Real-time superior vena cava isolation during cryoballoon ablation of the right pulmonary veins: A case report

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Introduction

Pulmonary vein antrum isolation (PVAI) is the established effective strategy for atrial fibrillation. Recently, PVAI with cryoballoon ablation continues to increase. Few authors have reported inadvertent superior vena cava (SVC) isolation after cryoballoon ablation to the right superior pulmonary vein (RSPV).[1–3] Here we report a case in which far-field SVC potential was recorded in the RSPV and in which real-time SVC isolation was monitored during cryoballoon ablation to the RSPV.

Case report

A 70-year-old man with drug-resistant paroxysmal atrial fibrillation was referred to our institution for catheter ablation. He underwent PVAI with a 28-mm fourth-generation cryoballoon (Arctic Front Advance PRO; Medtronic, Minneapolis, MN). PVAI was performed under sinus rhythm in the following order: left superior, left inferior, right inferior, and right middle pulmonary vein (RMPV), and then RSPV. Electrical isolation of each pulmonary vein was performed with 1 3-minute application using the proximal sealing technique. The time to isolation (TTI) and the nadir balloon temperature of the RMPV were 22 seconds and -46°C, respectively (Figure 1). Conduction time from HRA 1,2 to SVC 1,2 was prolonged from 63 ms to 111 ms after RMPV cryoablation. When the Achieve mapping catheter (Medtronic) was delivered to the distal portion of the RSPV after the cryoballoon ablation to the RMPV, the recorded potentials showed dissociated activities (Figure 2B). However, residual potentials were recorded when the Achieve mapping catheter was adjusted to the proximal portion of the RSPV (Figure 2C). Then, a cryoballoon ablation to the RSPV was applied. TTI and the nadir balloon temperature of RSPV were 104 seconds and -56°C, respectively. When the recorded potentials on the Achieve mapping catheter in the RSPV gradually prolonged and disappeared, the recorded SVC potentials on the BeeAT catheter (Japan-Life-Line, Tokyo, Japan) in the high right atrium also prolonged and disappeared simultaneously (Figure 2D). At 142 seconds, we terminated freezing with the emergent double stop owing to the amplitude drop of the diaphragmatic compound motor action potential. Although we did not apply another cryoballoon ablation to the RSPV considering the risk of right phrenic nerve palsy, the recorded SVC potentials in the high right atrium continued to demonstrate dissociated activities. Following the confirmation of bidirectional block between the left atrium and RSPV, the Achieve mapping catheter was delivered in the SVC. Dissociated activity on the Achieve mapping catheter was interlinked with the SVC potentials on the BeeAT catheter (Figure 3B), and bidirectional block between the right atrium and SVC was confirmed (Figure 3C).

KEY TEACHING POINTS

- Superior vena cava isolation during cryoballoon ablation to the right superior pulmonary vein is rare but possible.
- Recorded signals in the right superior pulmonary vein may be far-field superior vena cava potentials in case that the time to isolation is long despite a sufficient balloon occlusion and temperature.
- Attention should be paid to the superior vena cava potentials during cryoballoon ablation to the right superior pulmonary vein.

Discussion

It has been reported that cryoballoon ablation to the RSPV could induce an SVC potential conduction delay[4] and even inadvertent SVC isolation.[1–3] Shah and colleagues[5]

KEYWORDS Atrial fibrillation; Catheter ablation; Cryoballoon ablation; Pulmonary vein isolation; Right superior pulmonary vein; Superior vena cava

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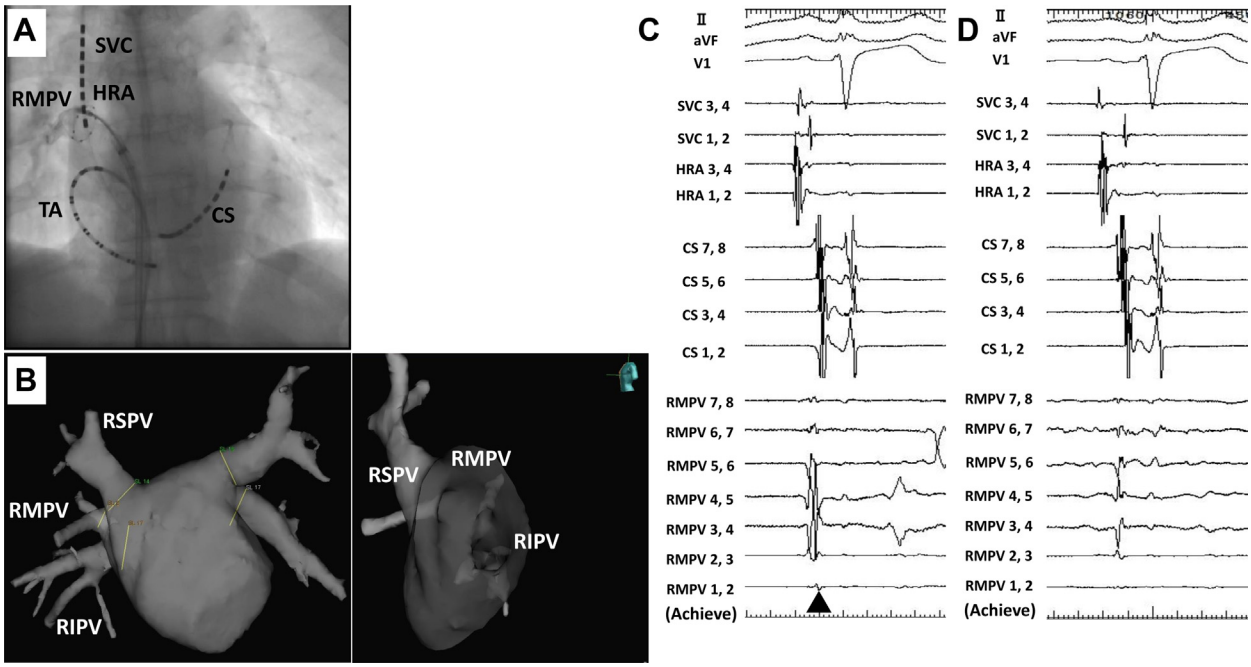

Figure 1 **A:** Fluoroscopic view of the location of right middle pulmonary vein (RMPV). **B:** Three-dimensional computed tomography image of left atrium and pulmonary veins (left: anterior-posterior view; right: inner view). **C:** Arrowhead indicates the pulmonary vein (PV) potentials at the beginning of the cryoballoon ablation to the RMPV. **D:** PV potentials disappeared. CS = coronary sinus; HRA = high right atrium; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein; SVC = superior vena cava; TA = tricuspid annulus.

reported that the far-field SVC potentials were recorded within the RSPV in 23% of patients. Miyazaki and colleagues[3] recommend considering the possibility that the recorded signals on the Achieve mapping catheter in the RSPV are far-field SVC potentials in case that TTI is long despite a sufficient pulmonary vein occlusion and balloon temperature. In the present case, it was considered that both the far-field SVC potentials and the dissociated

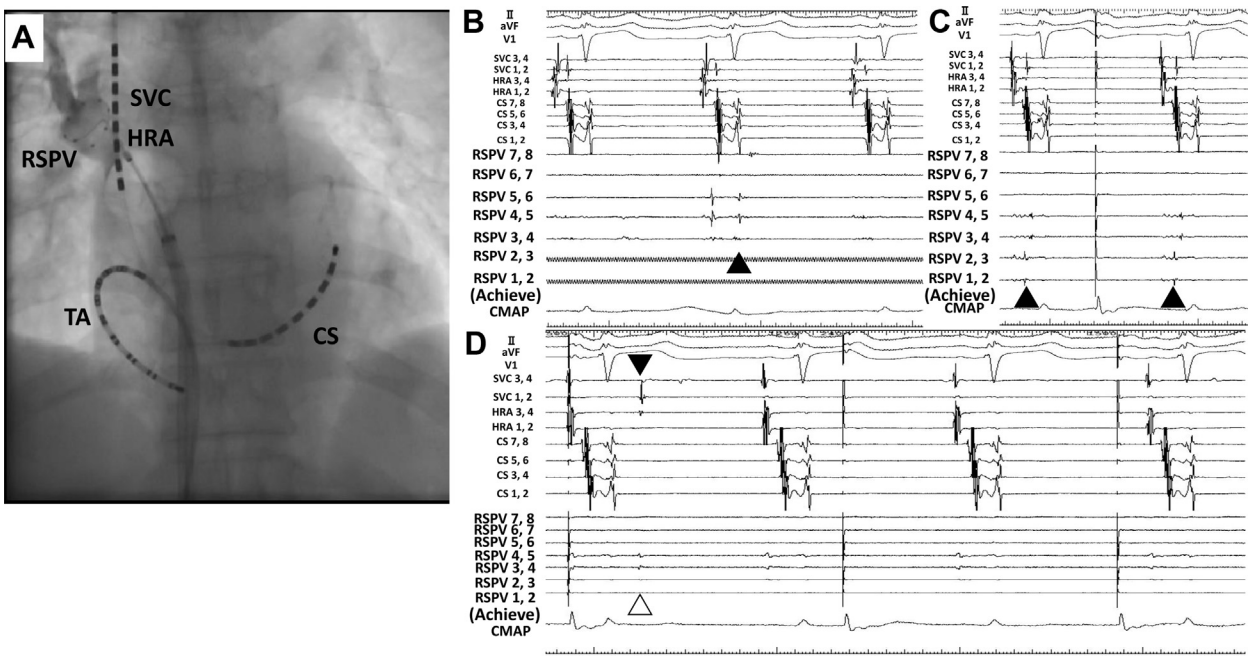

Figure 2 **A:** Fluoroscopic view of the location of right superior pulmonary vein (RSPV). **B:** Arrowhead indicates dissociated activities recorded in the distal portion of the RSPV. **C:** Arrowhead indicates residual potentials recorded in the proximal portion of the RSPV at the beginning of the cryoballoon ablation to the RSPV. **D:** Black arrowhead and white arrowhead indicate the prolonged superior vena cava (SVC) potentials in the SVC and the interlinked potentials in the RSPV, respectively. CMAP = diaphragmatic compound motor action potential; CS = coronary sinus; HRA = high right atrium; TA = tricuspid annulus.

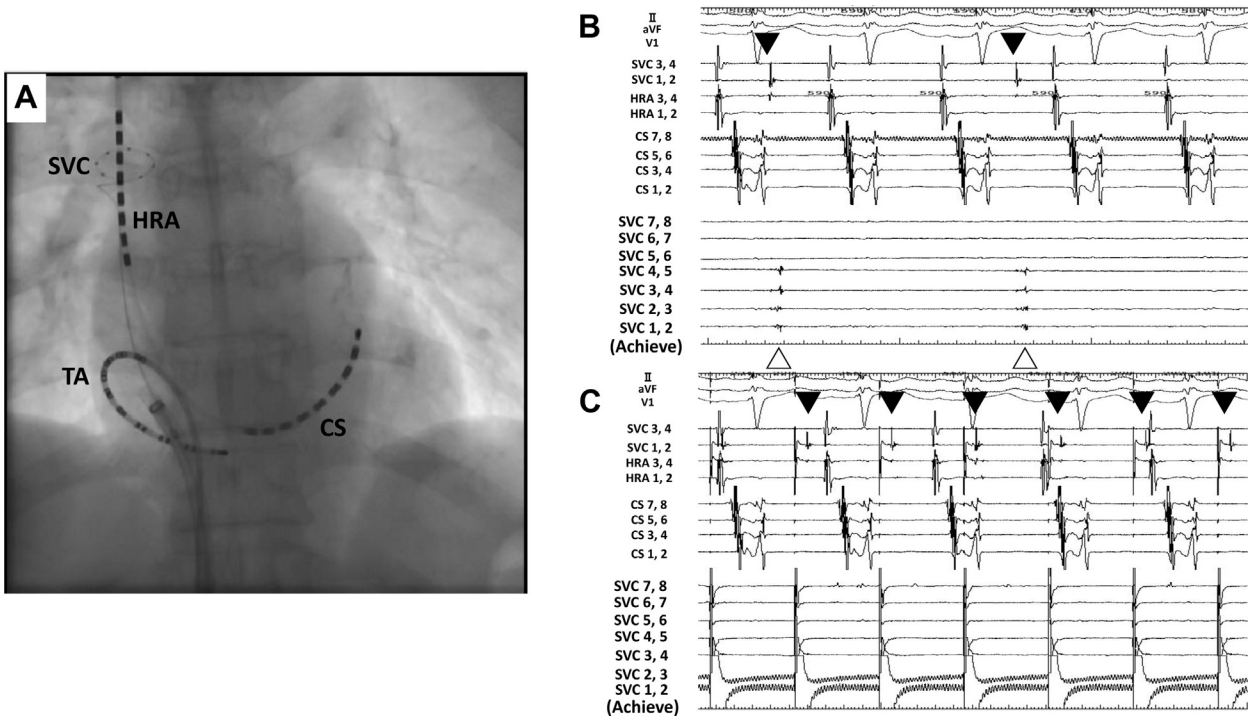

Figure 3 **A:** Fluoroscopic view of the location of superior vena cava (SVC). **B:** Black arrowhead and white arrowhead indicate the dissociated activities in the SVC. **C:** Bidirectional block between the right atrium and SVC was confirmed. Arrowhead indicates the local pacing capture of SVC potentials. CS = coronary sinus; HRA = high right atrium; TA = tricuspid annulus.

RSPV potentials were recorded at the distal RSPV on the Achieve mapping catheter, but only the far-field SVC potentials were recorded at the proximal RSPV. The near-field RSPV potentials already disappeared by the cryoballoon ablation to the RMPV. This presumption was supported by the finding that the recorded potentials on the Achieve mapping catheter were interlinked with the SVC potentials on the BeeAT catheter during cryoapplication. Goya and colleagues[6] reported that the mean number of electrical breakthroughs at the right atrium–SVC junction was 1.4 ± 0.5. It was considered that SVC was isolated because the electrical breakthrough at the right atrium–SVC junction existed only at the posterior-septal side in the present case. Fortunately, far-field SVC potentials in the RSPV and near-field SVC potentials in the SVC could be observed simultaneously, and this enabled real-time SVC isolation monitoring during cryoballoon ablation to the RSPV. In conclusion, attention should be paid to the SVC potentials during cryoballoon ablation to the RSPV.

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