Electrophysiological findings after surgical thoracoscopic atrial fibrillation ablation

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BACKGROUND Hybrid ablation (a combination of thoracoscopic epicardial ablation and catheter ablation) has become a new technique for atrial fibrillation treatment.

OBJECTIVE The goal of this study was to evaluate the success and electrophysiological follow-up after using the COBRA Fusion device to deliver a circumferential lesion set anterior to the pulmonary veins in an attempt to isolate the posterior left atrium (box isolation).

METHODS Surgical ablation was carried out via a thoracoscopic approach using the COBRA Fusion radiofrequency catheter. An electrophysiology study was done 2–3 months later to verify box isolation (and to complete it, if needed) and to perform right-sided isthmus ablation. Fat thickness along the presumed box lesion line was measured using preprocedural computed tomography.

RESULTS Thirty patients (mean age 60.0 ± 11.6 years; 22 men; 8 with long-standing persistent AF and 22 with persistent atrial fibrillation) were enrolled. The duration of the EP study was 216.3 ± 64.2 minutes. Box isolation, based on the EP study, was complete in 12 patients (40%) and incomplete in 18 patients (60%). Successful box isolation was achieved with catheter ablation in 16 of 18 patients (89%). A total of 39 gaps in these 16 patients were identified. Typical gap locations were the anterior-superior part of the superior pulmonary veins and the roofline. Fat thickness along the roofline was substantially higher than that along the inferior line (4.58 ± 1.61 mm vs 2.37 ± 0.76 mm; $P < .001$).

CONCLUSION There is a relatively low rate of complete isolation using the COBRA catheter ablation system. The superior line and anterior parts of superior pulmonary veins have most conduction gaps.

KEYWORDS Persistent atrial fibrillation; Long-standing persistent atrial fibrillation; Thoracoscopic ablation; Box lesion; Hybrid ablation

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Introduction

Since the landmark study on the significant role of pulmonary veins (PVs) in paroxysmal atrial fibrillation (AF) initiation, catheter ablation (CA) has become an effective therapy for paroxysmal AF.[1] More recently, treatment of persistent AF and long-standing persistent AF using CA has been introduced.[2] PV isolation (PVI) is the cornerstone of most existing techniques[3] and has been shown to have quite satisfactory efficacy in paroxysmal patients. Because of the limited efficacy in patients with persistent AF and long-standing persistent AF, additional ablation techniques have been developed, such as wide ablation procedures around the PV ostia,[4,5] linear ablation lesions (on the roofline or mitral line), or ablation of complex fractionated atrial electrograms.[3,6]

The surgical treatment of AF has shifted from open heart surgery toward minimally invasive procedures. Although there are many suitable types of minimally invasively ablation devices on the market, the box lesion technique is used in most of them. The goal is to isolate all PVs and the posterior aspect of the left atrium (LA) en block. To ensure (and complete) box isolation and to ablate structures that are difficult to ablate using the thoracoscopic approach (eg, cavotricuspid isthmus), the procedure can be followed by a subsequent transvenous electrophysiology (EP) study and CA. This approach, which is called *hybrid ablation*, seems to be an attractive alternative to overcome the limitations of epi- or endocardial ablation procedures alone. The whole procedure (thoracoscopic and transvenous) can be completed as a single intervention or separated using a 2-stage design. According to a review published by Gelsomino et al in 2013,[7] which included 335 patients, the success rate of "freedom from AF without antiarrhythmic drugs (AADs)" after 1 year was ~90% in patients treated using hybrid ablation.

Electrophysiological follow-up after surgical thoracoscopic ablation for AF, specifically mapping the locations of gaps in the ablation lines, has never been published in detail. The goal of our study was to report on the efficacy and typical gap locations after surgical thoracoscopic ablation. The unique stepwise design of our hybrid ablation approach

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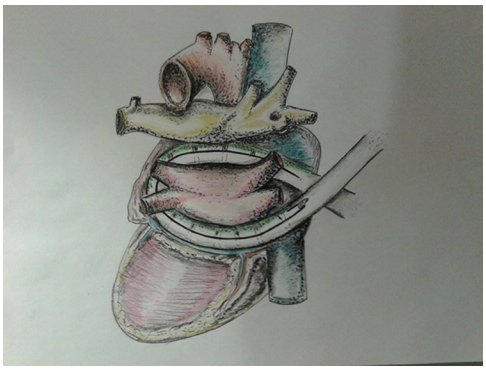

Figure 1 A schematic of the position of the surgical ablation catheter around all 4 pulmonary veins.

allowed us to perform a detailed endocardial mapping of the surgical ablation lines after recovery from the surgical procedure.

Methods

Consecutive patients with nonparoxysmal AF were considered suitable candidates. A 2-stage design was used. The first step was unilateral thoracoscopic approach for the placement of surgical ablation tools. During the surgical procedure, a circumferential lesion set was delivered anterior to the PVs in an attempt to isolate the PVs and posterior LA (box lesion set). The placement of the thoracoscopic ablation catheter around the PVs is shown in Figure 1, and box isolation on a CARTO map is shown in Figure 2. The staged EP study was done 2–3 months after the surgical procedure for the purpose of mapping the surgical lines and completing the isolation, if needed. Included in the EP procedure was ablation of the ganglionated plexi (GP) and ablation of the cavotricuspid isthmus. The project was approved by the local ethics committee and was conducted in accordance with the Declaration of Helsinki. All patients were required to sign an informed consent before study participation.

Inclusion criteria were as follows: (1) age $>$ 18 years, (2) persistent or long-standing persistent AF according to the standard European Heart Rhythm Association (EHRA) definition (3), (3) symptomatic AF that was refractory to at least 1 AAD, (4) absence of significant structural heart disease (eg, dilated cardiomyopathy, hypertrophic cardiomyopathy, valvular heart disease, and untreated coronary artery disease), (5) absence of any other heart disease with an indication for open heart surgery, and (6) the ability to sign an informed consent.

Exclusion criteria were as follows: (1) paroxysmal AF, (2) AF secondary to a reversible cause (ie, thyropathy etc), (3) indication for open heart surgery, (4) severe left ventricular dysfunction, which was clearly caused by some other cardiac disease, (5) known severe pericardial adhesions (eg, history of cardiac surgery), or (6) ablation for AF in the past.

Computed tomography (CT) of the LA was done in all patients before the surgical procedure. Coronary angiography was done in all patients, in whom the CT scan could not definitively exclude coronary artery disease. A transthoracic echocardiogram was used to exclude significant valvular disease. CT was repeated 6 months after the EP procedure to evaluate for PV stenosis, which was defined as $\geq$50% reduction in the diameter of a PV.

Surgical procedure

The procedure was done under general anesthesia by using a double lumen endotracheal tube and single-lung ventilation. The right chest was accessed using 3 thoracoscopic working ports that were placed in the fourth, fifth, and sixth intercostal space. The pericardium was then opened anterior to the phrenic nerve. The transverse and oblique sinuses were bluntly dissected and so was the layer of pericardial fat, mainly in the area of the interatrial groove and transverse sinus. A special introducer, with a magnetic tip, was inserted into each sinus to meet behind the heart and form a loop, and the COBRA Fusion 150 (Estech, San Ramon, CA) ablation catheter was then connected to the introducer and pulled around the PVs (Figure 1). The position of the introducer, and later that of the catheter, was checked visually and also by using transesophageal echocardiography (TEE). Contact between atrial tissue and the catheter was achieved using suction with a target of $-$500 mm Hg. The catheter can direct radiofrequency (RF) energy from the active RF electrodes toward the integrated indifferent electrode (bipolar mode) or toward the indifferent electrode pads that were placed on the patient's back (unipolar mode). The RF energy was applied in 2 steps (both bipolar and unipolar) using temperature-controlled mode with a setting of 70°C for 60 seconds. After this first cycle, the catheter was moved circumferentially in an attempt to complete the box lesion and a second cycle of energy (both mono- and bipolar) was applied. The continuity of lesion was checked visually in a reachable area (interatrial groove and both sinuses), and a third overlapping ablation procedure was performed if the line of the box lesion did not appear continuous. This third ablation was usually needed

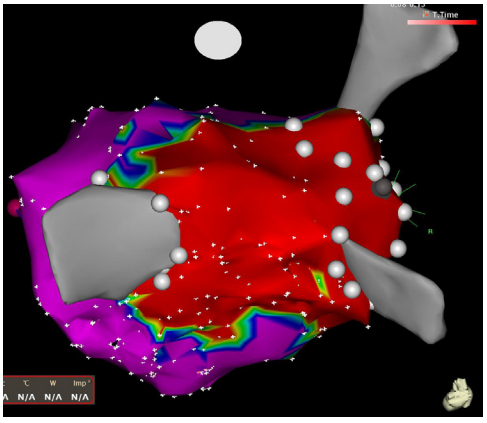

Figure 2 The voltage map showing the "red," no-voltage areas of the posterior wall of the left atrium. Superior and anterior to the left superior pulmonary vein, the tags of the ablation points are visible in places where box isolation was achieved. White tags represent the borders of the pulmonary veins.