Improved outcome following restoration of sinus rhythm prior to catheter ablation of persistent atrial fibrillation: A comparative multicenter study

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BACKGROUND Catheter ablation of persistent atrial fibrillation (AF) is associated with longer procedure times and lower long-term success rates than that of paroxysmal AF.

OBJECTIVE To test the hypothesis that restoration/maintenance of sinus rhythm (SR) preablation would facilitate AF termination and improve outcomes in patients with persistent AF.

METHODS We conducted a 2-group cohort study of consecutive patients with persistent AF and SR restored for at least 1 month prior to ablation (SR group; n = 40) and controls matched by age, sex, and AF duration (control group; n = 40). Radiofrequency stepwise catheter ablation was performed in AF for both groups (induced and spontaneous, respectively). Success was defined as freedom from atrial tachyarrhythmia without antiarrhythmic drugs beyond 1 year of follow-up.

RESULTS During the index ablation procedure, AF cycle length was longer in the SR group than in the control group (183 ± 32 ms vs 166 ± 20 ms; $P = .06$), suggestive of reverse remodeling. In the SR group, AF more frequently terminated during ablation (95.0% vs 77.5%; $P < .05$) and required less extensive ablation of complex fractionated electrograms (40.0% vs 87.5%; $P < .001$) and linear lesions (42.5% vs 82.5%; $P < .001$). Mean procedural (199.8 ± 69.8 minutes vs 283.5 ± 72.3 minutes; $P < .001$), fluoroscopy (51.0 ± 24.9 minutes vs 96.3 ± 32.1 minutes; $P < .001$), and radiofrequency energy delivery (47.5 ± 18.9 minutes vs 97.0 ± 30.6 minutes; $P < .001$) times were shorter in the SR group. Clinical success rates were similar between groups for first (55.0% vs 45.0%; $P = .28$) and last (80.0% vs 70.0%; $P = .28$) procedures, during similar follow-up periods (21.1 ± 9.7 months).

CONCLUSIONS Restoration of SR prior to catheter ablation for persistent AF whenever possible decreases the extent of ablation with the same high clinical efficacy.

KEYWORDS Atrial fibrillation; Catheter ablation

ABBREVIATIONS **AAD** = antiarrhythmic drug; **AF** = atrial fibrillation; **AFCL** = AF cycle length; **AT** = atrial tachycardia; **LA** = left atrial; **PV** = pulmonary vein; **PVI** = pulmonary vein isolation; **RF** = radiofrequency; **SR** = sinus rhythm

(Heart Rhythm 2012;9:1025–1030)

Introduction

The use of catheter-based techniques for the treatment of atrial fibrillation (AF) has grown rapidly over the last decade. Whereas ablation for paroxysmal AF targeting pulmonary veins (PVs) is now widely accepted, the ideal ablation strategy for persistent AF remains a matter of debate.[1,2] Catheter ablation of persistent AF requires a more aggressive ablation strategy that includes linear lesions and targeting of complex fractionated electrograms and is associated with a longer procedure duration, higher complication rate, and a lower long-term success rate than for paroxysmal AF.[3] It is well recognized that electrical, contractile, and structural remodeling is a fundamental contributor to the AF disease process.[4–7] Animal and human studies have shown that electrical remodeling reverses rapidly after electrical cardioversion of persistent AF[8–12] and is complete after 7–14 days of maintained sinus rhythm (SR).[10] We hypothesized that electrical remodeling contributes to the need for more complex procedures for patients with persistent AF and, consequently, that restoration (and maintenance) of SR before catheter ablation would facilitate the procedure and would increase procedural and clinical success in patients with persistent AF.

This study was supported by the European Network for translational research in atrial fibrillation "EUTRAF." Dr Khairy was supported by a Canada Research Chair in Electrophysiology and Adult Congenital Heart Disease. **Address for reprint requests and correspondence:** Dr Léna Rivard, MD, MSc, Montreal Heart Institute, 5000 Belanger St, Montreal, Quebec, Canada H1T1C8. E-mail address: lena.rivard@umontreal.ca.

1547-5271/$ -see front matter doi:10.1016/j.hrthm.2012.02.016

Methods

Patient population

A 2-group cohort study was conducted of patients undergoing a first catheter ablation procedure for persistent and long-lasting persistent AF from 2007 to 2009 at 3 participating institutions (Hôpital Cardiologique du Haut Lévêque, Bordeaux, France, n = 46; University Hospital Eppendorf, Hamburg, Germany, n = 27; and Clinique Ambroise Paré, Neuilly sur Seine, France, n = 7). The study group consisted of consecutive patients in whom SR was restored by electrical cardioversion and maintained at least 1 month prior to ablation (SR group). Patients who did not maintain SR were excluded from the study (n = 2). These patients were retrospectively matched 1:1 according to age, sex, and longest duration of continuous AF (categorized as 7 days to 1 month, 1–6 months, 6–12 months, and >12 months) with contemporary controls in whom no attempt to restore SR was made prior to ablation (control group). From a total of 2125 potential candidates, paired controls were identified in a 2-step fashion. First, control subjects were matched by sex and longest duration of AF category. Then, within this group of prospects, the patient closest in age (±2 years) was retained.

AF was defined as persistent or long-lasting persistent (continuous AF of >1 year duration) in accordance with HRS/EHRA/ECAS 2007 recommendations.[13] Patients were excluded if they had a prior AF ablation, cardiac surgery, a left atrial (LA) diameter of >55 mm, an LA thrombus, or if they were younger than 18 years. Patients with less than 12 months of follow-up after the last ablation procedure were also excluded (n = 10). All patients gave written informed consent.

Electrophysiological study and catheter ablation

After at least 4 weeks of effective anticoagulation therapy, a transesophageal echocardiogram was performed before the ablation procedure to exclude LA thrombus. All antiarrhythmic drugs (AADs) with the exception of amiodarone were discontinued 5 half-lives before the procedure.

Ablation was performed during AF in all patients. For patients in the SR group, AF was induced by atrial burst-pacing without isuprel. Sequential stepwise ablation was performed as previously described.[14] Briefly, pulmonary vein isolation (PVI) was achieved as antral as possible by using a 3.5-mm irrigated-tip catheter (ThermoCool, Diamond Bar, CA) and guided by a circular mapping catheter (LASSO; Biosense Webster, Inc, Diamond Bar, CA). Radiofrequency (RF) energy was delivered at a power of 25–35 W, with an irrigation flow-rate titrated for a target temperature of 38–40°C. After completing PVI, electrogram-based ablation was performed at right atrial and/or LA sites displaying any of the following features: continuous electrical activity, complex rapid and fractionated electrograms, and a gradient of activation. If AF persisted after these 2 steps, linear ablation was performed. First, a roof line was added between the superior PVs and if AF persisted, a mitral isthmus line was performed as previously described.[14] The end point of the stepwise ablation was termination of AF during ablation, whether directly to SR or via other atrial tachycardias (ATs), which were then mapped and ablated. If AF or AT persisted after completing all the steps, electrical cardioversion was attempted.

After restoration of SR, PVs were mapped with the LASSO catheter and further ablation was performed, if required, to achieve isolation. Conduction block across lines was assessed, with additional ablation performed if necessary.[15] A similar strategy was applied to repeat procedures. For ATs, activation and entrainment mapping were performed to differentiate focal from macroreentrant mechanisms as previously described.[16] For focal AT, the site of earliest atrial activation was targeted for ablation. Entrainment mapping techniques were used for macroreentrant circuits (initially at the roof and mitral isthmus) to identify a critical isthmus for RF ablation.

Follow-up

All patients were systematically followed at 1, 3, 6, and 12 months. Routine transthoracic echocardiograms, exercise testing, and 48-hour Holter monitoring were performed at each follow-up visit. Referring physicians were contacted to supplement follow-up information beyond

Table 1 Patient characteristics

	SR group (n = 40)	Control group (n = 40)	*P*
Age (y), mean ± SD	59.4 ± 11.0	58.4 ± 10.4	.08
Men, n (%)	34 (85.0)	34 (85.0)	
History of AF (mo), mean ± SD	76.0 ± 57.9	83.4 ± 74.1	.65
Long-lasting AF, n (%)	16 (40.0)	16 (40.0)	
Duration of continuous AF (mo), mean ± SD	14.9 ± 21.8	12.8 ± 12.1	.54
Hypertension, n (%)	24 (60.0)	18 (45.0)	.07
Diabetes, n (%)	1 (2.5)	2 (5.0)	.56
Structural heart disease, n (%)	6 (15.0)	8 (20.0)	.56
$CHADS_2$ score, mean ± SD	1.0 ± 0.7	1.1 ± 1.0	.82
History of stroke, n (%)	3 (7.5)	4 (10.0)	.65
Left atrial size (mm), mean ± SD	41.9 ± 6.2	43.2 ± 5.2	.39
Left ventricular ejection fraction (%), mean ± SD	63.9 ± 11.7	55.7 ± 14.9	*

AF = atrial fibrillation; $CHADS_2$ = congestive heart failure (1 point), hypertension (1 point), age > 75 y (1 point), diabetes (1 point), and stroke or transient ischemic attack (2 points). SD = standard deviation; SR = sinus rhythm.
*P <.05.