Mid-Term Results of the Cox Maze III Procedure Combined With Open Mitral Commissurotomy for the Treatment of Rheumatic Mitral Stenosis

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Background: The purpose of the present study was to evaluate the mid-term results of the Cox maze III procedure (CM-III) combined with open mitral commissurotomy (OMC) for the treatment of rheumatic mitral stenosis (MS) associated with persistent atrial fibrillation (AF).

Methods and Results: Cardiac rhythm was determined before and after surgery in 50 patients with MS presenting with AF who underwent OMC with modified CM-III using cryoablation between May 2001 and April 2009. At late follow up among 50 patients, 45 patients (90%) maintained sinus rhythm (SR) for 6–97 months after surgery. The maintenance rates of SR were 91.7%, 89.2%, and 89.2% at 1, 3, and 5 years after surgery, respectively. Preoperative left atrial dimension ($P=0.016$) and AF or junctional rhythm at discharge ($P<0.001$) were found to significantly influence the maintenance of SR after CM-III. Late follow-up echocardiography performed after a mean interval of 28.7 months (range, 1–85 months) showed mitral valve areas ranging from 1.20 to 2.60 cm² and pressure gradients across the mitral valve ranging from 1.80 to 7.0 mmHg. There were 2 late deaths, but no early death, and no reoperation was required during the follow-up period.

Conclusions: The addition of CM-III to OMC was safe and effective for selected patients. A preoperative large left atrial size was found to be significantly associated with AF treatment failure. (*Circ J* 2010; **74**: 1332–1338)

Key Words: Atrial fibrillation; Mitral valve; Rheumatic heart disease

Percutaneous balloon mitral commissurotomy (BMC) has become the procedure of choice for isolated, uncomplicated mitral stenosis (MS) with a favorable morphology.^{1,2} Open-heart surgical procedures, however, including open mitral commissurotomy (OMC), are still performed on patients with extensively damaged and calcified mitral valves or other valvular diseases, and on patients who require left atrial thrombectomy.³

Atrial fibrillation (AF) is a frequent complication in patients with MS. When AF develops, a patient with MS may experience problems, such as left atrial thrombus, systemic embolism,⁴ an increase in heart size, and reduced cardiac output. The maze procedure is currently regarded as an efficient surgical technique for the management of medically refractory AF, and has demonstrated efficacy in patients with AF associated with valvular, coronary, or congenital heart disease, similar to that in patients with AF alone.⁵ Several researchers have reported that combining the maze procedure

with mitral valve surgery has advantages with regard to survival,⁶ cardiac function,^{7,8} and stroke incidence.^{9,10} Little information, however, is available on late follow-up results after the Cox maze III procedure (CM-III) combined with OMC for the treatment of rheumatic MS.

In the present study we surveyed the course of cardiac rhythm after CM-III in 50 patients who underwent OMC for rheumatic MS over an 8-year period, and investigated the maintenance rate of sinus rhythm (SR) after it had been restored by surgery. In addition, we also sought to identify the risk factors of late AF recurrence and AF treatment failure in patients with MS.

Methods

Patients and Clinical Follow-up

Between May 2001 and April 2009 we performed OMC in 71 patients, which represented 22% of all mitral valve pro-

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cedures for rheumatic MS. Among these 71 patients, 50 patients (50/71, 70%) underwent concomitant CM-III for associated AF at the Samsung Medical Center, Seoul, Korea. We excluded patients who underwent concomitant coronary artery bypass grafting. Data obtained from operative notes, clinical case histories, and laboratory investigations, including electrocardiograms (ECG) and echocardiograms were retrospectively reviewed. Follow-up data were collected from outpatient clinic records or during telephone conversations with patients. Functional statuses were assessed according to the New York Heart Association (NYHA) classification. Preoperative profiles of the 50 patients are listed in **Table 1**. Preoperative mean mitral valve area was $1.07 \pm 0.33 \text{ cm}^2$ (0.44–2.3 cm^2). Pressure gradients across the mitral valve ranged from 2.8 to 42 mmHg (mean, $8.8 \pm 6.2 \text{ mmHg}$).

All patients in this series had persistent AF, defined as continuous AF >3 months before surgery, which was not self-terminating. There were several exclusion factors for CM-III including extremely enlarged left atrial size (>80 mm), left atrial calcification, and significant tricuspid valve regurgitation associated with severe right atrial enlargement. Transesophageal echocardiography was performed to evaluate left atrial thrombus. Indications for the operations included moderate–severe MS (n=45, 90%), significant tricuspid valve disease (n=4, 8%), left atrial thrombus (n=16, 32%), aortic valve disease (n=13, 26%), and re-stenosis after percutaneous BMC (n=5, 10%). Some patients had more than one indication.

Postoperative rhythms were checked during postoperative hospitalization on continuous cardiac monitoring with trans-telephonic ECG devices. Follow-up ECGs of the outpatient clinic were checked postoperatively at 1, 3, 6 months, and then annually in all patients. Late recurrence of AF was defined as AF recurrence or atrial flutter development at least 6 months after postoperative conversion to SR. Patients who developed early postoperative AF or late recurrent AF were treated with amiodarone. AF treatment failure was defined as permanent AF or junctional rhythm >1 year after CM-III despite the addition of anti-arrhythmic medications. Warfarin was given

Table 1. Preoperative Profile of the Study Cohort (n=50)

Characteristics	
Age (years)	54.3±10.9
Sex	M/F (12/38)
Weight (kg)	58.1±10.2 (42–82)
BSA (m ²)	1.59±0.18 (1.32–2.03)
AF duration (months)	38.1±45.9 (1.2–240)
Preoperative thromboembolic events	19 (38%)
Preoperative warfarin use	31 (62%)
NYHA (≥III)	22 (44%)
LA thrombus	16 (32%)
Echocardiogram data	
LAD (mm)	56.0±7.1
LVEF (%)	56.0±7.3
TR (≥moderate)	4 (8%)

BSA, body surface area; AF, atrial fibrillation; NYHA, New York Heart Association classification; LA, left atrium; LAD, left atrial dimension; LVEF, left ventricular ejection fraction; TR, tricuspid regurgitation.

to all patients for 3–6 months soon after starting oral intake, and was discontinued in patients with SR. In patients with sustained AF, warfarin was continued long term with a target international normalized ratio (INR) range of 1.8–2.5. Cardioversion was used when a patient had hemodynamic compromise during AF episodes. Risk factors of AF treatment failure were analyzed by comparing the patients who were in SR and those in permanent AF or junctional rhythm at late follow up.

Surgical Procedure (Figure 1)

All procedures were performed using routine cardiopulmonary bypass with bicaval and aortic cannulation under moderate hypothermia. After complete cardiac arrest was accomplished, we performed OMC first, and followed this with the maze procedure, which was performed using cryo-

Figure 1. Schematic diagram of the modified Cox maze III procedure using cryoablation. Ao, aorta; IVC, inferior vena cava; LAA, left atrial appendage; MV, mitral valve; PV, pulmonary vein; SVC, superior vena cava; TV, tricuspid valve.

Figure 2. (A) Custom-made T-shaped (4 cm) and (B) straight (6 cm) cryoprobes (Frigitronics, Cooper Surgical). Cryoablation lesions were created endocardially with custom-made straight (6 cm) and T-shaped (4 cm) cryoprobes (Frigitronics, Cooper Surgical; **Figure 2**). Cryogenerators were set at -60°C . Each cryoablation was delivered for 2 min 30 s to achieve transmural lesions, as pre-

Table 2. Concomitant Procedures	
	n (%)
Other mitral valve procedure	
Posterior leaflet augmentation	2 (4)
Aortic valve procedure	
AVR	9 (18)
AV repair	4 (8)
Tricuspid valve procedure	
TAP	35 (70)
TVR	1 (2)
ASD primary closure	1 (2)

AVR, aortic valve replacement; AV, aortic valve; TAP, tricuspid annuloplasty; TVR, tricuspid valve replacement; ASD, atrial septal defect.

viously described.¹¹ Our modified maze procedure included the substitution of cryoablation for multiple atrial incisions and the preservation of the right and left atrial appendages. The reduction of both atrial dimensions by partial resection of the atrial wall has been performed at Samsung Medical Center since 2005. Resection of the inferior wall of left atrium (LA) was performed as much as possible, whenever the size of the LA was >60 mm on preoperative echocardiogram or its enlargement was definite on operative findings ($n=11$, 22%).

First, the left-sided maze procedure was performed. A standard right-sided left atriotomy was made and extended superiorly and inferiorly. After left atriotomy, the cryoablation line was applied on the incisional ridge between the upper and lower left pulmonary veins. The lesion was then extended to the left atrial appendage isolating the left pulmonary veins. The left isthmus was cryoablated, and suture obliteration of the left atrial appendage was performed. Sec-

Figure 3. Changes in cardiac rhythm after surgery. AF, atrial fibrillation; OR, operating room; Preop., preoperative status.

Figure 4. Maintenance rate of sinus rhythm (SR) after surgery (**A**) in the OMC/CM-III patients, and (**B**) comparison between the (—■—) OMC/CM-III (n=50) and the (···○··) MVP/CM-III group (n=90). $P=0.250$ (log-rank test). CM-III, Cox maze III procedure; MVP, mitral valve repair; OMC, open mitral commissurotomy.

ond, the right-sided maze procedure was performed while preserving the right appendage in all patients. A lateral incision, parallel to the right atrioventricular groove, was placed from the base of the right atrial appendage toward the inferior vena cava. The cryoablation line was applied from the posterior annulus of the tricuspid valve toward the coronary sinus, and then this cryoablation lesion was extended to the site of the left atriotomy. When the right atrium was large or tricuspid valve incompetence was significant, another right-

sided lesion was made from the right atriotomy to the anterior annulus of the tricuspid valve. We placed a lesion from the superior vena cava to the inferior vena cava. After completing these procedures, other valve operations were performed. The concomitant procedures are detailed in [Table 2](#).

Data Collection and Statistical Analysis

Data were collected and managed using Microsoft Excel 2003 and analyzed using SPSS 11.0 (SPSS, Chicago, IL, USA).

Table 3. Factors Affecting AF Treatment Failure

Factors	Group A (n=45)	Group B (n=5)	P value
Age (years)	54.3±11.2	54.1±8.5	0.980
Preoperative Hb (g/dl)	13.5±1.7	13.2±1.0	0.732
Duration of AF (months)	38.0±47.9	38.9±23.7	0.968
Preoperative echo data			
LAD (mm)	55.2±6.9	63.2±5.0	0.016
LVEF (%)	56.1±7.5	55.0±6.0	0.759
TR ≥moderate	3	1	0.297
MVA <1.0 cm ²	17	4	0.070
NYHA class ≥III	18	4	0.087
CPB time (min)	121.0±39.2	119.6±27.5	0.937
ACC time (min)	98.7±34.6	95.8±26.8	0.857
AF or junctional rhythm at discharge	0	4	<0.001
Residual MS (postoperative MVA ≤1.5 cm ²)	10	1	0.955

Hb, hemoglobin; MVA, mitral valve area; CPB, cardiopulmonary bypass; ACC, aortic cross-clamp; MS, mitral stenosis. Other abbreviations see in Table 1.

Categorical variables were compared using the chi-square test, and continuous variables using Student's t-test. Kaplan–Meier survival curve analysis was used to estimate SR maintenance, and survival curves were compared using the log-rank test. All results are expressed as mean±SD, and $P<0.05$ was considered statistically significant. Early mortality was defined as death within 30 days of surgery or prior to hospital discharge.

The present study was approved by the institution's ethics committee/institutional review board. Informed consent was waived by the ethics committee/institutional review board owing to the retrospective nature of our study.

Results

Early Postoperative Data

Mean cardiopulmonary bypass time was 120.9±37.9 min and mean aortic cross-clamp time was 98.4±33.7 min. There was no in-hospital death. Mean ventilator care time was 11.3±7.0 h (range, 4–43 h), and mean hospital stay was 10.6±5.8 days (range, 6–33 days). Postoperative cardioversion was used in a patient, and then SR was restored. There was one early reoperation due to postoperative bleeding.

Late Follow-up Data

Late follow up was achieved in all 50 patients, with a mean follow-up duration of 45.2±26.4 months (range, 6–97 months). There were 2 late deaths (4%). One was a non-cardiac-related death (accident), and the other was a sudden death. No thromboembolic event occurred during follow up. Reoperation was not required by any patient, and there was no postoperative pacemaker insertion. When a patient with SR had residual mild MS, preoperative thromboembolic event, stroke history, or large left atrial size, we used low-dose warfarin (target INR range 1.5–2.0). Four patients with SR have used warfarin, which excluded the patients who had mechanical valve replacement surgeries. Low-dose amiodarone (50 mg/day) was used on 2 patients with SR at late follow up.

Changes in Cardiac Rhythm After Surgery (Figure 3)

SR was restored in 44 patients (88%) in the operating room (OR) after surgery. In 42 of these patients, SR was maintained during hospitalization after surgery, and the other two reverted to AF or junctional rhythm after surgery despite

amiodarone. The remaining 6 patients (12%) had junctional rhythm or bradycardia in the OR after surgery, but SR was restored in 4 of these patients during hospitalization after surgery. Summarizing, 46 (92%) out of 50 patients had successfully reverted to SR at the time of discharge from hospital. The maintenance rates of SR in all patients was 91.7%, 89.2%, and 89.2% at 1, 3, and 5 years after surgery, respectively (Figure 4A). The actuarial maintenance rate of SR in the patients who maintained SR at the time of discharge from hospital was 97.5% 5 years after surgery.

We compared the outcomes of the present 50 patients (the OMC/CM-III group) with those of 90 patients who underwent CM-III combined with mitral valve repair (MVP) for mitral regurgitation (MR) and associated AF at Samsung Medical Center over the same period (the MVP/CM-III group). There were 53 men and 37 women of overall mean age 58.1±11.5 years (range, 24–80 years) at operation. Mean duration of AF was 40.6±48.3 months (3–300 months) among these 90 patients. The sinus conversion rate at late follow up was 84.4% (76/90) in the MVP/CM-III group and 90% (45/50) in the OMC/CM-III group. Although the maintenance rate of SR in the OMC/CM-III group was higher than that in the MVP/CM-III group, this difference did not reach statistical significance ($P=0.250$; Figure 4B).

Factors Affecting AF Treatment Failure

We divided the present 50 patients into 2 groups according to cardiac rhythm after surgery: group A consisted of 45 patients (90%) who reverted to SR after surgery and maintained SR, and group B consisted of 5 patients (10%) who retained AF or junctional rhythm after surgery (Figure 3). Group A and group B were then compared with respect to various factors that were expected to influence mid-term CM-III results (Table 3). Notably, preoperative left atrial dimension ($P=0.016$) and AF or junctional rhythm at discharge ($P<0.001$) were found to be significant risk factors for AF treatment failure.

Changes in Mitral Valve Function and Functional Status After Operation

In the 50 patients, final echocardiography performed at a 28.7±22.8 months postoperatively (range, 1–85 months) indicated mitral valve areas ranging from 1.20 to 2.60 cm² (mean, 1.85±0.40 cm²) and pressure gradients across the mitral valve

ranging from 1.80 to 7.0 mmHg (mean, 3.85 ± 1.26 mmHg). Trivial MR was present in 13 patients (26%), and 1 patient (2%) had mild MR (Table 4). At the time of last follow up, 49 patients were in NYHA class I or II, and the functional status had improved after surgery ($P < 0.001$).

Discussion

Main Results

The main findings of the present study were as follows. First, CM-III after OMC was safe and effective in selected patients who had rheumatic MS with AF. Second, CM-III for persistent AF associated with rheumatic MS achieved a high rate of SR conversion after surgery. Third, patients who reverted to SR after surgery and were discharged from hospital in SR had a high SR maintenance rate during follow up. Fourth, the patients with late AF recurrence and those with AF treatment failure had larger left atrial dimensions than those in SR. In view of these findings, we concluded that CM-III combined with OMC could be an effective treatment option in patients with rheumatic MS associated with persistent AF, and that its use was associated with significant decreases in morbid events associated with MS or AF, such as systemic embolism, hemodynamic compromise, and adverse reactions to anti-arrhythmic agents and anticoagulants. To our knowledge this is the first report about the results of CM-III combined with OMC for the treatment of rheumatic MS, although there are several reports about BMC and radiofrequency catheter ablation in patients with MS.^{12–14}

At Samsung Medical Center percutaneous BMC is the procedure of choice for isolated uncomplicated MS.¹⁵ Although better hemodynamic and long-term results are obtained using OMC,^{16–18} it is viewed as a procedure of second choice because of its higher cost and higher level of surgery-related morbidities. But if a valve is calcified or affected by severe subvalvular disease, or if the associated left atrial/appendicular clot/thrombus does not dissolve after adequate anticoagulant therapy, open-heart surgical strategy is indicated. The presence of moderate–severe MR, significant tricuspid valve disease, or aortic valve disease also necessitates an open-heart procedure. OMC is not always possible in patients with MS undergoing open-heart surgical procedure. MVR is sometimes a simpler and more durable option than OMC in this patient subset, but patient survival is better after OMC.^{19,20} Furthermore, the presence of thromboembolism, anticoagulant-related hemorrhage, or other valve-related complications outweighs considerations of valve replacement durability.¹⁹ In our experience, no in-hospital death or thromboembolic event has occurred after surgery, and patient functional status invariably improved ($P < 0.001$).

Since Cox et al reported that CM-III is associated with a high rate of SR reinstatement, less arrhythmia recurrence, and improved atrial transport function,^{21,22} it has been viewed as the technique of choice for the management of medically refractory AF. Several researchers have reported encouraging results for CM-III in patients with mitral valve disease associated with AF.^{10,23–25} In the present study it was found that 88% of OMC/CM-III patients reverted to SR in the OR after surgery, and that 92% had successfully reverted to SR at discharge. Furthermore, the 46 patients who reverted to SR after surgery and were discharged in SR had a high SR maintenance rate (97.5%) during the follow-up period of 45.2 months. In addition, we also compared the outcomes of these patients with those of 90 MVP/CM-III patients treated for MR and associated AF to define the efficacy of the opera-

Table 4. Prevalence of MR Before and After Surgery

MR grade	Before surgery, n (%)	After surgery, n (%)
0	35 (70)	36 (72)
Trivial	15 (30)	13 (26)
Mild	0	1 (2)
Moderate	0	0
Severe	0	0

MR, mitral regurgitation.

tion in the OMC/CM-III group. It was found that the maintenance rate of SR among the patients in the OMC/CM-III group (90%) was greater than that in the MVP/CM-III group (84%). Although this difference did not reach statistical significance ($P = 0.250$), OMC/CM-III had reasonable results compared with the MVP/CM-III.

The risk factors of AF treatment failure identified in previous studies on patients with mitral valve disease associated with AF include advanced age, AF duration, larger left atrial dimension, lower amplitude f-wave, lower preoperative left atrial emptying fraction,²⁶ and a greater cardiothoracic ratio.^{25,27,28} In the present study we found that 10% of patients (5/50) were permanently in AF or junctional rhythm after surgery, and these patients were defined as having AF treatment failures. Preoperative left atrial dimension ($P = 0.016$) and AF or junctional rhythm at discharge ($P < 0.001$) were found to be significant risk factors for these patients.

Study Limitations

Several limitations of the present study require consideration. First, this was neither a prospective study nor a case-controlled study, and thus, patients were not matched for either demographics or concomitant surgical procedures. Second, the present study involved a relatively small number of patients, which may explain why some characteristics identified by others, especially as predictors of recurrent AF and AF treatment failure, were not found to be significant.

Conclusion

It was found that CM-III combined with OMC for persistent AF with rheumatic MS was safe and effective in a selected group of patients. Sinus conversion at discharge from hospital was found to predict SR maintenance significantly. The present findings also suggest that a large preoperative left atrial dimension is probably associated with AF treatment failure. For selected patients who have persistent AF associated with rheumatic MS, CM-III combined with OMC could be an effective treatment option.

References

- Reyes VP, Raju BS, Wynne J, Stephenson LW, Raju R, Fromm BS, et al. Percutaneous balloon valvuloplasty compared with open surgical commissurotomy for mitral stenosis. *N Engl J Med* 1994; **331**: 961–967.
- Ben Farhat M, Ayari M, Maatouk F, Betbout F, Gamra H, Jarra M, et al. Percutaneous balloon versus surgical closed and open mitral commissurotomy: Seven-year follow-up results of a randomized trial. *Circulation* 1998; **97**: 245–250.
- Choudhary SK, Dhareshwar J, Govil A, Airan B, Kumar AS. Open mitral commissurotomy in the current era: Indications, technique, and results. *Ann Thorac Surg* 2003; **75**: 41–46.
- Coulshed N, Epstein EJ, McKendrick CS, Galloway RW, Walker E. Systemic embolism in mitral valve disease. *Br Heart J* 1970; **32**: 26–34.

5. Prasad SM, Maniar HS, Camillo CJ, Schuessler RB, Boineau JP, Sundt TM 3rd, et al. The Cox maze III procedure for atrial fibrillation: Long-term efficacy in patients undergoing lone versus concomitant procedures. *J Thorac Cardiovasc Surg* 2003; **126**: 1822–1828.
6. Kobayashi J, Sasako Y, Bando K, Niwaya K, Tagusari O, Nakajima H, et al. Eight-year experience of combined valve repair for mitral regurgitation and maze procedure. *J Heart Valve Dis* 2002; **11**: 165–171; discussion 171–172.
7. Albirini A, Scalia GM, Murray RD, Chung MK, McCarthy PM, Griffin BP, et al. Left and right atrial transport function after the Maze procedure for atrial fibrillation: An echocardiographic Doppler follow-up study. *J Am Soc Echocardiogr* 1997; **10**: 937–945.
8. Yuda S, Nakatani S, Kosakai Y, Yamagishi M, Miyatake K. Long-term follow-up of atrial contraction after the maze procedure in patients with mitral valve disease. *J Am Coll Cardiol* 2001; **37**: 1622–1627.
9. Ad N, Cox JL. Combined mitral valve surgery and the Maze III procedure. *Semin Thorac Cardiovasc Surg* 2002; **14**: 206–209.
10. Bando K, Kobayashi J, Kosakai Y, Hirata M, Sasako Y, Nakatani S, et al. Impact of Cox maze procedure on outcome in patients with atrial fibrillation and mitral valve disease. *J Thorac Cardiovasc Surg* 2002; **124**: 575–583.
11. Kim YH, Lee SC, Her AY, Kim HJ, Choi JO, Shin DH, et al. Preoperative left atrial volume index is a predictor of successful sinus rhythm restoration and maintenance after the maze operation. *J Thorac Cardiovasc Surg* 2007; **134**: 448–453.
12. Machino T, Tada H, Sekiguchi Y, Tanaka Y, Naito S, Yamasaki H, et al. Hybrid therapy of radiofrequency catheter ablation and percutaneous transvenous mitral commissurotomy in patients with atrial fibrillation and mitral stenosis. *J Cardiovasc Electrophysiol* 2009 Oct 8 [Epub ahead of print].
13. Miyaji K, Tada H, Ito S, Naito S, Yamada M, Hashimoto T, et al. Percutaneous transvenous mitral commissurotomy and radiofrequency catheter ablation in patients with mitral stenosis. *Circ J* 2005; **69**: 1074–1078.
14. Yamane T. Catheter ablation for atrial fibrillation: What is the necessary and appropriate endpoint of the procedure? *Circ J* 2009; **73**: 227–228.
15. Bonow RO, Carabello BA, Chatterjee K, de Leon AC Jr, Faxon DP, Freed MD, et al. 2008 focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to revise the 1998 guidelines for the management of patients with valvular heart disease): Endorsed by the Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. *J Am Coll Cardiol* 2008; **52**: e1–e142.
16. Eguaras MG, Luque I, Montero A, Moriones I, Granados J, Garcia MA, et al. Conservative operation for mitral stenosis: Independent determinants of late results. *J Thorac Cardiovasc Surg* 1988; **95**: 1031–1037.
17. Ben Farhat M, Boussadia H, Gandjbakhch I, Mzali H, Chouaieb A, Ayari M, et al. Closed versus open mitral commissurotomy in pure noncalcific mitral stenosis: Hemodynamic studies before and after operation. *J Thorac Cardiovasc Surg* 1990; **99**: 639–644.
18. Dettler C, Fischlein T, Feldmeier C, Nollert G, Reichenspurner H, Reichart B. Mitral commissurotomy, a technique outdated? Long-term follow-up over a period of 35 years. *Ann Thorac Surg* 1999; **68**: 2112–2118.
19. Eguaras MG, Montero A, Moriones I, Granados J, Garcia MA, Luque I, et al. Conservative operation for mitral stenosis with densely fibrosed or partially calcified valves: An eight-year evaluation. *J Thorac Cardiovasc Surg* 1987; **93**: 898–903.
20. Glower DD, Landolfo KP, Davis RD, Cen YY, Harrison JK, Bashore TM, et al. Comparison of open mitral commissurotomy with mitral valve replacement with or without chordal preservation in patients with mitral stenosis. *Circulation* 1998; **98**: II-120–II-123.
21. Cox JL, Boineau JP, Schuessler RB, Jaquiss RD, Lappas DG. Modification of the maze procedure for atrial flutter and atrial fibrillation. I: Rationale and surgical results. *J Thorac Cardiovasc Surg* 1995; **110**: 473–484.
22. Cox JL, Schuessler RB, Lappas DG, Boineau JP. An 8½-year clinical experience with surgery for atrial fibrillation. *Ann Surg* 1996; **224**: 267–273; discussion 273–265.
23. Izumoto H, Kawazoe K, Kitahara H, Kamata J. Operative results after the Cox/maze procedure combined with a mitral valve operation. *Ann Thorac Surg* 1998; **66**: 800–804.
24. Baek MJ, Oh SS, Lee CH, Na CY. Outcome of the modified maze procedure for atrial fibrillation combined with rheumatic mitral valve disease using cryoablation. *Interact Cardiovasc Thorac Surg* 2005; **4**: 130–134.
25. Itoh A, Kobayashi J, Bando K, Niwaya K, Tagusari O, Nakajima H, et al. The impact of mitral valve surgery combined with maze procedure. *Eur J Cardiothorac Surg* 2006; **29**: 1030–1035.
26. Aikawa M, Watanabe H, Shimokawa T, Inoue K, Takamisawa I, Seki A, et al. Preoperative left atrial emptying fraction is a powerful predictor of successful maze procedure. *Circ J* 2009; **73**: 269–273.
27. Kamata J, Kawazoe K, Izumoto H, Kitahara H, Shiina Y, Sato Y, et al. Predictors of sinus rhythm restoration after Cox maze procedure concomitant with other cardiac operations. *Ann Thorac Surg* 1997; **64**: 394–398.
28. Kim KC, Cho KR, Kim YJ, Sohn DW, Kim KB. Long-term results of the Cox–Maze III procedure for persistent atrial fibrillation associated with rheumatic mitral valve disease: 10-year experience. *Eur J Cardiothorac Surg* 2007; **31**: 261–266.