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Catheter Ablation of Long-Standing Persistent Atrial Fibrillation

5-Year Outcomes of the Hamburg Sequential Ablation Strategy

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Objectives This study describes the 5-year efficacy of catheter ablation for long-standing persistent atrial fibrillation (LS-AF).

Background Long-term outcome data after catheter ablation for LS-AF are limited.

Methods Long-term follow-up of 56 months (range 49 to 67 months) was performed in 202 patients (age 61 ± 9 years) who underwent the sequential ablation strategy for symptomatic LS-AF. Initial ablation strategy was circumferential pulmonary vein isolation (PVI). Additional ablation was performed only in acute PVI nonresponder, if direct current cardioversion failed after PVI.

Results After the first ablation procedure, sinus rhythm was documented in 41 of 202 (20.3%) patients. After multiple procedures, sinus rhythm was maintained in 91 of 202 (45.0%) patients, including 24 patients receiving antiarrhythmic drugs. In 105 patients, PVI was the sole ablative therapy, 49 (46.7%) of those patients remained in sinus rhythm during follow-up. Patients with a total AF duration of <2 years had a significantly higher ablation success rate than patients whose AF duration was >2 years (76.5% vs. 42.2%, respectively; $p = 0.033$). Persistent AF duration (hazard ratio: 1.09 [95% confidence interval: 1.04 to 1.13]; $p < 0.001$) independently predicted arrhythmia recurrences, and acute PVI responders had a reduced risk of relapse (hazard ratio: 0.57 [95% confidence interval: 0.41 to 0.78]; $p < 0.001$) after the first ablation.

Conclusions During 5-year follow-up, single- and multiple ablation procedure success was 20% and 45%, respectively, for patients with LS-AF. For patients with a total AF duration of <2 years, the outcomes were favorable. (J Am Coll Cardiol 2012;60:1921–9) © 2012 by the American College of Cardiology Foundation

Pulmonary vein isolation (PVI) is a well-established treatment option in patients with atrial fibrillation (AF). In long-term follow-up of as long as 5 years, the multiple procedure success rate is approximately 80% in patients with paroxysmal AF (PAF) (1–3). However, recurrences are frequent, and repeat ablation is often required to maintain freedom from AF (1–3).

Current guidelines from HRS/EHRA/ECAS state that: 1) ablation strategies that target the PVs and/or PV antrum should form the cornerstone for most AF ablation procedures; and 2) if the PVs are targeted, complete electrical isolation should be the goal (1). However, in patients with long-standing persistent AF (LS-AF), PVI alone may not be sufficient as outcomes after PVI alone are disappointing, with success rates ranging from 36% to 56% at medium term follow-up (2–5). To improve outcomes in patients with LS-AF, various ablation strategies in addition to PVI have been described. The most widely used additional ablation strategy is the ablation of complex fractionated atrial electrograms (CFAE) (6,7). However, numerous gaps in our knowledge remain such as the adjunctive benefit of these techniques and the long-term efficacy of LS-AF ablation in general. Until recently, long-term outcome data of >2 years' follow-up after catheter ablation for LS-AF have been sparse (8).

See page 1930

We previously evaluated the short-term outcomes of catheter ablation for LS-AF (5). In this study, we present long-term follow-up data from the same cohort. The objectives of this study were to determine: 1) the long-term efficacy of the sequential

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Abbreviations and Acronyms

AAD = antiarrhythmic drug
AF = atrial fibrillation
AT = atrial tachycardia
CFAE = complex fractionated atrial electrograms
CI = confidence interval
HR = hazard ratio
LA = left atrium
LS-AF = long-standing persistent atrial fibrillation
OAC = oral anticoagulation
PAF = paroxysmal atrial fibrillation
PV = pulmonary vein
PVI = pulmonary vein isolation
SR = sinus rhythm

ablation strategy for treatment of LS-AF; 2) the regression of LS-AF toward PAF after ablation; and 3) predictors of recurrence.

Methods

Study population. Two hundred and five patients were consecutively enrolled in the initial study. The study population and methods have been published previously (5). Three patients were lost to follow-up. Long-term follow-up and data analysis were performed for the remaining 202 patients (age 61 ± 9 years). All patients had symptomatic LS-AF refractory to antiarrhythmic drugs (AAD) and underwent radiofrequency current catheter ablation at our institution between November 2003 and July 2007. The LS-AF was defined as continuous AF of >1 year duration (9). Baseline characteristics of the patient population are presented in Table 1. Total AF duration was 99 ± 64 months (median 84 months [range 60 to 120 months]), duration of continuous AF (persistent AF) was 49 ± 44 (median 36 months [range 20 to 60 months]). Clinical follow-up was completed in March 2011.

Electrophysiological study. After written informed consent, all patients underwent a transesophageal echocardiogram before the procedure. Oral anticoagulation (OAC) therapy was stopped at least 3 days before ablation and replaced with low-molecular-weight heparin. The procedure was performed under deep sedation utilizing midazolam, fentanyl, and a continuous infusion of propofol. Two standard catheters were positioned at the His bundle region and inside the coronary sinus. Two or 3 SL1 sheaths (St. Jude Medical, Minneapolis, Minnesota) were advanced to the left atrium (LA) using a modified Brockenbrough technique. After transseptal catheterization, intravenous heparin was administered, targeting an activated clotting time of 250 s to 300 s. Transseptal sheaths were continuously flushed with heparinized saline. Three-dimensional electroanatomical LA reconstruction using the CARTO system (Biosense Webster, Diamond Bar, California) and ablation were performed using a 3.5-mm tip catheter (ThermoCool Navi-Star, Biosense Webster) (10).

Table 1 Baseline Patient Characteristics (N = 202)

Age, yrs	61 ± 9
Male	160 (79)
Total AF duration, months	99 ± 64
Persistent AF duration, months	49 ± 44
Patients treated with amiodarone	115 (57)
Structural heart disease	32 (16)
LA diameter, mm	49 ± 6
Hypertension	155 (77)
LVEF, %	60 ± 7

Values are mean ± SD or n (%).
AF = atrial fibrillation; LA = left atrial; LVEF = left ventricular ejection fraction.

Ablation protocol during the initial procedure. All patients underwent circumferential PVI using irrigated radiofrequency current, as previously published (Fig. 1) (11). During PVI, 1 or 2 spiral mapping catheters (Lasso, Biosense Webster) were positioned inside the ipsilateral PVs. The endpoint of PVI was defined as the absence of any PV spike potential recorded on either Lasso catheter for at least 30 min after PVI. If after PVI, AF did not convert to sinus rhythm (SR) or atrial tachycardia (AT), up to 3 biphasic direct current shocks (200 J, 360 J, and 360 J) were administered aiming at restoration of SR. Defibrillator patches were positioned in an anterior-posterior position. If AF was reinduced by a non-PV trigger during the 30-min waiting period, the AF trigger was targeted for ablation but no CFAE ablation was performed. The CFAE ablation was only performed if SR could not be achieved at all. No medications or pacing maneuvers were used at that point. If DC cardioversion was successful, patients were defined as acute PVI responder (Fig. 1). The CFAE ablation was performed, as described before, in an attempt to convert AF to SR or AT (5). Termination was defined as transition directly from AF to SR or by 1 or multiple ATs (8). The CFAEs were analyzed visually and were defined as published by Nademanee et al. (6): 1) fractionated electrograms composed of >1 deflections and/or continuous deflection of a prolonged activation complex; and 2) atrial electrograms with <120 ms CL recorded over a 5-s recording period.

During ablation of CFAEs or LA linear lesions, the Lasso catheter was positioned in the left atrial appendage (LAA) to continuously record LAA activity. Only in the presence of a (macro) AT were linear lesions applied. Electrophysiological evidence of bidirectional block was validated in SR (12). Superior vena cava isolation was attempted only if spontaneous focal-discharge was demonstrated from this location. Patients requiring ablation strategies in addition to PVI were defined as acute PVI nonresponder.

Ablation protocol during repeat procedure. Repeated electrophysiology procedures were undertaken for recurrent atrial tachyarrhythmias (ATa). The initial strategy was an assessment of PV reconduction, followed by closure of all PV conduction gaps and electrical reisolation. Ablation of CFAEs was only performed in a PVI nonresponder if: 1) DC cardioversion failed after repeat PVI; or 2) patients demonstrated no PV reconduction (5). In patients with no PV reconduction presenting in SR, AF was induced by burst stimulation from the LAA before CFAE ablation.

Post-ablation treatment and follow-up. The OAC therapy was started immediately post-procedure, targeting an