Beware of superior vena cava isolation during cryoballoon ablation of the right superior pulmonary vein

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A 36-year-old man was referred for pulmonary vein (PV) isolation because of paroxysmal atrial fibrillation. PV isolation was performed with a 28 mm cryoballoon (Medtronic, Minneapolis, MN). Following the isolation of the left and right inferior PVs, the right superior PV (RSPV) was targeted. Before the application, a late sharp potential (P1) thought to represent PV activation was observed on the circular decapolar mapping catheter (Achieve™; Medtronic) (Figure 1A). P1 was preceded by a near-field signal (P2), which was simultaneous with the first half of the P wave and was interpreted as a superior vena cava (SVC) potential. Thirty seconds after the beginning of the application, P1 prolonged and disappeared, consistent with PV isolation (Figure 1A). At 90 seconds, P2 prolonged up to a transient 2:1 conduction block (Figure 1B), which recovered after the end of the application. In order to confirm the SVC origin of P2, a decapolar catheter was placed inside the SVC (Figure 1C), recording a near-field signal, with the same activation time as P2 (Figure 1C). During pacing from the distal dipole of the decapolar catheter, advancement of P2 was observed, proving its SVC origin (Figure 1C).

The SVC is located anteriorly, in close proximity to the RSPV (Figure 1D), and its far-field potential can be observed from inside the RSPV.1 Few cases of SVC isolation during RSPV cryoablation have been previously described.2 Recognizing SVC potential and differentiating it from RSPV potential is paramount as the persistence of the SVC potential or its delayed isolation can be misinterpreted as failed isolation, leading to unnecessary and potentially harmful multiple prolonged applications. The SVC potential usually falls into the first part of the P-wave due to its proximity to the sinus node. RSPV cryoablation can result in late SVC delay and even isolation.

WHAT WE LEARNED FROM THIS CASE

- The superior vena cava (SVC) is located anteriorly, in close proximity to the right superior pulmonary vein (RSPV) and its far-field potential can be observed from inside the RSPV. The SVC potential usually falls into the first part of the P-wave due to its proximity to the sinus node.
- RSPV cryoablation can result in late SVC delay and even isolation.
- Recognizing SVC potential and differentiating it from RSPV potential is paramount as the persistence of the SVC potential or its delayed isolation can be misinterpreted as failed isolation, leading to unnecessary and potentially harmful multiple prolonged applications.

References

1. Shah D, Buri H, Sunthorn H, Gentil-Baron P. Identifying far-field superior vena cava potentials within the right superior pulmonary vein. Heart Rhythm 2006; 3:898–902.
2. Kawai S, Okahara A, Tokutome M, Tobushi T, Mukai Y. Real-time superior vena cava isolation during cryoballoon ablation of the right pulmonary veins: a case report. HeartRhythm Case Rep 2020;6:922–924.
Figure 1  A: Surface electrocardiogram leads II, III, and aVF. Bipolar electrogram signals from the circular decapolar mapping catheter (Achieve [Ach]; Medtronic, Minneapolis, MN) and a decapolar catheter placed inside the coronary sinus (CS) are also displayed. Before the beginning of the application a late pulmonary vein (PV) potential (P1) can be appreciated on Ach 4–7. The signal is preceded by a near-field potential, falling inside the first half of the p wave (P2), consistent with superior vena cava (SVC) activation. Twenty seconds after the beginning of the application the P1 PV potential delays. At -30°C and 30 seconds, isolation of the PV is reached without any significant changes in the SVC P2 potential. B: At 90 seconds, with a temperature of -48°C, time to P2 potential starts to prolong. Transient 2:1 (white and black arrows) conduction block of P2 is observed. The pacing artefact of the phrenic stimulation can be appreciated in the middle of the tracing, as noted. C: The decapolar catheter, which was previously inside the CS, is now positioned in the SVC with the distal dipole pointing posterior, recording a signal that is “on time” with P2. Notably, compared to the basal recording, after the cryoapplication, the time to the SVC potential is significantly prolonged. Pacing from the distal dipole of the decapolar catheter placed inside the SVC (SVC-D) results in advancement of P2, proving its SVC origin. D: Anteroposterior fluoroscopic view of the decapolar catheter inside the SVC shows its close proximity to the right superior pulmonary vein (RSPV). Anteroposterior 3-dimensional reconstruction of the left and right atrium is shown in the right part of the figure. RAA = right atrial appendage.