Nifekalant unmasked residual gap of superior vena cava isolation by suppressing immediate recurrence of intra-superior vena cava fibrillation

Takayuki Sekihara MD | Takafumi Oka MD, PhD | Tomoaki Nakano MD | Kentaro Ozu MD | Yasushi Sakata MD, PhD

Faculty of Medical Sciences, Department of Cardiology, University of Osaka, Osaka, Japan

Correspondence
Takayuki Sekihara, Department of cardiovascular medicine, Osaka University Graduate School of Medicine, 2-2, Yamadaoka, Suita, Osaka 565-0871, Japan.
Email: javelin-decathlon@hotmail.co.jp

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A 78-year-old female was referred to our hospital for radiofrequency (RF) catheter ablation of symptomatic paroxysmal atrial fibrillation (AF). The ablation was performed using Rhythmia HDx™ (Boston Scientific). Because the patient was in AF at the start of the session, we performed direct current cardioversion (DCC). After that, immediate recurrence of AF (IRAF) repeatedly occurred from the superior vena cava (SVC) (Figure 1A,B). Because it was difficult to maintain sinus rhythm (SR), we performed SVC isolation during AF. With an encircling SVC ablation, the AF in the atria gradually organized and was terminated during the 21st RF application, while the fibrillatory activity inside the SVC (intra-SVC fibrillation) persisted (Figure 1C). At that point, we diagnosed an SVC exit block. However, the SVC entrance block could not be evaluated because a subsequent DCC resulted in immediate recurrences of intra-SVC fibrillation.

The atria remained in SR during subsequent pulmonary vein isolation (PVI). On the other hand, intra-SVC fibrillation continued even after PVI. We administered 4 μg (0.07 μg/kg) of isoproterenol (ISP) to test the durability of the SVC exit block and the inducibility of extra-PV foci. After that, atrial depolarization became rapid.
and irregular, with similar atrial sequence and P-wave polarity as SR (Figure 2A and Figure S1). The intra-SVC fibrillation still immediately recurred after multiple DCCs. Once the effect of ISP disappeared, the atria regained almost regular SR whereas the intra-SVC fibrillation persisted. The differential diagnoses were (i) ISP-induced SVC reconnection with the irregular conduction of intra-SVC fibrillation to the atria, and (ii) ISP-induced premature atrial contractions (PACs) originating near the high right atrium under a complete SVC exit block.

To suppress the immediate recurrences of intra-SVC fibrillation, we considered ablation of the focal source of intra-SVC fibrillation (e.g., the area with high-frequency depolarization during intra-SVC fibrillation or the earliest site at the onset). However, the risk of SVC stenosis and phrenic nerve injury could be increased if multiple RF applications inside the SVC were required.

Finally, to suppress intra-SVC fibrillation, we administered a low dose (7 mg, 0.13 mg/kg) of nifekalant. The QT interval was prolonged from 400 ms to 460 ms (Figure 2B), whereas the interatrial conduction time from the high right atrium to the distal coronary sinus remained almost the same (Figure 2C). At that point, intra-SVC fibrillation was successfully suppressed even under continuous ISP infusion at 80–160 μg/h (0.025–0.05 γ). Two gaps were detected and ablated sequentially by high-resolution gap mapping.
mapping: one in the posterior wall (Figure 3A) and the other in the lateral wall with 2:1 right atrium-SVC conduction (Figure 3B). After additional RF applications and a 60-min nifekalant washout, a bidirectional SVC conduction block was confirmed despite the recurrence of intra-SVC fibrillation under ISP infusion at 80μg/h (Figure 4).

SVC is one of the major AF triggers besides pulmonary veins. Sometimes, intra-SVC fibrillation persists after circumferential isolation is completed. Suppressing the immediate recurrence of intra-SVC fibrillation is essential for the definitive diagnosis of SVC exit and entrance block.

This case illustrates the usefulness of nifekalant when intra-SVC fibrillation complicates the evaluation of gap conduction after ablation. Nifekalant is a selective antagonist of the rapidly activated delayed rectifier potassium channel (IKr) and prolongs the effective refractory period of the myocardium. It does not inhibit inward sodium or calcium currents and thus has minimal negative inotropic and dromotropic effects. Nifekalant is mainly used for hemodynamically unstable ventricular arrhythmia. However, it has also been shown to reduce the defibrillation threshold of AF and terminate AF.1,2 Recently, Masuda et al. reported that nifekalant could also facilitate the identification of extra-PV foci by suppressing IRAF.3,4 Using nifekalant, we aimed to suppress the immediate recurrence of intra-SVC fibrillation to evaluate SVC gap conduction. Because the interatrial conduction time from the high right atrium to the distal coronary sinus was not prolonged after nifekalant infusion, the drug probably did not affect depolarization and the conduction velocity of the atrial muscle, confirming a previous report.5 Na channel blockers (class I drugs) constitute another possible means of suppressing intra-SVC fibrillation. However, using these agents might suppress gap conduction as well as intra-SVC fibrillation because they have a negative dromotropic effect.

In conclusion, low-dose nifekalant suppressed the immediate recurrence of intra-SVC fibrillation during the evaluation of gap conduction and successfully unmasked ISP-induced gap conduction. When SVC isolation is complexed by intra-SVC fibrillation, this pharmacological method may be an effective alternative to terminating it by the ablation inside SVC.

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CONFLICT OF INTEREST
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DATA AVAILABILITY STATEMENT
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ETHICS APPROVAL
N/A.
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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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