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Hybrid Thoracoscopic Surgical and Transvenous Catheter Ablation of Atrial Fibrillation

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Objectives The purpose of this study was to evaluate the feasibility, safety, and clinical outcomes up to 1 year in patients undergoing combined simultaneous thoracoscopic surgical and transvenous catheter atrial fibrillation (AF) ablation.

Background The combination of the transvenous endocardial approach with the thoracoscopic epicardial approach in a single AF ablation procedure overcomes the limitations of both techniques and should result in better outcomes.

Methods A cohort of 26 consecutive patients with AF who underwent hybrid thoracoscopic surgical and transvenous catheter ablation were followed, with follow-up of up to 1 year.

Results Twenty-six patients (42% with persistent AF) underwent successful hybrid procedures. There were no complications. The mean follow-up period was 470 ± 154 days. In 23% of the patients, the epicardial lesions were not transmural, and endocardial touch-up was necessary. One-year success, defined according to the Heart Rhythm Society, European Heart Rhythm Association, and European Cardiac Arrhythmia Society consensus statement for the catheter and surgical ablation of AF, was 93% for patients with paroxysmal AF and 90% for patients with persistent AF. Two patients underwent catheter ablation for recurrent AF or left atrial flutter after the hybrid procedure.

Conclusions A combined transvenous endocardial and thoracoscopic epicardial ablation procedure for AF is feasible and safe, with a single-procedure success rate of 83% at 1 year. (J Am Coll Cardiol 2012;60:54–61) © 2012 by the American College of Cardiology Foundation

In paroxysmal atrial fibrillation (AF), success rates of catheter ablation (CA) exceed 80%, and recurrence is associated mostly with pulmonary vein (PV) reconnection (1,2). By combining PV isolation, complex and fractionated atrial electrographic ablation, and linear lesions in patients with persistent AF, success rates without antiarrhythmic drugs (AADs) surpass 70% (3,4). However, multiple procedures are often necessary, and creating linear lesions is sometimes challenging.

Surgical AF ablation has evolved from the original Cox maze procedure toward a minimally invasive, video-assisted procedure with new ablation tools to isolate the PVs and create linear lesions without opening the heart (5). Nevertheless, even bipolar radiofrequency (RF) energy cannot guarantee transmural lesions (6). Linear lesions such as the mitral isthmus cannot be created solely from the epicardium, and proving bidirectional block epicardially can be challenging (7).

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Combining a transvenous endocardial and thoracoscopic epicardial approach in a single procedure overcomes these shortcomings.

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We report our initial experience with long-term follow-up of minimally invasive epicardial bilateral PV isolation and linear lesions in combination with endocardial proof of conduction block and endocardial touch-up if indicated.

Methods

Patient selection. Twenty-six consecutive patients with symptomatic AF underwent hybrid thoracoscopic surgical and transvenous CA with follow-up of 1 year. Definitions of paroxysmal, persistent, and longstanding persistent AF, success and failure of ablation, and follow-up monitoring were based on the Heart Rhythm Society, European Heart Rhythm Association, and European Cardiac Arrhythmia Society consensus statement (3). Therapy with at least 1 AAD had failed. Other selection criteria were previously failed CA, left atrial volume ≥29 ml/m^2, persistent or longstanding persistent AF, or patient preference for a hybrid procedure instead of a percutaneous approach.

Eleven patients (44%) had prior CA for AF or atrial flutter (AFL). All patients underwent transthoracic echocardiography, cardiac computed tomography, and pulmonary function testing preoperatively.

Hybrid procedure. The procedure was performed under general anesthesia with double-lumen endotracheal tube placement for selective lung ventilation. Transesophageal echocardiography was used to exclude a thrombus in the left atrium (LA). On the right side, a 12-mm camera port was placed in the fifth intercostal space midaxillary line and in the sixth or seventh intercostal space anterior axillary line. A 5-mm working port was placed in the third intercostal space anterior axillary line. The pericardium was opened anterior to the phrenic nerve. Blunt dissection was used to open the transverse and oblique sinuses.

Via the femoral venous approach, a His bundle (St. Jude Medical, St. Paul, Minnesota) and coronary sinus catheter (Medtronic, Minneapolis, Minnesota) were placed under fluoroscopy, and transseptal puncture was performed with a long 8-F sheath (SL0, St. Jude Medical) into the LA. The patient then underwent heparinization (1,000 U heparin per 10 kg body weight and a heparin infusion), with activated clotting time >300 s. During rapid ventricular pacing, we injected contrast through the long sheath to visualize left atrial anatomy. The PVs were mapped with a circular mapping catheter (Lasso, Biosense Webster, Diamond Bar, California). Antral isolation of the right PVs as a pair was performed with 4 to 6 applications using a bipolar RF clamp (Atricure, West Chester, Ohio) (Fig. 1). Each application had a duration of about 15 s, with a median output of 10 to 15 W. The same port incisions were made on the left side but placed more posteriorly (Fig. 2). The pericardium was divided posterior to the phrenic nerve. Left PV isolation was conducted as described earlier. We did not attempt ablation of the ganglionated plexi.

In patients with severe chronic obstructive pulmonary disease , we performed thoracoscopic epicardial isolation of the PVs only on the right, and the left PVs were isolated using a cryothermal energy balloon catheter (Arctic Front, Cryocath, Montreal, Quebec City, Canada) endocardially to avoid bilateral sequential lung deflation.

The end point for PV ablation was entrance and exit block. We defined exit block as local capture in the PV during pacing from the Lasso catheter (output 10 mA, pulse width 2 ms) without conduction to the LA. In the case of sinus rhythm after PV isolation, reinduction of AF was attempted 5 times by pacing in the coronary sinus for 10 seconds at the shortest cycle length resulting in 1:1 atrial capture. AF was considered inducible if it lasted more than 1 min. If AF became noninducible, isoproterenol was infused at rates of 10 to 30 μg/min. If AF had not terminated or still was inducible, linear lesions were deployed.

A roof line (connecting both superior PVs) and an inferior line (connecting both inferior PVs) were made epicardially using a bipolar RF pen or linear pen device (Isolater Pen and Coolrail, Atricure). If the right atrium was dilated, 2 additional ablation lines were placed: 1 encircling the superior caval vein using the clamp, the other connecting both caval veins using the pen.

By making a roof and an inferior line, we isolated the posterior LA (box lesion). If entrance and exit block were not reached, we identified the conduction gaps endocardially and ablated those with a 3.5-mm-tip catheter (ThermoCool, Biosense Webster). The location of the linear lesions was visualized with the linear pen device in situ and using fluoroscopy.

A left isthmus line was made in 3 patients using the bipolar RF pen device. The line was started from the ablation line on the antrum of the left inferior PV toward and crossing the coronary sinus. All patients needed endocardial touch-up ablation to reach bidirectional block, starting from the mitral annulus toward or inside the coronary sinus. If the patient was known to have typical AFL or if this arrhythmia occurred during the procedure, the cavotricuspid isthmus (CTI) was ablated endocardially. The endpoint was bidirectional block. In 7 patients, the left atrial appendage was removed using a stapling device.

The pericardium was approximated with a stitch, and a chest tube was placed in both pleural cavities. There was no drain left in the pericardial space.

Abbreviations and Acronyms

AAD = antiarrhythmic drug
AF = atrial fibrillation
AFL = atrial flutter
AT = atrial tachycardia
CA = catheter ablation
CTI = cavotricuspid isthmus
LA = left atrium
PV = pulmonary vein
RF = radiofrequency
SVT = supraventricular tachycardia

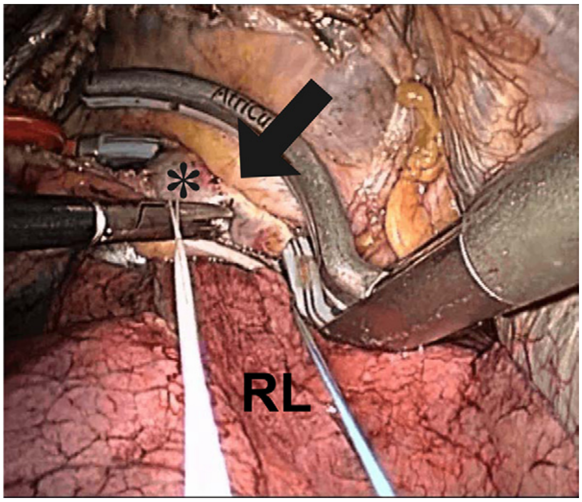

Figure 1 **Right Pulmonary Vein Isolation**

A large antral lesion **(arrow)** is created using a bipolar radiofrequency clamp, resulting in complete isolation of the right pulmonary veins (PVs). The antrum of the right PVs **(*)** is clearly visible. RL = right lung.