Pulmonary Vein Isolation for Atrial Fibrillation in Patients With Paroxysmal Atrial Fibrillation and Prolonged Sinus Pause

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SUMMARY

Background: Symptomatic prolonged sinus pauses upon termination of atrial fibrillation (AF) are an indication for pacemaker implantation.

Methods and Results: We evaluated the clinical outcomes of 4 patients who showed prolonged sinus pauses (> 2 seconds) upon termination of AF and thus underwent ablation. The ablative procedure included pulmonary vein isolation, superior vena cava isolation, and cavo-tricuspid isthmus ablation. Twenty-four-hour ambulatory electrocardiogram monitoring was performed before and 1 month after ablation. The maximum sinus pause decreased from 4.5 ± 2.1 seconds before ablation to 1.7 ± 0.2 seconds after ablation. Sinus pauses > 2.0 seconds disappeared after ablation in all 4 patients. Minimum heart rate increased from 35.0 ± 8.1 beats/minute before ablation to 52 ± 6.7 beats/minute after ablation. The number of heart beats in 24 hours did not change significantly after ablation.

Conclusion: Prolonged sinus pauses after paroxysmal AF may result from depressed sinus node function, which can be eliminated by curative ablation of AF. (Int Heart J 2007; 48: 247-252)

Key words: Atrial fibrillation, Sick sinus syndrome, Sinus pause, Pulmonary vein isolation

SICK sinus syndrome is a common clinical problem that manifests as weakness, presyncope, or syncope secondary to sinus pauses or severe bradycardia. Patients with sick sinus syndrome often have supraventricular tachycardia and atrial fibrillation (AF).1-3 Prolonged sinus pauses upon termination of AF are an accepted indication for pacemaker implantation. However, these frequently occur in patients taking antiarrhythmic or rate-controlling drugs. In this clinical study,
we hypothesized that curative ablation of AF, with the discontinuation of associated pharmacotherapy, would obviate the need for pacing in a subset of patients.

**METHODS**

**Patients:** The subjects were 4 patients who underwent curative ablation of drug-refractory paroxysmal AF between October 2003 and April 2005 because of documented, prolonged sinus pauses (> 2 seconds) upon termination of AF. All patients gave informed consent for participation in the study, which was approved by the Clinical Research and Ethics Committee of Nihon University Hospital.

**Mapping and ablation of AF:** Anticoagulation therapy had been performed in all 4 patients for ≥ 1 month, and all underwent transesophageal echocardiography to exclude left atrial thrombus before ablation. The ablation procedure included isolation of the pulmonary veins (PVs) and superior vena cava (SVC) and ablation of the cavo-tricuspid isthmus (CTI).4,5) Radiofrequency ablation was performed with continuous temperature feedback control using an 8-mm-tip thermocouple-equipped ablation catheter (Boston Scientific/EPT). PV and SVC ablation was performed at a target temperature of 50-55°C and a power limit of 30-35 W. For CTI ablation, the target temperature was 60°C, and the power limit was 50 W. Ablation of the PVs was performed by creating continuous circumferential lesions around the ipsilateral PVs guided by fluoroscopy and the double-Lasso technique.6) Bidirectional isolation of the PVs and SVC was confirmed by pacing from the atrium and from inside the vein.

**Sinus node function:** Minimum heart rate (10 beats averaged), maximum sinus pause, number of sinus pauses > 2 seconds, and the total number of heart beats in 24 hours were determined by 24-hour ambulatory ECG monitoring within 1 month before ablation (Figure 1) at which time all antiarrhythmic drugs were stopped for ≥ 3 half-lives, and 1 month after ablation (Figure 2).

**Follow-up:** All patients were monitored in the hospital for at least 2 days after ablation. Patients were clinically reevaluated at 1, 3, and 6 months after ablation, after which, in the absence of AF or symptoms, the referring physician provided follow-up data. After ablation, all antiarrhythmic drugs were discontinued in the absence of concurrent indications.

**RESULTS**

**Patient characteristics:** The patient group comprised 2 men and 2 women, aged 71.8 ± 4.9 years. Paroxysmal AF had been present for 67 ± 33 months, with documented prolonged sinus pauses (ranging from 2.1 to 7.2 seconds (4.5 ± 1.7 seconds)) upon termination of AF. Sinus pauses were associated with dizziness (n = 1)
PV ISOLATION FOR BRADYCARDIA-TACHYCARDIA SYNDROME

or presyncope (n = 3). Antiarrhythmic drug (3.3 ± 1.0) and/or rate-controlling drug administration failed in all 4 patients. Two patients had hypertension.

Ablation of AF: All 4 PVs and the SVC were electrically disconnected in all 4 patients. The CTI was also ablated in all 4 patients. No pericardial effusion or stroke developed.

Clinical outcome: At 21.5 ± 8.2 (14-32) months after ablation, no patient had recurrent episodes of AF, despite withdrawal of antiarrhythmic drugs. No patient developed symptoms attributable to sinus node dysfunction.

Sinus node function: No sinus pauses > 2 seconds were observed by ambulatory ECG monitoring 1 month after ablation in any patients.

Minimum heart rate: Minimum heart rate increased from 35.0 ± 8.1 beats/minute before ablation to 52.0 ± 6.7 beats/minute at 1 month after ablation (Table).

Figure 1. Twenty-four-hour ECG monitoring before pulmonary vein isolation in case 2. Maximum sinus pause in this patient was 7.2 seconds.
Total number of heart beats in 24 hours: The total number of 24-hour heart beats did not change (from 97,000.4 ± 2138.2 beats/day before ablation to 106,475 ± 11259.0 beats/day at 1 month after ablation) (Table).

Maximum sinus pause: Maximum sinus pause decreased significantly from 4.5 ± 2.1 (2.1-7.2) seconds before ablation (Figure 1) to 1.7 ± 0.2 (1.5-2.0) seconds 1 month after ablation (Figure 2) (Table).

Sinus pauses > 2 seconds: Five to 511 episodes of sinus pause > 2 seconds during 24-hour ambulatory monitoring were observed in 3 patients before ablation (in case 3, no data on the number of pauses > 2 seconds were available from 24-hour ambulatory monitoring before ablation). No sinus pause > 2 seconds was observed in any patient 1 month after ablation (Table).

DISCUSSION

The present study results show that prolonged sinus pauses upon termination of AF may be eliminated by curative ablation and the discontinuation of anti-arrhythmic or rate-controlling drugs. An association between sinus node dysfunction and atrial tachyarrhythmia has long been recognized. Elvan, et al in a canine model of pacing-induced chronic AF recognized sinus node remodeling resulting from AF. In this model, the corrected sinus node recovery time and
P-wave duration were prolonged and the maximal and intrinsic hearts rates were decreased. Prolonged corrected sinus node recovery time has been observed in humans after cardioversion of chronic AF. \(^8\) Reverse remodeling of sinus node function has been observed after termination of chronic atrial flutter, suggesting that atrial flutter results in sinus node remodeling and that this process is reversible. \(^9\) Furthermore, sinus node remodeling has recently been shown to occur even after brief periods (10-15 minutes) of rapid atrial pacing. \(^10\)

Recent basic and clinical studies have shown that local cardiac autonomic ganglia clustered in the fat pads at the margins of the PV antra innervate PV myocardial sleeves and adjacent atrial myocardium and that these clusters can play a critical role in the initiation and maintenance of AF. \(^11-13\) Pachon, et al reported recently that persistent parasympathetic denervation and sympathetic reinnervation after endocardial radiofrequency ablation of autonomic connections in the 3 main ganglia were demonstrated by the permanent modification of the heart rate variability in the chronic phase, leading to amelioration of sinus node function. \(^14\)

Recent reports have also shown improved sinus node function after PV isolation. \(^15,16\) Thus, both reverse remodeling of sinus node function and parasympathetic denervation might reduce the recurrence of AF.

**Study limitation:** This study was limited in that it was retrospective and involved a small number of patients who underwent PV isolation. A double-blind, randomized, placebo-controlled trial would strengthen the validity of the findings. Unfortunately, the clinical diagnosis of sick sinus syndrome by means of invasive measurement such as sinus node recovery time or sinoatrial conduction time was not confirmed in each patient. The improved sinus node function might be attributable to discontinuation of the antiarrhythmic medications, as well as to sinus node remodeling or changes in autonomic tone following PV isolation. Furthermore, comparison of the total number of heart beats in 24 hours before and after ablation had limitations because of frequent episodes of AF before ablation.

**Conclusion:** Prolonged sinus pauses after paroxysmal AF may result from depressed sinus node function, which can be eliminated by curative ablation of AF. Although further studies are needed to elucidate the mechanism underlying clinical improvement, the clinical effect of PV isolation in patients with sinus node dysfunction suggests that this procedure should be considered fairly early in the management of these patients.

**REFERENCES**

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