Clinical utility of adenosine-infusion test at a repeat atrial fibrillation ablation procedure

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BACKGROUND The majority of patients with recurrence of arrhythmia after the initial atrial fibrillation (AF) ablation procedure have resumption of pulmonary vein (PV) conduction. Adenosine-infusion test after PV isolation identifies acute dormant PV conduction during the index procedure.

OBJECTIVE To evaluate the utility of adenosine-infusion test at a repeat AF ablation procedure.

METHODS This study included 50 consecutive patients (38 men; mean age 65 ± 9 years) who underwent second ablation procedure for recurrent atrial tachyarrhythmia(s). At the index procedure, which was undertaken for paroxysmal AF, all patients underwent PV isolation and 48 of 50 (96%) underwent superior vena cava (SVC) isolation followed by adenosine infusion. PV and SVC were reisolated—if found reconnected—at the start of the second procedure. Thereafter, adenosine-infusion test was undertaken for all PVs in all patients.

RESULTS At the index procedure, adenosine infusion revealed dormant PV conduction in 15 of 50 (30%) patients. At the second procedure, after 10 ± 10 months, PV and SVC reconnections were observed in 46 of 50 (92%) and 33 of 48 (68.8%) patients and they were reisolated. Subsequently, adenosine-infusion test revealed dormant PV conduction in 9 of 50 (18%) patients, including 3 of 50 (6%) who had no PV reconnection at the start of the procedure. In these 3 patients, transient AF resulted after adenosine infusion, and at mean 8.0 ± 3.4 months, they were free from any atrial arrhythmia after the elimination of dormant PV conduction alone.

CONCLUSIONS Adenosine-infusion test reveals dormant thoracic vein conduction associated with arrhythmia recurrence in the chronic phase after the initial PV isolation.

KEYWORDS Adenosine; Pulmonary vein isolation; Catheter ablation; Atrial fibrillation; Dormant conduction

ABBREVIATIONS **AF** = atrial fibrillation; **ATP** = adenosine triphosphate; **ECG** = electrocardiogram; **LA** = left atrium/atrial; **PV** = pulmonary vein; **PVAI** = PV antrum isolation; **RA** = right atrium/atrial; **RF** = radiofrequency; **RMP** = resting membrane potential; **SVC** = superior vena cava

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Introduction

Paroxysmal atrial fibrillation (AF) is most often triggered by pulmonary veins (PVs), and catheter ablation of AF is a standard of care in patients with symptomatic drug refractory.[1] AF ablation consists fundamentally of electrical isolation of PVs.[2] Recent guidelines[3] indicate that PVAI is the cornerstone of AF ablation,[4–6] and it is well known that the majority of the recurrent atrial tachyarrhythmias result from the reconnection of PVs.[7–10] A recent histological study demonstrated that nontransmural lesion created by ablation could lead to persistent PV reconnection in the chronic phase.[11] Experimental studies have shown that adenosine test identified lesions with reversible thermally mediated membrane depolarization. Such lesions are likely to recover over a time frame of minutes.[12] Accordingly, adenosine test has been established in the identification of dormant PV conduction at the index procedure.[13–16] However, little is known about the utility of adenosine test at the repeat procedure. We hypothesized that some dormant conduction, which may not be identified at the start of the repeat procedure but may lead to clinical recurrence, may be identified by adenosine test. The objective of this study was to systemically evaluate the electrophysiological response to adenosine administration at a repeat AF ablation procedure.

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Methods

Study population

This study consisted of 50 consecutive patients (38 men; mean age 65.3 ± 8.9 years) who underwent second ablation procedure for recurrent atrial tachyarrhythmias at Tsuchiura Kyodo Hospital. All patients underwent index AF ablation procedure for drug-resistant paroxysmal AF. AF was classified according to the 2007 HRS/EHRA/ECAS expert consensus statement[3] on catheter and surgical ablation of AF. All patients gave written informed consent for participation in the study.

Mapping and ablation protocol

All antiarrhythmic drugs were discontinued for at least 5 half-lives before the procedure. All patients were effectively anticoagulated for more than 1 month before the procedure. Transesophageal echocardiography was performed to exclude atrial thrombi. Cardiac-enhanced computed tomography was performed to evaluate cardiac anatomy. The surface electrocardiogram (ECG) and bipolar intracardiac electrograms were continuously monitored and stored on a computer-based digital recording system (LabSystem PRO, Bard Electrophysiology, Lowell, MA). The bipolar electrograms were filtered from 30 to 500 Hz. A 7-F 14-pole two-site mapping catheter (Irvine Biomedical Inc, Irvin, CA) was inserted through the right jugular vein and positioned in the coronary sinus for pacing, recording, and internal AF cardioversion. The electrophysiological study was performed under mild sedation obtained with pentazocine and hydroxyzine pamoate.

Ablation at the index procedure

Ablation was performed according to the strategy described previously.[17,18] In brief, after 1 transseptal puncture, 2 long sheaths (SL0, AF Division, St Jude Medical, Minneapolis, MN) were introduced into both superior PVs via the same transseptal hole. Pulmonary venography during ventricular pacing and contrast esophagography were performed to obtain the relative locations of the PV ostia vis-à-vis esophagus. A 100 IU/kg body weight of heparin was administered after the transseptal puncture, and heparinized saline was additionally infused to maintain the activated clotting time at 300–350 seconds. Two circular mapping catheters (Lasso, Biosense Webster, Diamond Bar, CA) were placed in the superior and inferior PVs, and the left- and right-sided ipsilateral PVs were circumferentially and extensively ablated by point-by-point ablation guided by a 3-dimensional mapping system (CARTO 3, Biosense Webster). Posteriorly, ablation was performed anatomically in the left atrium (LA), approximately 1–3 cm from the PV ostia. Anteriorly, ablation was performed on the edge of the left PVs guided by early PV potentials. The electrophysiological end point was the achievement of bidirectional conduction block between the LA and the PVs, and the anatomic end point was the creation of complete continuous circumferential lesion around the ipsilateral veins.[19] Radiofrequency (RF) current was delivered point by point with 3.5-mm externally irrigated-tip quadripolar ablation catheter (Thermocool, Biosense Webster), with power up to 35 W, target temperature $\leq 38^{\circ}C$, and irrigation rate of 30 mL/min. The power was limited to 20 W on the posterior wall close to the esophagus. After completing the PVAI, a 30 mg bolus of adenosine triphosphate (ATP) was injected to unmask any dormant PV conduction, and additional RF applications were undertaken if it was observed until any dormant conduction was not provoked by repeat ATP injection.

Superior vena cava (SVC) isolation was performed systematically in 48 of 50 (96%) patients in whom the SVC potentials were recorded in sinus rhythm and during pacing from the high right atrium (RA). The circular mapping catheter was placed at the level of the lower border of the pulmonary artery above the SVC-RA junction guided by SVC angiography. During sinus rhythm, the SVC potentials were fused with the local RA signals, necessitating ablation during high-RA pacing. RF energy was delivered point by point for 30 seconds, each using 4-mm non-irrigated-tip catheter in a temperature-controlled mode, with maximum temperature set at $50^{\circ}C$ and maximum power at 35 W. Before RF delivery, high-output pacing (10 mA) was performed at every site and if diaphragmatic stimulation was observed then ablation was avoided locally to prevent phrenic nerve injury. The end point of ablation was the elimination of all SVC potentials on the circular recording catheter.

Ablation at the second procedure

In patients with clinical recurrence of atrial tachyarrhythmias, a second procedure was undertaken. At the outset, PVs were checked with circumferential catheter. In the case of PV reconduction, additional RF applications were performed to reisolate the PVs. After complete PV reisolation, a 30 mg bolus of ATP was injected to unmask any dormant PV conduction. Of note, adenosine test was undertaken for all PVs in all patients even if no PV reconduction was observed at the start of the second procedure. In addition, a pacing protocol was undertaken to identify non-PV triggers on high-dose isoproterenol infusion. Cardioversion of any AF induced by LA or RA pacing was undertaken. If a stable atrial tachycardia (AT) was present, its mechanism was elucidated by using 3-dimensional activation (CARTO 3, Biosense Webster) and entrainment mapping. This was followed by ablation of tachycardia.

Follow-up

Patients underwent continuous, in-hospital ECG monitoring for 3 days after the procedure. The first outpatient clinic visit was 3 weeks after the ablation procedure. Subsequent follow-up visits consisted of clinical interview, ECG, and 24-hour Holter monitoring every 3 months at our cardiology clinic. No antiarrhythmic drugs were prescribed after the procedure. Patients with palpitations were encouraged to use an event recorder. Recurrence was defined according to the