Box lesion in the open left atrium for surgical ablation of atrial fibrillation

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Objective: Cut-and-sew maze with a box lesion around the pulmonary veins is currently the criterion standard procedure for surgical ablation of atrial fibrillation. Recently, we changed our technique from standard bilateral epicardial pulmonary vein isolation with interconnecting lesions to a box lesion procedure with a bipolar radiofrequency ablation device. Our study describes this technique.

Methods: Between March 2009 and June 2012, we performed 90 ablations by the box technique with a bipolar radiofrequency device. Fifty-five patients (61%) had persistent atrial fibrillation, and 21 (23%) had long-standing persistent atrial fibrillation. The left atriotomy was performed along the interatrial septum and the left atrial appendage amputated. The box was made by connecting the left atriotomy to the base of the amputated appendage with lines along the transverse and oblique sinuses by epicardial and endocardial application of a bipolar radiofrequency ablation device. The left atrial isthmus was ablated by cryoprobe.

Results: There were no ablation-related complications. The box was easy to perform, with no dissection around the pulmonary veins. At 6-month, 1-year, and 2-year follow-ups, 80 (94%), 69 (93%), and 47 (91%) patients, respectively, were in sinus rhythm. Freedoms from antiarrhythmic medications in patients in sinus rhythm at 6 months, 1 year, and 2 years were 78%, 88%, and 85%, respectively.

Conclusions: The box lesion provided excellent freedom from atrial fibrillation and may improve transmurality through ablation of 1 rather than 2 layers of atrial wall, as in epicardial pulmonary vein isolation. With the box lesion, dissection around the pulmonary veins is unnecessary. (J Thorac Cardiovasc Surg 2014;147:956-9)

In recent years, both the development of new energy sources for ablation and new complex, effective lesion patterns have transformed surgical ablation of atrial fibrillation into a widely performed operative procedure. Bipolar radiofrequency (RF) ablation with bilateral epicardial pulmonary vein isolation is among the most important elements of these new techniques.[1-5] Nevertheless, the classic cut-and-sew maze procedure still provides the best results with respect to freedom from atrial fibrillation. The most important lesion in the left atrium in the maze III procedure is probably the box lesion around the pulmonary veins.[6-10] In this report, we describe our experience with a box lesion made in the open left atrium with a bipolar RF ablation device.

MATERIALS AND METHODS

Between March 2009 and June 2011, left atrial surgical ablation was performed in 90 patients with our box technique with a bipolar RF device (Cardioblate 2; Medtronic Inc, Minneapolis, Minn), with the addition of a cryoprobe (Frigitronics; Cooper Surgical, Trumbull, Conn). Procedures were performed by 2 surgeons (L.S. and E.R.).

All data for this study were obtained from the cardiac surgery department's database and were retrieved with the approval of our institutional review board, which waived the need for patient consent because individual patients were not identified. Each patient signed an informed consent form before surgery, and all ablation procedure details were explained to each patient. The preoperative patient characteristics are detailed in Table 1.

Operative Technique

We performed the same ablation procedure for all patients. All patients underwent an ablation procedure through a midsternotomy incision under cardioplegic arrest. The ablation was limited to the left atrium. The following ablation devices were used: a bipolar RF device (Cardioblate 2) and a cryoprobe (Frigitronics). To perform a box lesion, we opened the left atrium along the interatrial groove, following the accepted approach used for mitral valve surgery. The left atrial appendage was amputated, after which we made a dissection around the superior and inferior venae cavae to reach the transverse and oblique pericardial sinuses. After this dissection was complete, we placed a jaw of a bipolar RF ablation device epicardially and placed the other jaw of the clamp endocardially, performing ablation lines in the left atrium along the transverse and then the oblique sinuses. These 2 lines connected the atriotomy incision and the left atrial appendage stump. In cases in which the left atrium was enlarged, resulting in a bipolar clamp that was not long enough to reach the appendage stump along the oblique sinus line, we applied a bipolar RF clamp from the open stump of the left atrial appendage to complete the oblique sinus ablation line. In this way, the oblique sinus line made by RF ablation was angulated. This placement allowed narrowing down in a wedge shape of the isolated posterior portion of the left atrium. We were concerned that a problem with left atrial contractility might develop if the isolated posterior portion was too large.

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Abbreviation and Acronym
RF = radiofrequency

The upper and lower lines of the box lesion thus included the bipolar RF epicardial and endocardial lesion in the left atrial roof, along the transverse sinus, and a lesion along the oblique sinus. The right and left sides of the box lesion included the left atriotomy incision along the interatrial septum, and an incision left by the amputated left atrial appendage[11] (Figure 1). In all cases we added a left atrial isthmus line, which was made with a bipolar RF device and a cryoprobe, and closed the stump of the removed left atrial appendage with 2 layers of running 5-0 suture. Surgical data are presented in Table 2.

Postoperative Care and Follow-up

Atrial and ventricular pacing wires were placed in all patients at surgery. Atrial pacing was performed wherever possible to prevent atrial ectopic activity, which could potentially revert to atrial fibrillation. Amiodarone was administered only in cases of postoperative atrial fibrillation and not as a prophylactic treatment. Electrical cardioversion was attempted in cases of continuous atrial fibrillation lasting longer than 48 hours before hospital discharge; if necessary, it was also performed at 3 months after the surgery. Oral anticoagulation (warfarin) treatment was started on the first postoperative day and was continued for at least 3 months, depending on the type of surgery, the patient's heart rhythm, and the left atrial contractility.[12] During hospitalization, continuous electrocardiographic monitoring (telemetry) was performed on all patients. All electrocardiographic changes, recorded in real time, were stored in the monitor's memory. The follow-up, which was complete in terms of clinical and cardiac rhythm status, was 402 ± 258 days (median, 385 days; range, 85-912 days). All patients were seen by a surgeon at 1 month after discharge and then by an electrophysiologist at 3, 6, and 12 months after surgery and every 6 months thereafter. Twenty-four–hour Holter electrocardiographic monitoring was performed in all patients at either 3 or 6 months after the operation and then at 1 year after surgery and thereafter as needed but at least once a year. If a patient reported symptoms, Holter monitoring was performed immediately. All medical data from visits to any medical facilities concerning the patients' heart rhythm were also recorded. Echocardiography was performed at 6 months after surgery. Any adverse cardiovascular events were recorded.

RESULTS

There were no perioperative or late deaths. Two patients had a postoperative cerebrovascular accident occur. These patients did not emerge satisfactorily from anesthesia, and a computed tomographic scan revealed an ischemic brain infarction in each case. Later these patients had neurologic improvement, with one recovering completely and the other nearly completely.

The mean intensive care unit stay was 2 days (range 1-4 days), and mean hospitalization was 7 days (range 5-11 days). Eighty-five patients (94%) were discharged in sinus rhythm. At 6 months, 1 year, and 2 years of follow-up, 80 patients (94%), 69 patients (93%), and 47 patients (91%), respectively, were in sinus rhythm. Additional data regarding early and midterm follow-up, including anticoagulation and antiarrhythmic medications, appear in Tables 3 and 4, respectively.

TABLE 1. Preoperative patient characteristics

Age (y, mean ± SD)	63 ± 10
Male	59 (65%)
New York Heart Association functional class	
I-II	63 (70%)
III-IV	27 (30%)
Atrial fibrillation type	
Paroxysmal	14 (16%)
Persistent	55 (61%)
Long-standing persistent	21 (23%)
Atrial fibrillation duration (y, mean ± SD)	5.4 ± 9
<1	20 (22%)
1-5	34 (38%)
5-10	24 (27%)
>10	12 (13%)
Echocardiographic data	
Left atrial volume (mL, mean ± SD)	136 ± 55
Left atrial volume >200 mL	11 (12%)
Left ventricular function	
Normal	83 (92%)
Mild dysfunction	4 (5%)
Moderate dysfunction	3 (3%)
Severe dysfunction	0 (0%)
Ejection fraction (%, mean ± SD)	55% ± 9%

Data represent number and percentage of patients except as marked. *SD*, Standard deviation.

DISCUSSION

The classic cut-and-sew maze III procedure provides excellent results, with more than 90% freedom from atrial fibrillation.[1-3] The most important lesion in the maze III procedure is probably the box lesion located around the pulmonary veins.[6-8] The importance of isolating the pulmonary veins is clear from Haissaguerre and colleagues' classic study,[9] which shows that most atrial fibrillation originates from the pulmonary veins.[10] The maze III procedure has not been widely adopted by surgeons, however, because of its technical complexity. Recently, devices that use alternative energy sources have been developed for surgical ablation of atrial fibrillation.[1-5,9] One of the most widely used modern devices for atrial fibrillation surgery is the bipolar RF ablation device. This device is mostly applied for epicardial bilateral

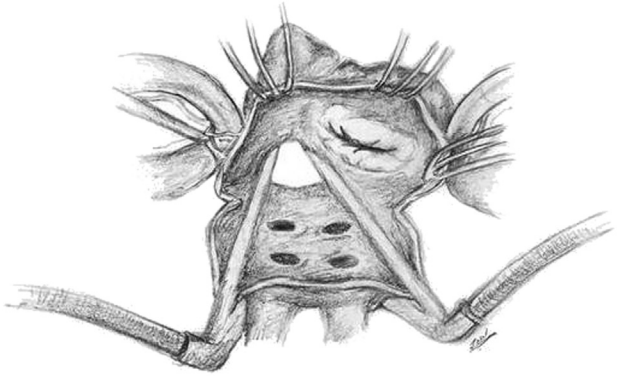

FIGURE 1. Box lesion with bipolar radiofrequency ablation device.