Journal of Cardiology 64 (2014) 57–63

Contents lists available at ScienceDirect

Journal of Cardiology

journal homepage: www.elsevier.com/locate/jjcc

Original article

Long-term outcome and preprocedural predictors of atrial tachyarrhythmia recurrence following pulmonary vein antrum isolation-based catheter ablation in patients with non-paroxysmal atrial fibrillation

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ARTICLE INFO

Article history:
Received 30 September 2013
Received in revised form 24 October 2013
Accepted 9 November 2013
Available online 25 December 2013

Keywords:
Atrial fibrillation
Persistent atrial fibrillation
Catheter ablation
Pulmonary vein antrum isolation
Predictor

ABSTRACT

Background: Although various empiric adjunctive ablation techniques are widely performed with pulmonary vein antrum isolation (PVAI) to enhance the procedural efficacy of catheter ablation in non-paroxysmal atrial fibrillation (NPAF) patients, they are not required in all NPAF patients.
Methods and results: Eighty consecutive NPAF patients refractory to antiarrhythmic drugs underwent a PVAI-based ablation. Structural heart disease was present in 40% of patients and systolic dysfunction in 21%. After 31 ± 16 months of follow-up, 41% of the patients were free of atrial tachyarrhythmia recurrences after a single procedure. Finally, during a mean follow-up of 25 ± 15 months, 63 of 80 (79%) patients remained in sinus rhythm (SR) after the final procedure (two procedures in 48%, and three in 3%). A Cox regression multivariate analysis revealed that left atrial volume (LAV) was the only independent predictor of atrial tachyarrhythmia recurrences not only after single procedures ($p = 0.027$), but also after the final procedures ($p = 0.001$). Ten patients (13%) needed ablation for concomitant atrial tachycardias originating from the left atrium and right atrium other than common atrial flutter. Repeat ablation procedures increased the best cut-off value for predicting recurrences analyzed by receiver operating characteristic curves, from 86 mL (sensitivity 70%, specificity 64%) to 92 mL (sensitivity 71%, specificity 78%).
Conclusions: PVAI-based ablation strategies could achieve SR maintenance in almost 80% of NPAF patients after multiple procedures during long-term follow-up. The preprocedural LAV was an important predictor of the procedural outcome.

Introduction

Various empiric adjunctive ablation techniques, such as complex fractionated atrial electrogram ablation, left atrial (LA) linear lesions, and ganglionated plexi (GP) ablation, have been developed to enhance the procedure efficacy of the catheter ablation of atrial fibrillation (AF). However, the role of additional empiric substrate modification beyond pulmonary vein (PV) antrum isolation (PVAI) in patients with non-paroxysmal AF (NPAF) remains controversial [1–5]. At least, such additional ablation methods are not required in all patients with NPAF [6]. On the other hand, there are few reports on the long-term outcome of PVAI-based strategies without additional empiric substrate modification in a population containing only patients with NPAF [7].

The aim of this study was to clarify the long-term outcome and the preprocedural predictors of atrial tachyarrhythmia (ATA) recurrence after a PVAI-based ablation strategy in NPAF patients.

Methods

Study population

This study included 80 consecutive patients who underwent catheter ablation for symptomatic, drug-refractory NPAF and who

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http://dx.doi.org/10.1016/j.jjcc.2013.11.010

were observed for at least 6 months following the last ablation procedure. All patients underwent a PVAI-based ablation. Persistent AF (PerAF) and long-standing persistent AF (LPAF) were defined according to the HRS/EHRA/ECAS 2007 Consensus Statement on Catheter and Surgical Ablation of AF [8]. All patients gave their written informed consent.

Preprocedural evaluation and management

As a preoperative evaluation, all patients underwent transthoracic echocardiography (TTE), trans-esophageal echocardiography (TEE), and multi-detector computed tomography (MDCT) using a 64-slice CT scanner within 2 days prior to the scheduled ablation procedure. All echocardiographic parameters were measured according to the recommendations of the American Society of Echocardiography [9]. The left atrial volume (LAV) was measured in the standard four- and two-chamber views. The end-systolic LAV was measured in each view using the modified Simpson's rule. The MDCT image was obtained with contrast enhancement in most patients, but without contrast enhancement in those with renal dysfunction. All patients were effectively anticoagulated for >1 month, and TEE was performed to exclude any LA thrombi prior to the ablation procedure. Before the procedure, all antiarrhythmic drugs (AADs) were discontinued for at least 5 half-lives except for amiodarone. Anticoagulation therapy using warfarin with a therapeutic international normalized ratio was continued during the periprocedural period.

Mapping and ablation protocol

All patients underwent a wide PVAI guided by electroanatomical mapping combined with image integration [10]. A 3.5-mm cooled-tip catheter (Navistar ThermoCool or ThermoCool SF, Biosense Webster Inc., Diamond Bar, CA, USA) was utilized for mapping and ablation. The circumferential ablation lines were created approximately 2–4 cm from the ipsilateral PV ostia except for the anterior aspect of the left PVs. PV isolation was confirmed by the electrograms recorded from circular mapping catheters and pacing maneuvers. Radiofrequency (RF) energy was delivered to the atrial tissue with a power of 25–30 W using irrigation rates of 17 mL/min with the Navistar ThermoCool or 8 mL/min with the Navistar ThermoCool SF to achieve the desired power delivery. The power was limited to 20–25 W at the posterior wall of the LA. The temperature was limited to 42 °C. After a successful wide PVAI, we tried to provoke a reconnection of the PVs (dormant PV conduction) with a 20 mg intravenous rapid injection of ATP administered under a 10 μg bolus injection of intravenous isoproterenol during sinus rhythm (SR) or CS pacing. If any dormant PV conduction was observed, additional RF energy was applied at the earliest PV activation site identified using the circular mapping catheters on the circumferential ablation lines, until the loss of any dormant PV conduction. An administration of ATP was given at least 20 min after the isolation of each PV [11]. If AF was sustained at the start of the ablation procedure, SR was restored by electrical cardioversion prior to the ablation. If cardioversion failed to restore SR, the PVAI was performed in AF and cardioversion was attempted later. Frequent atrial premature beats induced by a 10 μg bolus injection of isoproterenol were attempted to be abolished by a focal ablation of a specific origin or a superior vena cava (SVC) isolation for an SVC origin. Cavotricuspid isthmus (CTI) ablation was performed for common atrial flutter, which was clinically documented or induced during the procedure. We targeted the ablation of any ATAs, except for AF, induced by programmed electrical stimuli (PES) with/without isoproterenol. If AF was induced by the PES, we performed an electrical cardioversion to restore SR and finished the procedure. During and after the second ablation session in the patients with ATA recurrences after the index procedure, the previously delivered lesions were evaluated. If necessary, a re-isolation of the PVs and SVC, CTI ablation, focal ablation of frequent atrial premature beats, and ablation of any ATAs other than AF were performed.

Postablation follow-up

Ineffective AADs before the ablation were prescribed only if any early recurrences of an ATA were observed prior to discharge in patients with perAF. In patients with LPAF, discontinuation of the AADs was recommended 3 months after the ablation. The AADs for coexisting ventricular tachycardia in patients with structural heart disease (SHD) were continued. All patients were scheduled for visits in the outpatient clinic at 1, 2, 3, 6, 9, and 12 months after the ablation procedure and then every 6 months. The presence of AF was evaluated by the patient symptoms, electrocardiographic recordings, and 24-h ambulatory monitoring (1, 3, 6, 9, and 12 months after the ablation and then every 6 months). Patients with palpitations were encouraged to use portable electrocardiographic monitoring (HCG-801R; Omron, Kyoto, Japan). Recurrence was defined as recurrent symptoms and/or documented ATAs on the electrocardiogram, 24-h ambulatory monitoring, portable electrocardiographic monitoring, or cardiac rhythm management device (lasting >30 s) after a 2-month blanking period from the ablation procedure. In the absence of any AF recurrences after 6 months, the anticoagulant treatment was discontinued unless the patients had a $CHADS_2$ score of $\geq$2. The minimum follow-up of this series was 6 months after the final ablation procedure.

Statistical analysis

Data are presented as the mean ± SD, percentage, or number, as appropriate. Differences between the continuous values were assessed using an unpaired 2-tailed *t*-test for normally distributed continuous variables, the Mann–Whitney test for skewed variables, and the χ^2 test for nominal variables. A Cox proportional hazards model was used to identify any preprocedural predictors of ATA recurrences after single and repeat ablation procedures. All preprocedural potential confounders were entered into the model on the basis of known clinical relevance or significant association observed in the univariate analysis. All parameters with a significance of <0.05 in the univariate analysis were entered into the multivariate model. If more than 2 of the indices of the LA size, including the LA dimension, LAV, and LAV index, exhibited a $p < 0.05$ in the univariate analysis, we chose one of them, which had the lowest *p*-value among them, as one of the variables for the multivariate analysis. To obtain the best cut-off value of any predictor for an ATA recurrence after the ablation procedure, a receiver-operating characteristic (ROC) curve was generated and the area under the curve (AUC) was calculated. A Kaplan–Meier analysis with a log-rank test was used to determine the probability of the freedom from recurrent ATAs after the initial and last procedure. A *p*-value <0.05 was considered statistically significant. All statistical analyses were performed with JMP software version 10.0 (SAS Institute, Cary, NC, USA).

Results

Patient characteristics

The baseline patient characteristics are shown in Table 1. Of 80 NPAF patients, 15 (19%) had LPAF. The median value (interquartile range) of the AF duration was 4 (1–8) months in patients with PerAF and 30 (17–39) months in patients with LPAF. Thirty-two (40%) patients had SHDs including 11 with hypertrophic cardiomyopathy, 8 with dilated cardiomyopathy, 4 with dilated hypertrophic