The influence of postoperative mitral valve function on the late recurrence of atrial fibrillation after the maze procedure combined with mitral valvuloplasty

Joon Bum Kim, MD,^a Seung Hyun Lee, MD,^a Sung Ho Jung, MD,^a Sung Cheol Yun, PhD,^b
Suk Jung Choo, MD,^a Cheol Hyun Chung, MD,^a Hyun Song, MD,^c and Jae Won Lee, MD^a

Objectives: Although a number of reports have identified risk factors for postoperative recurrence of atrial fibrillation after the maze procedure, no studies have investigated the influence of postoperative mitral valve disease on atrial fibrillation recurrence after mitral valvuloplasty combined with the maze procedure.

Methods: Between January 1999 and October 2006, 228 patients underwent the maze procedure and concomitant mitral valve repair. There were 4 early deaths. Of the early survivors, 206 patients with restored sinus rhythm were chosen for analysis. During a median follow-up of 50.8 months (range, 0.6–122.8 months), there were 35 patients who had mitral regurgitation ($n = 26$) or mitral stenosis ($n = 9$). Patients who had postoperative mitral valve disease (disease group, $n = 35$) were compared with those who did not (control group, $n = 171$) for late recurrence of atrial fibrillation.

Results: Twenty-eight patients experienced late recurrence of atrial fibrillation. The disease group had a higher atrial fibrillation recurrence rate than the control group (5-year atrial fibrillation-free rates were $65.2\% \pm 10.3\%$ and $85.8\% \pm 3.4\%$, respectively; $P = .014$). Univariate and multivariate analyses of a range of variables revealed that a larger preoperative left atrial size (hazard ratio, 2.61; $P = .041$), the use of microwave ablation rather than cryoablation (hazard ratio, 2.33; $P = .041$), the presence of early (<3 months) postoperative atrial fibrillation events (hazard ratio, 3.75; $P = .001$), and the presence of postoperative mitral valve disease (hazard ratio, 3.67; $P = .005$) were independent predictors for late atrial fibrillation recurrence.

Conclusions: Maze procedure outcomes were negatively affected by postoperative mitral valve disease after mitral valvuloplasty, as evidenced by greater atrial fibrillation recurrence. (J Thorac Cardiovasc Surg 2010;139:1170-6)

The maze operation accompanied by mitral valve (MV) surgery is regarded as the best option for terminating atrial fibrillation (AF) in patients with mitral disease and AF.¹ However, long-term follow-up of patients who undergo the maze procedure suggests that late AF recurrence limits the benefits of the procedure.²⁻⁶ Studies investigating patients at greater risks of AF recurrence revealed that preoperative conditions, such as longer AF duration, a fine AF-wave pattern, a larger left atrial (LA) size, older age, a higher left ventricular mass index, and a higher cardiothoracic ratio, were positive predictors of AF recurrence.²⁻⁵

Increased pressure and volume load to the LA caused by remnant or recurrent mitral disease after mitral valvuloplasty can induce LA chamber enlargement. Because these processes are regarded as the source of AF generation in patients with mitral disease in general, patients with postoperative MV disease are expected to have a greater risk of AF recurrence after the maze operation. However, to our knowledge, no studies have investigated whether remnant or recurrent MV disease after MV repair is associated with an increased risk of AF recurrence after the maze operation.

The aim of this study was to investigate the influence of postoperative MV dysfunction on late AF recurrence after the maze procedure combined with MV repair. For this, we performed univariate and multivariate risk factor analyses for recurrent AF after surgical intervention, including postoperative MV disease as a candidate risk variable.

MATERIALS AND METHODS

Patients

From January 1999 to October 2006, 228 patients underwent the maze procedure combined with MV repair in Asan Medical Center, Seoul, South Korea. The maze procedure and MV repair were performed concomitantly with or without other cardiac procedures. There were 4 early deaths. Fifteen patients did not recover sinus rhythm, and of these patients, 3 underwent permanent pacemaker insertion. One patient was lost to follow-up. Of the early survivors, 208 (91.2%) had restored sinus rhythm. Patients were

From the Departments of Thoracic and Cardiovascular Surgery^a and Preventive Medicine,^b Asan Medical Center, University of Ulsan College of Medicine, and the Department of Thoracic and Cardiovascular Surgery,^c Seoul Saint Mary's Hospital, College of Medicine, Catholic University of Korea, Seoul, South Korea.

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Address for reprints: Jae Won Lee, MD, Department of Thoracic and Cardiovascular Surgery, Asan Medical Center, University of Ulsan College of Medicine, 388-1 Pungnap-dong Songpa-gu, Seoul 138-736, South Korea (E-mail: jwlee@amc.seoul.kr).

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Abbreviations and Acronyms

AF	= atrial fibrillation
CI	= confidence interval
HR	= hazard ratio
LA	= left atrium
MR	= mitral regurgitation
MV	= mitral valve

divided into 2 groups according to the presence or absence of postoperative MV disease. Postoperative MV disease was defined as follows: (1) mitral regurgitation (MR) of greater than grade 2 or (2) mitral stenosis defined by an MV area of less than 2.0 cm² or a transmitral peak pressure gradient of greater than 10 mm Hg. There were 37 patients who met these criteria (28 with MR and 9 with mitral stenosis). Two patients in the postoperative MV dysfunction group underwent reoperation. One patient revealed failed mitral repair on predischARGE echocardiographic analysis and underwent tissue valve replacement on postoperative day 14. Another patient showed late MR recurrence caused by chordae rupture and underwent redo mitral repair (the Alfieri technique) on postoperative day 547. Because these 2 patients do not represent the true postoperative MV dysfunction group after reoperation, they were excluded from the present study. Finally, 35 patients with postoperative MV dysfunction were included in this study and were defined as the disease group.

Those who did not show postoperative MV disease were defined as the control group (n = 171). The study compared the 2 groups in terms of AF recurrence, changes in LA size, and transmitral A-wave characteristics.

This study was approved by our institution's ethics committee/institutional review board.

Surgical Procedures

A median sternotomy approach was used for most patients (n = 169 [82.0%]), and a right anterolateral minithoracotomy approach with the AESOP 3000 system (Computer Motion, Inc, Santa Barbara, Calif) was used in the most recent patients (n = 37 [18.0%]). Conventional ascending aorta and bicaval cannulation was used for the sternotomy approach, and the minimally invasive approach involved peripheral cannulation through the right internal jugular vein, right femoral vein, and right femoral artery. Myocardial protection was achieved with antegrade and retrograde tepid blood cardioplegia. After aortic crossclamping, MV exposure was obtained through an LA incision.

A modification of the maze procedure was performed, the details of which have been described previously.⁷ LA size was reduced by means of generous resection of redundant atrial tissue off the posterior LA wall parallel to the posterior mitral annulus. The degree of LA wall resection was determined based on preoperative LA size, with a target postoperative LA size of less than 50 mm.

Echocardiography

Two-dimensional echocardiographic analysis and Doppler color-flow imaging were performed on all patients with a Hewlett-Packard Sonos 2500 or 5500 imaging system equipped with a 2.5-MHz transducer (Hewlett-Packard, Andover, Mass). Preoperative echocardiographic analysis (both transthoracic and transesophageal) was performed in all patients within 2 months before the operation. Postoperative transthoracic echocardiographic evaluation was performed at 3 and 6 months and every year thereafter. Doppler flow mapping was used for semiquantitation of MR; at least grade 3 MR was defined as a distal regurgitant jet area of greater than 8 cm² or a radius of proximal flow convergence of greater than 0.5 cm at the aliasing velocity of 40 cm/s. MV area was estimated by using the pressure

half-time method. LA size was measured based on its anteroposterior diameter on the parasternal long-axis view at end-systole.

Postoperative Rhythm Follow-up

Postoperatively, in-patient rhythms were monitored daily by using standard 12-channel surface electrocardiographic analysis. Patients were routinely evaluated with 24-hour Holter monitoring before hospital discharge. Follow-up electrocardiograms were performed at 3- to 6-month intervals during the first 2 years and every year thereafter. Any symptoms suspicious of arrhythmia were assessed by means of 24-hour Holter monitoring during follow-up. Recurrences or events of AF during the initial post-ablation blanking period of 3 months are defined as early events. A failure of the maze procedure defines any recurrent AF, atrial tachycardia, or atrial flutter at least 3 months after stopping antiarrhythmic agents as beyond the initial blanking period. The results are presented in "Freedom from AF without antiarrhythmic agent." The definitions on early events (initial blanking period) and a failure of the maze procedure were based on the consensus of reporting standards made by the Heart Rhythm Society Task Force on Catheter and Surgical Ablation of AF.⁸

All data were collected prospectively and stored for later assessment in a specially designed and regiminated database.

Postoperative Management

Postoperative AF, atrial flutter, atrial tachycardia, frequent atrial premature beats, and recurrent atrial tachyarrhythmia were treated with amiodarone, which was commenced at 1200 mg/d and tapered according to the patients' rhythm status. A rapid ventricular rate despite the amiodarone therapy was controlled with β -blockers or calcium-channel blockers. Patients were routinely anticoagulated with warfarin for 3 to 6 months postoperatively with a target international normalized ratio of 1.5 to 2.5 at the discretion of the attending surgeon. The maintenance of anticoagulation therapy thereafter was determined according to the individual patient's risk factors of thromboembolism and cardiac rhythm status. Postoperative AF or the absence of effective atrial contraction resulted in anticoagulation therapy that was continued until both sinus rhythm and atrial contractility were restored.

Statistics

Categorical variables were presented as frequencies and percentages and were compared by using the χ^2 or Fisher's exact tests. Continuous variables were expressed as means $\pm$ standard deviations or medians with ranges and were compared by using the Student's unpaired *t* test or the Mann-Whitney *U* test, as appropriate. Kaplan-Meier curves were used to delineate freedom from MV disease and freedom from AF, and log-rank tests were used to compare the differences in AF-free rates between groups. Stratified survival curves (freedom from AF without an antiarrhythmic agent) were plotted to explore unadjusted differences for variables of interest. For multivariate analyses, the updated covariate Cox models were used to examine the association of baseline characteristics with time to AF recurrence.⁹ Variables with a *P* value .20 or less in univariate analyses were candidates for the multivariable updated covariate Cox models. Multivariate analyses involved a backward elimination technique, and only variables with a *P* value of less than .10 were used in the final model. Results were expressed as hazard ratios (HRs) with 95% confidence intervals (CIs). All reported *P* values are 2-sided. SAS software version 9.1 (SAS Institute, Inc, Cary, NC) and SPSS version 12 were used for the statistical analysis.

RESULTS

Baseline Characteristics

The median age at the time of the operation was 50 years (range, 18–80 years), and 114 (55.3%) patients were women. Clinical follow-up was completed with all patients, with a median follow-up period of 50.8 months

TABLE 1. Preoperative patient profiles

	Control group	Disease group	P value
No. of patients	171	35	
Age (y), median (range)	50 (18–80)	50 (30–69)	.838
Female sex (no.)	91	23	.175
Cardiothoracic ratio (%)	58.7 ± 8.4	58.9 ± 11.5	.897
Presence of coronary disease (no.)	22	4	1.00
Previous cardiac surgery (no.)	5	2	.339
Diagnosis			.346
Mitral regurgitation (no.)	126	23	
Mitral stenosis (no.)	12	5	
Mitral stenoregurgitation (no.)	33	7	
Cause of MV disease			.058
Degenerative (no.)	81	11	.095
Rheumatic (no.)	77	21	.120
Ischemic (no.)	11	1	.695
Infective (no.)	2	1	
Congenital (no.)	0	1	
Echocardiographic data			
LV ejection fraction (%)	55.3 ± 11.0	55.4 ± 10.2	.961
LA dimension (mm)	60.1 ± 9.7	60.8 ± 8.4	.727
LV end-systolic diameter (mm)	42.5 ± 8.7	39.7 ± 7.0	.131
LV end-diastolic diameter (mm)	62.2 ± 9.9	59.2 ± 8.6	.125
AF profiles			
AF duration, years, median (range)	2 (0–25)	3 (0–20)	.331
Paroxysmal AF (no.)	21	4	>.999
Fine (<1 mm) AF wave (no.)	72	14	.985

Data represent means ± standard deviations. MV, Mitral valve; LV, left ventricular; LA, left atrial; AF, atrial fibrillation. Data represent mean (SD).

(range, 0.6–122.8 months). Acquisition of electrocardiograms and echocardiographic data for more than 12 months postoperatively was possible in 193 (93.6%) patients. The control and disease groups were similar in terms of preoperative demographic characteristics, echocardiographic profiles, and clinical manifestation of MV disease and AF (Table 1). LA wall resection was preformed for 186 (90.3%) patients, and both groups had a similar proportion of patients who underwent the LA reduction procedure ($P = .538$). Ring annuloplasty was used more frequently in the control group, whereas the papillary muscle-splitting technique was used more frequently in the disease group. The 2 groups were similar in terms of concomitant cardiac operations (Table 2).

Immediate and Long-Term Clinical Outcomes

There were 3 late strokes and 7 late deaths. The overall cerebrovascular accident-free survival rate was $96.9\% \pm 1.3\%$ at 5 years. Of the 35 patients in the disease group, echocardiographic analysis detected postoperative MV

TABLE 2. Surgical procedures

	Control group	Disease group	P value
No. of patients	171	35	
Cardiopulmonary bypass time (min)	159.4 ± 43.7	165.4 ± 45.1	.469
Aortic clamping time (min)	114.1 ± 32.3	115.5 ± 31.0	.817
MV procedure			
Ring annuloplasty (no.)	156	27	.016*
Commissurotomy (no.)	31	11	.105
Commissural repair (no.)	13	0	.131
Triangular or quadrangular resection (no.)	24	6	.605
Leaflet mobilization (no.)	26	8	.316
New chordae formation (no.)	40	4	.173
Papillary muscle splitting (no.)	16	9	.019*
Annular plication or sliding technique (no.)	8	3	.351
Leaflet patch or extension (no.)	9	2	>.999
Chordae transfer (no.)	2	0	>.999
Alfieri technique (no.)	2	2	.135
Cardiac cooperation			
Tricuspid valve repair (no.)	62	18	.759
Ring annuloplasty (no.)	41	12	
Kay method (no.)	8	1	
De Vega method (no.)	13	3	
Other cardiac procedures			.185
Aortic valve replacement (no.)	15	4	
Aortic valve repair (no.)	2	3	
Coronary artery bypassing (no.)	14	3	
ASD, VSD, PDA (no.)	6	1	
Aortic operation (no.)	1	0	
Others (no.)	1	0	
Minimally invasive approach (no.)	33	4	.339
Alternative energy sources for the maze procedure (no.)			.879
Cryoablation (no.)	115	24	
Microwave ablation (no.)	56	11	

MV, Mitral valve; ASD, atrial septal defect; VSD, ventricular septal defect; PDA, patent ductus arteriosus. * $P < .05$.

disease in 3 before discharge, whereas the remaining 32 were detected during follow-up. In terms of valvulopathy response to medical therapy, improvement to regression of MR of grade 2 or less was observed in 15 patients, and there was no response or aggravation in the remaining 20 patients. The overall postoperative MV disease-free rates were $84.1\% \pm 2.7\%$ at 3 years and $79.0\% \pm 3.4\%$ at 5 years (Figure 1). Although log-rank-univariate risk factor analysis identified no use of an annuloplasty ring ($P = .031$) and use of the papillary muscle-splitting technique ($P = .015$) as risk factors for postoperative MV dysfunction, Cox multivariate analysis revealed that none of those factors were independently associated with postoperative MV dysfunction (no use of an annuloplasty ring: HR, 1.19; 95% CI, 0.44–3.19; $P = .773$; papillary muscle-splitting technique: HR, 2.15; 95% CI, 0.86–5.39; $P = .102$). Rheumatic MV

FIGURE 1. Freedom from postoperative mitral valve (*postop. MV*) disease. Overall postoperative MV disease-free rates were $84.1\% \pm 2.7\%$ at 3 years and $79.0\% \pm 3.4\%$ at 5 years.

pathology was not related to postoperative MV dysfunction (HR, 1.39; 95% CI, 0.62–3.09; $P = .416$).

Rhythm Outcomes and Antiarrhythmic Medication

Thirty-seven (17.9%) patients experienced early AF events (29 in the control group and 8 in the disease group, $P = .468$). Twenty-eight patients experienced late (>3 months) recurrence of AF during follow-up (18 in the control group and 10 in the disease group). Of them, 20 received amiodarone, which resulted in sinus rhythm conversion in all. Of those 20 patients, 11 re-experienced AF recurrence after discontinuation of amiodarone and were restarted on the medication subsequently. Of 8 individuals who were not treated with amiodarone, 2 regained sinus rhythm by means of electrical cardioversion, and 6 were left untreated for AF because they were single episodes detected by means of Holter monitoring without symptoms. None of the patients who experienced late AF recurrence progressed to persistent AF. Another 34 patients had been taking amiodarone from the early postoperative period, and the treatment was eventually discontinued without any episode of late AF recurrence. The overall AF-free rates without antiarrhythmic medication were $89.2\% \pm 2.3\%$ at 3 years, $82.0\% \pm 3.5\%$ at 5 years, and $75.5\% \pm 5.4\%$ at 8 years. Late AF recurrence was more frequent in the disease group than in the control group ($P = .014$, Figure 2).

Univariate risk factor analysis for other variables revealed that a larger preoperative LA size (>60 mm, $P = .045$) and the presence of an early postoperative AF event ($P = .008$) were factors associated with late AF recurrence. Cox multivariate analysis revealed that a larger preoperative LA size, the use of microwave ablation rather than cryoablation, and the presence of an early postoperative AF event or postoper-

FIGURE 2. Freedom from atrial fibrillation (AF) without amiodarone (AMD). In the control group AF-free rates were $91.1\% \pm 2.3\%$ at 3 years and $85.9\% \pm 3.4\%$ at 5 years. In the disease group they were $81.1\% \pm 6.9\%$ at 3 years and $65.2\% \pm 10.3\%$ at 5 years.

ative MV disease were independent factors associated with AF recurrence (Table 3).

Postoperative LA Size and Transmitral A-Wave Assessments

LA size decreased immediately after the operation, from 60.1 ± 9.7 mm to 46.6 ± 6.7 mm ($P < .001$), without an intergroup difference ($P = .204$). LA size was larger in the disease group than in the control group over the 6-month to 3-year period (Figure 3).

The transmitral A-wave prevalence of patients in normal sinus rhythm was 74.5% to 95.4%. In between-group comparisons differences were found over a postoperative 2- to 3-year period (Figure 4, A). There were no significant differences in transmitral A-wave velocity between groups at each postoperative time point up to 4 years (Figure 4, B).

DISCUSSION

The present study investigated the association between postoperative mitral valvulopathy after mitral repair and maze procedure outcomes. The study found that postoperative mitral valvulopathy was associated with a greater risk of AF recurrence and patients who showed early AF events had more incidence of late AF recurrence than those who did not.

The Cox maze procedure is the most effective surgical procedure for treating AF and its adverse consequences of irregular rhythm, altered hemodynamics, and increased thromboembolic risk.^{2,10-12} Although the procedure is very effective, it does not resolve AF in all patients.^{3,5,6,10,11} A number of studies have reported that of patients who regained sinus rhythm after the maze procedure, some experienced late recurrence of AF, which limits the benefit of the

TABLE 3. Univariate and multivariate analyses of AF recurrence

	Univariate analysis	Multivariate analysis		
	<i>P</i> value	HR	95% CI	<i>P</i> value
Preoperative factors				
Age >60 y	.706			
Presence of coronary disease	.814			
Ejection fraction <50%	.455			
Left atrial size >60 mm	.028*	2.61	1.04–6.52	.041*
Cardiothoracic ratio >60%	.715			
Fine AF-wave pattern	.134	2.00	0.92–4.34	.079
Persistent vs paroxysmal AF	.271			
AF duration >5 y	.435			
Rheumatic vs degenerative	.401			
Preoperative MR vs MS	.513			
Operative factors				
Mitral ring annuloplasty	.175			
Microwave ablation vs cryoablation	.080	2.33	1.03–5.23	.041*
Minimally invasive approach	.058			
Postoperative factors				
Postoperative MV dysfunction	.014*	3.67	1.48–9.08	.005*
Presence of early AF event	.003*	3.75	1.65–8.52	.002*

HR, Hazard ratio; CI, confidence interval; AF, atrial fibrillation; MR, mitral regurgitation; MS, mitral stenosis; MV, mitral valve. **P* < .05.

procedure. The risk factors for late recurrence of AF after the maze procedure include patient age, longer preoperative AF duration, fine AF-wave pattern, and increased LA size.^{3,5,6}

Long-term pressure and volume overload on the LA wall caused by MV disease induces LA tissue stretching and fibrosis and resultant LA wall thinning and enlargement.³ These changes in LA tissue increase susceptibility to AF development. As a result, AF is observed in 40% to 60% of patients who require MV surgery.¹ Considering the preoperative pathogenesis, it can be speculated that postoperative remnant or recurrent MV disease is likely to increase the risk of AF recurrence. Although previous studies that analyzed AF recurrence after the maze procedure mainly investigated which preoperative factor might affect AF recurrence,^{3,5,6} the present study is the first to examine the association between postoperative mitral valvulopathy and rhythm outcomes. Univariate and multivariate analyses confirmed the association between postoperative mitral dysfunction and late AF recurrence, and the sequentiality of

FIGURE 3. Postoperative changes in left atrial dimension (in millimeters). Left atrial size was significantly larger in the disease group than in the control group over a 6-month to 3-year period.

events was in the order of AF recurrence following the MV dysfunction. These results strongly suggest that postoperative MV dysfunction negatively affects the rhythm outcomes after the combination of MV repair and the maze procedure.

In the present study LA size was significantly larger in the disease group than in the control group in most postoperative periods. However, postoperative LA size was about 47 to 50 mm in the disease group, and intergroup discrepancy in LA size was about 4 mm, which is not similar to the degree of LA enlargement seen in patients with MV disease who have AF in general. This relatively small between-group difference in LA size might be explained by LA wall resection performed during the maze procedure. With the same amount of volume and pressure load, the effect of LA enlargement is expected to be reduced if the LA wall mass is reduced.

The present study revealed that patients who had early AF events had more than 3 times the incidence of late AF recurrence than those who did not (HR, 3.75). It seems to be a significant finding that the rhythm status in the early postoperative period has a strong predictive value in the long-term rhythm outcome after the maze procedure. This finding suggests that patients who have early AF events should not be regarded as they are in a transient state in the postablation blank period but should be carefully monitored for late AF recurrence in the long-term.

Since the introduction of standardized techniques for MV reconstruction, MV repair has become the surgical treatment of choice for MR.¹³ Although repair durability is acceptable for most patients, some require late reoperation for recurrent MV dysfunction.^{14–18} A study evaluated MR recurrences using echocardiographic follow-up after mitral repair and found that freedom from recurrence of nontrivial MR was 58.6% at 5 years and only 27.2% at 7 years.¹⁴ In that study the linearized recurrence rate of MR of greater than grade 1 was 6.9% per year, and that of MR of greater than grade 2

FIGURE 4. Transmittal A-wave prevalence (A) and velocity (B). Beyond the immediate postoperative period, A-wave prevalence was maintained at greater than 80% up to 4 years. In intergroup comparisons the differences were found over a 2- to 3-year period, with a lower A-wave prevalence in the disease group. There were no significant differences in transmittal A-wave velocity between groups throughout the postoperative period.

was 2.5% per year. These findings strongly suggest progression of the degenerative process over time. In the present study the presence of postoperative MV disease was defined by using echocardiographic data and was presented as a time-related event to precisely delineate the relationship between postoperative MV dysfunction and AF recurrence. Of the 39 patients who had postoperative MV disease, the disease was detected in only 6 before hospital discharge, whereas it was detected in the remaining 33 patients during follow-up. If we had defined the risk group according to the immediate postoperative echocardiographic assessment only, those patients with late recurrence of MV disease would have been included in the control group, which in turn would have created a misinterpretation regarding the relationship between postoperative MV dysfunction and AF recurrence. The finding that MV dysfunction was mostly detected after discharge reflects that the recurrence of MV disease after MV repair is an ongoing process, which is consistent with a previously reported study.¹⁴ The findings highlight that even when initial echocardiographic assessment indicates successful MV repair, careful long-term follow-up echocardiographic analysis is required to assess

any MV function deterioration. These efforts seem to be necessary not only for the selection of reoperation candidates but also for predicting AF recurrence, which heightens the risk of lethal thromboembolic complications.

Another interesting finding in this study is that the use of microwave ablation resulted in greater AF recurrence compared with cryoablation. Although a number of studies had reported excellent results with the use of microwave ablation in AF ablation surgery, those studies have recorded follow-up rhythm data for only less than 1 year.¹⁹⁻²¹ This is quite contrary to cryoablation, for which long-term results have shown similar results as seen with the conventional cut-and-sew Cox maze procedure in terms of restoration and maintenance of sinus rhythm.^{4,22,23} To our knowledge, only 1 study has investigated the long-term (>1 year) outcomes of LA endocardial microwave ablation.²⁴ In that study, with a mean follow-up duration of 5.37 ± 0.91 years, only 39.3% of patients were in sinus rhythm after 5 years. The authors concluded that microwave ablation is not a reliable method for achieving long-term conversion to sinus rhythm because of a lack of lesion transmural. In support of their hypothesis, a postmortem histologic study in which 3 patients underwent microwave ablation for the treatment of AF showed that in autopsies performed within 22 days of surgical intervention, the atrial lesions were not transmural and the extent of myocardial damage was highly variable.²⁵

The result of the present study also raises a question on the efficacy of microwave ablation. Because there has been no study comparing the long-term effect of microwave ablation and cryoablation, further studies are necessary to verify the result from the present study.

Limitations

This study is subject to the limitations inherent to retrospective observational data studies. Efforts made to overcome such limitations included prospective data collection and storage of data in a designed and regimented database. The purpose of this study was to delineate the influence of postoperative MV dysfunction on AF recurrence in the long-term after surgical intervention. Therefore patients who initially did not have restored sinus rhythm were excluded from the analyses. This patient selection might have led to the difference with results from other studies, which reported the clinical significances of patients' preoperative conditions on the rhythm outcomes after the maze procedure.

LA size dilatation caused by MV disease is the most important phenomenon in the pathogenesis of AF development. However, AF itself has the effect of LA chamber enlargement when assessed by means of echocardiography or other imaging studies. In our study we could not determine whether an increase in LA size in the disease group was the result of postoperative MV dysfunction or

a phenomenon caused by AF recurrence. To address this issue, patients should be grouped into 4 groups according to the presence or absence of postoperative MV dysfunction and AF recurrence, respectively, and LA size should be compared between the groups. However, there were only 11 patients who showed recurrent AF in the disease group and only 18 patients in the control group. This sample size was too small to generate statistical power when serial changes in LA size were compared between the groups. Such analysis requires a larger patient population.

The measurement of LA dimension was used in the present study; however, LA volume index might be a better indicator of LA size, which takes into account the patient's body surface area.

CONCLUSIONS

Postoperative MV dysfunction and early AF events were found to be independent factors associated with late AF recurrence after MV repair combined with the maze procedure. Patients with postoperative MV dysfunction had a greater LA size throughout the postoperative period than those without MV dysfunction. Any patient with MV dysfunction postoperatively should be closely monitored for AF recurrence and adequately managed.

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