

Intraoperative Microwave Ablation in Patients Undergoing Valvular Surgery: Midterm Results

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ABSTRACT

Aim of the Study: To assess the safety and efficacy of intraoperative microwave ablation to restore sinus rhythm and systolic atrial function in patients undergoing valvular surgery.

Methods: Forty-one patients with atrial fibrillation (AF) underwent operations. The mean age was 61 years (range, 45-76 years). AF was permanent in 30 patients and paroxysmal in 11. Associated cardiac procedures were mitral valve repair in 10 patients, mitral valve replacement in 12, and mitro-aortic valve replacement in 19. The microwave procedure (FLEX, AFx inc.) was performed to create an endocardial bilateral encircling isolation of the ostia of the pulmonary veins.

Results: There was no hospital mortality or morbidity. The mean follow-up period was 14.2 months. At follow-up, sinus rhythm was found in 34 patients (82.9%). Echocardiography results at follow-up showed no major or minor left atrial thrombosis and only a mild impairment of the systolic left atrial function.

Conclusion: Intraoperative microwave ablation is a safe and effective treatment to restore sinus rhythm and a mildly impaired left atrial function in patients with AF undergoing cardiac surgery.

INTRODUCTION

Atrial fibrillation (AF) is the most common cardiac arrhythmia and is characterized by disorganized atrial activity. AF is fairly common in patients with mitral valve disease and a markedly dilated left atrium. These patients rarely return to sinus rhythm spontaneously, even after a successful mitral valve operation [Flugelman 1984].

Prof. James L. Cox designed the maze procedure to cure AF [Cox 1991, Cox 1993, Cox 1995]. However, most surgeons are reluctant to expose their patients to the risk of the surgical maze because of the significantly increased aortic cross-clamping time and the morbidity risks, including

postoperative bleeding and a possible lifelong pacemaker dependence.

To simplify the maze procedure, surgeons are currently using different types of energy to eliminate AF in patients undergoing heart surgery by creating ablation lines in the left and right atrium, thereby avoiding the "cut and sew" technique. There are three methods (radiofrequency, microwave, and cryoablation) that have been put into practice in open heart surgery for the curative treatment of atrial fibrillation [Chen 1998, Knaut 1999]. However, long-term results from a large number of patients are not yet available.

MATERIALS AND METHODS

Patient Characteristics

Between June 2001 and December 2002, 41 patients with AF underwent operations at our institution for valve disease (Table 1). The population consisted of 10 men (24.4%) and 31 women (75.6%) whose ages ranged from 45 to 76 years (mean, 61 years). Most of the patients (76%) were in New York Heart Association class II.

Concomitant cardiac pathologies were mitral regurgitation (10 patients, 24.4%), mitral stenosis (12 patients, 29.3%), and combined aortic and mitral valve disease (19 patients, 46.3%) (Table 2). Twenty-one patients (51.2%) had associated tricuspid valve regurgitation.

AF was permanent in 30 patients (73.2%) and paroxysmal in 11 patients (26.8%). The median duration of AF was 24 months (range, 2-324 months).

Most of the patients were on oral digoxin medication before the operation.

Surgical Procedure

Ablations were performed with the Flex catheter (AFx, Fremont, CA, USA). An endocardial bilateral encircling isolation of the ostia of the pulmonary veins was performed. We started from the right side and then moved to the left side (Figure). The generator was set to provide a power output of 65 W for 60 seconds. Ablation of the right pulmonary veins usually requires 1 or 2 applications, and 3 to 4 are necessary to complete the left side.

Concomitant cardiac procedures (Table 3) were mitral valve repair with Gore-Tex neochordae implantation and pericardium annuloplasty (10 patients, 24.4%), mitral valve replacement (12 patients, 29.3%), and mitral and aortic valve replacement (19 patients, 46.3%).

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Table 1. Patient Characteristics*

Sex (M/F), n	10/31
Mean age (range), y	61 (45-76)
Type of AF, n	
Permanent	30 (73.2%)
Paroxysmal	11 (26.8%)
Median AF duration (range), mo	24 (2-324)

*AF indicates atrial fibrillation.

Tricuspid valve repair according to De Vega was performed in 21 patients (51.2%).

Follow-up

Early postoperative care was similar to that for routine heart surgery. Amiodarone infusion (900 mg in 24 hours) was started in the intensive care unit for most of the patients.

Patients with postoperative early atrial arrhythmias were treated with intravenous amiodarone (300 mg in 30 minutes plus 900 mg in 24 hours), sometimes with oral administration of low-dose (25 mg) atenolol.

At discharge, most patients were on oral amiodarone therapy.

Direct current cardioversion (DCS), if necessary, was planned one month after operation and was performed in 16 patients (39.0%).

Patients were seen in the outpatient clinic 3 and 12 months after operation.

Electrocardiography and Doppler echocardiography were performed 2 and 12 months after surgery.

RESULTS

There were no in-hospital deaths. No patients required reexploration for bleeding or permanent pacemaker insertion.

The mean follow-up period was 14.2 months (range, 5-21 months).

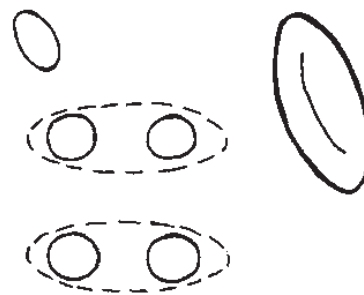
At discharge, 16 patients (39%) were in AF. All were on oral amiodarone therapy, and DCS was performed one month after operation in 16 patients. Four patients in the AF group did not need DCS because they were found to be in sinus rhythm at the electrocardiography examination performed before the scheduled electric cardioversion. Among the 25 patients discharged in sinus rhythm, 4 required DCS because of AF recurrence.

At the final follow-up, the presence of stable sinus rhythm was found in 34 patients (82.9%; Table 4).

Doppler echocardiography (Sonos 5500; Hewlett-Packard, Palo Alto, CA, USA) was performed in all patients at follow-up and showed no major or minor left atrial throm-

Table 2. Concomitant Cardiac Pathologies

Mitral valve regurgitation, n	10 (24.4%)
Mitral valve stenosis, n	12 (29.3%)
Mitral and aortic valve disease, n	19 (46.3%)



Surgical procedure (ablation: interrupted line).

bosis and only a mild impairment of the systolic left atrial function. We measured the atrial filling fraction (AFF), the percentage of the diastolic ventricular filling given by the atrial contraction: $[(Vti\ a)/(Vti\ a + Vti\ e)]$ (where $Vti\ a$ is the late velocity time integral and $Vti\ e$ is early velocity time integral). Left atrial function impairment was severe (AFF <20%) in 5 patients (14.7%) and mild to moderate (AFF 20%-29%) in 9 patients (26.5%). Left atrial transport function was normal (AFF >30%) in 20 patients (58.8%).

In the group of 34 patients who were free of AF at follow-up, antiarrhythmic therapy was maintained in the majority. Twenty-five patients (73.5%) were on amiodarone therapy, and the remaining patients were on sotalol (3 patients, 8.8%) or digoxin (6 patients, 17.7%).

DISCUSSION

Various alternative methods of creating lesions have been discussed, including ultrasound, laser, radiofrequency, microwave, and cryoablation. Three methods (radiofrequency, microwave, and cryoablation) have been put into practice and applied in open heart surgery for the curative treatment of AF.

Microwave energy is considered capable of effective and controlled heating of large tissue volumes without causing endocardial charring. Microwaves, electromagnetic waves at 2.45 GHz, generate frictional heating by the induction of dielectric ionic movements.

An important point for discussion is: where do we have to apply the energy? Do we need to follow the design of the Cox maze procedure?

The rationale of the surgical maze procedure is the following: AF is the consequence of multiple circling wavelets of activity. For the fibrillatory activity to be perpetuated, it is now established that a critical area of atrial musculature must remain in electrical continuity. If the atrial walls can be compartmented so that the area of each unit thus isolated

Table 3. Associated Cardiac Procedures

Mitral valve repair, n	10 (24.4%)
Mitral valve replacement, n	12 (29.3%)
Mitral and aortic valve replacement, n	19 (46.3%)
Tricuspid valve repair, n	21 (51.2%)

Table 4. Patients with Presence of Sinus Rhythm

At discharge, n	25 (60.9%)
At final follow-up, n	34 (82.9%)

is insufficient to support the circling wavelets, then fibrillation ceases.

Similar “mazes” can be created by constructing linear lesions with catheter ablation.

Many authors have designed their own modified maze procedure. It is rather difficult to find two authors using the same design. This situation means there is some degree of confusion caused by an incomplete knowledge of the pathophysiology of AF.

The lesions that are now more commonly used on the left side include:

- Separate encirclings of the left and right pulmonary veins;
- A line connecting the two encirclings that should be made either more cranially or more caudally, according to different opinions;
- Excision of the left atrial appendage;
- A line connecting the left pulmonary island with the left atrial appendage;
- A line connecting the left pulmonary veins with the mitral valve annulus;
- A line between the islands of the pulmonary veins;
- A line going inside the ostia of the pulmonary vein for 1 cm. The most commonly used right atrial lesions include:
- A line connecting the superior and inferior vena cava;
- Excision of the right atrial appendage;
- A line connecting the tricuspid valve annulus to the right atrial appendage;
- A line connecting the tricuspid valve annulus to the caudal end of the posterior longitudinal atriotomy at the atrioventricular groove.

Recently, Dr. Michel Haissaguerre and colleagues [Haissaguerre 1998] discovered that the pulmonary veins are an important source (up to 94%) of ectopic beats that initiate frequent paroxysms of AF. He demonstrated that these foci respond to treatment with radiofrequency ablation.

To simplify the maze procedure and to try to understand a little bit about AF, we decided, in accordance with Dr. Haissaguerre’s experience, to perform a separate encircling of the left and right pulmonary veins only.

Our high percentage (82.9%) of patients with sinus rhythm at the final follow-up is similar to what has been found by the other previously mentioned authors who used different ablation lines.

Even if we have to await a larger number of patients in the long run to reach more precise conclusions, we think that there is no need for the use of additional lines. Moreover, our experience with many patients with permanent AF shows

how the pulmonary veins play a key role, not only in paroxysmal AF but also in permanent AF.

Another important point for discussion is how the left atrial function changes after the microwave ablation. Dr. Itoh and colleagues [Itoh 1995] demonstrated that after the surgical maze the AFF was significantly reduced ($17.6\% \pm 8.8\%$ versus $36.8\% \pm 6.4\%$ in the control group). Another study from St. Louis [Feinberg 1994] showed similar findings indicating a moderate-to-severe reduction in the left atrial contribution to ventricular filling.

We found that left atrial activity was normal in 20 of our patients (58.8%).

Only 5 patients (14.7%) showed a severe impairment of the left atrial function (AFF <20%). It is not widely accepted whether there is a cutoff in left atrial function below which we should continue oral anticoagulation therapy. Further investigations are required to draw precise conclusions.

REFERENCES

- Chen MC, Guo GB, Chang JP, Yeh K, Fu M. 1998. Radiofrequency and cryoablation of atrial fibrillation in patients undergoing valvular operations. *Ann Thorac Surg* 65:1666-72.
- Cox JL, Boineau JP, Schuessler RB, Kater KM, Lappas DG. 1993. Five year experience with the maze procedure for atrial fibrillation. *Ann Thorac Surg* 56:814-24.
- Cox JL, Jaquiss RDB, Schuessler RB, Boineau JP. 1995. Modification of the maze procedure for atrial flutter and atrial fibrillation, II: surgical technique of the maze III procedure. *J Thorac Cardiovasc Surg* 110:485-95.
- Cox JL, Schuessler RB, D’Agostino HJ Jr, et al. 1991. The surgical treatment of atrial fibrillation, III: development of a definitive surgical procedure. *J Thorac Cardiovasc Surg* 101:569-83.
- Feinberg MS, Waggoner AD, Kater KM, Cox JL, Lindsay BD, Perez JE. 1994. Restoration of atrial function after the maze procedure for patients with atrial fibrillation: assessment by Doppler echocardiography. *Circulation* 90:II-285-92.
- Flugelman MY, Hasin Y, Katznelson N, Kriwisky M, Shefer A, Gotsman MS. 1984. Restoration and maintenance of sinus rhythm after mitral valve surgery for mitral stenosis. *Am J Cardiol* 54:617-9.
- Haissaguerre M, Jais P, Shah DC, et al. 1998. Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins. *N Engl J Med* 339:659-66.
- Itoh T, Okamoto H, Nimi T, et al. 1995. Left atrial function after Cox’s maze operation concomitant with mitral valve operation. *Ann Thorac Surg* 60:354-60.
- Knaut M, Spitzer FG, Karolyi L, et al. 1999. Intraoperative microwave ablation for curative treatment of atrial fibrillation in open heart surgery: the MICRO-STAF and MICRO-PASS pilot trial. *MICROWave Application in Surgical Treatment of Atrial Fibrillation. MICROWave Application for Treatment of Atrial Fibrillation in Bypass-Surgery. Thorac Cardiovasc Surg* 47(suppl):379-84.