

INTRAOPERATIVE RADIOFREQUENCY AND CRYOABLATION FOR ATRIAL FIBRILLATION IN PATIENTS WITH VALVULAR HEART DISEASE

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Abstract- Patients with valvular heart disease and suffering from atrial fibrillation of more than 12 months duration have a low probability of remaining in sinus rhythm after valve surgery alone. We performed intra-operative radiofrequency ablation or cryoablation as an alternative to surgical maze III procedure to create linear lesions for conversion of this arrhythmia to sinus rhythm. A total of 30 patients with valvular heart disease and chronic persistent atrial fibrillation underwent different combinations of valve surgery and concomitant maze procedure with radiofrequency or cryo probes. These patients aged 48.10 ± 9.84 years in radiofrequency ablation group and 51.10 ± 13.93 years in cryoablation group. Biatrial ablation with radiofrequency probes needed 26.15 ± 3.67 min extra ischemic time and ablation by means of cryo-probes needed an extra ischemic time of 29.62 ± 4.27 min. There was no mortality except one in-hospital death postoperatively because of respiratory failure. Six months after the operation, among 30 patients with biatrial ablations, 25 patients were in sinus rhythm, no patient had junctional rhythm and 5 patients had persistent atrial fibrillation. At 12 months follow up, freedom from atrial fibrillation was 85% in radiofrequency group and 80% in cryo group. Doppler echocardiography in these patients demonstrated atrial contractility in 70% of the patients. Intraoperative radiofrequency or cryo-ablation of both atriums are effective and less invasive alternatives for the original maze procedure to eliminate the atrial fibrillation and can be done in patients with valvular heart disease without increasing the risk of operation.

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INTRODUCTION

Atrial fibrillation (AF) is a common arrhythmia that affects 0.4% of the general population and up to 10% of persons older than 65 years of age. AF is seen in about 5% of patients undergoing coronary artery bypass operation. Mitral valve disease predisposes patients to persistent AF. About 60% of patients

admitted for mitral valve surgery are known to have chronic persistent AF. In general, the arrhythmia will persist even after the valve surgery.

This rhythm affects the patients in an adverse way. Multiple side effects occur with AF, including tachycardia, palpitation, thromboembolism and 15% to 20% decrease in cardiac output due to loss of ventricular filling. At the same time, studies have provided data that a heart rate more than 120 beats/min over a prolonged period of time may lead to left ventricular dysfunction (1). Because developing AF signifies pathologic degradation and symptomatic deterioration in these patients, simultaneous treatment of AF and organic lesions

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has long been desired and expected to improve prognosis.

During the last decade, several techniques have been designed to either ablate the arrhythmia or ameliorate its detrimental effects. Attention has been focused on the development of catheter ablation technique for reversal of AF rhythm, but it has several limitations to apply a linear ablation. The only proven technique that cures all forms of AF is the Cox Maze III procedure. This operation is the result of decades of research by James Cox. He proposed that AF is due to simultaneous presence of multiple, randomly wandering reentrant wavelets. He reported a 99% success rate with his operations (2). However, the length of time it takes to do this operation is significant, lengthening pump time and aortic cross clamp time, and there are significant bleeding complications from the suture lines. Also, due to its technical complexity it has been performed on a limited number of the patients.

Radiofrequency energy produces lesions on the heart, eliminating the incisions necessary in the Maze procedure. Melo *et al.* did radiofrequency pulmonary vein isolation in association with mitral valve surgery. Atrial contractility recovered in 70% of their patients after the operation. As these procedures are not done routinely in Iran, we decided to evaluate the efficacy of these procedures in patients with AF and concomitant valvular heart disease at Madani Heart Center in Tabriz.

MATERIALS AND METHODS

From September 2003 to October 2004, 30 patients with different forms of valve pathologies and permanent AF were studied. All patients had chronic permanent AF of more than 12 months. Patients with paroxysmal AF or with persistent AF lasting less than 12 months were excluded from this study. We obtained informed consent from all patients.

The patients were 14 men (46.6%) and 16 women (53.3%), whose age ranged from 18 to 72 years with an average of 49.10 ± 11.22 years (mean \pm SD). The preoperative characteristic of the patients are shown in Table 1. Twenty four patients (80%) were in New York Heart Association (NYHA) class III. Mitral valve disease was the primary indication for surgery.

Associated morphologic cardiac diseases included mitral stenosis (n=28, 93.3%), aortic valve insufficiency (n=18, 60%), mitral valve regurgitation (n=16, 53.3%), sever tricuspid regurgitation (n=4, 13.33%), aortic valve stenosis (n = 4, 13.3%) as are shown in Table 2. Two patients (6.6%) had previously undergone mitral valve surgery.

The average size of the left atrium as measured by echocardiography was 5.52 ± 0.78 mm (range 42-78 mm). In all patients rate control medications such as calcium blocker and/or digoxin were continued until the day before surgery. ECGs were recorded during recovery and before discharge. Standard 12 leads ECGs and TTE were performed 1, 3, 6 and 12 months after operation. The follow up period ranges from 3 to 12 months.

Surgical technique

These patients underwent a modified maze III procedure with the use of radiofrequency energy or cryo, combined with valvular surgery. They were submitted to different combinations of valve surgery.

After the induction of anesthesia, the heart was exposed through the conventional median sternotomy. After heparin administration and cannulation, cardiopulmonary bypass with moderate hypothermia, the heart was arrested by antegrade crystalloid cold cardioplegia.

The right atrium was opened and by means of a radiofrequency saline irrigated probe or cryoablation probe, ablation was done in the right atrium. In the surgical field, in addition to the temperature control during the RF ablation, the lesion formation was visually evaluated by the surgeon as a uniform white coagulation line to guarantee continuity of the lesions. Then a conventional left atriotomy was performed parallel to the interatrial groove,

Table 1. Preoperative patient characteristics*

Variables	Group 1	Group 2
Number of patients†	20	10
Age (years)	48.10 ± 9.84	51.10 ± 13.93
Gender (males) †	9	5
EF (%)	47.00 ± 6.95	48.00 ± 7.88
LA size (mm)	5.53 ± 0.84	5.50 ± 0.66

*Data are given as mean \pm SD unless specified otherwise.

†Data are given as number.

Table 2. Associated heart disease*

	Group 1	Group 2
Mitral valve disease	8 (40%)	4 (40%)
Mitral and aortic valves disease	9 (45%)	5 (50%)
Mitral, aortic and tricuspid valves disease	3 (15%)	1 (10%)
Coronary artery disease	1 (10%)	1 (10%)

* Data are given as number (percent).

connecting the ends of right pulmonary veins with the ablation lines.

Two linear lesions was also performed to join the mitral annulus and left appendage to the pulmonary veins encircling. During ablation of the left atrium, low flow cardioplegia was administered to protect the circumflex artery from heat trauma. Left auricle was resected and carefully sutured. We performed all ablations endocardially and it takes only about 25 minutes extra time.

Antiarrhythmic prophylactic treatment was carried out on a routine basis. Amiodarone was begun after the induction of the anesthesia (300 mg I.V. bolus followed by 1200 mg/24 h until the first post operative day, when oral administration of 200 mg/8 h was begun; after discharge, a maintenance regimen of 200 mg/24 h was continued up to 6 months). Anticoagulation was administered in the postoperative period.

Statistical analysis was performed with Student's *t* test and data are expressed as mean \pm standard deviation (SD). Left atrial diameter, cardio-thoracic ratio and AF duration before the operation were considered to be the variables that affect the surgical results. The greatest risk of the procedure is damage to the surrounding structure, such as the esophagus, AV node and coronary arteries.

RESULTS

The mean cardiopulmonary bypass time and aortic cross clamp time were 145.93 ± 34.36 min and 107.35 ± 29.50 min, respectively, including 27.18 ± 4.10 min ischemic time to perform these modified maze procedures endocardially (Table 3). 30 patients underwent both atrial ablations and 41 concomitant cardiac procedures (Table 4), including mitral valve replacement (n = 25), aortic valve replacement (n = 9), mitral valve repair (n = 2), tricuspid valve repair

Table 3. Operative data*

Data	Group 1	Group 2
Cardiopulmonary bypass time	137.90 \pm 31.55	166.00 \pm 34.76
Aortic cross clamp time	103.00 \pm 29.22	118.25 \pm 29.22
Ablation time	26.15 \pm 3.67	29.62 \pm 4.27

* Data are given as mean \pm SD.

(n= 3), aortic valve repair (n= 2), coronary artery bypass (n= 2), reoperation (n= 2).

Out of 25 patients undergoing mitral valve replacement a bioprosthesis was implanted in 2. One patient had postoperative bleeding which was controlled with re-exploration. One patient with previous stroke had a postoperative pneumonia which responded to medical treatment. One patient with cryoablation died postoperatively because of respiratory failure and pneumonia. No patient needed permanent pacemaker implantation for postoperative A-V block or sinus node dysfunction. Three cases of fluid retention occurred in our series. During the endocardial RF ablation no complication was produced.

During the hospital stay after RF ablation in 20 patients, different types of atrial arrhythmias were seen. At the time of discharge 14 patients (70%) recovered sinus rhythm, 4 patients (20%) presented with junctional rhythm, and 2 patients (10%) persistent AF did not convert to sinus rhythm at all. After 12 months 3 patients were in AF rhythm and 17 patients (85%) presented with sinus rhythm.

In 10 patients ablations were performed with cryo probe. In cryo group, at the time of discharge 5 patients (50%) were in AF rhythm and only 5 patients (50%) were in sinus rhythm.

Table 4. Type of concomitant operations*

Operation	Group 1	Group 2
Mitral valve replacement	7 (35%)	6 (60%)
Mitral and aortic valve replacement	7 (35%)	2 (20%)
Mitral valve replacement and tricuspid repair	3 (15%)	1 (10%)
Mitral and aortic valve repair	2 (10%)	0
Coronary artery bypass	1 (5%)	1 (10%)
Reoperation	2 (10%)	0

* Data are given as number (percent).

After 6 months, 8 patients (80%) recovered sinus rhythm, 2 patients (20%) had permanent AF. At present, there have been no cases of perforation, pulmonary vein stenosis, or esophageal injury secondary to radiofrequency or cryo-ablation in our patients. Atrial function checked at hospital discharge showed bilateral contraction in 70% (21 of 30) of the patients. At the end of the follow up, there was a recovery of atrial function in 25 patients (83.33%).

DISCUSSION

Reliable and effective treatment strategies for permanent AF are of greatest interest in cardiac surgery because AF causes two times higher rates of death, five times higher risk of stroke, reduced cardiac output and the need of systemic anticoagulation with the danger of bleeding (3). The incidence among patients scheduled for open heart surgery is particularly high among heart valve cases and of special importance in mitral valve disease. According to pooled analysis of controlled clinical trials with warfarin, anticoagulation therapy can only reduce the risk of stroke rate by 62% and there is a risk of bleeding in these patients (4).

In most patients with AF and valvular heart disease, the arrhythmia will remain after surgical correction of the valvular heart disease, but in patient with intermittent AF or AF duration less than 1 year, valvular surgery alone is sufficient to restore the sinus rhythm in majority of patients (5). The Cox's maze procedure involves extensive incision and suturing of the atria, and prolongs the arrest time in valvular heart surgery. We try to simplify the original maze procedure with the use of radiofrequency energy or cryo endocardially. Under direct vision we created linear non-conductive barrier with saline irrigated RF or cryoablation probes in both atriums. As a consequence, the extra arrest time to complete the ablation was about 25-30 min. Discontinuous or non-transmural lesions are probably the most important factor in the result of RF ablation and are responsible to the origin of the new postoperative arrhythmias (6). With the use of saline irrigated probe, the sub-endocardial

temperature increases more than when we use a dry probe and creates a better linear non-conductive barriers. In our study we used this kind of probe to ablate both atriums and obtained AF treatment effectiveness in 85% of the patients and are consistent with other publication (7). As reported in literature early atrial arrhythmias occurred within the first weeks postoperatively, the majority of these events responded to antiarrhythmic therapy or DC cardioversion, if necessary. These arrhythmias seemed to diminish when the healing processes was completed. Endocardial ablation can prevent thromboembolism in patients with left atrial thrombosis and has a better result in redo operation with thickened epicardial surface (8). Other studies with simple AF procedures in patients with valvular heart diseases, such as epicardial and/or endocardial selective isolation of pulmonary vein had a success rate of 50-85%, but in our experience we have obtained a sinus rhythm in 83.33% of the patients with biatrial ablations. In epicardial ablation, fatty areas and epicardial fibrosis in re-operations are difficult point for ablation. In our cases we performed the ablation endocardially with RF and cryo probes, which was simple, fast and safe with no complication and can be done in every patient with AF rhythm. But in patients with cryoablation the in hospital success rate to sinus rhythm was only 50% but in follow up the results of both methods were nearly the same.

The aim of AF surgery is restoration of atrial contraction and sinus rhythm. In our series we detected a bilateral contraction in (70%) of sinus rhythm patients by trans-thoracic Doppler echocardiography. In addition we have observed immediate recovery of left atrial function in the majority of patients, with trans-esophageal echocardiography after the operation in the operative room. AF ablation during valvular surgery, yielded in our experience a 83.33% success rate about 1 year after the operation, whereas spontaneous sinus rate restoration following conventional heart surgery occurs in 4.5 to 36% of patients with chronic AF (9). So we suggest ablation for every patient with valvular heart diseases and permanent AF rhythm.

Auricle resection was done in all of our patients to simplify the completion of ablation scheme and to

decrease the potential for development of thromboembolism in cases with recurrent AF, even with appropriate anticoagulation regimen.

In our study we used both the radiofrequency and cryo probes with no significant difference in convergence of AF to sinus rhythm. But we found drawing of the lesion lines with saline irrigated RF probes much easier, which accounted for shorter ablation time. Ablation for AF has been demonstrated to improve the quality of life (10). Ablation with saline irrigated probe can yields a better results than dry probe and RF energy penetrate the atrial wall more easily with saline irrigated probe (11).

Ablation can be performed successfully in a beating heart without cardiopulmonary bypass or atriotomy, but can not be done in redo operation and in patients with left atrial clot (12). Ablation with RF or cryo probes yields restoration of atrial function earlier than standard maze procedure and we could see atrial contraction by echocardiography just after the operation (13).

Our study has several limitations. The small number of the patients in the study, the relative high cost of the disposable RF probes, no histological study of atrial wall after ablation. Use of amiodarone in the first 6 month after the operation is another limitation for this study, especially for the short follow up time in a type of surgery that requires long term result.

Our data suggest that intraoperative both atrial ablations with saline irrigated RF or cryo probes endocardially are low risk, effective procedures to treat AF in patients undergoing valvular heart surgery. These techniques are extremely simple and we suggest to be performed routinely in AF patients, scheduled for open heart surgery in other heart centers in Iran.

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Conflict of interests

We have no conflict of interests.

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