Analysis of risk factors for recurrence after video-assisted pulmonary vein isolation of lone atrial fibrillation—results of 5 years of follow-up

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Objective: The purpose of the present study was to assess the efficacy of the long-term results after video-assisted pulmonary vein isolation and left atrial appendage excision for lone atrial fibrillation (AF) and to determine the most significant risk factors for the long-term results.

Methods: From December 2006 to December 2012, 332 consecutive patients with lone AF underwent minimally invasive surgical ablation at our center. Of the 332 patients, 91, who had undergone video-assisted pulmonary vein isolation >5 years earlier, were evaluated in the present study (48 with paroxysmal AF, 21 with persistent AF, and 22 with long-standing persistent AF). The median follow-up period was 66 months. The primary endpoint was the success rate of video-assisted pulmonary vein isolation, defined as the absence of any atrial arrhythmia recurrence lasting >30 seconds at the clinical visit and on the electrocardiogram or long-term cardiac rhythm recording after discharge.

Results: During the follow-up period, 1 patient (1.1%) experienced a stroke and 4 (4.4%) died of noncardiac disease. At the 5-year follow-up point, 43 of 78 patients (55.1%) were in normal sinus rhythm. Of the 39 patients with paroxysmal AF and 39 with nonparoxysmal AF, 27 (69.2%) and 16 (44.1%) were in normal sinus rhythm, respectively. The results of the univariate and multivariate analyses of the preoperative risk factors for AF recurrence showed a left atrial diameter of ≥44 mm (hazard ratio, 5.56; 95% confidence interval, 1.68-18.387; $P = .005$) and an AF duration of ≥31.5 months (hazard ratio, 3.67; 95% confidence interval, 1.50-8.95; $P = .004$) were the most significant independent risk factors.

Conclusions: Patients with lone AF with a large preoperative left atrial diameter and long AF duration will not be suitable for video-assisted pulmonary vein isolation alone and might need to undergo ablation of the lesions. (J Thorac Cardiovasc Surg 2014;148:2174-80)

Since Haissaguerre and colleagues[1] reported that ectopic beats originating in the pulmonary veins can result in the spontaneous initiation of AF in 1998, concept development in AF treatment has brought about changes in the technology and methods of AF surgery. In 2005, Wolf and colleagues[2] performed video-assisted pulmonary vein isolation (PVI) on 27 cases of lone AF (LAF) and reported that 97% of the patients were free of AF at early follow-up. Since then, a variety of minimally invasive surgical techniques have been widely applied worldwide. The percentage of success with minimally invasive surgery for AF has ranged from 42% to 95.5% in the published data, with a follow-up period of 6 to 36 months.[3-10] We retrospectively analyzed the data from patients who had undergone video-assisted PVI and left atrial appendage (LAA) excision with >5 years of follow-up at our center, representing one of the rare experiences with 5 years of follow-up.

METHODS

Patient Selection

From December 2006 to December 2012, 332 patients with LAF underwent minimally invasive surgery at the Atrial Fibrillation Center, Beijing Anzhen Hospital. The 91 patients who had undergone video-assisted PVI ≥5 years earlier were enrolled in the present study. The institutional review board approved the research protocol, and all patients provided informed consent before surgery. We classified all the patients as having either paroxysmal AF (PAF) or non-PAF. The non-PAF group included those with persistent AF and longstanding, persistent AF. We followed the European Society of Cardiology guidelines to score the AF-related symptoms (European Heart Rhythm Association score).[11] Preoperative data were collected for each patient enrolled in the present study, including preoperative AF history, body mass index, and $CHADS_2$ score. The patient characteristics are listed in Table 1.

Preoperative Management

The patients underwent a detailed evaluation before surgery. Baseline 12-lead electrocardiographic (ECG) analysis, chest radiography, transthoracic ultrasound cardiography, transesophageal echocardiography, and computed tomography coronary artery enhancement scanning or coronary angiographic analysis were performed on admission. Also, all the patients

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Abbreviations and Acronyms

AF = atrial fibrillation
AFL = atrial flutter
CI = confidence interval
ECG = electrocardiographic
EP = electrophysiologic
LAA = left atrial appendage
LAD = left atrial diameter
LAF = lone AF
LVDd = left ventricular end-diastolic dimension
LVEF = LV ejection fraction
PAF = paroxysmal AF
PV = pulmonary vein
PVI = PV isolation

were required to complete a health questionnaire about their AF history, previous procedures, antiarrhythmic drug use, preoperative cerebrovascular adverse events, and so on.

Surgical Technique

We used the surgical technique we have previously reported.[12] This technique consisted of epicardial radiofrequency isolation of the bilateral pulmonary vein (PV) antrum, excision of the LAA, division of the ligament of Marshall, and electrophysiologic testing. Overall, bilateral PVI was performed using an Isolator Transpolar ENDO ablation clamp (AtriCure, West Chester, Ohio) and the Wolf Lumitip Dissector (AtriCure). LAA removal was performed using the EZ-45 Endostapler (Johnson & Johnson Medical, Inc, Arlington, Tex). The ligament of Marshall was cut under direct vision. Intraoperative electrophysiologic testing was performed using 2 types of sensing and pacing devices (Detect and Carelink 2090 programmer, Medtronic, Minneapolis, Minn). The procedure was performed using a 10-mm, 30° thoracoscope.

Electrophysiologic Testing

Intraoperative electrophysiologic (EP) testing was performed in the latest 30 consecutive patients (15 with PAF and 15 with persistent AF). EP testing included the bilateral PV antrum and baseline and postisolation sensing and pacing. A baseline positive sensing result (rapid and disorderly atrial potentials) in the PV antrum area could be detected before PVI, and a negative sensing result (no atrial potentials) could be detected in the same area after PVI, which is termed an "entrance block." A positive baseline pacing result was defined as obtaining atrial and ventricular capture. "Capture" has been defined as the contraction of the atrium and ventricle in response to the electrical stimulus sent from the temporary pacemaker. A negative postablation pacing result would indicate that no capture was obtained in the same area after ablation. A combined positive baseline pacing and negative postablation pacing result has been termed "exit block." Achieving both entrance and exit block has been regarded as a transmural lesion blocking conduction in the PV antrum area.

Postoperative Management

We have recommended that patients take amiodarone in small doses for 3 months postoperatively, with the medicine tapered off in the presence of a stable sinus rhythm. A β-receptor blocking drug was used for patients intolerant to amiodarone. We have recommended that patients take a vitamin K antagonist for postoperative anticoagulation in the initial 3-month postoperative period. The international normalized ratio was required to be 2.0 to 3.0. After 3 months, the patients with AF recurrence or a $CHADS_2$ score >2 points with NSR were recommended to take aspirin for anticoagulation. During the follow-up period, direct-current cardioversion was recommended if the ECG analysis showed AF recurrence. Recurrent AF was defined as AF, atrial flutter (AFL), or atrial tachycardia (AT) sustained for $\geq$30 seconds and occurring out of the postablation blanking period.[13,14]

Follow-up

Regular follow-up visits were scheduled at 3 and 6 months postoperatively and every year after discharge. At each visit, we offered the patients free physical examinations, 12-lead ECG examinations, and 24- or 48-hour Holter monitoring (Del Mar Reynolds Medical, Inc, Irvine, Calif). During the follow-up period, the primary endpoint was defined as the absence of AF and any atrial arrhythmia recurrence. In the present study, 63 of the 91 patients (69.2%) lived outside of Beijing. It was difficult for these patients to come to our center for each examination. We advised those who could not come to our center to undergo the ECG and echocardiographic examinations in their local city and to mail the results to us. If the patients developed a relapse during the follow-up period, we enquired and recorded the details of the recurrence.

Statistical Analysis

The patient characteristics and continuous variable data are presented as the mean $\pm$ standard deviation or simple frequencies and percentages. The outcomes of the rhythms were descriptively analyzed at the follow-up intervals. Also, according to the presence of postoperative AF recurrence during the follow-up period, the patients were classified into 2 groups (nonrecurrence and recurrence). The AF-related risk factors for recurrence between these 2 groups included gender, age, AF type, AF duration, left ventricular end-diastolic dimension (LVDd), LV ejection fraction (LVEF), left atrial diameter (LAD), and body mass index. These were included in the univariate analysis using the t test or χ^2 test, according to the data type. Risk factors with $P < .1$ on univariate analysis were considered significant to avoid missing more possibly meaningful variables and to relax the variable selection criteria. Receiver operating characteristic curves were used to determine the cutoff value for the continuous variables that were statistically significant on univariate analysis. These continuous variables were classified into dummy variables according to their cutoff value, and their statistically significant differences in each group were tested in Kaplan-Meier curves. The Cox proportional hazards model was used to assessed the risk factors (the dummy variables and the statistically significant categorical variables on univariate analysis). The forward stepwise selection procedure was used. Statistical analyses were performed using the Statistical Package for Social Sciences, version 20.0 (SPSS, Chicago, Ill).

RESULTS

Operative Results, Complications, and Mortality

The mean ablation time was 2.5 hours (range, 2.0-5.5). Of the 91 patients, 75 (82.4%) were in normal sinus rhythm (NSR) after surgery. Before ablation, 1 patient (1.1%) underwent permanent pacemaker implantation because of bradyarrhythmia and slow ventricular conduction. Also, 2 patients (2.2%) were found to have an unidentified smoke shadow located in the LAA base on the transesophageal echocardiogram preoperatively. To confirm the transesophageal echocardiographic results, the 2 patients underwent computed tomography. The computed tomography results showed the smoke shadow was in a nonenhanced area