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Catheter Ablation of Atypical Atrial Flutter and Atrial Tachycardia Within the Coronary Sinus After Left Atrial Ablation for Atrial Fibrillation

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OBJECTIVES The goal of this study was to describe the prevalence and ablation of coronary sinus (CS) arrhythmias after left atrial ablation for atrial fibrillation (AF).

BACKGROUND The CS has been implicated in a variety of supraventricular arrhythmias.

METHODS Thirty-eight patients underwent mapping and ablation of atypical flutter that developed during (n = 5) or after (n = 33) ablation for AF. Also included were two patients with focal CS arrhythmias that occurred during an AF ablation procedure. A tachycardia was considered to be originating from the CS if the post-pacing interval in the CS matched the tachycardia cycle length and/or if it terminated during ablation in the CS.

RESULTS Among the 33 patients who developed atypical flutter late after AF ablation, 9 (27%) were found to have a CS origin. Overall, 16 of the 40 patients in this study had a CS arrhythmia. The tachycardia was macro–re-entrant in 14 patients (88%) and focal in two patients. Radiofrequency ablation with an 8-mm-tip catheter was successful in 15 patients (94%) without complication. In eight patients (50%), ≥45 W was required for successful ablation. Thirteen of the 15 patients (87%) with a successful ablation acutely remained arrhythmia-free during 5 ± 5 months of follow-up.

CONCLUSIONS The musculature of the CS serves as a critical component of the re-entry circuit in approximately 25% of patients with atypical flutter after ablation for AF. The CS may also generate focal atrial arrhythmias that may play a role in triggering and/or maintaining AF. Catheter ablation of these arrhythmias in the CS can be performed safely. (J Am Coll Cardiol 2005;46:83–91) © 2005 by the American College of Cardiology Foundation

The musculature of the coronary sinus (CS) has been implicated in a variety of arrhythmias, including those mediated by accessory pathways (1), and focal (2,3) and macro–re-entrant (4) atrial tachycardias. Electrical disconnection of the CS from the left atrium has also been shown to decrease the probability of induction of atrial fibrillation (AF) in patients undergoing pulmonary vein isolation (5). However, the role of the CS in arrhythmias after left atrial ablation has not been described. The purpose of this study was to determine the prevalence and mechanisms of atrial arrhythmias originating from the CS in patients who underwent left atrial ablation for AF.

METHODS

Patient characteristics. The study group (Fig. 1) consisted of 38 patients who underwent mapping and ablation of atypical flutter that developed either during (n = 5) or late after (n = 33) left atrial ablation for AF. In the latter group of 33 consecutive patients, the atypical flutter was diagnosed a mean of 8 ± 10 weeks after ablation of AF, and the flutter ablation procedure was performed a mean of 8 ± 4 months after the ablation procedure for AF. Also included in this study were two patients with a focal atrial arrhythmia originating in the CS that occurred during an ablation procedure for AF.

The musculature of the CS was considered to be a component of the re-entry circuit if the post-pacing interval (PPI) in the CS was within 20 ms of the tachycardia cycle length or if the arrhythmia terminated during energy delivery in the CS. Table 1 describes the clinical characteristics of the 40 patients.

Left atrial ablation for AF. Antiarrhythmic medications were discontinued at least five half-lives before the procedure, with the exception of amiodarone. In patients with paroxysmal AF, amiodarone was discontinued ≥6 weeks before the procedure, and in patients with persistent or chronic AF, amiodarone therapy was not discontinued before the procedure. The ablation procedure was performed in the fasting state after written informed consent was obtained. Catheters were inserted into the right femoral vein and/or the right internal jugular vein. A quadripolar electrode catheter was positioned within the CS for atrial pacing. After transeptal catheterization, heparin was infused to maintain an activated clotting time of 300 to 350 s. A deflectable quadripolar catheter (EP Technologies, Inc., Sunnyvale, California) was placed in the coronary sinus for atrial pacing (EP-3 Clinical Stimulator, EP MED Systems, Inc., West Berlin, New Jersey).

Left atrial circumferential ablation was performed as

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Abbreviations and Acronyms
AF = atrial fibrillation
CS = coronary sinus
ECG = electrocardiogram
PPI = post-pacing interval

previously described (6). An 8-mm-tip deflectable ablation catheter (Navistar, Biosense Webster, Diamond Bar, California) was used to create a three-dimensional replica of the left atrium with an electroanatomic mapping system (CARTO, Biosense Webster). Tubular models of the pulmonary veins and the outline of the mitral valve annulus were also depicted. Radiofrequency current was applied with a target temperature of 50°C to 55°C and a power of 50 to 70 W (Stockert 70 RF generator, Biosense Webster). Left atrial ablation was performed 1 to 2 cm from the pulmonary vein ostia to encircle the left- and right-sided pulmonary veins. The encircling ablation lines were then connected with one to two ablation lines in the posterior left atrium. An ablation line also was created between the inferior aspect of the left-sided encircling ablation line and the mitral annulus. After the recognition of the possibility of left atrial-esophageal fistula (7), the posterior line was moved to the anterior portion of the roof and lower power and/or temperature settings were used on the posterior wall. The end point of ablation was voltage abatement of the local atrial electrogram by >80% or to <0.1 mV.

If the procedure was performed during AF and the patient converted to sinus rhythm during ablation, atrial pacing was performed on five occasions for 10 s at cycle lengths of 200 to 220 ms and programmed atrial stimulation was performed with a single atrial extrastimulus to determine whether AF or another arrhythmia was inducible. If after ablation the patient remained in AF, ibutilide was administered or transthoracic cardioversion was performed. Atrial flutter was defined as a macro–re-entrant, regular, atrial tachycardia with a cycle length of ≥200 ms and a consistent atrial activation sequence. It was considered atypical if the PPI at the cavotricuspid isthmus exceeded the cycle length of the tachycardia by >30 ms. Macro–re-entry was confirmed by observing that atrial electrograms spanned the cycle length of the tachycardia. An atrial tachycardia was considered focal if there was a centrifugal pattern of spread from a focal source.

Table 1. Clinical Characteristics of the Study Patients

Number of patients	40
Age (yrs)	55 ± 9
Males/females	26/14
Duration of AF (yrs)	6 ± 7
Paroxysmal/persistent AF	22/18
LV ejection fraction	0.52 ± 0.12
Left atrial diameter (mm)	43 ± 6
Structural heart disease	8

Data are shown as mean ± SD.
AF = atrial fibrillation; LV = left ventricular.

Ablation was performed in the cavotricuspid isthmus in patients with a history of typical atrial flutter, and in patients in whom cavotricuspid isthmus-dependent atrial flutter was induced by atrial pacing (8).

Mapping of CS arrhythmias. An activation map of the atypical flutter was performed with an electroanatomic mapping system. A CS origin was suspected if the entire cycle length of the macro–re-entrant tachycardia could not be accounted for by a left atrial activation map or if the CS atrial electrogram occurred in mid-diastole. Entrainment mapping was performed to identify sites within the re-entry circuit (9). During pacing from the CS, the pacing output was gradually decreased to avoid concomitant capture of the adjacent left atrium. Sites harboring split, fragmented, or diastolic potentials were labeled on the activation map. Focal arrhythmias were mapped by identifying the site of earliest atrial activation with respect to the P-wave on the 12-lead electrocardiogram (ECG) and/or with an electroanatomic mapping system. Each pulmonary vein was analyzed during tachycardia with a mapping catheter to rule out

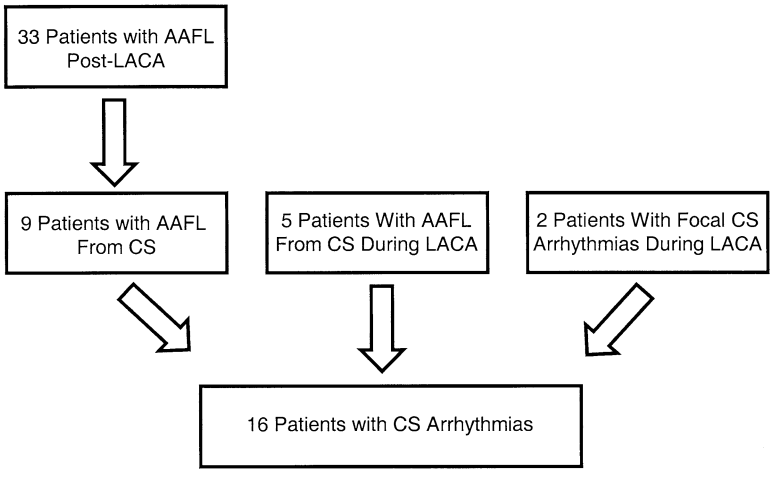

Figure 1. A flow chart showing how the patients were selected for the study. AAFL = atypical atrial flutter; CS = coronary sinus; LACA = left atrial circumferential ablation.