



Left atrial volume is more important than the type of atrial fibrillation in predicting the long-term success of catheter ablation



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ABSTRACT

Background: The type of atrial fibrillation (AF) is the sole prognostic factor that affects the level of recommendation for catheter ablation in the current guidelines. Despite being recognized as a predictor of recurrence, relatively little emphasis is given to left atrium (LA) size. The aim of this study was to assess the relative importance of LA volume and type of AF as predictors of outcome after PVI.

Methods: We assessed 809 consecutive patients with symptomatic drug-refractory AF (584 male, mean age 57 ± 11 years) undergoing 905 percutaneous PVI procedures in two centers. LA volume was assessed by cardiac CT and/or electroanatomical mapping prior to AF ablation. The study endpoint was symptomatic and/or documented AF recurrence.

Results: The majority of patients (73.2%, $n = 592$) had paroxysmal AF. The mean indexed LA volume was 55 ± 20 ml/m². During a follow-up of 2.4 ± 1.7 years, there were 280 recurrences. The relapse rate of patients with paroxysmal AF in the highest tertile of LA volume was higher than the relapse rate of patients with non-paroxysmal AF in the lowest tertile (20.0% vs. 10.9% per person-year, respectively, $p = 0.041$). LA volume (HR 1.16 for each 10 ml/m², 95% CI 1.09–1.23, $p < 0.001$), female gender (HR 1.55, 95% CI 1.19–2.03, $p = 0.001$), and non-paroxysmal AF (HR 1.31, 95% CI 1.01–1.69, $p = 0.039$) were the only independent predictors of AF recurrence. Split-sample cross-validation resampling confirmed LA volume as the strongest predictor of relapse after PVI.

Conclusion: Left atrial volume seems to be more important than the type of atrial fibrillation in predicting the long-term success of pulmonary vein isolation.

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1. Introduction

Catheter ablation has become an established treatment for patients with drug-refractory symptomatic atrial fibrillation (AF) [1,2]. Despite high early success rates, late recurrence of AF after an ablation procedure is common [3]. Identifying the predictors of long-term success is therefore essential to select the patients who are most likely to benefit and avoid the unnecessary risks and costs of ineffective procedures. The type of AF (paroxysmal vs. non-paroxysmal) is one of the most consistently reported predictors of outcome after pulmonary vein isolation (PVI), and is the sole prognostic factor that affects the level of

recommendation for catheter ablation in the current guidelines, mainly due to efficacy concerns in patients with non-paroxysmal AF [1,2,4]. Despite being recognized as a predictor of recurrence, relatively little importance is given to left atrium (LA) size, compared to the type of AF. However, and while a dilated LA usually underlies nonparoxysmal AF, it is not uncommon to find patients with persistent AF and normal sized LA, or with paroxysmal AF and dilated LA. The efficacy of AF catheter ablation in these subgroups is not well established. The purpose of this study was to assess the relative importance of LA volume and type of AF as predictors of outcome after PVI.

2. Methods

2.1. Patient characteristics and study design

All consecutive patients with symptomatic drug-refractory AF undergoing percutaneous PVI in two Portuguese centers (Hospital Santa

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Cruz, Carnaxide, Portugal; and Hospital da Luz, Lisbon, Portugal) were included in a prospective registry. Patients were enrolled between June 2005 and December 2011 in the first center, and between June 2007 and November 2012 in the second (with the overlapping period accounting for 79% of included patients). For the purposes of the present study, 197 patients (16.8%) who had no three-dimensional evaluation of LA volume prior to their ablation (either by cardiac computed tomography (CT) or by electroanatomical mapping) were excluded (Fig. 1).

The majority of patients ($n = 583$, 72.1%) underwent a 64-slice cardiac CT scan less than 48 h before the ablation procedure for the assessment of pulmonary vein anatomy, measurement of LA volume, exclusion of LA thrombi, and integration with electroanatomical mapping [5]. LA volume was calculated by tracing the LA borders on sequential CT images (excluding the pulmonary veins at their ostia and the left atrial appendage at its base) [6]. When cardiac CT could not be performed for logistical reasons ($n = 226$, 27.9%), electroanatomical mapping at the time of ablation (using a duodecapolar circular mapping catheter) was used to calculate LA volume [7,8]. In patients with LA volumes assessed by both methods ($n = 357$, 44.1%), the correlation between the two techniques was good (Pearson's R of 0.75, $p < 0.001$). Overall, 26% of the patients were in AF during the measurement of LA volume. For those with more than one ablation procedure, the first LA volume assessment was retained. LA volumes were indexed to body surface area.

AF was categorized as paroxysmal if self terminated in < 7 days, persistent if episodes lasted ≥ 7 days or required pharmacological or electrical cardioversion, or long-standing persistent if AF was maintained for more than 12 months [4]. The presence of structural heart disease and left ventricular systolic dysfunction was assessed by clinical history, physical examination, and transthoracic echocardiography.

This observational study conforms to the ethical guidelines of the 1975 declaration of Helsinki and was approved by both of the institutional review boards. All patients gave written informed consent.

2.2. Ablation protocol

The ablation procedure was guided by CARTO™ (Biosense Webster® Inc., Diamond Bar, California, USA) or NavX™ (St. Jude Medical® Inc., St. Paul, Minnesota, USA) electroanatomical mapping. Three catheters were introduced via right femoral venous access under local anesthesia, supplemented by sedation whenever necessary. A multipolar diagnostic

catheter was placed in the coronary sinus. An irrigated-tip ablation catheter and a duodecapolar circular mapping catheter were placed at the pulmonary veins (PV) ostia via transeptal access under IV heparin for an activated clotting time greater than 300 s. Irrigated radiofrequency ablation was performed with continuous lesions encircling both pairs of pulmonary veins and deployed more than 5 mm from the PV ostia. In Hospital Santa Cruz all patients underwent conventional manually guided ablation, whereas in Hospital da Luz a Niobe II magnetic navigation system (Stereotaxis® Inc., St. Louis, Missouri, USA) was used. Complete electrophysiological isolation of the PV was achieved in 97% of all patients. Cavo-tricuspid isthmus ablation line was performed when there was previously documented typical atrial flutter or when typical sustained atrial flutter occurred during the procedure. Whenever necessary, patients were cardioverted to sinus rhythm at the end of the procedure. Oral anticoagulation was restarted on the day of the procedure, maintained for 6 months and then suspended according to CHADS2 criteria. If necessary, patients were kept on subcutaneous enoxaparin 1 mg/kg every 12 h until a therapeutic international normalized ratio (INR) was reached. As a general rule, class I or III antiarrhythmic drugs were maintained in all patients for the first three months after the procedure and then withdrawn if there was no AF recurrence. Proton pump inhibition was used by protocol during the first month.

2.3. Study endpoint and patient follow-up

The study endpoint was AF recurrence, defined as the presence of symptomatic or documented AF after a 3-month blanking period. Symptomatic AF was defined as the presence of symptoms that could be related to AF episodes. Documented AF was defined by the presence of at least one episode of AF lasting more than 30 s in any electrocardiogram (ECG), 24 h Holter monitoring or event-loop recording.

The follow-up protocol consisted of outpatient visits with 12-lead ECGs and 24 h Holter monitoring at 1, 3, 6 and 12 months in the first year, and yearly thereafter. Patients were encouraged to contact the department whenever they experienced symptoms of AF recurrence or signs of complications. Additional ECGs, 24 h Holter monitoring and event-loop recordings were performed whenever necessary to assess symptoms of possible recurrence. When clinical records were insufficient, a structured telephonic interview was conducted. Fifty-five patients (5.1%) were lost to follow-up and excluded from this analysis.

2.4. Statistical analysis

The indexed LA volume was examined both as a categorical variable (classified by tertiles) and as a continuous variable. Baseline clinical characteristics were analyzed by type of AF (paroxysmal vs. non-paroxysmal) and presented as proportions and mean values \pm standard deviation, as appropriate. Comparisons between groups were performed using independent sample t-test and Fisher's exact test for continuous and categorical variables, respectively. Kaplan–Meier curves were used to describe the occurrence of AF relapse over time across strata of LA size and type of AF. Differences in AF-free survival were assessed with the log-rank test. Since many patients require more than one ablation to achieve an enduring AF remission, the last procedure was considered the index procedure for our primary analysis. Multivariable proportional hazard Cox regression was used to identify independent predictors of AF recurrence. Potential confounders were included based on known or presumed clinical relevance, irrespective of statistical significance in this particular cohort. The following variables were entered simultaneously into the model: age, sex, type of AF (paroxysmal vs. non-paroxysmal), hypertension/structural heart disease, indexed LA volume, left ventricular systolic dysfunction (ejection fraction $< 50\%$), ablation technique (magnetic navigation vs. manual ablation), and having done more than one ablation procedure. To assess the relative strength of the independent predictors of AF relapse, we

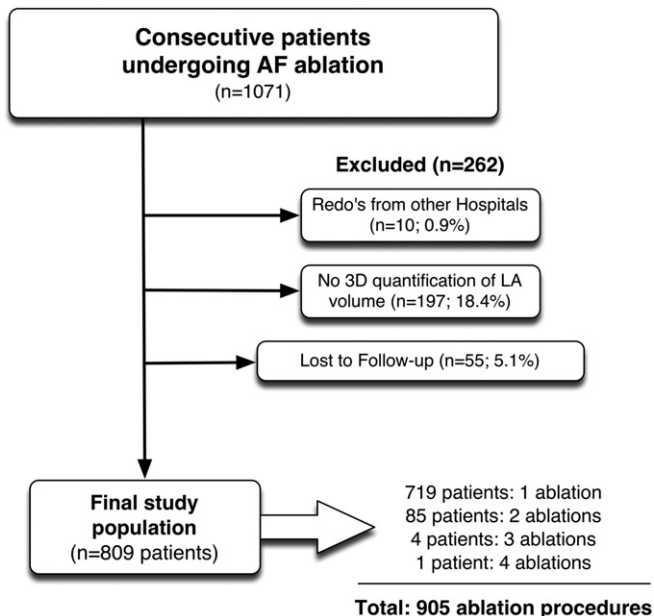


Fig. 1. Flowchart illustrating study population.

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