Visualization of pulmonary vein–left atrium lesions using delayed-enhancement magnetic resonance imaging after cryothermal balloon catheter ablation: A case report

Tsuyoshi Mishima, MD,* Koji Miyamoto, MD, PhD,* Yoshiaki Morita, MD,† Takashi Noda, MD, PhD,* Takeshi Aiba, MD, PhD,* Kengo Kusano, MD, PhD*

*From the *Department of Cardiovascular Medicine, National Cerebral and Cardiovascular Center, Suita, Japan, and †Department of Radiology, National Cerebral and Cardiovascular Center, Suita, Japan.*

Introduction

Electrical pulmonary vein (PV) isolation is an effective technique that is used to treat patients with paroxysmal atrial fibrillation (AF).[1–5] In recent years, PV isolation by cryothermal balloon (CB) ablation has been increasingly adopted by electrophysiology laboratories around the world.[6–8] This technology is associated with more reproducible results and reduced procedural times and may be less influenced by operator dexterity than the traditional point-by-point approach with radiofrequency catheter ablation. Although it may offer the invaluable advantage of achieving PV isolation with a single application, little is known about the extension of the PV–left atrium (LA) lesion after the procedure in clinical practice. Although delayed-enhancement magnetic resonance imaging (DE-MRI) has been reported as a noninvasive tool for visualizing lesions after radiofrequency or CB ablation,[9–13] the relationship between the CB ablation procedure and lesions on DE-MRI results has not yet been assessed in detail.

Case report

A 54-year-old man experiencing palpitations was referred to our hospital, National Cerebral and Cardiovascular Center, for ablation because of drug-refractory paroxysmal AF. After a preprocedural examination including multidetector computed tomography, CB ablation was considered appropriate. After written informed consent was obtained from the patient, the electrophysiological study and ablation were performed under conscious sedation. The standard Brockenbrough technique was used; an 8.5F transseptal sheath (SL0, St. Jude Medical, St. Paul, MN) was introduced into the LA and exchanged for a 12F steerable sheath (FlexCath Advance, Medtronic, Minneapolis, MN). Intravenous heparin was administered to maintain an activated clotting time of >300 seconds immediately after the atrial transseptal puncture.

CB catheter ablation

The 28-mm CB was advanced into the LA via the 12F steerable sheath. The CB was inflated proximal to the left superior PV ostium and then was pushed gently, aiming for complete sealing at the antral aspect of the PV. Contrast medium injected through the central lumen of the CB was used to verify complete occlusion of the PV ostium (Figure 1). A 180-second freeze cycle was then performed for the left superior PV. Although PV potentials could not be recorded for live verification of PV isolation, PV isolation was confirmed after the first freeze cycle. This confirmation was followed by an additional freeze cycle of 180 seconds. A 180-second freeze cycle was applied 2 times for left inferior PV isolation in the same way. Left inferior PV isolation was also confirmed after the first freeze cycle. During cryoenergy application along the right PVs, continuous pacing of the phrenic nerve was performed using a diagnostic catheter (15–25 mm diameter; A-focus, St. Jude Medical) positioned within the superior vena cava. As there have been some difficulty in attaching the balloon to the bottom of the right inferior PV, there remained PV potentials at the bottom of the right inferior PV after a total of 5 freezing times (720 s in all). The right inferior PV was finally isolated 10 seconds after the sixth freeze began, and this isolation was followed by a freeze cycle of 50 seconds. The freeze for right superior PV isolation was performed next. Right superior PV isolation was confirmed after the first freeze cycle of 180

KEYWORDS Atrial fibrillation; Cryothermal balloon; Delayed-enhancement magnetic resonance imaging

ABBREVIATIONS **3D** = 3-dimensional; **ACT** = activated clotting time; **AF** = atrial fibrillation; **CB** = cryothermal balloon; **DE-MRI** = delayed-enhancement magnetic resonance imaging; **EAM** = electroanatomic mapping; **LA** = left atrium; **LAO** = left anterior oblique; **LIPV** = left inferior pulmonary vein; **LSPV** = left superior pulmonary vein; **PV** = pulmonary vein; **RAO** = right anterior oblique; **RIPV** = right interior pulmonary vein; **RSPV** = right superior pulmonary vein

(Heart Rhythm Case Reports 2015;1:424–428)

Conflicts of interest: The authors have no conflicts of interest to declare.

Address reprint requests and correspondence: Dr Koji Miyamoto, Division of Arrhythmia and Electrophysiology, Department of Cardiovascular Medicine, National Cerebral and Cardiovascular Center, 5-7-1 Fujishirodai Suita, Osaka 565-8565, Japan. E-mail address: kojimiya@tempo.ocn.ne.jp.

http://dx.doi.org/10.1016/j.hrcr.2015.04.011

KEY TEACHING POINTS

- Delayed-enhancement magnetic resonance imaging can clearly visualize the lesion set after cryothermal balloon ablation.
- The extent of lesions set and the locations of gaps seem to be associated with the ablation procedure. The gaps were located around right-sided pulmonary veins, to which the cryothermal balloon had difficulty attaching in the ablation procedure.
- The clinical significance of gaps detected by DE-MRI in relation to the recurrence of atrial fibrillation is controversial. Large and prospective studies are required to assess the usefulness of the DE-MRI in clinical practice.

seconds, and an additional 120-second freeze cycle followed. The bidirectional PV-LA conduction block was confirmed by pacing from the coronary sinus and each PV, and all PVs were electrically isolated from the LA after the procedure. The patient was discharged from our hospital 3 days after the procedure, without complications such as thromboemboli, bleeding, or phrenic nerve injury.

Delayed-enhancement magnetic resonance imaging

DE-MRI was performed 1 month after discharge using a 1.5-T scanner (MAGNETOM Sonata, Siemens, Erlangen, Germany) with a 6-channel body array coil. An intravenous bolus of 0.15 mmol/kg gadolinium contrast (Omniscan, Daiichi Sankyo, Tokyo, Japan) was administered 20 minutes before a 3-dimensional (3D) electrocardiographically gated inversion-recovery gradient-echo sequence was applied in the axial orientation. The acquired voxel size was $2.0 \times 1.3 \times 2.5$ mm. Other typical sequence parameters were as follows: repetition time/echo time, 3.5/1.4 milliseconds; flip angle, 10°; bandwidth, 360 Hz/pixel; inversion time, 300 milliseconds. Scan time for the DE-MRI sequence was approximately 25 seconds during breath hold. Cardiac magnetic resonance images were reconstructed and analyzed using the software module workstation (Ziostation2; Ziosoft, Tokyo, Japan). The scar was extracted by tracing the hyperenhanced area on a source image, and 3D volume-rendering images of the magnetic resonance angiography overlaid with PV-LA scars were reconstructed. The overlaid 3D images were analyzed in terms of whether each PV was completely encircled by the scar and where the suspicious gaps in the lesions were located. Circumferentiality (which was defined as the ratio of the scar to the circumference of each PV) and the volume of the scar around each PV were measured.

DE-MRI could clearly visualize PV-LA lesions around the left and right PVs. (Figures 2 and 3). There was clear, circumferential delayed enhancement around the left superior and inferior PVs, including the carina region. Although there was also clear delayed enhancement around the right superior PV, there were deficits of delayed enhancement at the carina of the right PVs and at the bottom of the right inferior PV. The circumferentialities of the left superior, left inferior, right superior, and right inferior PV were 100%, 100%, 87.1%, and 78.2%, respectively.

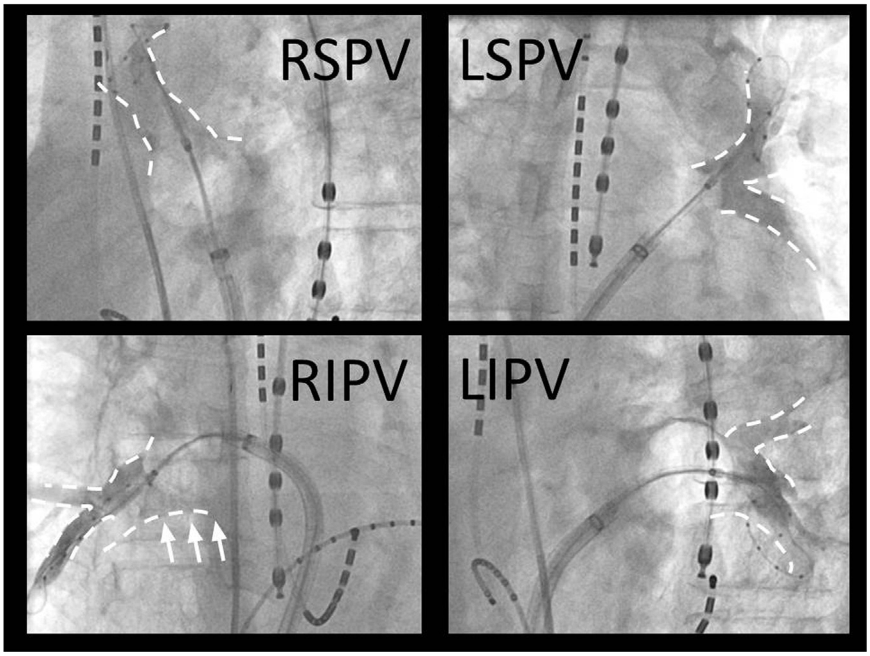

Figure 1 Fluoroscopic images of contrast medium injection at the left superior pulmonary vein (LSPV), left inferior pulmonary vein (LIPV), right superior pulmonary vein (RSPV), and right inferior pulmonary vein (RIPV). LSPV and RSPV are right anterior oblique (RAO) views, and LIPV and RIPV are left anterior oblique (LAO) views, respectively. The broken lines show the pulmonary vein (PV) wall. The arrows in RIPV show the leakage at the bottom of the PV, indicating insufficient cryothermal balloon attachment to the PV ostium.