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Incidental LV LGE on CMR Imaging in Atrial Fibrillation Predicts Recurrence After Ablation Therapy

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ABSTRACT

OBJECTIVES This study sought to evaluate the prognostic significance of left ventricular late gadolinium enhancement (LV-LGE) incidentally found in atrial fibrillation (AF) patients who undergo ablation therapy.

BACKGROUND LV-LGE provides prognostic information in patients with ischemic and nonischemic cardiomyopathies. However, data on the clinical significance of incidental LV-LGE in the AF population are limited.

METHODS A total of 778 patients who were referred for radiofrequency ablation of AF underwent cardiac magnetic resonance examinations between June 2006 and January 2013. Patients with a history of myocardial infarction or ablation therapy were excluded. The presence of LV-LGE was assessed by experienced imaging physicians. Patients were followed for arrhythmia recurrence after the radiofrequency ablation procedure.

RESULTS Of 598 patients included in the study, 60% were men with a mean age of 64 years and a median AF duration of 25 months. LV-LGE was detected in 39 patients (6.5%). There were 240 arrhythmia recurrences observed involving 40% of patients over a median follow-up period of 52 months. On univariate analysis, age (hazard ratio [HR]: 1.02; 95% confidence interval [CI]: 1.00 to 1.03), male sex (HR: 0.63; 95% CI: 0.47 to 0.86), diabetes (HR: 1.53; 95% CI: 1.03 to 2.27), $CHADS_2$ score (HR: 1.19; 95% CI: 1.04 to 1.36), CHA_2DS_2-VASc score (HR: 1.18; 95% CI: 1.08 to 1.30), left atrial (LA) fibrosis (HR: 1.66; 95% CI: 1.41 to 1.96), LV-LGE (HR: 1.83; 95% CI: 1.11 to 3.03), persistent AF (HR: 1.52; 95% CI: 1.11 to 2.09), and LA area (HR: 1.03; 95% CI: 1.01 to 1.05) were significantly associated with arrhythmia recurrence. The recurrence rate was 69% in patients with LV-LGE compared with 38% in patients without LV-LGE ($p < 0.001$). In a multivariate model, LA fibrosis and LV-LGE were independent predictors of arrhythmia recurrence.

CONCLUSIONS In AF patients without history of myocardial infarction, LV-LGE is a significant independent predictor of arrhythmia recurrence after ablation therapy. (J Am Coll Cardiol Img 2015;8:793–800) © 2015 by the American College of Cardiology Foundation.

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ABBREVIATIONS AND ACRONYMS

AF = atrial fibrillation

CMR = cardiac magnetic resonance

DM = diabetes mellitus

HTN = hypertension

LA = left atrium

LGE = late gadolinium enhancement

LV = left ventricle

MI = myocardial infarction

PAD = peripheral arterial disease

PV = pulmonary vein

SRM = structural remodeling

Atrial fibrillation (AF) is the most common sustained arrhythmia and can result in heart failure (1), stroke (2), and death (3). To achieve rhythm control, catheter ablation is becoming more common due to improved ablation techniques and limited success with anti-arrhythmic drugs.

In a growing number of centers, pre-ablation cardiac magnetic resonance (CMR) is performed to determine if patients are reasonable candidates for ablation therapy (4) and to provide 3-dimensional (3D) left atrial and pulmonary venous anatomy to help guide catheter navigation (5). This CMR study also provides left ventricular function and viability information.

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Left ventricular late gadolinium enhancement (LV-LGE) has prognostic value in patients with ischemic and nonischemic cardiomyopathies (6,7). Recently, incidental LV-LGE found by CMR in AF patients has been associated with mortality (8). However, the relationship between incidental LV-LGE in AF patients and specific cardiovascular outcomes has not been well studied. The goal of this study was to determine whether there is an association of incidental LV-LGE with cardiovascular risk factors and cardiovascular disease processes and to study the relationship between LV-LGE and arrhythmia recurrence after ablation.

METHODS

STUDY POPULATION. We retrospectively collected data on all consecutive patients from June 2006 to January 2013 who were referred for radiofrequency AF ablation and underwent CMR before the procedure. Of the 778 patients, 16 with known coronary artery disease and prior myocardial infarction (MI), 48 with prior AF ablation, and 116 who did not undergo ablation therapy were excluded. The final study population included 598 AF patients who underwent AF ablation. In AF patients with planned ablation therapy, CMR is the primary imaging modality for left atrial (LA) and pulmonary venous (PV) anatomy at our center. Contraindication for CMR included severe renal impairment (glomerular filtration rate <30 ml/min/1.73 m^2), severe claustrophobia, and the presence of a permanent pacemaker or implantable cardioverter-defibrillator. Paroxysmal AF was defined as any AF episode that terminated spontaneously within 7 days after onset (9). Persistent AF was defined as an AF episode that extended beyond 7 days. We defined prior MI by either clinical documentation of MI in the electronic medical record or electrocardiographic evidence per Minnesota codes 1.1.1 to 1.2.8 (10). The patients' $CHADS_2$ and CHA_2DS_2-VASc characteristics were determined by systematic chart review. The study protocol was approved by our Institutional Review Board.

CMR PROTOCOL. All studies were performed either on a 1.5-T Avanto or 3-T Verio scanner (Siemens Medical Solutions, Erlangen, Germany). The CMR protocol consisted of cine steady state free precession imaging for cardiac structure and function, 3D contrast enhanced magnetic resonance angiography for LA and PV anatomy, 2D LGE imaging for viability, and 3D LGE for LA fibrosis. 2D LGE imaging for viability was acquired approximately 12 min after contrast injection (0.1 mmol/kg, MultiHance [Bracco Diagnostics, Inc., Princeton, New Jersey]) using single-shot, electrocardiogram (ECG)-triggered, free-breathing, phase-sensitive inversion recovery sequences in short-axis and horizontal and vertical long-axis orientations covering the whole heart. Scan parameters for 2D LGE imaging were as follows: 3-T - echo time (TE) = 1.1 ms, repetition time (TR) = 2.5 ms, flip angle (FA) = 35°, pixel size = 1.88 × 1.88 × 2.07 mm, slice thickness = 7 mm; 1.5-T - TE = 1.1 ms, TR = 2.5 ms, FA = 45°, pixel size = 1.85 × 1.85 × 2.05 mm, slice thickness = 6 mm.

High-resolution LGE images for assessment of LA fibrosis were acquired 15 min after contrast injection using a 3D respiratory-navigated, ECG-gated, inversion recovery-prepared gradient-recalled pulse sequence. Inversion preparation was applied every heartbeat, and fat saturation was applied immediately before data acquisition. Data acquisition was limited to 15% of the cardiac cycle and was performed during LA diastole. The other scan parameters for assessment of LA LGE at 3-T were as follows: axial imaging volume with field-of-view (FOV) = 400 × 400 × 110 mm, voxel size = 1.25 × 1.25 × 2.5 mm, TR/TE = 3.1/1.4 ms, FA = 14°. Scan parameters for assessment of LA LGE at 1.5-T were as follows: axial imaging volume with FOV = 360 × 360 × 100 mm, voxel size = 1.25 × 1.25 × 2.5 mm, TR/TE = 5.2/2.4 ms, FA = 20°. Typical scan time for the LGE study was 6 to 12 min at 1.5-T and 5 to 9 min at 3-T, depending on patient respiration. LGE images were interpreted by 2 experienced CMR physicians. LV-LGE was considered present only if it was visible in all corresponding myocardial locations on short-axis, horizontal long-axis, and vertical long-axis images. LGE distribution was categorized as subendocardial, mid-myocardial, epicardial, transmural, or adjacent to right ventricular insertion points. Post-processing of LGE images