Ablation surgery in patients with persistent atrial fibrillation: An 8-year clinical experience

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Objective: This analysis was undertaken to evaluate the results of persistent atrial fibrillation ablation procedures concomitant to open surgery and to identify risk factors for persistent atrial fibrillation recurrence.

Methods: Since 2001, a total of 325 consecutive patients with persistent atrial fibrillation (duration, 0.5–33 years) have undergone persistent atrial fibrillation ablation concomitant to open surgery by creating 2 encircling isolation lesions around the left and right pulmonary veins and a connecting lesion between both with the use of radiofrequency ablation procedures. Patients were restudied at discharge, 3 months, and 3 years after surgery.

Results: Survivals at the time of reexamination at discharge, 3 months, and 3 years were 97.8%, 96.2%, and 94.4%, respectively. Stable sinus rhythm could be documented in 72.1%, 73.9%, and 75.6% of surviving patients, respectively. Long-term persistent atrial fibrillation before surgery and a larger left atrium were predictive of postoperative persistent atrial fibrillation return ($P < .001$). Statistical analysis demonstrated cutoff points of 5 years for persistent atrial fibrillation and 55 mm for left atrium diameter; 89.7% of patients with persistent atrial fibrillation duration of less than 5 years and 84.5% of patients with left atrium size of 55 mm or less were in stable sinus rhythm at late follow-up. Cardiac rhythm at discharge and at 3 months was predictive of long-term rhythm prognosis ($P < .001$). Age, gender, concomitant diseases (eg, arterial hypertension, diabetes, renal insufficiency, or pulmonary disease), and the underlying cause of heart disease did not significantly influence the postoperative cardiac rhythm.

Conclusions: The duration of persistent atrial fibrillation and the size of the left atrium are the most reliable preoperative variables to predict the success rate of ablation concomitant to open surgery. The probability of reestablishing stable sinus rhythm is excellent when persistent atrial fibrillation duration is short and left atrium size is small. (J Thorac Cardiovasc Surg 2011;141:377-82)

Atrial fibrillation (AF) is the most prevalent cardiac arrhythmia treated in clinical practice. In cardiac surgery, persistent atrial fibrillation (pAF) is exceptionally important because it is frequently found as a concomitant disease in patients who are scheduled for open surgery for other reasons.[1] The morbidity associated with pAF results in significantly poorer survival than in patients with stable sinus rhythm (SR).[2] Since the Cox maze procedure demonstrated that AF can be eradicated, less-invasive ablation procedures were brought to clinical practice a decade ago.[3-5] The present study evaluates the early and late results of a strategy that was started in 2001 using radiofrequency (RF) ablation in patients with concomitant pAF who were scheduled for open surgery and identifies the risk factors for postoperative pAF recurrence. The data of 8 years of clinical experience with 325 cases were analyzed.

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PATIENTS AND METHODS

The investigation comprised 325 consecutive patients with a given indication for open surgery and concomitant persistent, not paroxysmal, AF (following the terminology of the current American College of Cardiology/American Heart Association/European Society of Cardiology guidelines[6]). This analysis included only patients who had persistent, not paroxysmal, AF for at least 0.5 years (median: 4.0 years, Perc25/75 1.5/8.0; range: 0.5–33 years) and were scheduled for surgery at the Asklepios Klinik St Georg between February 2001 and January 2009. The patient characteristics are shown in Table 1. Exclusion criteria for concomitant ablation in other cases with pAF ($n = 60$), as defined in 2001, were pAF duration of less than 0.5 years, emergency operation, severely reduced left ventricular ejection fraction (<15%), acute endocarditis or myocardial infarction (<7 days), considerable cachexia (body mass index ≤ 18), and severe intracardiac thrombosis or extreme left atrium (LA) size (diameter ≥ 72 mm).

Surgical Technique

The ablation procedure included a bilateral isolation of the right pulmonary veins (RPVs) and left pulmonary veins (LPVs), which were connected in the middle by a transverse lesion across the posterior LA wall. When the LA had to be opened (eg, during mitral valve [MV] surgery), the Cobra device (Boston Scientific Corp, San Jose, Calif) was used for RF ablation (100 W RF power for 120 seconds); the local temperature was set at 70°C (monopolar endocardial application). For this procedure, the LA was opened via a standard left atriotomy and MV analysis was performed. Next, by performing a left atriotomy, the first ablation lesion completed the isolation of the RPVs from the inferior to the superior RPV (Figure 1). Isolation of the LPVs was performed with a semicircular ablation line close to the inferior LPV and another one around the superior LPV. These were

Abbreviations and Acronyms

AF = atrial fibrillation
CABG = coronary artery bypass grafting
DC = direct current
ECG = electrocardiogram
LA = left atrium
LPV = left pulmonary vein
MV = mitral valve
NYHA = New York Heart Association
OR = odds ratio
pAF = persistent atrial fibrillation
RF = radiofrequency
RPV = right pulmonary vein
SR = sinus rhythm

connected by a transverse lesion. Arrangements to avoid thermic esophageal injury were as follows: The ablation was performed under direct view during conventional open surgery only, the transesophageal echocardiogram probe was removed during the ablation procedure, a dry compress was passed behind the LA before energy delivery, the flexible ablation probe was adapted to the tissue without pressure, the local temperature was set at only 70°C, and cachectic patients were excluded.

In cases without a left atriotomy (eg, aortic valve procedures or coronary artery bypass grafting [CABG]), the Atricure device (Atricure Inc, Cincinnati, Ohio) was used for *bipolar* RF ablation: Isolation of the RPVs and LPVs was performed on cardiopulmonary bypass with the heart beating by impacting the atrial tissue between the jaws of the Atricure hand piece and delivering energy with a local temperature of 40°C to 55°C. Ablation was terminated when the ablation and sensing unit indicated that the tissue conductance was at least 10 seconds less than 2.5 millisiemens, which is in parallel with transmurality of the lesion. Next, a purse-string 2-0 Ethibond suture (Ethicon, Johnson & Johnson Inc, New Brunswick, NJ) was set at the posterior LA wall. The distal jaw was inserted through an incision in the direction of the LPVs, and ablation was performed after clamp closure. The distal jaw was inserted in the direction of the RPVs, and the connecting lesion was completed (Figure 1). The purse-string suture was closed and protected with a 3-0 Prolene (Ethicon) suture. The LA appendage was occluded routinely from the endocardial side (MV cases; using two 3-0 Prolene running sutures) or the epicardial side (non-MV cases; using 4-0 Prolene [Ethicon] sutures; double layer) in cases with an LA diameter of more than 55 mm.

Management of Cardiac Rhythm and Follow-up

Transthoracic echocardiogram and standard 12-lead electrocardiogram (ECG) were performed on admission and before discharge by an experienced cardiologist. LA size was assessed by evaluating the LA diameter (anteroposterior diameter on parasternal axis view at end systole). An LA of more than 55 mm was termed as large ($\leq$55 mm, small). A tricuspid regurgitation of grade 2 or more documented by transthoracic echocardiogram was interpreted as an indication to perform concomitant tricuspid valve repair. Amiodarone administration was started with an intravenous bolus of 300 mg before the end of cardiopulmonary bypass, followed by an infusion of 900 mg/d for 3 days. Oral administration of 5 $\times$ 200 mg up to 7 to 10 g depending on body weight was begun, followed by 1 $\times$ 200 mg/d for 3 months. In cases of thyroid disease, amiodarone incompatibility, or other contraindication for amiodarone administration, sotalol was given alternatively (an intravenous bolus of 10 mg and then 1 mg/kg for 24 hours; oral administration of 2–3 $\times$ 40–80 mg for 3 months). When postoperative bradycardia persisted for more than 10 days, the amiodarone/sotalol therapy was stopped. An indication for permanent pacemaker implantation was bradycardia persisting for 14 days. In cases with early AF recurrence during hospital stay after saturation with amiodarone/sotalol and after exclusion of intracardiac thrombosis by transesophageal echocardiogram, direct current (DC) cardioversion was recommended. During initial antiarrhythmic drug saturation, patients were observed for at least 7 days with continuous monitoring (first in the intensive care unit and then in an intermediate care unit). Heparin was given after resolution of postoperative bleeding. Patients with heart valve repair or bioprosthesis received coumarin for 3 months. Patients with mechanical valves, lifelong anticoagulation, or CABG received aspirin for lifetime. All survivors were restudied before discharge (n = 318; 10 $\pm$ 2 days); 307 patients were studied early (3 $\pm$ 1 months) and 287 patients were studied late (3.0 $\pm$ 1.6 years) after surgery by standard 12-lead ECG and clinical examination. A standard 24-hour ECG registry also was performed at early and late follow-ups. According to the protocol during the hospital stay, the following variables and events were documented: age, gender, pAF duration, LA size, left ventricular ejection fraction, cause of heart disease, concomitant pulmonary disease, diabetes, arterial hypertension, renal insufficiency, New York Heart Association (NYHA) class, aortic crossclamping time, cardiopulmonary bypass time, total operation time, ablation time, total ablation procedure time, postoperative drug therapy, permanent pacemaker implantation, early AF recurrence, DC cardioversion (successful, unsuccessful), cardiac and noncardiac death, reoperation for bleeding, perioperative myocardial infarction, cerebrovascular events, pneumonia, and wound infection. At follow-up, the following variables and events were noted: cardiac and noncardiac death, cardiac rhythm, reoperation for recurrent heart disease, endocarditis, myocardial infarction, stroke, anticoagulation, and NYHA class.

Statistical Analysis

Quantitative preoperative and operative data were described by arithmetic mean $\pm$ standard deviation or (if appropriate) by median and Perc25/75. Qualitative distributed data were presented as absolute frequencies. For data assessment, an explorative data analysis was performed; no adjustments for multiple tests were calculated. Univariate and multivariate binary logistic regression models were used to evaluate pAF recurrence and persistence early and late after surgery. Continuous measurements and parameters grouped by clinical relevant values (eg, LA size $\geq$ 55 mm vs < 55 mm; pAF duration $\geq$ 5 years vs < 5 years) were included. Qualitative characteristics were also compared using chi-square tests (Fisher's exact test and McNemar test). Changes in NYHA class were investigated using the Friedman test (Monte Carlo method; upper bound of 99% confidence given). All *P* values were 2 tailed and interpreted as nominal. Analysis was performed with the Statistical Package for the Social Sciences for Windows 11.5.2.1 (SPSS Inc, Chicago, Ill), which uses the label ''Exp(B)'' for the odds ratio (OR), showing the OR of the independent with the dependent variable and the predicted change in odds for a unit increase in the corresponding independent variable (ORs < 1 correspond to decreases; ORs > 1.0 correspond to increases in odds; ORs $\sim$ 1.0 indicate that unit changes in that independent variable do not affect the dependent variable).

RESULTS

Of 325 cases in 201 patients, ablation was performed concomitant to MV surgery (61.8%). In 124 patients, other procedures (eg, aortic valve replacement or CABG; 38.2%) were carried out. All relevant surgery data are shown in Table 2. Hospital mortality was 2.2% (3 noncardiac and 4 cardiac deaths; 3/7 patients died in SR, 4/7 patients had AF). One patient (0.3%) underwent reoperation for bleeding, 2 patients (0.6%) had perioperative myocardial infarction, 17 patients (5.2%) had cerebrovascular events