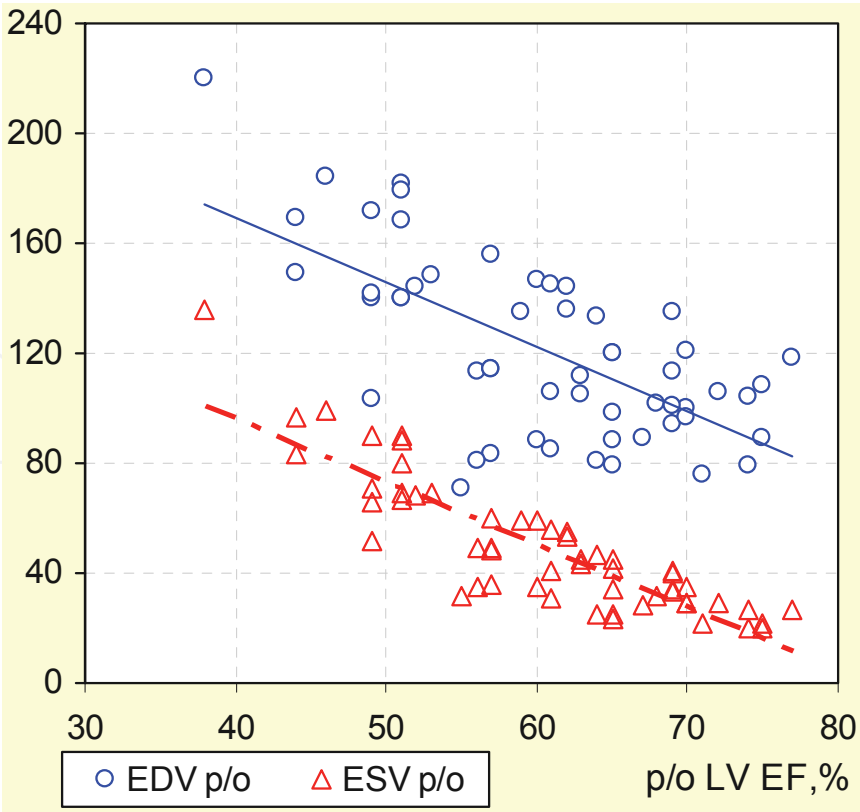


Fig. 6. Influence of p/o EDV and p/o ESV on p/o LV ejection fraction

LV parameters had direct correlation with prognosis ($r>0.224$) and LV EF dynamics ($r>0.598$) and reverse correlation with SPG ($r<-0.343$). LV end-diastolic dimension (EDD) and end-diastolic volume (EDV) had a greater influence on prognosis ($r=0.349$ and $r=0.429$, respectively), than LV end-systolic dimension (ESD) and end-systolic volume (ESV) ($r=0.303$ and $r=0.352$, respectively). Even in cases when increase in LV EDD (EDV) was observed after surgery and LV ESD (ESV) was constant (or decreased), possibility of favorable surgery prognosis was increased. This relationship between EDV and ESV contributes to increase in stroke volume (SV) and suggests preservation of LV myocardial contraction. The analysis showed that increased SV ($r=0.458$) and stroke index (SI) ($r=0.385$) was associated with increased percentage of favorable prognosis. We have found that if SI was $>40\text{ ml/m}^2$ ($\text{SV}=80\text{ ml}$), positive surgery prognosis was more than 80% (Figure 4).

Analysis of influence of baseline EDV and ESV on postoperative LV EF has shown that this value was greater in patients with preserved LV parameters (Figure 5), and in patients with significant reduction of LV EDV and ESV (Figure 6).

The performed analysis revealed that in patients with normal LV myocardial contractility at baseline we had good prognosis and increased LV EF after surgery. It was determined that if LV EF is higher than 50% at baseline, the positive surgery prognosis exceeds 80%. Such pattern of baseline EDV and ESV influence on LV EF dynamics was observed, if LV EF parameters obtained from calculation using the program for prognosis were analyzed. (Figure 7).

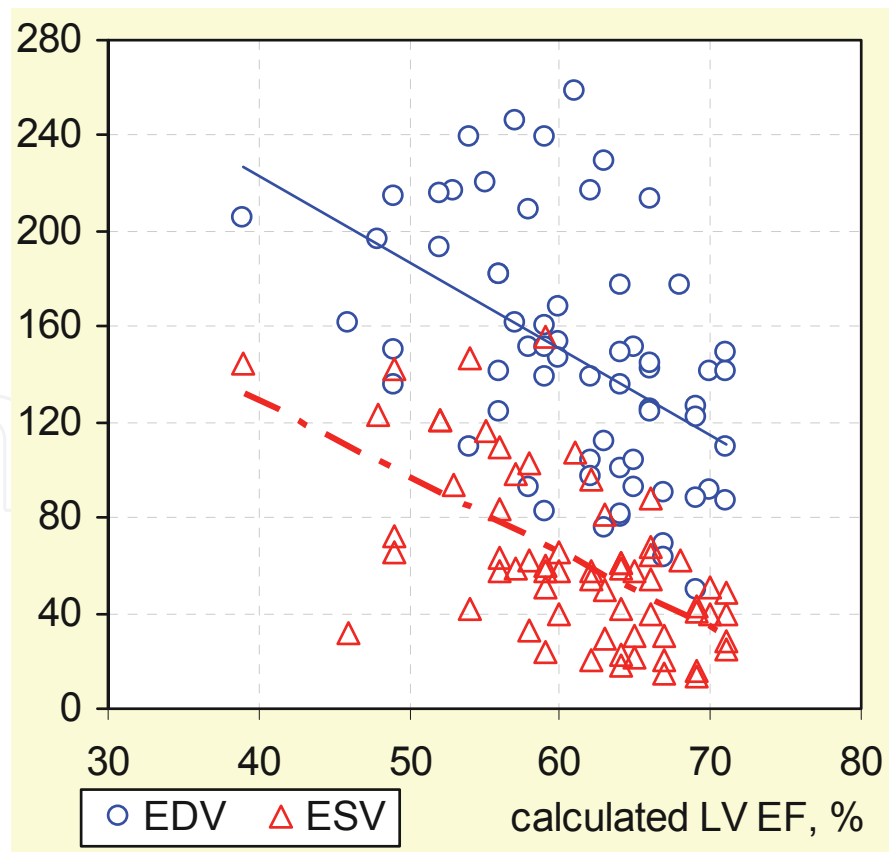


Fig. 7. Influence of baseline EDV and ESV on calculated LV EF

LV EF calculated using the program for prognosis significantly correlated with true numbers of baseline and postoperative LV EF (Figure 8).

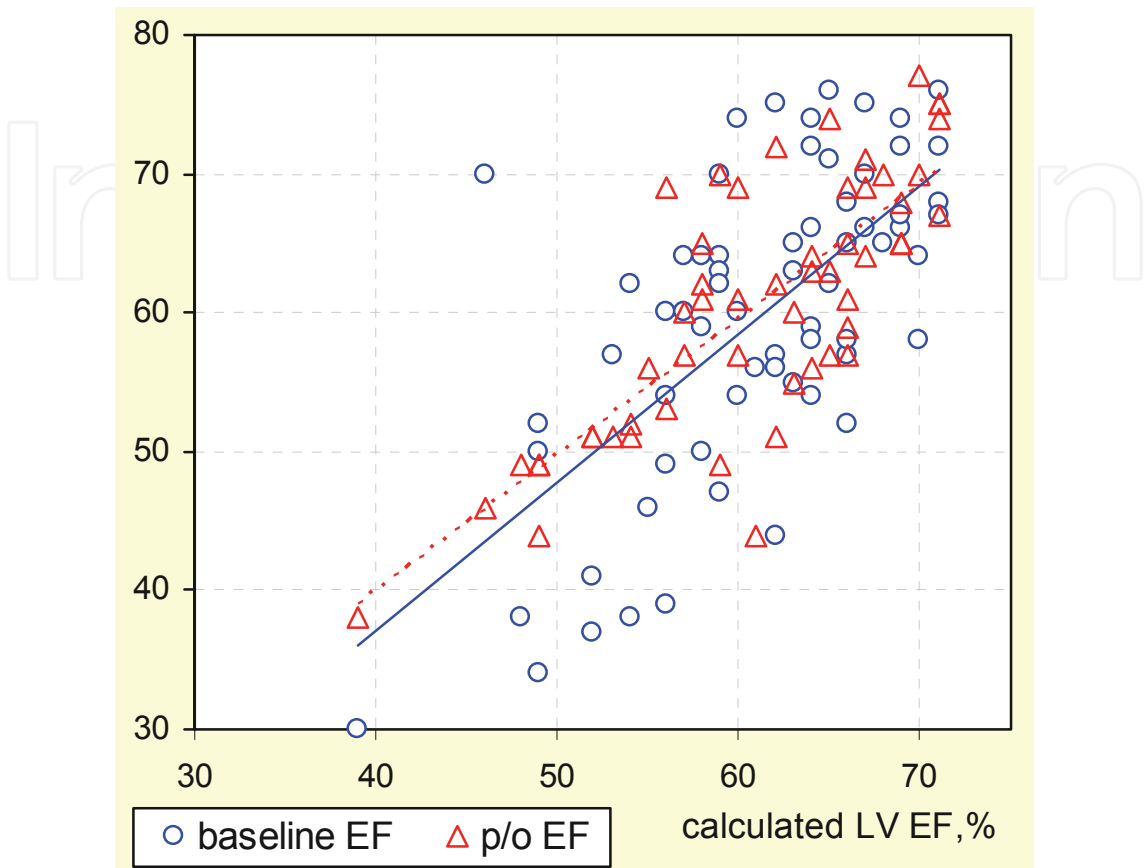


Fig. 8. Correlation of calculated LV EF with pre- and postoperative LV EF

Assessment of correlation between postoperative LV EF parameters and calculated ones using the program for surgery prognosis revealed a common pattern (trend lines had similar direction of dynamics and were approximately at the same level) (Figure 9).

Decrease in postoperative LV EF is caused by cardiopulmonary bypass, aortic occlusion, and cardioplegia through unfavorable influence on myocardial contractility in spite of coronary artery bypass grafting, procedure improving coronary blood supply, activation of hibernated myocyte.

Analysis of myocardial function parameters (F5) showed that surgery prognosis is highly affected by posterior left ventricular wall thickness (PLVWT) ($r=-0.306$) and to lesser extent by interventricular septum thickness (IVST) ($r=-0.072$). Increase in IVST leads to greater increase in peak SPG rather than PLVWT ($r=0.679$ and $r=0.526$, respectively). It can be possibly explained by appearance of additional component of LV outflow tract obstruction as a hypertrophied IVS. When thickness of IVC and PLVW ranges from 1.5 to 2.0 cm, SPG is equal to 80-120 mmHg, and positive surgery prognosis is 80-100%. However, increased dimensions of IVS and PLVW lead to decrease in percentage of favorable prognosis. Degree of ejection fraction increase was mostly related to PLVWT ($r=0.433$) than to IVST ($r=0.265$), had no relation with LV myocardial mass ($r=-0.113$), although increase in myocardial mass improved surgery prognosis. Thus, optimal left ventricle myocardial mass (LVMM) value

was 350-600 g (200-400 g/m²) in the presence of corresponding linear parameters of LV and IVS. In these cases, positive surgery prognosis was more than 80%. Increase in ejection fraction more than 50% was postoperatively observed especially in patients with such characteristics. Analysis of valve morphology parameters (F6) revealed that significance of aortic valve calcification increases in peak SPG ($r=0.448$), but not affecting surgery prognosis ($r=0.172$). Baseline AV regurgitation also does not influence on surgery outcome ($r=0.263$). We can see the possible explanation of this fact is that AV calcification in the patients was mostly caused by age-related sclerosis and rheumatoid degeneration with no elements of myocardial inflammation (myocarditis) and inflammation of conduction system.

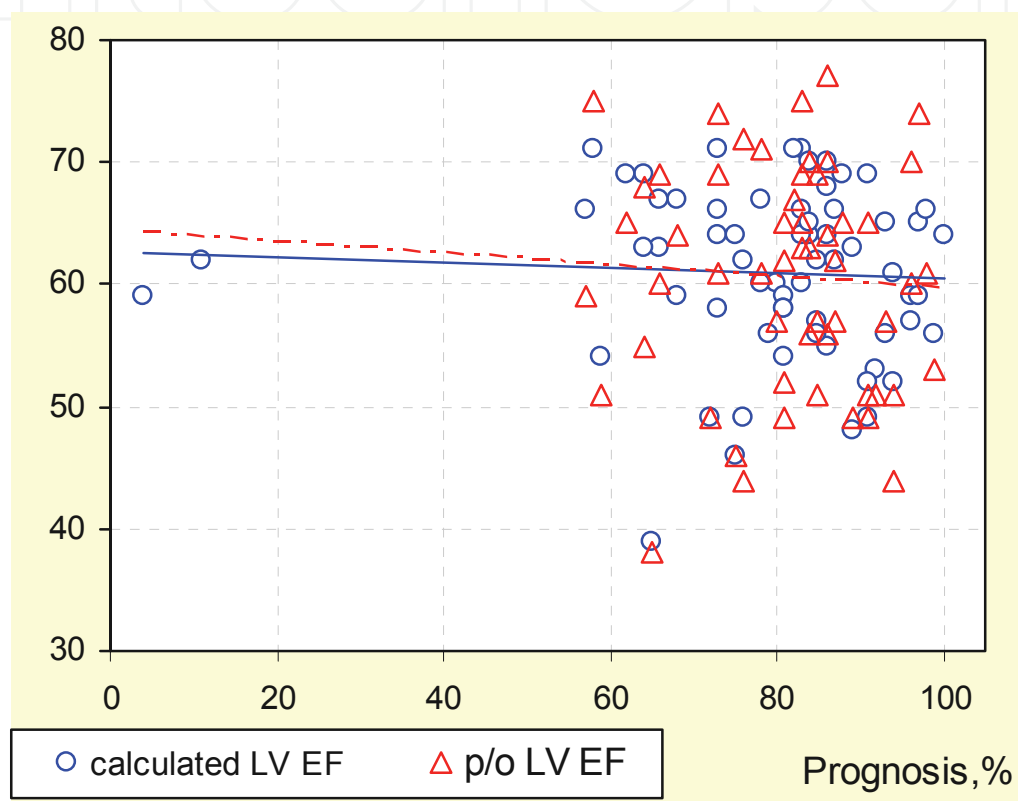


Fig. 9. Correlation between postoperative EF and calculated LV EF

Decreased ejection fraction was observed in patients who had regurgitation on MV ($r=-0.377$) and TV ($r=-0.313$) exceeding Grade I, this also resulted in impairment of surgery prognosis. Analysis of valve function parameters (F7) demonstrated that lower baseline SBG value was associated with more favorable surgery prognosis ($r=-0.284$). When peak SPG was less than 80 mmHg, favorable surgery prognosis ranged from 90 to 100%. Therefore, in the patients with coronary artery lesions aortic valve replacement should be performed at the early stages of defect manifestations when a systolic gradient is 60-80 mmHg. Analysis of coronary blood supply factor (F8) showed that patients with right dominance had worse surgery prognosis than patients with left dominance. Analysis demonstrated that among patients with right dominance only one artery was grafted in 41.9% patients, and 58.1% patients had two grafted arteries (35.5%) or more (22.6%). However, among patients with left dominance, one artery was grafted in 66.7% patients and only 33.3% patients had two (22.2%) or more (11.1%) grafted arteries, i.e. we see that the larger grafting volume was

performed in patients with right dominance. Thus, greater number of grafts required corresponds to worse surgery prognosis ($r=-0.312$). Analysis of coronary artery lesions showed that significance of left descending artery (LAD) lesions, i.e. necessity of its grafting makes worse surgery prognosis ($r=-0.303$). It was also revealed that there is a direct correlation between grade of LAD lesion and value of mitral regurgitation ($r=0.283$). This suggests a significant role of LAD in coronary blood supply and it should be grafted if affected, especially in patients with combined lesion of aortic valve and coronary arteries. Our conclusions generally support the literature data. Analysis of the huge body of materials (108 687 aortic valve replacements) performed by Brown et al. in 2009 demonstrated that female gender, age above 70 years and ejection fraction less than 30% led to higher postoperative mortality, higher percentage of postoperative stroke, and prolonged duration of hospitalization.

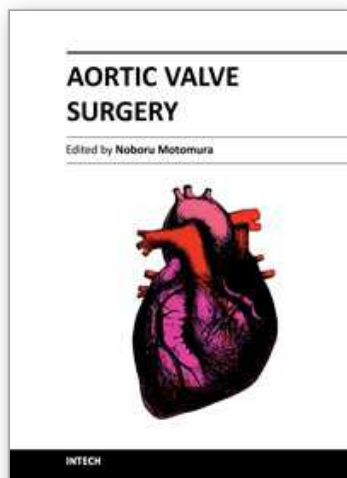
The authors confirmed the data published by Doenst et al. in 2006 on higher incidence of stroke in women during immediate postoperative period, and did not confirmed the data on a similar percentage of mortality. Although, Doenst et al. (2006) analyzed cases of combined CABG and valve replacement (1567 patients). But this also cannot be a final conclusion (combined interventions have worse results than that of one-organ surgeries). However, Thulin and Sjogren (2000) did not demonstrate any differences in the results of simple aortic valve replacement (121 patients) and valve replacement in combination with CABG (98 patients). Some investigators apart from hemodynamic parameters pay attention on the values of laboratory tests. Thus, Florath et al. (2006) showed that elevated blood levels of glucose, creatine kinase, lactate dehydrogenase, sodium, and proteins in patients prior to aortic valve replacement and CABG (908 patients) resulted in increased postoperative mortality. Jamieson et al. demonstrated results similar to our ones (2003). Bioprosthetic valve replacement and CABG was performed in 1388 patients. The mortality rate in NYHA I-II and NYHA IV was 2% and 16%, respectively. The mortality rate in men and women was 4.6% and 13.8%, respectively. Older patients more often required repeated interventions (59 versus 52 years). Nardi et al (2009) showed that surgery prognosis was worse in patients with low ejection fraction, history of paroxysmal ventricular tachycardia, renal insufficiency, and anterior myocardial infarction prior to surgery.

4. Conclusion

Patients with aortic valve lesion combined with coronary artery lesion are a severe group for surgical treatment and require intervention at early stages of the disease. NYHA FC IV is a high-risk predictor for combined surgeries CHD + CABG. We believe that systolic gradient ≥ 60 mmHg in patients assigned to CABG is an indication for combined aortic valve surgery. Analysis of LV linear and volume parameters revealed that LV diastolic dimension and diastolic volume had the greatest influence on prognosis in this patient group. iEDV/iESV ratio with $SI > 40$ ml/ m² ($SV=80$ ml) is a good prognostic sign allowing to predict a prognosis of more than 80%. The optimal LVMM value was 350-600 g (200-400 g/m²) in the presence of corresponding linear parameters of LV and IVS, when a surgery prognosis was higher than 80%, and baseline LVEF was more than 50%. Appearance of functional changes in MV (regurgitation grade >1) and TV (regurgitation grade >1) is a poor prognostic factor. LAD grafting in these patients is a required intervention, even is a lesion degree is less than 70%. It allows increasing the favorable surgery percentage.

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