

Plasma C-reactive protein is not related to sinus non-conversion by maze procedure adjunct to mitral valve surgery

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Abstract. In Framingham cohort study, C-reactive protein was not associated with incident atrial fibrillation (AF) after adjustment for left atrial size. This study examined whether levels of plasma inflammatory markers would be significant risk factors for failed maze procedure for AF. This study enrolled 88 patients with mitral valve disease undergoing valve surgery ($n = 32$, sinus control group) or concomitant maze procedure for persistent atrial fibrillation (AF) ($n = 56$, AF group). The mean follow-up in the AF group was 55.0 ± 17.5 months. The AF and sinus control groups did not differ in preoperative levels of C-reactive protein ($p = 0.636$). In the AF group receiving maze procedure, the sinus conversion ($n = 37$) and non-conversion ($n = 19$) groups did not significantly differ in preoperative levels of interleukin-6 ($p = 0.607$) and tumor necrosis factor- α ($p = 0.379$). In multivariate analysis after adjustment for preoperative plasma inflammatory markers, independent factors associated with sinus conversion were AF duration ($p = 0.003$), and left atrial area ($p = 0.014$). In conclusion, plasma inflammatory markers are not associated with sinus non-conversion by radiofrequency maze procedure.

Keywords: Atrial fibrillation, inflammation, maze procedure, mitral valve surgery

1. Introduction

Atrial fibrillation (AF), the most frequent sustained cardiac arrhythmia, has been shown to increase the risk of systemic embolization and mortality [1,2], and is frequently observed in clinical situations associated with atrial enlargement, such as mitral valve disease. Mitral valve disease is among the more important underlying causes of heart failure [3–5]. We have shown that preoperative and postoperative atrial sizes and AF duration

are primary predictors of sinus conversion by radiofrequency maze procedure for patients with persistent AF and mitral valve disease [6,7].

Epidemiological and clinical studies have identified an association between C-reactive protein (CRP) and both the presence of AF and risk of developing future AF [8]. Cytokines [tumor necrosis factor- α (TNF- α), interleukin-1 β and particularly, interleukin-6 (IL-6)] stimulate and induce hepatic production of other acute-phase reactants, such as CRP. However, CRP, an acute-phase protein and a marker of systemic inflammation, is produced in non-specific physiological and biochemical responses to most forms of organ or tissue damage, infection and inflammation [9]. Roldan et al. showed that high plasma levels of interleukin-6 in AF appear to be related to clinical variables in non-rheumatic AF patients rather than to the presence of AF per se [10]

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Additionally Akar et al. showed no association between acute onset human AF and plasma inflammatory markers [11]. In Framingham cohort study, CRP was not associated with incident AF after adjustment for left atrial size [12]. Accordingly, this study investigated the association between plasma inflammatory markers and the development of AF after radiofrequency maze procedure in patients undergoing concomitant mitral valve surgery.

2. Methods

2.1. Patient population

This study conducted a case-control cohort analysis from 233 patients with mitral valve disease undergoing valve surgery and concomitant radiofrequency maze procedure for persistent AF ($n = 189$) or valve surgery alone (sinus control; $n = 44$). Exclusion factors include febrile disorder, hyperthyroidism, infectious or inflammatory disease, autoimmune disease, malignancy, chronic renal failure (serum creatinine > 2.5 mg/dL), acute or chronic viral hepatitis and use of immunosuppressive drugs. An estimated sample size of 60 patients ($n = 30$ for each group) was based on the effective size with an $\alpha = 0.05$, a power of 80%, using a CRP interquartile range of 0.63 to 3.4 mg/L during sinus rhythm in paroxysmal AF patients, according a previous study [13]. A case-control sample was randomly selected of those who had plasma frozen and stored at baseline before surgery and during follow-up ($n = 88$). The study cases (AF group; $n = 56$) comprised subjects with persistent AF [mean (\pm SD) with duration of 54.1 ± 60.8 months; duration range, 1 to 183 months] before surgery. All patients in the AF group had mitral valve disease, 39 (69.6%) patients suffered concomitant tricuspid valve disease and seven (12.5%) patients suffered concomitant aortic valve disease. The radiofrequency maze procedure was performed simultaneously with the following procedures: mitral valve replacement (mechanical valve, $n = 8$; tissue valve, $n = 18$), mitral valve repair ($n = 30$), aortic valve replacement (mechanical valve, $n = 2$; tissue valve, $n = 2$), aortic valve repair ($n = 3$), tricuspid tissue valve replacement (mechanical valve, $n = 1$; tissue valve, $n = 1$), and tricuspid repair or annuloplasty ($n = 37$). Thirty-two age- and sex-matched controls with sinus rhythm (sinus control group) were also randomly sampled and biochemical analysis was performed. All patients in the sinus group had mitral valve disease, eight (25.0%)

patients had concomitant tricuspid valve disease and five (15.6%) patients had concomitant aortic valve disease. The baseline and follow-up data were prospectively obtained. Informed consent was obtained from all subjects. The study protocol was approved by the Institutional Review Committee for Human Research at our institution.

2.2. Radiofrequency maze procedure

All the AF patients enrolled in this study received the same maze procedure. The maze procedure was performed with handmade saline solution-irrigated, radiofrequency catheter ablation guided by direct visualization, which has been described in details by Chen et al. [14]. In brief, the radiofrequency ablation part of the surgical procedure replaced most of the atrial incisions used in the Cox maze III procedure, with the exception of an incision in the right atrial free wall and a standard left atrial incision in the Waterston groove, which were used to enter both atrial cavities. The left atrial appendage was ligated, and a cryoablation lesion (15-mm head probe at -60°C for 2 min; Frigitronics; Shelton, CT) was created around the orifice. The right and left islands of the pulmonary veins were isolated separately and then interconnected with an additional line in the inferior left atrial floor. Cryoablation was also applied to produce lesions in the proximal coronary sinus and away from the posterior descending artery. The right atrial maze procedure was performed as follows: the right atrium was opened through the excised right atrial appendage; and an anterior incision was made from the middle of the anterolateral aspect of the base of the amputated auricle toward the inferior caval vein orifice. Additional radiofrequency ablation lines were drawn from the medial aspect of the base of the excised right atrial appendage into the annulus of the tricuspid valve and from the caudal end of the first radiofrequency ablation line at the atrioventricular groove to the posterior part of the annulus of the tricuspid valve. The septal stage of the procedure was performed as the Cox maze III procedure, but the intercaval counterablation was moved posterolaterally.

2.3. Echocardiography

Transthoracic echocardiographic examinations were performed on all patients on the day before valve surgery and at 3-month follow-up after surgery [6,7].

2.4. Blood sample collection and measurement of plasma high-sensitivity C-reactive protein, tumor necrosis factor- α and interleukin-6 concentrations

Blood samples from all study subjects were obtained immediately before valve surgery during the fasting period, non-sedative state on study entry and at 3-month follow-up. The plasma was immediately separated and frozen at -80°C until the assay. The human plasma high-sensitivity CRP (hs-CRP) (AssayPro; Missouri, USA), high-sensitivity TNF- α (R and D Systems; Minnesota, USA) and high-sensitivity IL-6 concentrations (R and D Systems; Minnesota, USA) were quantified using a commercially available ELISA. The samples were processed according to the manufacturer's instructions.

2.5. Electrocardiography and medications at follow-up

After hospital discharge, patients underwent monthly follow-up for cardiac rhythm assessment by 12-lead surface electrocardiograms for six months and thereafter, electrocardiograms were obtained every 2–3 months on clinic visit, or if cardiac symptoms developed. No class I or III anti-arrhythmic agents were prescribed to patients at follow-up.

2.6. Statistical analysis

Data are presented as means \pm SD or percentages. Categorical variables were compared using the chi-square or Fisher exact tests, as appropriate. Moreover, continuous variables were compared by the Mann-Whitney U test. The significance of multiple variables identified as significant via univariate analysis was calculated using forward stepwise logistic regression analysis. To compare the predictive values of significant variables in logistic regression analysis, areas under the Receiver Operator Characteristic curve were constructed for sensitivity and specificity to predict AF development after the maze procedure. The best bound for predicting AF development was defined as that producing the highest sensitivity and specificity for differentiating sinus conversion and sinus non-conversion patients. In risk stratification analysis of event rates of AF during follow-up after radiofrequency maze procedure, we divided AF patients into four groups on the basis of whether they were above or below the threshold of the AF duration and left atrial area according to the predic-

tor cutoff values determined by the discriminant analysis. Differences between groups were compared by means of the log-rank test, and Kaplan-Meier survival curves were generated for each group. Finally, statistical analyses were performed using a statistical software program (SPSS version 13.0; SPSS Inc.; Chicago, Illinois, U.S.A.). All p values were two-tailed, and the level of statistical significance was set at $p < 0.05$.

3. Results

3.1. Baseline clinical characteristics, echocardiographic data and levels of inflammatory markers of both AF and sinus control patients before surgery

Table 1 lists the clinical characteristics of the study patients. The AF and sinus control groups did not significantly differ in age, gender, body mass index, heart failure status, leukocyte count, or prevalence of diabetes mellitus, hypertension and hyperlipidemia. However, the AF group contained significantly more patients with significant tricuspid regurgitation than the sinus control group. The AF and sinus control subgroups were balanced in terms of use of drugs such as statins, β -blockers and Ca-channel blockers before surgery. However, the AF group contained significantly more patients taking digoxin and warfarin, and fewer patients taking angiotensin converting enzyme inhibitors or type I angiotensin II receptor blockers before surgery. Furthermore, the preoperative left atrial diameter, left atrial area and right atrial area were significantly larger in the AF group than the sinus control group.

The AF and sinus control groups did not differ significantly in preoperative levels of hs-CRP and IL-6 (Table 1).

3.2. Echocardiographic data and levels of inflammatory markers of AF and sinus control patients after surgery

Table 2 lists the echocardiographic data and levels of inflammatory markers of the study patients after surgery. The postoperative left atrial diameter, left atrial area and right atrial area at 3-month follow-up were significantly larger in the AF group than the sinus control group. The AF and sinus control groups did not differ significantly in levels of inflammatory markers after surgery.

Table 1
Baseline clinical characteristics of patients studied before surgery

	Atrial fibrillation group (n = 56)	Sinus control group (n = 32)	p value
Age (years)	56 ± 13	52 ± 15	0.320
Men (%)	26 (46.4%)	18 (56.3%)	0.375
Body mass index (kg/m ²)	24.0 ± 3.7	24.1 ± 3.7	0.825
Duration of AF (months)	54.1 ± 60.8		
New York Heart Association classification	56 (100.0%)	32 (100.0%)	0.327
II	9 (16.1%)	7 (21.9%)	
III	35 (62.5%)	22 (68.8%)	
IV	12 (21.4%)	3 (9.4%)	
Previous embolism (%)	3 (5.4%)	3 (9.4%)	0.664
Mitral valve disease (%)	56 (100.0%)	32 (100.0%)	1.000
Tricuspid regurgitation (%)	39 (69.6%)	8 (25.0%)	< 0.001
Aortic valve disease (%)	7 (12.5%)	5 (15.6%)	0.681
Hypertension (%)	19 (33.9%)	10 (31.3%)	0.797
Diabetes mellitus (%)	10 (17.9%)	7 (21.9%)	0.646
Hyperlipidemia (%)	11 (19.6%)	10 (31.3%)	0.219
Coronary artery disease (%)	3 (5.4%)	3 (9.4%)	0.664
Angiotensin converting enzyme inhibitor or type I angiotensin II receptor blocker (%)	32 (57.1%)	29 (90.6%)	0.001
Statins (%)	1 (1.8%)	3 (9.4%)	0.135
Fibrate (%)	1 (1.8%)	0 (0.0%)	1.000
Beta blockade (%)	21 (37.5%)	6 (18.8%)	0.067
Calcium blockade (%)	13 (23.2%)	7 (21.9%)	0.885
Digoxin (%)	41 (73.2%)	10 (31.3%)	< 0.001
Antiplatelets (%)	10 (17.9%)	4 (12.5%)	0.563
Warfarin (%)	35 (62.5%)	0 (0.0%)	< 0.001
Propafenone (%)	1 (1.8%)	0 (0.0%)	1.000
Amiodarone (%)	12 (21.4%)	0 (0.0%)	0.074
WBC (cells/uL)	6364.3 ± 2021.6	6703.1 ± 2423.9	0.630
Serum creatinine (mg/dL)	1.23 ± 2.91	1.09 ± 1.36	0.783
Left atrial diameter (mm)	54.4 ± 10.3	42.6 ± 7.7	< 0.001
Left atrial area (cm ²)	45.9 ± 19.4	30.3 ± 9.0	< 0.001
Right atrial area (cm ²)	26.2 ± 8.6	17.6 ± 5.9	< 0.001
Left ventricular ejection fraction (%)	64.6 ± 12.3	69.9 ± 12.6	0.033
high-sensitivity C-reactive protein (mg/L)	1.32 ± 0.89	1.35 ± 1.16	0.636
Tumor necrosis factor-α (pg/mL)	1.92 ± 1.28	2.71 ± 1.44	0.015
Interleukin-6 (pg/mL)	2.45 ± 3.19	1.38 ± 1.36	0.113

Table 2
Echocardiographic and biochemical data of study patients after surgery

	Atrial fibrillation group (n = 56)	Sinus control group (n = 32)	p value
Left atrial diameter (mm)	43.5 ± 9.6	35.0 ± 5.5	< 0.001
Left atrial area (cm ²)	29.8 ± 12.0	21.0 ± 7.0	< 0.001
Right atrial area (cm ²)	20.0 ± 6.4	16.3 ± 5.1	0.009
Left ventricular ejection fraction (%)	65.0 ± 10.8	65.5 ± 12.4	0.800
high-sensitivity C-reactive protein (mg/L)	2.01 ± 1.44	1.71 ± 1.45	0.222
Tumor necrosis factor-α (pg/mL)	3.27 ± 4.05	3.03 ± 2.04	0.745
Interleukin-6 (pg/mL)	1.66 ± 1.32	1.44 ± 1.39	0.323

3.3. Factors associated with sinus conversion by the radiofrequency maze procedure in AF patients

The mean duration of follow-up in the AF group was 55.0 ± 17.5 months (range, 12 to 84 months). Two deaths occurred during follow-up: one sudden death at 12-month follow-up and one death from hepatic encephalopathy at 18-month follow-up. Sinus con-

version after radiofrequency maze procedure was defined as achieving persistent sinus rhythm without antiarrhythmic drug therapy or electrical cardioversion at 2-month follow-up and thereafter. Thirty-seven patients achieved persistent sinus conversion following the radiofrequency maze procedure (sinus conversion group), and 19 patients did not regain sinus rhythm (sinus non-conversion group).

Table 3
Baseline clinical characteristics and biochemical data of atrial fibrillation patients with and without sinus conversion after maze procedure

	Sinus converters (n = 37)	Sinus non-converters (n = 19)	p value
Age (years)	54 ± 13	58 ± 14	0.328
Men (%)	19 (51.4%)	7 (36.8%)	0.303
Body mass index (kg/m ²)	24.1 ± 4.1	23.9 ± 2.77	0.856
Duration of atrial fibrillation (months)	29.7 ± 43.7	101.6 ± 62.1	< 0.001
Tricuspid regurgitation (%)	25 (67.6%)	14 (73.7%)	0.637
Aortic valve disease (%)	5 (13.5%)	2 (10.5%)	1.000
Hypertension	15 (40.5%)	4 (21.1%)	0.233
Diabetes mellitus	6 (16.2%)	4 (21.1%)	0.720
Hyperlipidemia (%)	6 (16.2%)	5 (26.3%)	0.368
Coronary artery disease	3 (8.1%)	0 (0%)	0.544
WBC (cells/uL)	6446.0 ± 1889.8	6205.3 ± 2303.3	0.406
Preoperative left atrial diameter (mm)	51.9 ± 9.5	59.3 ± 10.2	0.028
Preoperative left atrial area (cm ²)	40.2 ± 15.4	56.9 ± 21.9	0.002
Preoperative right atrial area (cm ²)	23.2 ± 6.7	32.1 ± 9.0	0.001
Preoperative left ventricular ejection fraction (%)	66.0 ± 13.0	62.1 ± 10.7	0.166
Preoperative high-sensitivity C-reactive protein (mg/L)	1.16 ± 0.90	1.62 ± 0.81	0.027
Preoperative tumor necrosis factor-α (pg/mL)	1.82 ± 1.18	2.15 ± 1.48	0.379
Preoperative interleukin-6 (pg/mL)	2.80 ± 3.67	1.70 ± 1.60	0.607
Postoperative left atrial diameter (mm)	39.7 ± 6.9	50.8 ± 9.9	< 0.001
Postoperative left atrial area (cm ²)	24.8 ± 6.3	39.6 ± 14.5	< 0.001
Postoperative right atrial area (cm ²)	17.2 ± 3.7	25.6 ± 6.8	< 0.001
Postoperative left ventricular ejection fraction (%)	66.5 ± 11.0	62.1 ± 10.1	0.090
Postoperative high-sensitivity C-reactive protein (mg/L)	2.06 ± 1.60	1.88 ± 0.99	0.966
Postoperative tumor necrosis factor-α (pg/mL)	3.26 ± 4.73	3.30 ± 2.32	0.306
Postoperative interleukin-6 (pg/mL)	1.48 ± 1.04	2.05 ± 1.75	0.336

Table 4
Multiple stepwise logistic regression analysis of baseline characteristics and biochemical data of atrial fibrillation patients in predicting atrial fibrillation after maze procedure

Variables	Odds ratio	95% CI	p value
Duration of atrial fibrillation (months)	1.030	1.010–1.051	0.003
Left atrial area (cm ²)	1.062	1.012–1.115	0.014
Right atrial area (cm ²)	1.153	1.011–1.314	0.034
high-sensitivity C-reactive protein (mg/L)	2.623	0.846–8.131	0.095

CI = confidence interval.

Table 3 lists the baseline clinical characteristics for AF patients with and without sinus conversion after maze procedure. The preoperative level of hs-CRP was significantly lower in the sinus conversion group than in the sinus non-conversion group. However, the sinus conversion and sinus non-conversion groups did not significantly differ in preoperative levels of IL-6 and TNF-α and postoperative levels of hs-CRP, IL-6 and TNF-α. The preoperative and postoperative left atrial area, left atrial diameter and right atrial area were significantly smaller in the sinus conversion group than the sinus non-conversion group. The pre-surgery duration of AF was significantly shorter in the sinus conversion group than in the sinus non-conversion group. In multivariate analysis, preoperative hs-CRP level was no longer a predictor for persistent AF after surgery. After adjustments for preoperative hs-CRP level, the only significant variable other than AF duration and preoper-

ative left and right atrial sizes in univariate analysis, via multiple stepwise logistic regression analysis (Table 4) independent factors associated with sinus conversion by radiofrequency maze procedure were identified as AF duration, with an odds ratio for persistent AF after surgery of 1.030 for each 1-month increment in AF duration (95% confidence interval 1.010 to 1.051, $p = 0.003$), and preoperative left atrial area, with an odds ratio for persistent AF after surgery of 1.062 for each 1-cm² increment in preoperative left atrial area (95% confidence interval 1.012 to 1.115, $p = 0.014$).

3.4. Preoperative duration of AF and left atrial size as factors associated with the success of sinus conversion by the radiofrequency maze procedure in AF patients

Discriminant analysis was performed to identify the duration of AF as factor associated with AF develop-

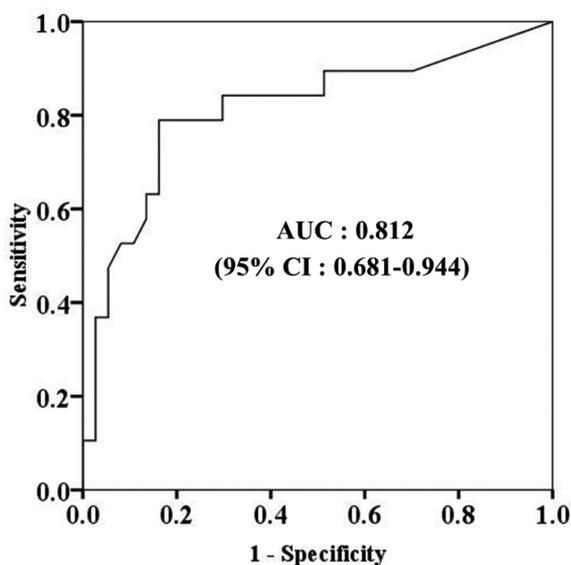


Fig. 1. Receiver Operator Characteristic curve for the cut-off value of the duration of AF in predicting sinus rhythm restoration by the radiofrequency maze procedure. The area under curve (AUC) for the cut-off value of the AF duration of 43.5 months was 0.812 [95% confidence interval (CI), (0.681, 0.944), $p < 0.001$]. The sensitivity and specificity of the cut-off value of 43.5 months were 78.9% and 83.8%, respectively.

ment after the radiofrequency maze procedure. The area under the Receiver Operator Characteristic curve for the cut-off value of 43.5 months was 0.812 (95% confidence interval, [0.681, 0.944]) (Fig. 1). The sinus conversion rate was significantly lower in patients with AF duration > 43.5 months than in patients with AF duration < 43.5 months (odds ratio 14.47, 95% confidence interval 3.77 to 55.48, $p < 0.001$).

Discriminant analysis was performed to identify the preoperative left atrial area as factor associated with AF development after radiofrequency maze procedure. The area under the Receiver Operator Characteristic curve for the cut-off value of 37.5 cm^2 was 0.760 (95% confidence interval, [0.636, 0.883]) (Fig. 2). The sinus conversion rate was significantly lower in patients with preoperative left atrial area $> 37.5 \text{ cm}^2$ than in patients with left atrial area $< 37.5 \text{ cm}^2$ (odds ratio 21.18, 95% confidence interval 2.56 to 175.53, $p = 0.002$). None of the patients with preoperative left atrial area $< 33.5 \text{ cm}^2$ developed AF after radiofrequency maze procedure. Additionally, the area under the Receiver Operator Characteristic curve for the cut-off value of the preoperative left atrial diameter of 51.5 mm was 0.681 (95% confidence interval, [0.530, 0.831]). The sinus conversion rate was lower in patients with preoperative left atrial diameter > 51.5 mm than in patients

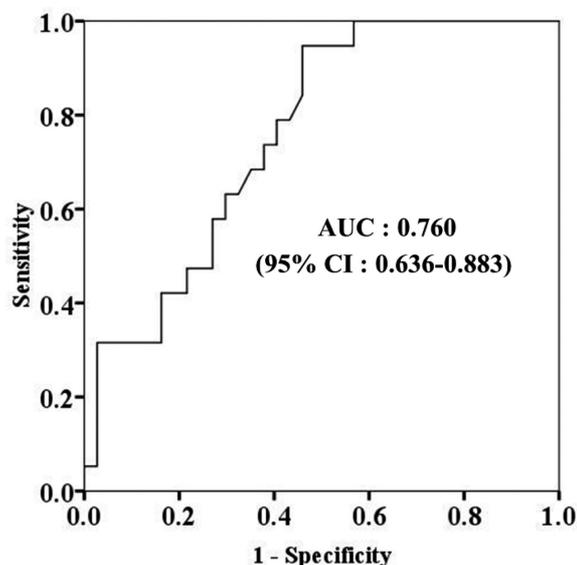


Fig. 2. Receiver Operator Characteristic curve for the cut-off value of the preoperative left atrial area in predicting sinus rhythm restoration by the radiofrequency maze procedure. The area under curve (AUC) for the cut-off value of the preoperative left atrial area of 37.5 cm^2 was 0.760 [95% confidence interval (CI), (0.636, 0.883), $p = 0.002$]. The sensitivity and specificity of the cut-off value of 37.5 cm^2 were 94.7% and 54.0%, respectively.

with left atrial area $< 51.5 \text{ mm}$ (odds ratio 2.857, 95% confidence interval [0.794, 10.280], $p = 0.101$).

For the entire AF group, AF event-free survival was 100% for patients with preoperative AF duration ≤ 43.5 months and preoperative left atrial area $\leq 37.5 \text{ cm}^2$, 72.2% for patients with preoperative AF duration ≤ 43.5 months and preoperative left atrial area $\geq 37.5 \text{ cm}^2$, and 23.5% for patients with preoperative AF duration ≥ 43.5 months and preoperative left atrial area $\geq 37.5 \text{ cm}^2$ (Fig. 3). The incidence of AF during follow-up was significantly greater in patients with preoperative AF duration ≥ 43.5 months and preoperative left atrial area $\geq 37.5 \text{ cm}^2$ than in those with preoperative AF duration ≤ 43.5 months and preoperative left atrial area $\leq 37.5 \text{ cm}^2$ ($p < 0.001$). The incidence of AF during follow-up was significantly greater in patients with preoperative AF duration ≤ 43.5 months and preoperative left atrial area $\geq 37.5 \text{ cm}^2$ than in those with preoperative AF duration ≤ 43.5 months and preoperative left atrial area $\leq 37.5 \text{ cm}^2$ ($p = 0.017$).

4. Discussion

This study examined the clinical and biochemical factors associated with sinus conversion by the radiofre-

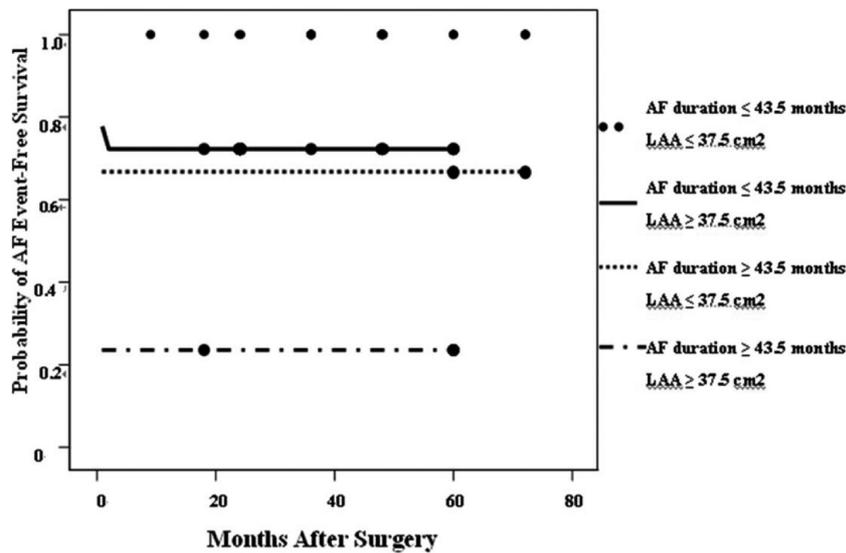


Fig. 3. Atrial fibrillation (AF) event-free survival curves following radiofrequency maze procedure among AF patients that have been divided into four groups based on whether they were above or below the threshold of the preoperative AF duration and left atrial area (LAA). Notably, the incidence of AF was significantly higher in patients with preoperative AF duration > 43.5 months and LAA > 37.5 cm² than in patients with preoperative AF duration < 43.5 months and LAA < 37.5 cm² ($p < 0.001$).

quency maze procedure for patients with mitral valve disease and persistent AF. This study demonstrated that plasma inflammatory markers, hs-CRP, IL-6 and TNF- α , were not significant factors associated with sinus non-conversion by the radiofrequency maze procedure for AF. Preoperative AF duration and preoperative left atrial size were identified as independent factors associated with sinus conversion by the radiofrequency maze procedure.

Epidemiological and clinical studies have shown an association between CRP and risk of developing future AF [8]. However, CRP, an acute-phase protein and a marker of systemic inflammation, is produced in non-specific physiological and biochemical responses to most forms of organ or tissue damage, infection and inflammation [9]. Additionally, Marcus et al. showed that there was a transcardiac gradient of CRP [15]. Thus, plasma inflammatory levels may not accurately reflect the genuine inflammatory status of atrial myocardium [15,16]. This study showed that plasma inflammatory markers, hs-CRP, IL-6 and TNF- α , were not important factors associated with sinus non-conversion by the radiofrequency maze procedure for AF. Thus, this study showed that plasma inflammatory markers were not significant risk factors for failed maze procedures. This finding suggests that a systemic anti-inflammatory strategy may not be appropriate for therapeutic intervention after radiofrequency maze procedure adjunct to mitral valve surgery. Our finding is supported by

the clinical observation that the routine use of statins, angiotensin converting enzyme inhibitor or type I angiotensin II receptor blocker do not improve outcomes of AF catheter ablation [17].

Atrial fibrillation is the most frequent sustained cardiac arrhythmia in patients with mitral valve disease, contributing to increased risk of mortality and systemic embolization [2,18]. Additionally, development of AF after cardiac surgery is associated with increased morbidity and mortality [19]. The saline-irrigated radiofrequency maze procedure successfully restores sinus rhythm and atrial contractility in patients with persistent AF and mitral valve disease [6,20,21] and improves survival, late cardiac function, and freedom from late stroke [22]. We have shown that atrial size reduction after radiofrequency maze procedure adjunct to mitral valve surgery predicts the success of sinus conversion after surgery [6]. Matsuo et al. have recently shown that continuous AF duration predicts maintenance of sinus rhythm after catheter ablation for persistent AF [23]. Longer duration of persistent AF and large left atrium indicated more structural remodeling of the atria.

4.1. Study limitations

Only 12-lead surface electrocardiograms had been used in the follow-up period. This may be a limited way of rhythm monitoring.

5. Conclusion

Plasma inflammatory markers are not associated with sinus non-conversion by the radiofrequency maze procedure adjunct to mitral valve surgery.

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