Left atrial deformation predicts success of first and second percutaneous atrial fibrillation ablation

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BACKGROUND Predictors of second radiofrequency catheter ablation (RFCA) success are not well known. Surgical ablation is accepted for failed first RFCA, but second RFCA has fewer complications.

OBJECTIVE The purpose of this study was to evaluate left atrial (LA) size and function as potential predictors of second RFCA for atrial fibrillation (AF).

METHODS Thirty-three healthy volunteers (group I) and 83 patients with symptomatic drug-refractory AF treated with a first RFCA (group II, n = 48) or a second RFCA (group III, n = 35 patients) were included. Echocardiography was performed in all patients in sinus rhythm before RFCA and in all volunteers. LA size and function were measured using longitudinal strain and strain rate during ventricular systole (LASs, LASRs) and during early diastole (LASRe) or late diastole (LASRa) with speckle tracking echocardiography. The effectiveness of RFCA on arrhythmia recurrence was evaluated at 6-month follow-up.

RESULTS LASs, LASRs, and LASRa were significantly lower in group III patients compared to other groups ($P < .001$ for all). LA diameter or volumes did not predict success after RFCA. LASs was an independent predictor of arrhythmia suppression after a first RFCA and after a second RFCA, with the best cutoff at LASs >20% (sensitivity 86%, specificity 70%) and LASs >12% (sensitivity 84%, specificity 90%), respectively.

CONCLUSION LA myocardial deformation imaging is a reliable tool for predicting success after a first and a second RFCA. These parameters could improve candidate selection, especially for a second RFCA.

KEYWORDS Atrial fibrillation; Atrial function; Second catheter ablation; Predictors; Strain; Strain rate

ABBREVIATIONS **AF** = atrial fibrillation; **LA** = left atrial; **LASRa** = longitudinal left atrial late diastole strain rate with speckle tracking; **LASRe** = longitudinal left atrial early diastole strain rate with speckle tracking; **LASRs** = longitudinal left atrial systolic strain rate with speckle tracking; **LASs** = longitudinal left atrial systolic strain with speckle tracking; **LV** = left ventricle; **RFCA** = radiofrequency catheter ablation; **ROC** = receiver operating characteristic; **ST** = speckle tracking

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Introduction

Radiofrequency catheter ablation (RFCA) has become an important alternative for the treatment of patients with symptomatic drug-refractory atrial fibrillation (AF).[1,2] However, potential—albeit infrequent—complications of the procedure and the arrhythmia recurrence rate warrant careful selection of candidates for RFCA.[3] Enlarged left atrium (LA)[4–9] has been related to AF recurrence after a first RFCA procedure, and LA function assessed by 3-dimensional echocardiography is a predictor of success in eliminating the arrhythmia after a first RFCA procedure.[10]

Despite improved RFCA success with repeated procedures, predictors of arrhythmia suppression after a second RFCA procedure are not known.[11] In a previous study, LA size and LA function assessed by 3-dimensional echocardiography failed to predict AF recurrence after a second RFCA.[10] Myocardial deformation imaging derived from speckle tracking (ST) represents a novel tool for evaluating LA performance.[12–14]

Accordingly, the aim of the present study was to analyze LA function with myocardial deformation imaging in patients before a first or second RFCA procedure and to

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determine if deformation parameters could improve patient selection for second RFCA procedures.

Methods

Study subjects and protocol

In order to compare values of LA myocardial deformation values between patients with AF and healthy individuals, a group of 33 healthy volunteers (group I) was recruited from the staff of our institution. Volunteers with no record of cardiovascular disease were matched for age, sex, and body surface area with AF patients.

Eighty-three patients with symptomatic drug-refractory AF undergoing RFCA were included in the study. A first RFCA was performed in 48 patients (58%, group II), and a second RFCA was carried out in 35 patients (42%, group III). None of the patients underwent electrical cardioversion in the previous 3 months before ablation. Indications for a first RFCA were symptomatic drug-refractory AF or intolerance to at least 1 class I or III antiarrhythmic medication. A second RFCA procedure was indicated in patients with symptomatic drug-refractory AF after a blanking period of 3 months after a first RFCA following current recommendations.[15] Patients with significant valvular heart disease or prior valve surgery and those with moderate-to-severe left ventricular (LV) hypertrophy were excluded.

All patients provided written informed consent, and the study was approved by the ethics committee of our institution.

Percutaneous radiofrequency ablation

Catheter ablation was performed using a 3-dimensional electroanatomic mapping system (CARTO, Biosense Webster, Diamond Bar, CA) to support the creation and validation of radiofrequency lesions. The integration of previously acquired multidetector computed tomography or cardiac magnetic resonance imaging helped to optimize 3-dimensional reconstruction.

Both an ablation catheter and a circular catheter for registry and stimulation (Lasso, Biosense Webster; or Inquiry Optima, St. Jude Medical, Minnesota) were introduced percutaneously through the femoral vein. A double transseptal puncture was performed to access the LA.[3]

Radiofrequency was delivered through an irrigated-tip thermocouple-equipped catheter (3.5 mm) using a target temperature of 45°C at 40 W. Radiofrequency lesions were delivered surrounding each ipsilateral pulmonary vein as previously described.[16,17] The target was reduction of local electrogram to <0.15 mV and elimination of pulmonary vein potentials with establishment of bidirectional conduction block between the LA and pulmonary veins. In patients with persistent AF, additional radiofrequency applications were made along the LA roof, LA posterior wall, and along the mitral isthmus at the discretion of the operator. In repeated RFCA procedures, the first goal was reisolation of the pulmonary veins and then identification of nonpulmonary vein triggers.[15]

Clinical follow-up

All patients were evaluated at 1-, 3-, and 6-month follow-up after RFCA, including outpatient visits with clinical evaluation, serial ECG, rigorous pharmacologic control of hypertension, and 24-hour Holter monitoring to detect asymptomatic AF episodes.[15] After ablation, all patients continued oral anticoagulation for a minimum of 3 months, and continued anticoagulation therapy was based on CHA2DS2-VASc cardioembolic risk score.[15] Previous antiarrhythmic therapy was maintained for at least 1 month and then discontinued if no AF recurrences were detected. The procedure was considered successful if there were no recurrences of atrial tachycardia lasting >30 seconds during follow-up, after a blanking period of 3 months.[15]

Echocardiography

All patients underwent transthoracic and transesophageal echocardiography before the RFCA procedure, using a commercially available ultrasound scanner (Philips IE33, Andover, MA) to rule out structural heart disease and LA thrombi and to assess LA size and function. All images were digitally stored and transferred to a workstation for offline analysis. Special care was taken to acquire 2D images with a frame rate >50 frames per second for adequate analysis of myocardial deformation with ST.

LA and LV measurements were obtained according to the recommendations of the American Society of Echocardiography.[18] LV ejection fraction was determined using the biplane Simpson method.[18]

LA atrial deformation study

Special care was taken during echocardiographic image acquisition to ensure adequate LA tracking and avoid interference with the pulmonary veins and the LA appendage to measure global strain and strain rate of the LA. LA longitudinal myocardial deformation assessed by 2-dimensional echocardiography using ST was analyzed offline with a commercially available software package (Qlab version 7.1, Speckle Tracking, Philips, Andover, MA). From the apical 4-chamber view, 3 points in the LA (2 in the mitral annulus and 1 in the LA roof) were marked, and the endocardial border was manually traced using a point-and-click technique. All patients were in sinus rhythm during echocardiography. To assess longitudinal deformation of the LA, the following parameters were calculated, with the reference point set at the onset of the QRS complex of the surface ECG[13,14]: LASs (LA strain during ventricular systole) (Figure 1), LASRs (LA strain rate during ventricular systole), LASRe (LA strain rate during early ventricular filling phase), and LASRa (LA strain rate during late diastole) (Figure 1). The software divided the LA wall into 6 segments,[19] and the average was taken for analysis.

Statistical analysis

Continuous variables are given as mean value ± SD. Categorical variables are expressed as total number