Visualization of persistent superior vena cava isolation by cryoballoon ablation

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Abstract

A 54-year-old man with paroxysmal atrial fibrillation underwent pulmonary vein (PV) isolation using a 28 mm second-generation cryoballoon catheter. Unexpected electrical superior vena cava (SVC) isolation during cryoballoon application to the right superior PV was observed in the first procedure. Thirteen-months after cryoballoon-based PV isolation, sustained SVC fibrillation was confirmed irrespective of sinus rhythm. Voltage mapping visualized a low voltage area around the SVC was consistent with that around the right superior PV. SVC isolation was obtained by cryoballoon application to the right superior PV and persisted for over a year.

Introduction

A previous case report demonstrated inadvertent electrical superior vena cava (SVC) isolation during radiofrequency and cryoballoon application to the right superior pulmonary vein (RSPV) in the acute phase.[1-4] However, the long-term impact of RSPV isolation on the right atrial (RA) and SVC junction is undetermined. Here we describe a case of persistent SVC isolation by cryoballoon-based PV isolation. The electroanatomical mapping system clearly visualized the persistent effect of the cryoballoon application to the SVC.

Case presentation

A 54-year-old man with drug-resistant paroxysmal atrial fibrillation (AF) underwent PV isolation using a 28 mm second-generation cryoballoon catheter (Medtronic Inc., MN, USA). Simultaneous isolation of the RSPV and SVC was obtained at 30 s after cryoballoon application and was subsequently followed by an additional freeze-time of 120 s (total 150 s, minimum temperature -44°C).[5] Complete PV isolation was achieved without any complications.

The frequency of AF decreased after cryoballoon-based PV isolation, however, a low frequency AF recurrence was noted. A second procedure with radiofrequency catheter ablation was performed 13 months after the first procedure. No phrenic nerve injury nor PV stenosis was observed. Although there was no reconnection of all PVs, sustained fibrillatory potential was recorded in the SVC (Figure A). No dormant reconnection between the RA and SVC was induced by adenosine triphosphate intravenous injection. A three-dimensional voltage mapping using the CARTO-3 system (Biosense Webster Inc., CA, USA) clearly illustrated that the low voltage area around the SVC was consistent with that around the RSPV (Figure B). These findings implied that simultaneous isolation of both the RSPV and SVC had persisted for over a year. Ablation of the left atrial (LA) roof and floor was performed to prevent non-PV triggers from the posterior LA. Complete electrical silence and non-capture of the posterior LA was confirmed in the second procedure.

Discussion

Anatomically, the myocardial sleeves extended from the RA into the SVC. Simultaneous isolation of both the RSPV and SVC implied that the anterior aspect of the SVC had poor myocardial sleeves in the present case. The posterior aspect of the SVC was close to the anterior aspect of RSPV. The anatomical distance between the RSPV ostium and SVC was significantly correlated with the conduction delay of the SVC potentials produced during the RSPV isolation with the cryoballoon ablation. A distance between the RSPV ostium and SVC of < 4 mm has been demonstrated to have a significant effect on the RA-SVC junction during cryoballoon application.[6] The distance between the RSPV ostium and SVC was just 1 mm in the patient presented here. Despite the relatively mild cryoballoon application (150 s and nadir -44°C), the SVC isolation had persisted for over a year. A small anatomical distance between the RSPV ostium and SVC may be the main factor for persistent SVC isolation following cryoballoon application.

Conclusion

Unexpected electrical SVC isolation during cryoballoon application to the RSPV had persisted for over a year. This finding may be associated with poor myocardial sleeves at the anterior aspect of the SVC and a small anatomical distance between the RSPV-SVC.

Figure legend

Persistent SVC isolation with RSPV isolation. **(A)** Sustained SVC fibrillation was confirmed irrespective of sinus rhythm in other electrocardiograms (lead II, the RA and CS). **(B)** Voltage mapping of the SVC, RA and LA. Low voltage area around the SVC was consistent with that around the RSPV. CRA: cranial, CS: coronary sinus, LA: left atrium, RA: right atrium, RAO: right anterior oblique, LAO: left anterior oblique, LIPV: left inferior pulmonary vein, LSPV: left superior pulmonary vein, RIPV: right inferior pulmonary vein, RSPV: right superior pulmonary vein, SVC: superior vena cava.

References

1. Kimura T, Fukumoto K, Nishiyama N, Takatsuki S. Inadvertent electrical superior vena cava isolation during right pulmonary vein isolation.*Heart Rhythm.* 2012; 9: 1177-1178.
2. Yagishita A, Yamauchi Y, Hirao K. Superior vena cava isolation by right pulmonary vein ablation. *Europace* . 2014; 16: 346.
3. Yamasaki H, Adachi T, Komatsu Y, Kuroki K, Sekiguchi Y, Nogami A, Aonuma K. Unexpected Electrical Isolation of the Superior Vena Cava During Radiofrequency Hot Balloon Ablation in the Right Superior Pulmonary Vein. *Circ J.* 2017; 81: 763-765.
4. Watanabe T, Hachiya H, Igarashi M, Kusa S, Iesaka Y. A case of bidirectional conduction block within the superior vena cava induced by cryoballoon pulmonary vein isolation. *Pacing Clin Electrophysiol.* 2019; 42:107–109.
5. Reissmann B, Wissner E, Deiss S, Heeger C, Schlueter M, Wohlmuth P, Lemes C, Mathew S, Maurer T, Sohns C, Saguner A, Santoro F, Hayashi K, Riedl J, Ouyang F, Kuck KH, Metzner A. First insights into cryoballoon-based pulmonary vein isolation taking the individual time-to-isolation into account. *Europace.* 2017; 19:1676-1680.
6. Ichihara N, Miyazaki S, Kuroi A, Hachiya H, Nakamura H, Taniguchi H, Araki M, Takagi T, Iwasawa J, Iesaka Y. Impact of Pulmonary Vein Isolation on Superior Vena Cava Potentials With a Second-Generation Cryoballoon. *J Cardiovasc Electrophysiol.* 2015; 26:1321-1326.

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