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Clinical Research

Clinical Predictors of Termination and Clinical Outcome of Catheter Ablation for Persistent Atrial Fibrillation

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Objectives This study evaluated the role of pre-procedural clinical variables to predict procedural and clinical outcomes of catheter ablation in patients with long-lasting persistent atrial fibrillation (AF).

Background Catheter ablation of persistent AF remains a challenging task.

Methods Catheter ablation was performed in 90 patients (76 men, age 57 ± 11 years) with long-lasting persistent AF. The history of AF, echocardiographic parameters, presence of structural heart disease, and surface electrocardiogram (ECG) AF cycle length (CL) were assessed before ablation and analyzed with respect to procedural termination and clinical outcome. Mean follow-up was 28 ± 4 months.

Results Persistent AF was terminated in 76 of 90 patients (84%) by ablation. The duration of continuous AF was shorter ($p < 0.0001$), the surface ECG AFCL was longer ($p < 0.0001$), and the left atrium was smaller ($p < 0.01$) in patients in whom AF was terminated by catheter ablation. The surface ECG AFCL was the only independent predictor of AF termination ($p < 0.01$). Maintenance of sinus rhythm was associated with a shorter duration of continuous AF ($p < 0.0001$), a longer surface ECG AFCL ($p < 0.001$), and a smaller left atrium ($p < 0.05$) compared with those with recurrent arrhythmia. In multivariate analysis, the surface ECG AFCL and the AF duration predicted clinical success of persistent AF ablation ($p < 0.01$ and $p < 0.05$, respectively).

Conclusions The surface ECG AFCL is a clinically useful pre-ablation tool for predicting patients in whom sinus rhythm can be restored by catheter ablation. The duration of continuous AF and the surface ECG AFCL are predictive of maintenance of sinus rhythm. (J Am Coll Cardiol 2009;54:788–95) © 2009 by the American College of Cardiology Foundation

Atrial fibrillation (AF) accounts for almost one-third of all admissions to a hospital for a cardiac rhythm disturbance. Catheter ablation targeting isolation of the pulmonary veins (PVs) has evolved over the past decade and has become the treatment of choice for drug-resistant paroxysmal AF. The use of ablation for treatment of persistent AF has been expanding, with more centers now offering the procedure. Catheter ablation can terminate persistent AF and can result in maintenance of sinus rhythm, at least in the medium term (1–5). The AF cycle length (CL) measured from the left atrial appendage (LAA) has been used as a predictor of procedural termination of persistent AF (5); however, this can only be performed at the

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time of the procedure. The purpose of this study was to investigate which clinical variables, including a noninvasive measurement of AFCL from the surface electrocardiogram (ECG), are predictive of a successful procedural and medium-term clinical outcome using a sequential catheter ablation approach in patients with persistent AF.

Methods

Patient population. Of a total of 92 consecutive patients, 90 patients who underwent first-time radiofrequency cath-

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eter ablation for long-lasting persistent AF were included in the present study, with 2 patients excluded because of low-amplitude fibrillatory waves (minimal voltage <0.01 mV) that precluded accurate measurement of AFCL from the surface ECG. Long-lasting persistent AF was defined as continuous AF lasting longer than 1 month, resistant to either electrical or pharmacological cardioversion. All patients gave written informed consent.

Electrophysiological study. All patients had effective anticoagulation therapy (target international normalized ratio of 2 to 3) for more than 1 month, and atrial thrombus was excluded by transesophageal echocardiography before the procedure. All antiarrhythmic drugs, with the exception of amiodarone, were discontinued 5 half-lives before the procedure. The electrophysiological study was performed in the fasting state under mild sedation using midazolam and morphine. The following catheters were introduced via the right femoral vein: 1) a steerable decapolar catheter (Xtrem, Sorin Group, Le Plessis-Robinson, France) was positioned within the coronary sinus; 2) a circumferential mapping catheter (Lasso, Biosense Webster, Diamond Bar, California) was introduced after transseptal access; and 3) a 4-mm externally irrigated-tip ablation catheter (Thermocool, Biosense Webster) was used for mapping and ablation. After transseptal access, a single bolus of 50 IU/kg body weight of heparin was administrated and repeated only for procedures lasting more than 4 h. Surface ECG and endocardial electrograms were continuously monitored and recorded for off-line analysis (Bard Electrophysiology, Lowell, Massachusetts).

Measurement of the AFCL from surface ECG and intracardiac electrograms. The surface ECG AFCL was compared with the endocardial AFCL obtained simultaneously from the intracardiac recordings at both the LAA and the right atrial appendage (RAA) before ablation. In all patients, the surface ECG AFCL was manually measured from 10 unambiguous fibrillatory waves on lead V_1 (minimal voltage >0.01 mV) that were not fused with QRST segments (Fig. 1) at a paper speed of 50 mm/s and a gain setting of 20, 40, or 80 mm/mV. The mean LAA CL and RAA CL were calculated using custom software (Bard Electrophysiology) with manual verification (5).

Abbreviations and Acronyms

- **AF** = atrial fibrillation
- **CI** = confidence interval
- **CL** = cycle length(s)
- **ECG** = electrocardiogram
- **LA** = left atrium
- **LAA** = left atrial appendage
- **PV** = pulmonary vein
- **RAA** = right atrial appendage
- **ROC** = receiver-operator characteristic
- **TFA** = time frequency analysis

In the first 30 patients, intraobserver and interobserver error of the surface ECG AFCL from 10 CL was assessed. The surface ECG AFCL from 10 CL was measured on 2 different days and using 2 independent experts, respectively. The mean surface ECG AFCL from 10 CL was compared with that from 30 CL (manually measured) and with the mean AFCL using automated time frequency analysis (TFA) of 60 s of simultaneous surface ECG recording as

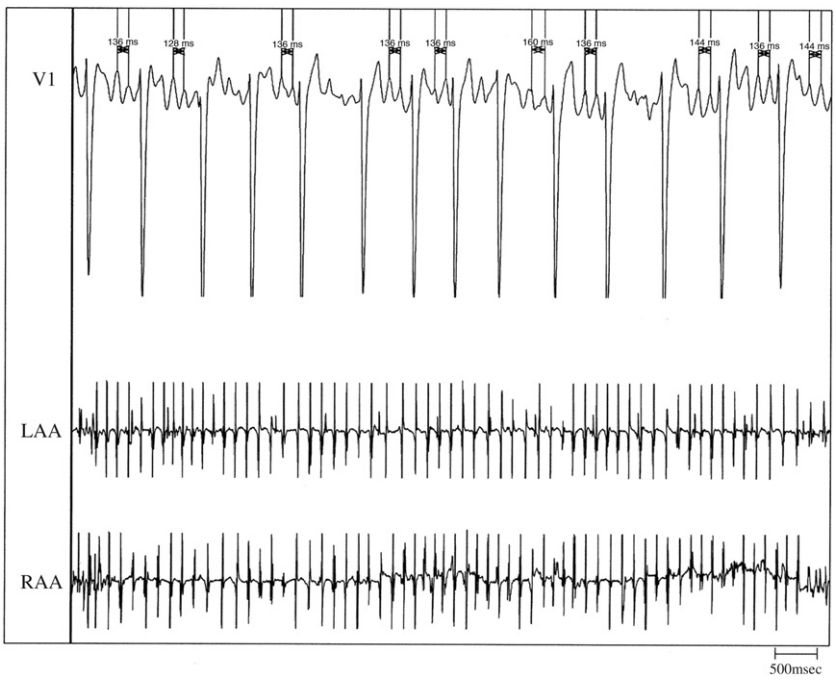

Figure 1 Measurements of AFCL

Simultaneous measurements of the atrial fibrillatory (AF) cycle length (CL) from surface electrocardiogram (ECG) and the left and right atrial appendages (LAA and RAA). The AFCL from surface ECG, the LAA, and the RAA in this case were 139, 144, and 145 ms, respectively.