

## ORIGINAL PAPER

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# Time of Occurrence and Duration of Atrial Fibrillation Following Coronary Artery Bypass Grafting

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## ABSTRACT

**Introduction:** Dilatation of the left atrium and left ventricular diastolic dysfunction (DDLV) according to recent studies has significance in the occurrence of postoperative atrial fibrillation (AF), stroke and death. Authors of some studies found no relationship between these parameters and atrial fibrillation. **Objective:** this study is to determine the time of occurrence and duration of atrial fibrillation in patients after surgical revascularization (CABG) due to the presence of left ventricular diastolic dysfunction and left atrium dilatation and identify the most significant predictors of incident AF. **Methods:** Prospective study included 116 patients undergoing surgical myocardial revascularization followed from admission to discharge. The study was conducted at the Special Hospital "Heart Center BH" Tuzla for a period of one year (March 2011/2012 g.). For all patients was performed preoperative ultrasound examination, especially parameters of diastolic function of the left ventricle and left atrium volume index (LAVi), as the best parameter sized left atrium, and the postoperative occurrence of certain AF and day occurrence, duration in hours, the number of attacks. To assess whether an event occurred or not was used logistic regression, and the effect of time on the event of interest is analyzed by Cox's regression hazard parallel. **Results:** 75.9 % of patients had DDLV, and 91.4 % were hypertensives, 12.9 % from the previous stroke (ICV) and 42.2 % diabetics (DM), 14 % with COPD. The average age of patients was  $61.41 \pm 4.69$  years. In both groups was 32.8 % women and 67.2 % men. LAVi preoperative values were significantly higher as DDLV greater degree. In patients with DDLV and higher values LAVi risk of AF is higher, the greater the length of AF and significantly higher number of attacks FA. Early occurrence of atrial fibrillation and its longer duration in function with increasing LAVi a marked increase in the value LAVi have the greatest hazard for the early appearance of atrial fibrillation. As a result of analysis of the most significant predictors of AF are: DDLV and LAVi. **Conclusion:** Postoperative atrial fibrillation occurs earlier and lasts longer in patients with DDLV and elevated left atrial volume index especially  $LAV > 36 \text{ ml/m}^2$ . LAVi has the best explanation of the function of hazard occurrence of atrial fibrillation after CABG.

**Key words:** left atrial volume index, left ventricular diastolic dysfunction, atrial fibrillation, surgical revascularization.

## 1. INTRODUCTION

Atrial remodeling and its dilation represent anatomical substrate over which trigger factors in the postoperative period after CABG can cause electrical inhomogeneity and post-operative atrial fibrillation (POAF).

Dilatation of the left atrium has significance in the development of atrial fibrillation, stroke and death

(1). Also, the authors of some studies report that found no link between the size of the left atrium and atrial fibrillation (2). Dilatation of the left atrium presented as a two-dimensional echocardiography LAVi is associated with the severity of DDLV, this is a powerful marker of cardiovascular risk in the general population (3). In recent studies increased  $LAVi > 26 \text{ ml/m}^2$  has been recog-

nized as an independent marker of left ventricular filling pressure and DDLV in patients with suspected heart failure with normal ejection fraction of the left ventricular (LVEF) (4). Therefore LAVi suggested as a biomarker for both diastolic dysfunction of the left ventricle and the cardiovascular risk (5).

Those patients who develop postoperative AF, to have subclinical atrial mechanical dysfunction, but it is usually displayed by a conventional ultrasound parameters such as left atrial area (LAA), left atrial volume (LAV) and the most credible parameter is volume index of the left atrium (LAVi). LA dilatation is common in POAF, particularly in patients with mitral valvular disease, left ventricular dilatation, or calcification circular hypertension who subsequently develop DDLV. LAVi represents the ratio volume of the left atrium to the surface of the body (LAV/BSA). According to the value LAVi too, can work categorization DDLV. LAVi > 34 ml / m<sup>2</sup> is an independent predictor of mortality, heart failure, atrial fibrillation and ischemic stroke (6).

## 2. PATIENTS AND METHODS

The prospective study included patients undergoing surgical myocardial revascularization performed in Special Hospital "Heart Center BH" Tuzla in the period from year 2011/2012, and included 116 patients who were followed from admission to the Centre to discharge. All the patients indicated for surgical revascularization for the first time in the past they were not made stenting, not had severe valvular disease, and there was no need for combined cardiac surgery. All patients included in the study were before surgery had normal sinus rhythm documented the preoperative ECG. The study based on medical history determined the basal characteristics of patients included in the study, namely: age, sex, presence of risk factors that could lead to cardiovascular diseases such as: smoking, obesity, hypertension, hyperlipidemia, heredity. For each patient, the detected presence of comorbidity as cerebrovascular and peripheral vascular disease, diabetes, chronic obstructive pulmonary disease, old or new myocardial infarction.

Preoperatively for all patients underwent Doppler echocardiography Acuson CV70 probe 2.5-3.5 MHz and the M mode, 2D with the application of pulsed Doppler laying down the essential parameters of diastolic left ventricular function and the parameters of LV is calculated left ventricular mass index (LVMI). On the basis of echocardiographic parameters of diastolic LV function, patients were divided into 2 groups: the first group consists of patients without DDLV a second group of patients with DDLV. Based on ultrasonic parameters estimate DDLV complemented by the values LAVi.

The volume of the left atrium as calculated over Bi-plane methods according to the formula:  $LAV = 0.85 \times LA \text{ area in section 4 cavities} \times LA \text{ area in section 2-cavity} / \text{perpendicular axis LA}$ , the level of the ring of the mitral valve (MV) to the roof (upper portion) LA - taken from section 4 shorter cavity (4CH) and 2 holes (2CH).

All measurements are made in endsistoly, the LAVi was introduced as the LAV compared to body surface

area/BSA/. Areas have been made in the apical position with the exclusion of the left appendage, tenting areas mitral valve and pulmonary veins. LAVi is categorized as  $\leq 28 \text{ mL/m}^2$  (normal  $20 \pm 6 \text{ mL/m}^2$ ), from 28.1 to 32 mL/m<sup>2</sup> (a slight increase in LAV), from 32.1 to 36 mL/m<sup>2</sup> (moderate) and  $> 36 \text{ mL/m}^2$  (difficult). In assessing DDLV normal form of diastolic LV function when LAVi < 28 mL/m<sup>2</sup> and Level II DDLV-stage pseudonormalisation is present if the LAVi  $\geq 28 \text{ mL/m}^2$ . DDLV is categorized in 3 levels as follows: Level I DDLV is present if the E/A < 0.75 or DT > 240 ms, IVRT > 105ms. Level III DDLV is present if with E/A > 1.5 ms or DT  $\leq 150$ , IVRT < 60ms and value LAVi were > 32 mL/m<sup>2</sup>. Postoperatively in the first 24 h after CABG patients are continuously monitored (telemetry) in the intensive care unit (ICU), and then the department of cardiology where monitored by the anesthesiologists, then cardiac surgeons and cardiologists, as well as professional medical staff, where in addition to other complications in the postoperative period, and to observe the possible occurrence of postoperative atrial fibrillation (POAF), which is index events that immediately and documented. To test the hypothesis and assess the impact of one or more of individual independent variables on the dependent variable with that information whether an event has occurred or has information about the time when the event took place, used the Cox's regression parallel hazard using a time-dependent where we covariates dependent variable "postoperative atrial fibrillation"; a predictor of special interest, left ventricular diastolic dysfunction.

## 3. RESULTS

Among patients who had coronary bypass them 75.86% had DDLV, 89.66% were hypertensive, 12.93% from the previous ICV and 42.24% diabetics, 16.38% with COPD. The average age of respondents was  $61.41 \pm 8.64$  years. Both groups were 32.76% and 67.24% Men's men. According to the performed ultrasound parameters of preoperative values LAVi are significantly more as the degree DDLV higher (Figure 1, 2).

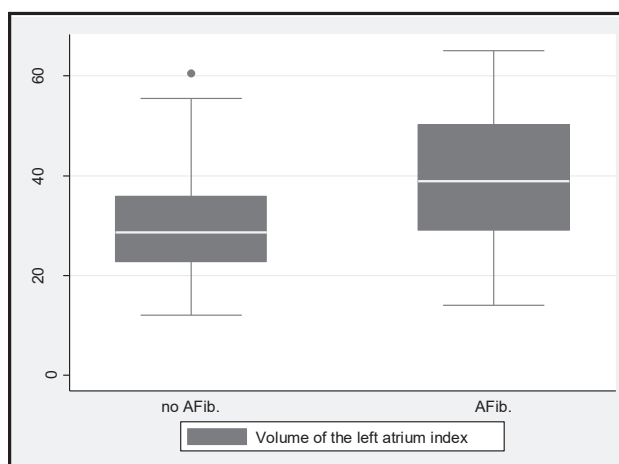


Figure 1. Preoperative volume of left atrium index and degree of DDLV

According to the degree of diastolic dysfunction preoperatively was mostly represented diastolic dysfunction

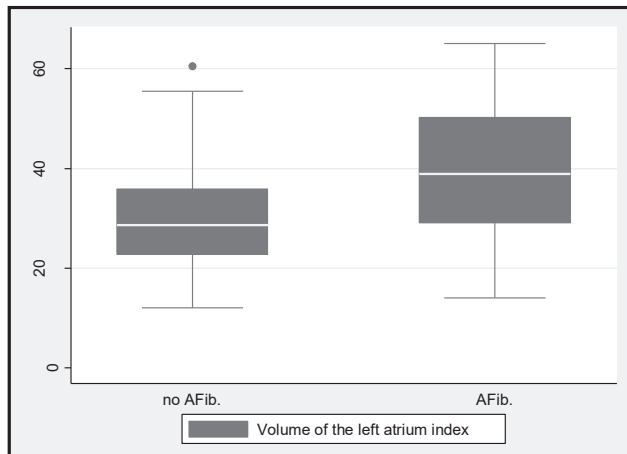


Figure 2. Value of LAVi and POAF

			Atrial fibrillation		Total
			No	Yes	
Diastolic dysfunction left atrium (preoperative)	With- out-DDLV	n	26	2	28
		%	22.41%	1.72%	24.14%
	DDLVI-I	n	50	22	72
		%	43.10%	18.97%	62.07%
	DDLVI-II	n	2	7	9
		%	1.72%	6.03%	7.76%
	DDLVI-III	n	2	5	7
		%	1.72%	4.31%	6.03%
	Total	n	80	36	116
		%	68.97%	31.03	100%

Legend: Variables presents as n-absolute number and as a percentage. a - Chi-square test: Pearson Chi-Square  $\chi^2 = 21.9993$ , df=1, p=3, Cramer's V 0.4355, medium effect size. Fisher's exact p < 0.0001

Table 1. Preoperative DDLV and incidence of AF.

in the first degree 72/116 (Goodness-of-fit Chi-Square  $\chi^2 = 4.033$ , df 1, p<0.0001) (Table 1). A total of 36 patients had atrial fibrillation, and that 22 of them had DDLV first degree.

Chi-square test of independence, which examines the relationship between two categorical variables, shows us the important link diastolic function and postoperative atrial fibrillation (Pearson Chi-Square  $\chi^2 = 21.99$ , df 3, p<0.0001, Cramer's in 0435), Fisher's exact p<0.0001.

The correlation coefficient Cramer's V is 0.435 (medium effect size), according to Cohen's criteria that takes into account the number of categories that. Number of degrees of freedom, the value obtained coefficient tells us to medium impact cross variables.

Table 2 shows that if the pattern was uneven by category LAVi (Goodness-of-fit Chi-Square  $\chi^2 = 19.96$ , df 3, p<0.0001), extremely elevated index LAVi and atrial fibrillation had 52.78%. Chi-square test of independence, shows us the important link Lavi and postoperative atrial fibrillation (Pearson Chi-Square  $\chi^2 = 11.036$ , df=3, Cramer's V 0.3098. P=0.012), according to Cohen's criteria value obtained coefficient tells us to moderate association that medium impact cross variables. The indicator prediction model for the dependent variable AF, tested and supported Hosmer-Lemeshow  $\chi^2 (8) = 14.59$ , p=0.0676. The model correctly classified 64.66% of those with AF.

Prediction binary dependent variable1 (Prediction of the dependent variable FA) based on the values of the in-

			Atrial fibrillation		Total
			No	Yes	
LAVi (category)	Normal <26	n	35	7	42
		%	44.30%	19.43%	36.52%
	Supplies in- creased 27-32	n	14	7	21
		%	17.72%	19.44%	18.26%
	Moderately in- creased 32-36	n	10	3	13
		%	12.8%	8.3%	11.4%
	Markedly in- creased >36	n	19	19	38
		%	24.05%	52.78%	33.04%
	Total	n	79	36	115
		%	100%	100%	100%

Legend: LAVi - index of left atrial volume (preoperative). Parameters are expressed as n-absolute number and as a percentage. a - Chi-square test: Pearson Chi-Square  $\chi^2 = 11.036$ , df=3, Cramer's V 0.3098. p = 0.012

Table 2. Preoperative category index of left atrial volume and the occurrence of atrial fibrillation

	B	S.E.	Wald	df	p-value	Exp(B)	95% C.I. for EXP (B)	
							Lower	Upper
Gender	0.304	0.52	0.34	1	0.56	1.35	0.48	3.77
Age	0.05	0.03	2.91	1	0.08	1.05	0.99	1.12
DDLVI pre OP			10.04	3	0.018			
DDLVI-I	1.226	0.89	1.89	1	0.169	3.40	0.59	19.53
DDLVI-II	3.01	1.18	6.50	1	0.011	20.38	2.010	206.7
DDLVI-III	3.27	1.37	5.70	1	0.017	26.4	1.79	387.6
LAVi	0.055	0.022	6.18	1	0.013	1.05	1.012	1.104

Legend: B-beta coefficient, SE-standard error, Wald stats; df-degree of freedom, Exp(B)-exponent coefficient B (OR); 95% C.I. - range OR (odds ratios).

Table 3. Predictors of atrial fibrillation

Explainers:	b	S.E.	p-value	Exp(B) Hazard	C.I. for Exp (B)	
					Lower	Upper
Gender	0.05	0.01	0.008	1.04	1.02	1.07
Age	0.06	0.36	0.87	1.06	0.52	2.16
LVMi	0.005	0.02	0.25	1.00	0.99	1.01
LAVi	0.04	0.01	0.0001	1.05	1.02	1.07
Normal <26			0.05			
Supplies increased 27-32	0.54	0.53	0.30	1.7	0.6	4.9
Moderately increased 32-36	0.19	0.69	0.77	1.2	0.3	4.7
Markedly increased >36	1.12	0.4	0.01	3.0	1.2	7.2

Legend: LVMi - index of left chamber; LAVi - index of left atrial volume.

Table 4. Results Cox-regression to estimate hazard of atrial fibrillation.

dependent predictors, rank them in order of importance and estimate the effect of interaction was performed by logistic regression, and then the regression model containing the following predictors: gender, age, DDLV, DDLV-I -II-III degree and Lavi.

The whole model with all predictors was statistically significant (LR Chi-square (8) 41.19, p<0.0001) which shows that the chosen model makes a clear distinction between the criterion - atrial fibrillation. Model as a whole explain 30.65% of variance in the status of atrial fibrillation and accurately classified 68.7% of cases. After the introduction of the predictors in the model prediction accuracy is increased to 80%. Only preoperative DDLV and LAVi gave statistically significant contribution to the model, while gender and age are not. The strongest predictor of post-operative atrial fibrillation is DDLV II and III. The chance of the occurrence of atrial fibrillation (odds ratio) 3:56 times higher among DDLV compared to those that do not have a disorder of diastolic function. The coefficient beta for LAVi is positive and amounts to 0.55, with 2:56, p <0.013, OR (odds ratio):

1.05, and it shows us that the increase in volume of the left atrium for measuring unit ( $1 \text{ ml} / \text{m}^2$ ) increases the incidence of atrial fibrillation for 1 times.

Cox regression showed a statistically significant effect on the value LAVi time of occurrence and duration of atrial fibrillation (Odds Ratio 1.055, to 2.56, CI: 1012-1100,  $p < 0.011$ ). Cox regression analysis, the influence of covariates that significantly affect the time of occurrence and duration of atrial fibrillation and found that DDLV and LAVi have the greatest contribution option discussed variance. The regression coefficient beta indicates that the increase in the value LAVi for one unit of measurement reduces the occurrence of atrial fibrillation 4 times, which means that the atrial fibrillation occurs earlier and lasts longer (Table 3).

Early occurrence of fibrillation and its longer duration as a function of the increase in LAVi. Subjects with extremely elevated values LAVi have the greatest hazard for the early detection of atrial fibrillation.

From Table 4. shows that left ventricular mass index (LVMI) and sex were not significant predictors of atrial fibrillation, while age and LAVi are and it markedly increased, which carries a 3 times higher risk of postoperative atrial fibrillation.

#### 4. DISCUSSION

Postoperative atrial fibrillation (AF) is a significant problem after surgical myocardial revascularization. The incidence of this disorder rhythm is around 30%. after isolated coronary artery bypass grafting (CABG). Most often occurs 2-4. postoperative day. In most cases treated medication and may be associated with an increased risk of postoperative thromboembolism and stroke (6). The most common risk factors for the development POAF are older patient age, previous episodes of AF, male sex, decreased ejection fraction of the right ventricle, COPD, DM, chronic renal failure and rheumatic diseases (8-10). In our study, we are particularly focused on the problem of dilatation of the left atrium and left ventricular diastolic dysfunction. Of the total number of patients studied 75.86% of them had DDLV, which speaks in favor of long-term heart disease. Most patients 89.66% were hypertensive patients treated with medication, and at 12.93% was recorded earlier ICD. Almost half of surgical patients were treated with 42.24% for DM, while in 16.38% existing COPD (11, 12). All this shows that the majority of patients were high risk for the development POAF. Echocardiographically parameters preoperative values LAVi were significantly higher as the degree of DDLV higher, preoperatively was usually represented DDLV first degree. A total of 36 patients was observed occurrence of postoperative AF and of that number, 22 had DDLV first degree. There was a significant relationship between diastolic function and postoperative atrial fibrillation. The chance to appear POAF 3.56 times higher among DDLV compared to those who do not have the disorder. It is also observed that the increase in volume of the left atrium for measuring unit ( $1 \text{ ml} / \text{m}^2$ ) increases the incidence of POAF for once. Early occurrence of POAF and its duration is proportional to the increase in

LAVi. In our study we have shown that DDLV and LAVi have the greatest impact on the time of occurrence and duration of AF. Subjects with extremely elevated values LAVi have the highest risk for early-onset POAF. Left ventricular mass index (LVMI) and half were not significant predictors of PO AF, while age and LAVi are as follows for three times. Consequently the emphasis remains on good preoperative preparation and diagnostics in order to efficiently surgery and postoperative course.

#### 5. CONCLUSION

Postoperative atrial fibrillation is occurring earlier and last longer in patients with elevated left atrial volume index in particular LAVi  $> 36 \text{ ml} / \text{m}^2$ .

The second most important independent predictors of who contribute to an earlier occurrence of postoperative atrial fibrillation and its longer duration after coronary artery bypass surgery have diastolic dysfunction of the left ventricle and LAVi.

- **Author's contribution:** all authors were included in all phases of preparing this article, including final proof reading.
- **Conflict of interest:** none declared.

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