THE “BOX” LESION IN THE MODIFIED MAZE PROCEDURE FOR THE SURGICAL TREATMENT OF ATRIAL FIBRILLATION

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Lesione “Box” nella procedura modificata di Maze per il trattamento chirurgico della fibrillazione atriale

ABSTRACT

Objectives: In surgical treatment of atrial fibrillation, transmurality of the ablation lesions remains the key point of the durability of the maneuver. In the replace of the traditional Maze procedure, a “Box” lesion with bipolar radiofrequency ablator has emerged as a novel technique substituting the usual bilateral epicardial isolation of the pulmonary veins. The aim of the present study was to describe the preliminary utilization of Medtronic devices in making a “Box” lesion in comparison with that produced by Flex 4/10 reported in the literature.

Patients and methods: Between February 2004 and March 2011, 58 patients with atrial fibrillation were operated on for a Maze procedure with a “Box” lesion using a bipolar radiofrequency device.

Results: Epi- and endocardial lesions were produced on the arrested heart. A sinus rhythm rate was 88%, 94%, and 85% at 3, 6 and 12 months, respectively with no postoperative amiodarone use.

Conclusions: Our results of better radiofrequency ablation success rate and sinus rhythm rate emphasize how important is the strategy in doing a better transmurality lesion with the epi- and endocardial bipolar energy source, along with the left atrial isthmus line to the mitral valve.

Key words: Amiodarone, atrial fibrillation, cardiac arrhythmias, cardiac surgical procedures.

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Introduction

As an effective surgical strategy for the treatment of atrial fibrillation (AF), the Cox-maze procedure was introduced into clinical practice in 1987. Later, the surgical incisions were modified with linear lines of ablation on the atria. Unipolar radiofrequency catheters led to less satisfactory outcomes probably due to the incomplete transmural lesions produced by the epicardial ablations on the beating heart. Hence, bipolar systems were designed specifically for the epicardial lesions. Microwave energy ablation has simplified the surgical technique for AF, making it possible to perform an operation on the beating heart. Transmurality of the lesions made on the atrium has been taken as a key point of the durability of the procedure, with freedom from the recurrence of AF as the standpoint of evaluation.

The “Box” lesion is a novel technique that simplifies the surgical maneuver of pulmonary vein ablation. The four surgical incisions make up the “Box” lesion just like a tetragon with four lines: epi- and endocardial lesions in the left atrial roof along the transverse and oblique sinuses form the upper and lower borders and the left atriotomy incision along the interatrial septum and the amputation line of left atrial appendage constitute the left and right borders of the tetragon. The peculiarity of the “Box” lesion has not been sufficiently described so far. The purpose of this article is to present the clinical features of the patients receiving a “Box” lesion, and to compare between the efficacies of the “Box” lesions made by Medtronic apparatus and those made by Flex 4/10 reported in the literature.
Patients and methods

Patient Information

Between February 2004 and March 2011, 58 patients with AF were operated on for a Maze procedure with a “Box” lesion technique using a bipolar radiofrequency device (Cardioblate 2, Medtronic Inc, Minneapolis, MN, USA). There were 36 (64%) males and 22 (36%) females who were at the age of 68 ± 13.5 years. Of them, 66% of patients were in NYHA classes 1-2 perioperatively. Of this patient setting, the AF was permanent in 14 (25%), persistent in 32 (54%), and paroxysmal in 12 (21%) patients, respectively. The AF duration was less than one month in 11 (20%), lasted 1-5 months in 22 (38%), lasted 5-10 months in 20 (33%), and longer than 10 months in 5 (9%) patients, respectively. The patients received only “Box” lesion for AF in 1 (1.7%), and received a “Box” lesion secondary to a mitral and tricuspid valvular surgery in 38 (65.5%) (mitral valve repair in 25 and mitral valve replacement in 13), aortic valve replacement plus coronary artery bypass grafting in 12 (20.7%), and coronary artery bypass grafting in 7 (12.1%) patients, respectively.

Operative Technique

The “Box” lesion ablation was performed on the arrested heart. After the left atrial appendage was amputated, a bipolar radiofrequency lesion was made in the left atrial roof above the pulmonary veins from the left atriotomy incision to the stump of the appendage as the upper line; an alternative incision by bipolar radiofrequency made below the pulmonary veins through the oblique sinus constituted the lower line of the “Box”. The left atriotomy incision along the interatrial septum and the incision of the amputated left atrial appendage formed the left and right lines of the “Box” (Fig. 1). In all cases a left atrial isthmus line was made to the mitral valve by bipolar radiofrequency and cryo-probe (Frigitronics, Cooper Surgical, Trumbull, CT, USA). Then the stump of the amputated left atrial appendage was sutured with two layers of running 5-0 suture.

Ethics

All data for this retrospective study were obtained from the cardiac surgery department’s database, and an approval for their use was received from our institutional review board.

Results

The average ablation time was 25 minutes (range 17-31 minutes). Cardiopulmonary bypass time was 118 ± 35 minutes, and crossclamp time was 94 ± 29 minutes. Oral anticoagulation treatment with warfarin was started on the first postoperative day, and was continued postoperatively for at least three months, depending on the type of surgery and the patient’s heart rhythm. During hospitalization continuous electrocardiogram monitoring was performed on all patients. All electrocardiogram changes, recorded in real time, were stored in the monitor memory.

The immediate postoperative radiofrequency ablation success rate was 100%, and the percentage of the patients with immediate postoperative sinus rhythm was 100%. Length of follow-up was 9 ± 6 months. The sinus rhythm was maintained in 45/51 (88%) at 3 months, 40/43 (94%) at 6 months, and 24/28 (85%) at 12 months. Amiodarone was administered in the patients with recurrent AF, and not as prophylactic treatment. Electrical cardioversion was attempted in the patients with continuous AF prior to hospital discharge and, if necessary, was performed at 3 months post surgery.

Discussion

Several types of arrhythmias, most notably, AF and atrial flutter, are amenable to ablation therapy. The posterior atrium and the pulmonary veins have been taken as the origin of AF as evidenced by clinical implications. However, direct evidence is still
scanty. Unipolar RF and epicardial cryothermy on a beating heart do not guarantee transmural lesions. The Flex 2TM, Flex 4TM and Flex 10TM microwave ablation probes are sterile, single-use, hand-held surgical devices used exclusively with the AFx Microwave Generator (AFx Inc, Fremont, California, USA), which may produce durable epicardial transmurality lesions.

Disadvantages of epicardial pulmonary vein isolation included incomplete transmurality due to excessive tissue thickness when ablations of two layers of atrial walls were performed in epicardial pulmonary veins, and probable complications caused by dissection around the pulmonary veins especially with aberrant veins. Ablation line connecting the superior right and left pulmonary veins, namely the “Box” lesion, around all 4 pulmonary veins in the Cox maze III procedure has been proposed by Voeller et al. since June 2004. The “Box” lesion did not add any extra crossclamp or cardiopulmonary bypass time, with a connection line on the roof of the left atrium and an additional line to the left atrial appendage. However, connecting lesions to the mitral annulus and right-sided lesions may add potential morbidity without additional efficacy.

The overall freedoms from AF recurrence were significantly greater in the “Box” lesion group at 1 (87% vs. 69%, p < 0.015) and 3 (96% vs. 85%, p < 0.028) months. The rates of antiarrhythmic drug use were significantly lower in the “Box” lesion group at 3 (35% vs. 58%, p < 0.018) and 6 (15% vs. 44%, p < 0.002) months. The late recurrence of AF was lower at 3 months in the “Box” lesion group. The freedoms from AF recurrence at 1 and 3 months were much greater and the rates of antiarrhythmic drug use at 3 months and 6 months were much lower in the “Box” lesion than in the single connecting ablation lesion. The “Box” lesion group resulted in a significant decrease of hospital stay due to its simplified surgical procedure along with less postoperative atrial tachyarrhythmia and less postoperative antiarrhythmic drug use.

Experimental studies have shown FLEX 10 microwave device may produce epicardial lesions on myocardium. When ablations were performed for 120 seconds with a cardiac output of 0.0 to 0.5 L/min, 100% of lesions were transmural. The Flex 10 device (Guidant, Santa Clara, CA) at 65 watts for 90s each could produce a lesion depth of 0.2-0.6 cm (4), and hence was proved of enabling producing reliable transmural lesions.

From 2004 to present, a “Box” lesion around the pulmonary veins produced by Flex 4/10 in the modified Maze procedure was reported from seven reports in the literature. Totally 243 patients received the operation. Their mean ages were between 60 and 73 (median, 69) years. The nature of the AF before the operation was described in four reports in 191 patients, which was paroxysmal in 69 (36.1%), persistent in 13 (6.8%) and permanent in 109 (57.1%) patients, respectively. The duration of AF was 2-26.8 (median, 6.5) years. The surgery was performed on the beating heart, on-pump or off-pump, or on the beating heart for pulmonary vein ablation and subsequent arrested heart for Maze. The “Box” lesion was epicardial in 98 (40.3%), and epi- and endocardial in 145 (59.7%) patients. The “Box” lesion was an only maneuver performed in 114 (46.9%), and secondary to a valvular or coronary artery bypass operation in 129 (53.1%) patients, with a postoperative stay of 3.4-6 and 6.3-22.8 days, respectively. Postoperative sinus rhythm was present in 42-75% (median, 69.5%), 67-89.3% (median, 72.2%), 66.7-100% (median, 72%) and 65.7-67% (median, 66.4%) at discharge or completion of the operation, and 3-, 6- and 12-month follow-up, respectively. Amiodarone use was in 22 (9.1%) patients.

In the present study, epi- and endocardial “Box” lesions were performed on the arrested heart by Medtronic apparatus in 58 patients, 25% of them having permanent AF. A sinus rhythm rate was 88%, 94%, and 85% at 3, 6 and 12 months, respectively. There was no amiodarone use postoperatively.

In conclusions, our results of better radiofrequency ablation success rate and sinus rhythm rate emphasize how important the strategy is in doing a better transmurality lesion with the epi- and endocardial bipolar energy source, along with the left atrial isthmus line to the mitral valve.

References


