Surgical Treatment of Chronic Atrial Fibrillation: Report of 8 cases

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Since February 2003, we have conducted surgical treatment on 8 patients complicated with chronic atrial fibrillation during cardiac surgery. A radial procedure was conducted on 7 patients, and pulmonary vein isolation was conducted on 1 patient. Underlying diseases included mitral regurgitation (MR) in 5 patients, mitral stenosis (MS) in 1 patient, aortic stenosis (AS) + MS in 1 patient and chronic type A dissociation in 1 patient. Simultaneous procedures included mitral valve plasty (MVP) in 3 patients, mitral valve replacement (MVR) in 3 patients, aortic valve replacement (AVR) + MVR in 1 patient, and aortic root reconstruction by reimplantation procedure + total arch replacement in 1 patient. The operation time was 320 to 840 minutes and 458.1 ± 171.1 minutes on average. The cardiopulmonary bypass time was 204 to 404 minutes and 266.7 ± 62.7 minutes on average. The aortic cross-clamp time was 142 to 271 minutes and 171 ± 41.5 minutes on average. One patient died in hospital. Six patients returned to sinus rhythm, and 1 patient required pacemaker implantation. The follow-up period was 2 to 37 months and 13.6 ± 15 months on average. When cryoablation was changed to radiofrequency ablation to assist preparation of the block line, a tendency toward shortening of the aortic clamping time was observed.

Key words: atrial fibrillation, MAZE procedure, radial procedure, radiofrequency ablation, cryoablation

INTRODUCTION

Atrial fibrillation (AF) is the most common arrhythmia associated with poor prognosis in clinical practice [1]. The morbidity associated with AF includes patient's discomfort and anxiety caused by tachyarrhythmia, hemodynamic compromise secondary to loss of atrial contraction, and thromboembolic complications, as a result of stasis in the left atrium [2-5]. Current management of AF includes antiarrhythmic drugs, cardioversion, percutaneous transcatheter ablation, and surgery. Although drugs can induce chemical cardioversion, their failure rate in some series is as high as 60% in 2 years [6]. When cardioversion fails, the use of chronic anticoagulation for stroke prevention is associated with significant morbidity. Because the pulmonary veins have been shown to be the source of ectopic foci in many patients with paroxysmal AF, the use of catheter ablation and isolation of the pulmonary veins has gained popularity [7-9]. Unipolar catheter applications using radiofrequency (RF) energy have some limitations, including high tissue temperature (90˚C) and resultant collateral tissue damage. Although RF energy by endocardial application has met with good short-term success, long-term results have demonstrated a significant recurrence rate and a defined incidence of pulmonary vein stenosis [7, 10-13].

The MAZE procedure, first performed in 1988, involved the creation of a myriad of incisions to interrupt macro-reentrant circuits felt to be responsible for AF [14]. Long-term results have been outstanding with this procedure, with a freedom from AF of 97% at a median of 5.4 years [15-16]. This procedure is difficult to perform and widespread adoption has been hindered by concerns regarding prolonged cardiopulmonary bypass and cross-clamp times, technical complexities, and bleeding complications. A variety of energy sources have been designed to create linear transmural lesions capable of reliably creating atrial conduction block.

In Japan, the MAZE procedure has been modified in various ways. Kosakai *et al*. modified the incision line in the MAZE procedure and designed the Kosakai-MAZE method [17] using cryoablation in place of many incision lines. Sueda *et al*. considered that the left atrium played an important role in maintenance of AF in AF complicated with mitral valve disease, proposed the left atrium-MAZE procedure to incise the left atrium only [18] and designed PV isolation based on Haissaguerre's report that paroxysmal AF originated more frequently from the pulmonary vein [19]. Nitta *et al*., moreover, reported a radial procedure [21] compensating the disadvantages of the MAZE procedure [20]. This procedure has an advantage that physiological atrial excitation pattern and the atrial contractility are preserved by making the atrial incision line not isolating the posterior wall of the left atrium to be radial from the sinus node to the atrioventricular annulus.

We have used a method to cut the conduction of many incision lines by cryoablation in not only mitral valve disease but also AF occurring concomitantly in cardiac surgery. Recently, simple RF ablation devices have been developed, and further shortening of operation time and improvement of defibrillation rate have been expected. Our department has conducted the radial procedure in cardiac surgery accompanied by chronic AF since February 2003, and the present study

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Table 1 Patient profile.

	Age	Gender	Underlying disease	Concomitant procedures
1	48	M	MS	MVR
2	77	M	MR, TR, Constrictive pericarditis	MVP, TAP, Pericardiectomy
3	48	F	MR, TR	MVP, TAP
4	21	F	MR, Mar	MVP (MICS)
5	58	F	AS MS (post OMC)	AVR, MVR
6	56	M	MR, TR	MVR, TAP
7	55	M	Chronic aortic dissection	Reimplantation, Arch replacement
8	74	M	MR, TR	MVR, TAP

AS: aortic stenosis; Mar: Marfan syndrome; MICS: minimally invasive cardiac surgery; MR: mitral regurgitation; MS: mitral stenosis; OMC: open mitral commisurotomy; TAP: tricuspid annuloplasty; TR: tricuspid regurgitation.

Table 2 AF procedures and Cardiopulmonary bypass data.

			Oper. time (min)	CPB time (min)	AXC time (min)
1	Radial	cryo	373	253	164
2	Radial	cryo	547	292	167
3	Radial	cryo	412	283	163
4	Radial	RF	390	204	142
5	Radial	RF	460	243	146
6	Radial	RF	323	234	166
7	PV isolation	RF	840	404	271
8	Radial	RF	320	221	149

AXC time: aortic cross-clamp time; cryo: cryoablation; CPB time: cardiopulmonary bypass time; Oper.: operation; Radial: Radial operation; RF: radiofrequency ablation.

examined the results.

SUBJECTS AND METHODS

Since February 2003, as the method of surgical treatment of chronic AF associated with cardiac surgery, the radial procedure has been conducted in 7 patients, and pulmonary vein (PV) isolation has been conducted in 1 patient. In 3 of the 7 patients, cryoablation was used concomitantly, and in the other 5 patients, RF ablation was used concomitantly. The age of patients was 21 to 77 years old and 54.6 ± 17.4 years old on average. The patients included 5 males and 3 females.

Underlying diseases included MR in 5 patients, MS in 1 patient, AS + MS in 1 patient and chronic type A dissociation in 1 patient. As simultaneous procedures, MVP was conducted in 3 patients with MR (including 1 patient with Marfan syndrome), and MVR was conducted in 2 patients. MVR was conducted in a patient with MS. AVR and MVR were conducted in patients with AS + MS (post open mitral commisurotomy). The patient with chronic dissociation underwent a reimplantation procedure to preserve the root of the autologous valve and total arch replacement. Since this patient with chronic dissociation showed prolongation of myocardial ischemia, the radial procedure was omitted, and only PV isolation was conducted (Table 1).

The surgery was conducted by medial sternotomy in all the patients. The right-angled cannula was connected to the superior vena cava (SVC) and inferior vena cava (IVC), and the cardiopulmonary bypass was established. Moderate hypothermia at 32 to 33°C was conducted, and intermittent cold blood cardioplegia was used for myocardial protection. The radial procedure [8] was conducted in accordance with the report of Nitta *et al*., and the sites where the incision in the radial procedure was substituted with cryoablation or RF ablation included the block line surrounding the bilateral PV, the one connecting the resection line of the left atrial appendage to the surrounding of the left PV, the one in the posterior wall of the left atrium toward the mitral valve annulus (between P2 and P3), the one in the lateral wall of the right atrium connecting between the SVC and IVC and two block lines toward the tricuspid valve annulus. Cryothermia was performed using 10- and 15-mm cryoprobes for 1-2 min at a temperature of −60°C. Linear lesions of RF ablation were made by a monopolar and bipolar radiofrequency irrigated ablation system (Cardioblate BP system, Medtronic, Inc., Minneapolis, MN). The time required for cautery of 1 cm was about 14 to 20 seconds in the monopolar cases, and the time required for cautery of 5 cm was about 16 seconds in the bipolar cases.

RESULTS

The operation time was 320 to 840 minutes and 458.1 ± 171.1 minutes on average. The cardiopulmonary bypass time was 204 to 404 minutes and 266.7 ± 62.7 minutes on average. The aortic cross-clamp time was 142 to 271 minutes and 171 ± 41.5 minutes on average. One patient died due to pneumonia in

hospital (case 2). Since case 5 had sinus rhythm but showed symptomatic bradycardia, DDD mode pacemaker implantation was conducted. The remaining 6 patients except for the patient who died during surgery returned to sinus rhythm. The follow-up period was 2 to 37 months and 13.6 ± 15 months on average, and sinus rhythm is maintained at present (Table 2).

COMMENTS

Since the patients with AF complicating valvular diseases have atrial loading as an underlying disease, it is difficult to treat AF alone unless the underlying disease is improved. As the surgical treatment of AF is resistant to medical treatment, Cox developed the MAZE procedure in 1988. Various modifications have been made since then, but this procedure is still the standard surgical treatment of atrial fibrillation [20].

Electrophysiological conditions of AF have not been elucidated, but it was confirmed by epicardial mapping that many electric excitations occur simultaneously in the atrium. Moe demonstrated in the simulation that reentry could occur even in the plain surface and reported the possibility of the presence of multiple wavelets (multiple wavelet hypothesis) [22]. When Cox *et al*. induced AF in patients with Wolff-Parkinson-White syndrome and conducted epicardial mapping of the atrium, it was found that multiple simple macroentries and secondary microentries disunited and fused [23]. Cox considered this to be consistent with the multiple wavelet theory showing the presence of multiple reentry circuits and wavelets and came up with the MAZE procedure [24]. In the MAZE procedure, AF is assumed to be an aggregate of macroentry, the core stimulus conduction tract is left, and the atrium is cut at a small part not inducing macroentry and sutured again. That is, the atrium is incised like a maze. Since the original MAZE procedure has many incision lines and the risk of prolongation of operation time and bleeding increases, it was not a generally applicable. Many modifications of this procedure have therefore been reported, and preparation of the block line has been simplified by using cryoablation or RF ablation in place of cut-and-saw.

We also found a tendency toward shortening of the aortic cross-clamping time by substituting cryoablation with RF ablation for preparation of the block line, and the recovery rate to sinus rhythm was relatively good in both procedures. For the treatment of paroxysmal AF and chronic AF, it is expected that the results of surgery will be improved and that surgical treatment of AF will be used more widely by selecting procedures such as PV isolation and the MAZE procedure, respectively, and by developing an energy source to prepare the block line more securely and transmurally in a shorter time.

CONCLUSIONS

When we conducted the radial procedure in patients complicated with AF during cardiac surgery, the rate of restoration to sinus rhythm was relatively good. It is expected that the results of surgery will be improved and that surgical treatment of AF will be used more widely by selecting the procedures and by developing the energy source to prepare the block line more securely and transmurally in a shorter time.

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