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Initial Experience with Total Thoracoscopic Ablation

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Background: Recently, a hybrid surgical-electrophysiological (EP) approach for confirming ablation lines in patients with atrial fibrillation (AF) was suggested. The aim of this approach was to overcome the limitations of current surgery- and catheter-based techniques to yield better outcomes. ***Methods:*** Ten consecutive patients with AF underwent total thoracoscopic ablation (TTA) following transvenous catheter EP ablation (residual gap and cavotricuspid isthmus [CTI] ablation). Holter monitoring was performed 6 months postoperatively. ***Results:*** Ten patients (90% with persistent AF) underwent successful hybrid procedures, and there was no in-hospital mortality. An EP study was performed in 8 patients and showed that successful antral ablation in all pulmonary veins was achieved in 7 of them. The median follow-up duration was 7.63 months (range, 6.7 to 11.6 months). Nine patients underwent Holter monitoring 6 months postoperatively, and the results indicated an underlying sinus rhythm without AF, atrial flutter, or atrial tachycardia lasting more than 30 seconds in all of the patients. There was no recurrence of AF during follow-up. ***Conclusion:*** A hybrid approach that consists of TTA followed by transvenous catheter EP ablation (residual gap and CTI ablation) yielded excellent outcomes in our patient population. A hybrid approach should be considered in patients with a high risk of AF recurrence.

Key words: 1. Atrial fibrillation
2. Ablation
3. Thoracoscopy

INTRODUCTION

Atrial fibrillation (AF) is the most common supraventricular arrhythmia requiring treatment in the world. A catheter-based ablation (CA) approach has been attempted in patients with pharmacologically refractory AF. Despite the considerable success rate (range, 45% to 90%) [1,2], multiple procedures are often necessary and the creation of linear lesions is sometimes challenging. From a surgical standpoint, the Cox maze III procedure is the gold standard treatment for AF. However, the technical complexity and the invasiveness of this procedure limit its use [2-4]. In 1998, Haissaguerre et al. [5] found that the pulmonary veins (PV) were an important source of triggers that initiated AF [6]. Transvenous radiofrequency (RF) ablation of the PV was introduced for the treatment of AF. However, PV reconduction is still challenging, and transmural lesions are difficult to achieve. Subsequently, thoracoscopic epicardial pulmonary vein isolation (PVI) has been drawing attention as an alternative technique for the ablation of AF. The parasympathetic and sympathetic efferent neurons present in the epicardial ganglionic plexi (GPs) and the intrinsic cardiac autonomic nervous system play an important role in triggering the PV firing, and the ligament of Marshall (LoM) was also determined to play

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Table 1. Baseline characteristics

Patient no.	Age	Sex	AF type	AF duration (mo)	BMI (kg/m^2)	Previous RFCA	LAD (mm)	CHADS2	CHF	DM	HTN	Stroke history
1	66	M	Persistent	24	1.81	N	38	0	N	N	N	N
2	51	M	Persistent	72	1.94	N	60	2	N	Y	Y	N
3	44	M	Persistent	19	1.80	Y	41	0	N	N	N	Y
4	62	M	Persistent	12	1.85	N	43	1	Y	N	N	N
5	54	M	Persistent	54	1.95	N	45	2	Y	N	Y	N
6	62	F	Persistent	240	1.65	N	50	2	Y	N	N	N
7	43	M	Paroxysmal	24	2.00	N	40	0	N	N	N	N
8	56	M	Persistent	48	1.90	N	39	2	N	N	N	Y
9	60	M	Persistent	45	1.86	N	48	0	N	N	N	N
10	63	M	Persistent	15	1.82	N	48	1	N	Y	N	N

AF, atrial fibrillation; BMI, body mass index; RFCA, radiofrequency catheter ablation; LAD, left atrial diameter; CHF, congestive heart failure; DM, diabetes mellitus; HTN, hypertension.

a role in triggering AF in some individuals. The left atrial appendage (LAA) was thought to be a potential source of thromboembolism [16]. Accordingly, the detection and ablation of the GPs, division of the LoM, and removal of the LAA have been incorporated in epicardial bipolar RF ablation of PVI. More recently, a hybrid surgical-electrophysiological (EP) approach for confirming ablation lines has been suggested because of the association between AF recurrences or atrial arrhythmias and conduction across ablation lines [7]. Here, we report our initial experience with total thoracoscopic ablation (TTA) followed by an EP study in Korean patients with AF.

METHODS

1) Study population

Ten consecutive patients with symptomatic AF underwent TTA followed by an EP study. Following the recommendations of the Heart Rhythm Society, inclusion criteria were paroxysmal, persistent, and longstanding persistent AF refractory to at least one antiarrhythmic drug (either class I or class III). The other selection criteria were previously failed CA and a left atrial volume of less than 100 mL/m^2. Detailed patient characteristics are listed in Table 1. Three patients had congestive heart failure. One patient had an atrial septal defect, and the others had chronic persistent AF. The study protocol was approved by the institutional review board of Samsung Medical Center.

2) Operative technique

Under general anesthesia, double-lumen endotracheal intubation was performed for selective pulmonary ventilation. TTA was performed through three ports on each side. First, on the right side, a 5-mm port was inserted in the fourth intercostal space at the mid-axillary line. The pleural cavity was insufflated with carbon dioxide in order to expand the operative field and to depress the diaphragm. A 0° thoracoscope was inserted for the visualization of the pleural cavity. Two additional ports were inserted into the third intercostal space at the anterior axillary line and into the sixth intercostal space at the mid-axillary line. Pericardial tenting was done, and the Waterstone groove was dissected. Then, a rubber band was passed under the PV antrum by using a lighted dissector (AtriCure Lumitip Dissector; AtriCure Inc., Cincinnati, OH, USA). An AtriCure Isolator Transpolar Clamp (AtriCure Inc.) (Fig. 1) was then connected to the rubber band and placed around the PV antrum.

The PV antrum isolation was achieved by 6 applications of bipolar RF energy to the clamps around the PV antrum. In order to prevent macro re-entry, an additional inferior ablation line connecting both PVI lines was made using the AtriCure Cooltip pen (AtriCure Inc.). The GPs ablation was performed, and the AtriCure Cooltip pen (AtriCure Inc.) was used for confirming the placement of the ablation lines, and a pacing

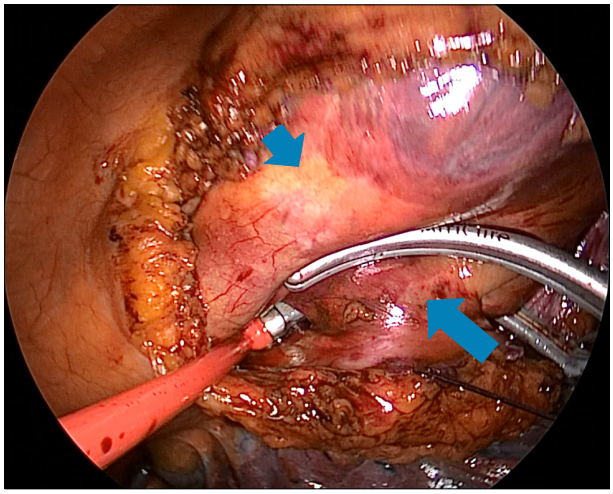

Fig. 1. Right pulmonary vein isolation; the pulmonary vein antrum (long arrow) and a sinoatrial node (short arrow) are clearly visible.

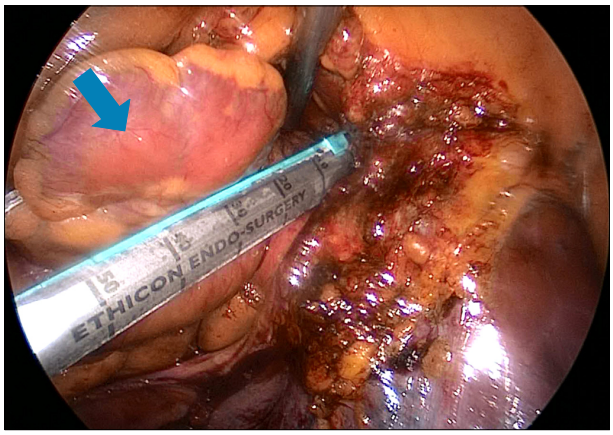

Fig. 2. Excision of the left atrial appendage (LAA); the LAA (arrow) is excised with an endoscopic stapler.

test was subsequently conducted. The operation was then repeated on the left side. After ablation of the PV and the GPs, the LoM was identified and ablated. After all ablations and conduction blockades were completed, the LAA was removed by stapling with an endoscopic stapling device (Fig. 2).

Single chest tubes were inserted in each pleural cavity. The patients were monitored for the first 24 hours in the intensive care unit. Postoperatively, both warfarin and amiodarone were prescribed for six months.

3) Electrophysiological study

Postoperatively, patients underwent a follow-up EP study at postoperative day 4. The PV potentials were assessed using lasso catheters having a diameter of 15 to 25 mm. The conduction intervals of the PA, AH, and HV were measured. The antegrade and retrograde refractory periods were also determined. The cavotricuspid isthmus (CTI) was ablated endocardially.

4) Follow-up

Any patient with episodes of AF, atrial flutter (AFL) or atrial tachycardia (AT) was cardioverted during hospitalization. Holter monitoring was performed six months postoperatively. According to current guidelines, success was defined as no episode of AF, AFL, or any AT lasting more than 30 seconds with the patient off antiarrhythmic drugs after the six-month blanking period.

RESULTS

1) Perioperative outcomes

Nine patients underwent PVI on both sides, while the remaining patient underwent left-side PVI only due to a history of right non-tuberculous mycobacterial lung disease. All of the patients underwent excision of the LAA. The median operation time was 3 hours 31 minutes. There was no hospital mortality and no postoperative transfusion, and 4 patients required electrical cardioversion because of an episode of AF during hospitalization. One patient had a stroke, another had pericardial effusion, and a third one had a pulmonary complication, pneumonia, and re-expansion pulmonary edema. One patient was in AF at the time of discharge, but the rhythm had converted to a sinus rhythm after 2 weeks of follow-up. Eight patients (80%) underwent an EP study. The patient who had a stroke did not undergo the EP study, and the remaining patient was excluded from the EP study due to a previous device closure of the atrial septal defect. Among the patients in whom the EP study was performed, one patient underwent ablation of the anterior line of the septum for an atypical atrial flutter around the septum. The EP study results of the other seven patients showed successful antral ablation in all PV. Six patients underwent CTI ablation. Patients generally presented mild postoperative pain on a visual analog scale

from 2 to 3. The median duration of the intensive care unit stay was 27 hours. The median postoperative hospital stay was 12 days.

2) Follow-up

The median follow-up period was 7.63 months (range, 6.7 to 11.6 months). A total of nine patients underwent Holter monitoring six months postoperatively. The Holter monitoring results indicated an underlying sinus rhythm without AF, AFL, or AT lasting more than 30 seconds in all of these patients. Antiarrhythmic and anticoagulation therapy was discontinued in all of these patients after six months of follow-up. There was no recurrence of AF or late complications during follow-up.

DISCUSSION

This report describes our initial experience with TTA followed by an EP study for paroxysmal and persistent AF. All patients successfully underwent TTA, and eight patients (80%) participated in the EP study. Six patients received CTI ablation. Among the patients who participated in the EP study, seven (90%) showed successful antral ablation in all PV. There were no recurrences of AF during follow-up.

In spite of superior long-term results of the Cox maze procedure, thoracoscopic or mini-thoracotomy approaches have been suggested as alternatives to the Cox maze procedure for the treatment of AF because of the technical complexity, associated co-morbidity, and invasiveness of this procedure. Although technical evolution in the minimally invasive era has yielded effective techniques, there is a possibility that a minimally invasive surgical approach could yield limited ablation lesions. As such, several authors have suggested a hybrid approach rather than a purely minimally invasive or thoracoscopic approach [8-10].

For the hybrid approach discussed here, the follow-up EP study is important because gaps in the roof or at the bottom of the PVI ring may play an important role in the underlying mechanism of recurrent arrhythmia [11]. We encountered one such patient with a large left atrium (>60 mm) in whom the EP study revealed small residual potentials in the left PV despite our intraoperative confirmation of the ablation lines. These potentials were sufficiently small, and hence, additional management was not indicated; however, they could be a possible cause of AF recurrence during long-term follow-up. Based on this experience, we suggest a hybrid TTA procedure followed by EP confirmation, particularly in patients at a high risk of recurrence, such as in patients with a large atrium.

Controversy remains about the precise role of ablation of the GPs. It is performed to decrease the risk of AF recurrence by modifying the local neurohumoral triggers of the atria; however, its value in the epicardial treatment of AF has not yet been established [12]. There is evidence that the endocardial ablation of the GPs might increase the success rate of catheter-based PVI. A vagal response during a catheter-based PVI procedure is associated with a lower recurrence of AF [13]. Further, long-term follow-up studies are needed to confirm the usefulness and effects of ablation of the GPs.

Besides its likely contribution to strokes, LAA is important because it is a driver of AF [14,15]. Edgerton and colleagues reported that nearly 82% of the patients that underwent LAA excision were able to stop anticoagulation therapy and remained free of AF six months after TTA with no postoperative transient ischemic attacks or cerebrovascular accidents [16]. All of our patients underwent LAA excision following these strategies and six months of anticoagulation with warfarin. One patient had a stroke on the second postoperative day; however, we suspect the reason for the stroke was recurrent AF with a rapid ventricular response because the international normalized ratio level was low during the immediate postoperative period, as warfarin therapy had just been initiated.

Our study has several limitations. It was retrospective, and the number of patients considered was small. In addition, since we began performing these procedures in February 2012, the longest follow-up period was only slightly more than 12 months. A large number of prospective, randomized, long-term follow-up studies are needed to confirm our findings. However, in this preliminary series, the early outcomes of our hybrid approach consisting of TTA followed by an EP study were excellent. There were no recurrences of AF or late complications during follow-up.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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