Localized reentry within the left atrial appendage: arrhythmogenic role in patients undergoing ablation of persistent atrial fibrillation

Mélèze Hocini, MD, Ashok J. Shah, MD, Isabelle Nault, MD, Prashanthan Sanders, MBBS, PhD, Matthew Wright, MBBS, PhD, Sanjiv M. Narayan, MD, FACC, Yoshihide Takahashi, MD, Pierre Jaïs, MD, Seiichiro Matsuo, MD, Sébastien Knecht, MD, Frédéric Sacher, MD, Kang-Teng Lim, MD, Jacques Clémenty, MD, Michel Haïssaguerre, MD

From the Hôpital Cardiologique du Haut-Lévêque and the Université Victor Segalen Bordeaux II, Bordeaux, France.

BACKGROUND: Left atrial appendage (LAA) is implicated in maintenance of atrial fibrillation (AF) and atrial tachycardia (AT) associated with persistent AF (PsAF) ablation, although little is known about the incidence and mechanism of LAA AT.

OBJECTIVE: The purpose of this study was to characterize LAA ATs associated with PsAF ablation.

METHODS: In 74 consecutive patients undergoing stepwise PsAF ablation, 142 ATs were encountered during index and repeat procedures. Out of 78 focal-source ATs diagnosed by activation and entrainment mapping, 15 (19%) arose from the base of LAA. Using a 20-pole catheter, high-density maps were constructed (n = 10; age 57 ± 6 years) to characterize the mechanism of LAA-AT. The LAA orifice was divided into the posterior ridge and anterior-superior and inferior segments to characterize the location of AT.

RESULTS: Fifteen patients with LAA AT had symptomatic PsAF for 17 ± 15 months before ablation. LAA AT (cycle length [CL] 283 ± 30 ms) occurred during the index procedure in four and after 9 ± 7 months in 11 patients. We could map 89% ± 8% AT CLs locally with favorable entrainment from within the LAA, which is suggestive of localized reentry with centrifugal atrial activation. ATs were localized to inferior segment (n = 4), anterior-superior segment (n = 5), and posterior ridge (n = 6) with 1:1 conduction to the atria. Ablation targeting long fractionated or mid-diastolic electrogram within the LAA resulted in tachycardia termination. Postablation, selective contrast radiography demonstrated atrial synchronous LAA contraction in all but one patient. At 18 ± 7 months, 13/15 (87%) patients remained in sinus rhythm without antiarrhythmic drugs.

CONCLUSION: LAA is an important source of localized reentrant AT in patients with PsAF at index and repeat ablation procedures. Ablation targeting the site with long fractionated or mid-diastolic LAA electrogram is highly effective in acute and medium-term elimination of the arrhythmia.

KEYWORDS: Left atrial appendage; Atrial tachycardia; Localized reentry; Persistent atrial fibrillation; Catheter ablation

ABBREVIATIONS: **AF** = atrial fibrillation; **AT** = atrial tachycardia; **CL** = cycle length; **LA** = left atrium/atrial; **LAA** = left atrial appendage; **PsAF** = persistent atrial fibrillation; **RF** = radiofrequency; **LV** = left ventricular

(Heart Rhythm 2011;8:1853–1861)

Introduction

The role of left atrial appendage (LAA) has been increasingly recognized in the initiation and maintenance of atrial fibrillation (AF).[1–3] Besides sporadic cases, systematically conducted studies have reported electrocardiographic and electrophysiologic characteristics of focal atrial arrhythmias arising from the LAA.[4–10] However, little is known about the mechanism and characteristics of organized atrial arrhythmia, atrial tachycardia (AT), arising from LAA in association with the ablation of persistent AF (PsAF).[11] We present the incidence, electrophysiologic characteristics, and outcomes of LAA AT arising in the context of PsAF ablation in a consecutive series of patients.

Address for reprints and correspondence: Dr. Mélèze Hocini, Hôpital Cardiologique du Haut-Lévêque, Service de Rythmologie, Avenue de Magellan, 33604 Bordeaux-Pessac, France. E-mail address: meleze.hocini@chu-bordeaux.fr. (Received March 2, 2011; accepted July 6, 2011.)

Methods

Study population

Parent AF population

Seventy-four consecutive patients (ages 55 ± 13 years) who underwent ablation of PsAF (AF duration 17 ± 15 months) were included in the study. Among them, 44 patients had long-standing PsAF (AF duration 24 ± 14 months). The mean duration of PsAF in the remaining 30 patients was 7 ± 3 months. All patients provided written informed consent and were in spontaneous AF at the beginning of the procedure. The procedural target was termination of AF

1547-5271/$ -see front matter doi:10.1016/j.hrthm.2011.07.013

without antiarrhythmic drugs or electrical cardioversion. Ablation was undertaken in a stepwise manner as described elsewhere.[3,12,13] Briefly, pulmonary vein isolation was performed with the endpoint of complete abolition or dissociation of potentials in all veins. Electrogram-guided ablation was performed at the sites featuring characteristic electrograms such as continuous electrical activity, disorganized, high-frequency, and multicomponent electrograms and a gradient of activation (a temporal gradient of at least 70 ms between the distal and proximal bipoles of the roving ablation catheter). These features may represent a local circuit. The endpoint was transformation of disorganized and fractionated electrograms into discrete electrograms associated with organization of local cycle length (CL). Linear ablation was performed if AF persisted at this stage. The left atrial (LA) roof and mitral isthmus were sequentially ablated with the endpoint of abolition of local electrograms or >80% reduction in their amplitude. After restoration of sinus rhythm, further ablation, if required, was performed at these sites to achieve bidirectional conduction block.[14,15]

Population with AT

Among 74 patients undergoing stepwise PsAF ablation, 50 ATs were encountered during the index procedure and 92 during the follow-up of 7 ± 5 months. Among 142 ATs, 64 were macroreentrant and 78 were diagnosed to have a focal source, including 15 (19%) wherein the focus was confined to the base of the LAA. High-density mapping was performed in 10 out of 15 LAA ATs using a multipolar catheter or three-dimensional electroanatomical mapping system.

Arrhythmia definition

(1) AF was defined as persistent (sustained beyond 7 days or lasting less than 7 days but necessitating cardioversion) or long-lasting persistent (continuous AF of greater than 1 year duration) according to the Heart Rhythm Society/European Heart Rhythm Association/European Cardiac Arrhythmia Society 2007 Consensus Statement on Catheter and Surgical Ablation of AF.[16]

(2) In accordance with the consensus statement from the Working Group of Arrhythmias of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, AT was defined as a rapid regular atrial rhythm with stable CL, surface ECG morphology, and endocardial activation pattern.[17]

Macroreentry was diagnosed and confirmed using the following criteria: (1) sequential activation mapping (with eight or more evenly distributed points in each atrium) demonstrating >50% of the tachycardia CL; and (2) postpacing interval not longer than the tachycardia CL by ≥30 ms at two separate atrial sites. Typical macroreentrant circuits involved the mitral or the tricuspid annulus or the ipsilateral veins (indicating roof-dependent macroreentry).[18]

Focal AT was defined as AT with a discrete source of origin of activation spreading centrifugally to the rest of the atrium.

Electrophysiology study

Electrophysiological study was performed in the postabsorptive conscious state with minimal sedation. All antiarrhythmic drugs were discontinued for at least 5 half-lives before ablation, with the exception of amiodarone (n = 5). Oral anticoagulation was administered (target international normalized ratio 2–3) for at least 1 month before the procedure, and transesophageal echocardiography was performed within 5 days of the procedure to exclude atrial thrombus.

Surface electrocardiogram and bipolar endocardial electrograms were continuously monitored and stored on a computer-based digital amplifier/recorder system (Bard Electrophysiology, Lowell, MA). Intracardiac electrograms were filtered from 30–500 Hz. After transseptal puncture, a single intravenous bolus of 50 IU/kg of heparin was administered. Heparin was repeated if the procedural duration exceeded 4 hours.

Conventional mapping

A steerable quadripolar/decapolar catheter (Xtrem; Ela Medical, Le Plessis Robinson, France) was placed in the coronary sinus, and a roving 3.5-mm externally irrigated tip ablation catheter (Thermocool, Biosense Webster, Diamond Bar, CA) was used for conventional mapping.

High-density mapping catheter and electroanatomical mapping

Mapping was performed using a high-density mapping catheter (20 pole PentaRay catheter, Biosense Webster) as described elsewhere.[19] The atria were mapped to determine the location and mechanism of the AT.

Once the source of the AT had been determined using conventional mapping techniques, the high-density mapping catheter was applied to the endocardial surface around the source to identify the earliest endocardial activity relative to the surface tachycardia P wave and/or to a reference atrial electrogram on one of the coronary sinus electrodes. In patients in whom >70% of the tachycardia CL could be identified on the bipoles of PentaRay, entrainment maneuvers were used to confirm the reentrant mechanism. Finally, we evaluated the amplitude of electrograms during AT and in sinus rhythm at these sites.

Delineation of the LAA

In patients with AT originating from the LAA, we anatomically delineated LAA by manually performing selective LAA contrast atriography using a 6-Fr National Institutes of Health catheter (Biosense Webster) through a long sheath. For precisely defining the location of LAA AT, the LAA was divided into three segments: posterior ridge, anterior-superior segment, and the inferior segment (Figure 1A). After restoration of sinus rhythm, the P-A_{LAA} interval (onset of P wave in lead II to atrial potential in the LAA) was measured to evaluate the effect of ablation on the conduction of sinus impulse to the LAA.