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Video-Assisted Epicardial Ablation and Left Atrial Appendage Exclusion for Atrial Fibrillation: Extended Follow-Up

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Background. **New ablation technologies have spurred development of less invasive operations for atrial fibrillation. The long-term efficacy of these procedures is unknown.**

Methods. **This was a retrospective study of 22 patients aged 63 ± 9 years with symptomatic, intermittent atrial fibrillation who underwent video-assisted, thoracoscopic pulmonary vein isolation and left atrial appendage exclusion from April 2004 through July 2005. The procedure consisted of bilateral 10-mm ports and 5-cm non–rib-spreading working ports. The left atrial appendage was excised with a surgical stapler. All patients were followed for at least 1 year, and all underwent Holter monitoring at study end point.**

Results. **The procedure was performed safely in all patients. One patient did not undergo left atrial appendage excision because of preexisting adhesions. No stroke, reoperation for bleeding, or patient mortality occurred. Average hospital stay was 3.2 ± 2.0 days (range, 2 to 10 days). No patient required repeat atrial fibrillation ablation. One patient underwent right atrial flutter ablation 7 months postoperatively. Average follow-up time was 18.1 ± 4.1 months (range, 12 to 27 months). At the end of follow-up, 20 patients (91%) were free of symptoms without antiarrhythmic therapy. Holter monitoring in these patients (performed more than 6 months after cessation of antiarrhythmic drugs) showed sinus rhythm and no atrial fibrillation. Twenty patients (91%) were no longer taking warfarin at the end of the study period.**

Conclusions. **Bilateral, video-assisted, thoracoscopic pulmonary vein isolation with left atrial appendage exclusion has favorable single-procedure efficacy after extended follow-up for selected patients with atrial fibrillation.**

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Atrial fibrillation (AF) is the most common cardiac arrhythmia in adults and affects more than 2.2 million persons in the United States yearly [1]. The inconsistent efficacy and potential toxicity of antiarrhythmic medications have stimulated evolving surgical and catheter-based solutions for the treatment of selected patients with AF, which have been incorporated into the current American College of Cardiology/American Heart Association guidelines [2]. Catheter-based ablation and pulmonary vein isolation have gained popularity because of the realization that the pulmonary veins are the source of ectopic foci in most patients with paroxysmal AF [3, 4]. Catheter-based ablation, however, has variable rates of success among centers [5, 6], often requires repeat procedures [6–8], and is associated with serious, although infrequent, complications [5, 9]. Additionally, it does not deal with the left atrial appendage (LAA), the source of embolic thrombi in at least 90% of patients with AF [10, 11]. Although the Cox Maze procedure is the surgical standard for the treatment of AF [12], recent advances in ablation energy sources have caused a shift in surgeons' interest toward technically simpler and less invasive procedures that can be performed on a beating heart without cardiopulmonary bypass [13–15]. Wolf and colleagues [15] reported encouraging early experience with a stand-alone, minimally invasive, video-assisted thoracoscopic technique for the epicardial ablation of AF on a beating heart with the use of dry radiofrequency bipolar energy. Left atrial appendage exclusion is performed concomitantly. The long-term efficacy of these new procedures, however, has not been studied. The present study therefore examines the extended follow-up and single-procedure efficacy of the video-assisted thoracoscopic technique of epicardial ablation and LAA exclusion for patients with symptomatic, intermittent AF.

Patients and Methods

Patient Population

The retrospective study was completed according to all local institutional review board guidelines. The chairperson of the institutional review board approved the study and waived the need for patient consent. Twenty-three consecutive patients underwent video-assisted thoracoscopic surgery for the treatment of intermittent AF from April 2004, the time at which the procedure was initiated at our institution, through July 2005. One patient, despite being asymptomatic and having taken no medication 16

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months after surgery, refused Holter monitoring and was excluded from the analysis, leaving 22 patients who completed all required aspects of the study. All patients had intermittent AF by the Cox classification [16]. By the AHA classification [2] and Heart Rhythm Society guidelines [17], 8 patients had persistent and 14 had paroxysmal AF. No patient had long-standing persistent AF, continuous AF, or preoperative evidence of left atrial reentrant tachycardia. The surgical procedures were performed by one surgeon, and all patients had been previously evaluated by a cardiologist. All patients had refractory, symptomatic, intermittent AF and had either undergone unsuccessful antiarrhythmic drug therapy (21 of 22 patients), were intolerant of anticoagulants (6 of 22 patients), had a failed catheter-based ablation (7 of 22 patients), or had any combination thereof. Patients with greater than mild mitral regurgitation, severe systolic dysfunction, untreated coronary disease, morbid obesity, or significantly enlarged left atrium were, in general, not considered candidates for this procedure. The patients' characteristics are shown in Table 1.

Surgical Procedures

The procedure was completed according to that developed by Wolf and colleagues [15]. Briefly, with the patient under general anesthesia, bilateral video-assisted thoracoscopic surgery was performed with a 10-mm camera port and a 5-cm working port. As shown in Figure 1, each set of pulmonary veins was encircled and ablated on the left atrium by using an epicardial-placed bipolar radiofrequency clamp (Atricure Inc, Cincinnati, OH). No other epicardial lesions were placed. The ligament of Marshall was taken down in all patients. Detailed ganglionic plexus mapping and ablation was not performed. As the procedure evolved, routine conduction block was verified by either inability to pace or inability to sense from the pulmonary veins (last 18 patients). Thoracoscopic LAA exclusion was then performed using a Thoracic Endoscopic Linear Cutter EZ45G (Ethicon Endo-Surgery, Inc,

Table 1. Patient Characteristics

Characteristics	Results
Number of patients	22
Age (y)	62.7 ± 8.9 (range, 49–81)
Sex	
Male	15 (68.2%)
Female	7 (31.8%)
Atrial fibrillation (AF)	
Intermittent AF	22 (100%)
Duration of AF (mo)	45.2 ± 41.1 (range, 12–168)
Ejection fraction	0.548 ± 0.036 (range, 0.40–0.60)
Left atrial size (mm)	34.7 ± 11.5 (range, 30–55)
Preoperative conditions	
Unsuccessful AAD therapy (1–3 drugs)	21 (95.5%)
Previous cardioversion	8 (36%)
Inability to take warfarin	6 (27.3%)
Previous catheter ablation	7 (31.8%)
Preoperative pacemaker	3 (13.6%)
Dilated cardiomyopathy	1 (4.5%)
Previous cardiac surgery	1 (4.5%)
Coronary artery disease	1 (4.5%)
Mitral regurgitation > mild	0
History of TIA/CVA	1 (4.5%)
IHSS	1 (4.5%)
Hypertension	19 (86.4%)
Pulmonary disease	3 (13.6%)

AAD = antiarrhythmia drug; CVA = cerebrovascular accident; IHSS = idiopathic hypertrophic subaortic stenosis; TIA = transient ischemic attack.

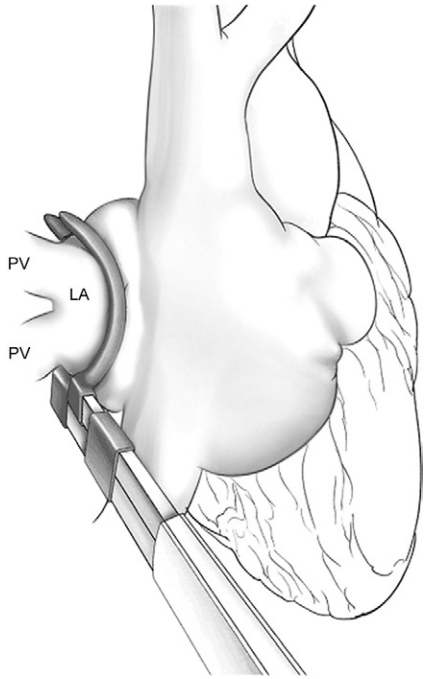

Fig 1. The bipolar radiofrequency device positioned around the left atrium (LA) proximal to the confluence of the right pulmonary veins (PV) on the beating heart.

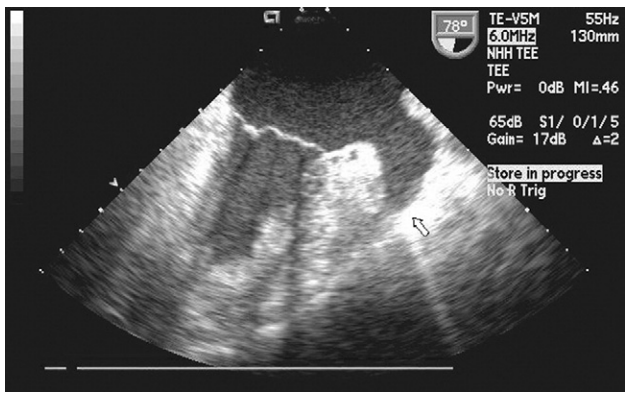

Fig 2. Left atrial appendage as seen on transesophageal echocardiography before occlusion (arrow).

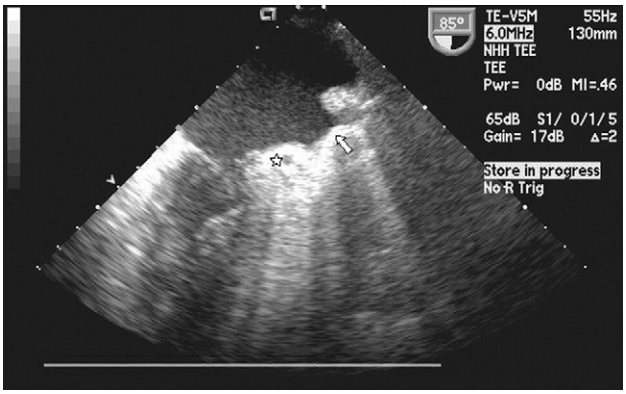

Fig 3. Confirmation of left atrial appendage exclusion (arrow). Proximity of exclusion to circumflex artery (star).

Cincinnati, OH), with nonbuttressed 4.8-mm staples. Appropriate stapler angle and adequate appendage coverage was enhanced by direct visualization through the working port. Obliteration was confirmed using intraoperative transesophageal echocardiography (Figs 2, 3). The patients were typically extubated in the operating room.

Follow-Up

Each patient was seen in an outpatient clinic 3 months after the ablation procedure, and a routine electrocardiogram was obtained at that visit. Patients were then followed by the referring physician at 6 months, yearly, and at the end of follow-up in July 2006. All patients were followed for a minimum of 1 year after surgery, and all patients were in a local catchment area. Anticoagulation and antiarrhythmic drug therapies were withdrawn at the discretion of the referring cardiologist according to the absence of patient symptoms, normal electrocardiogram results, or negative Holter monitor results. At the end of follow-up in July 2006, the patients were again evaluated through the use of detailed mailed or telephone questionnaires for symptoms of recurrence and underwent 24-hour Holter monitoring.

Results

All patients successfully underwent the ablation procedure and recovered in a step-down unit. Twenty-one of the 22 patients underwent LAA excision successfully as confirmed by intraoperative transesophageal echocardiography. In 1 patient, LAA excision was not attempted because of adhesions secondary to a previous catheter ablation. The patients' perioperative outcomes are shown in Table 2. The average length of the procedure was 182 ± 47 minutes (range, 99 to 270 minutes). There was no pulmonary vein injury, mortality, stroke, or reoperation for bleeding. The average hospital stay was 3 ± 2 days (range, 2 to 10 days). All patients were followed up for at least 1 year, with an average length of follow-up of 18 ± 4.1 months (range, 12 to 27 months).

Complications

Major complications occurred in 2 patients. One patient had a pulmonary embolism requiring rehospitalization, and the second patient, a female, required outpatient skin incision revision. No patient experienced a stroke during the follow-up period.

No patient has required the insertion of a pacemaker or an additional AF ablation procedure. One patient underwent right-sided catheter ablation for typical atrial flutter 7 months after surgery.

Follow-Up: Heart Rhythm and Medication Withdrawal

At the end of follow-up (18.1 ± 4.1 months, range 12 to 27 months), 20 of 22 patients (91%) were asymptomatic, had no palpitations, and felt well. All 20 asymptomatic patients had been off antiarrhythmic drugs for at least 6 months (average, 12.9 ± 5.9 months; range, 6 to 24 months) before the last follow-up; Holter monitoring in these 20 patients at the end of follow-up showed sinus rhythm with no AF or atrial flutter. Two patients had 4 beats each of paroxysmal atrial tachycardia.

Two of 22 patients (9%) had fewer complaints of AF postoperatively compared with preoperatively but remained on antiarrhythmic drugs for symptom control. Neither patient required additional ablation. Holter monitoring in these patients at follow-up conclusion showed sinus rhythm with periods of AF for durations of 30 seconds to 25 minutes, respectively. Neither patient showed evidence of atrial flutter.

Twenty of 22 patients (91%) were not on warfarin at the conclusion of the study period. Two patients continued on warfarin secondary to symptomatic AF.

Comment

Treatment with antiarrhythmic and anticoagulation drugs has been considered the first line of therapy in patients with symptomatic AF [1]. Because these drugs are mostly suboptimal and frequently have serious side effects, however, an effective surgical approach for the treatment of AF was established: the Cox Maze procedure.

Despite a greater than 90% success in patients undergoing the Cox Maze III, widespread adoption of this procedure has been limited because of its length, tech-

Table 2. Patient Perioperative Outcomes

Outcome	Results
Procedure time (min)	181.8 ± 46.5 (range, 99–270)
Hospital stay (days)	3.2 ± 2.0 (range, 2–10)
Complications	2 (9.1%)
Wound revision	1 (4.5%)
Pulmonary embolism	1 (4.5%)
Preoperative or postoperative mortality	0
Stroke	0
Bleeding	0

nical difficulty, and prolonged cardiopulmonary bypass times [12]. After the implication of pulmonary veins in the pathogenesis of AF [4], catheter-based ablation was developed to electrically isolate the pulmonary veins and further reduce the invasiveness of AF surgery. Ongoing advances in technology have enabled the ablation of myocardial tissue epicardially by use of a less invasive approach, and several groups have reported early results with a variety of energy sources [13–15]. Long-term follow-up with these new techniques has not been reported, however. Direct comparison of these studies is difficult because of different AF patient cohorts, energy sources, and lesion sets. Additionally, the interpretation of both catheter ablation and surgical series of AF is complicated by the varying definitions of success. Therefore, in the present study, we attempted to define a homogeneous patient cohort undergoing a stand-alone procedure with a constant ablation strategy to determine the efficacy of this procedure beyond 1 year.

The ability of dry bipolar radiofrequency to produce transmural lesions epicardially on the beating heart without cardiopulmonary bypass has been previously documented [18, 19]. Since the realization that pulmonary vein isolation is a key step in the interventional treatment of AF [4], it has formed the basis of virtually all ablation strategies. The lesion set in the patients in the present study was limited to the pulmonary veins through the use of dry bipolar radiofrequency, and no other epicardial lesions were attempted given the technology available at the time and concerns regarding creation of potentially arrhythmogenic nontransmural lesions. As the procedure evolved, however, intraoperative pulmonary vein isolation confirmation was performed routinely, which may have contributed to the present results. Interestingly, the 2 patients with evidence of continued AF underwent surgery before the routine adoption of intraoperative confirmation of conduction block.

The present study population consisted of only patients with intermittent AF. Although catheter ablation may be a potential option for these patients, catheter ablation has variable success rates among centers, often requires repeat procedures, and is not without serious complications [5–9]. Additionally, the ability to occlude the LAA, which is not possible with catheter ablation, is a key to further decreasing the risk of stroke in this patient population [10, 11, 20, 21]. Left atrial appendage exclusion may be an option for patients who are intolerant of anticoagulants or for patients with clinical AF ablation success who wish to avoid long-term anticoagulation therapy. This concept, although clinically appealing, requires careful attention to LAA exclusion technique and warrants further analysis [20, 22].

Ideally, patients with symptomatic, intermittent AF should undergo extended monitoring preoperatively to quantify the AF burden; that was not possible in these patients. However, the high rate of failed catheter ablation, cardioversion, and antiarrhythmic drugs does imply a very symptomatic group of patients. Patients undergoing this stand-alone procedure did not have significant left atrial enlargement, which was previously shown to be a predictor of surgical Maze failure [23]. Preoperative duration of AF has also been shown to be a predictor of late recurrence after the Cox Maze procedure [24]. One could speculate that the favorable results seen here, although performed in a highly symptomatic group of patients, reflect earlier surgical referral for a less invasive procedure.

Silent AF is a concern with any ablation procedure [25] because the ability to track every episode of AF is currently not possible. The extended period of follow-up in the present patients, the absence of antiarrhythmic drug therapy (91%), and the absence of AF on Holter monitoring (91%) suggest a favorable extended clinical outcome. Continued follow-up is warranted.

This study provides midterm follow-up results, an average of 18 months (range, 12 to 27 months), on the minimally invasive video-assisted thoracoscopic procedure for symptomatic AF. This finding highlights the therapeutic clinical value and single-procedure efficacy of this approach.

In conclusion, video-assisted bilateral pulmonary vein isolation and LAA exclusion is a minimally invasive technique that is safe and effective, has desirable midterm success, and is a viable option for selected patients with AF.

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