# Cryoballoon ablation of atrial fibrillation in a patient with partial anomalous pulmonary vein drainage in the superior vena cava

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Sergio Rizzi, MD, Erwin Ströker, MD, PhD, Maysam El Housari, MD, Dries Belsack, MD, Gian Battista Chierchia, MD, PhD, Carlo de Asmundis, MD, PhD, FHRS

*From the Heart Rhythm Management Centre, Postgraduate Program in Cardiac Electrophysiology and Pacing, Universitair Ziekenhuis Brussel – Vrije Universiteit Brussel, European Reference Networks Guard-Heart, Brussels, Belgium.*

## Introduction

Ectopic foci arising from the pulmonary veins (PVs) are the predominant source for the initiation and maintenance of atrial fibrillation (AF). Electrical isolation of the PVs represents the main target in the treatment of refractory AF, using different ablation technologies. However, in some patients AF can be triggered by non-PV foci originating from discrete anatomical structures including thoracic veins, such as the superior vena cava (SVC). Partial anomalous pulmonary venous drainage (PAPVD) refers to the drainage of 1 or more PVs outside the left atrium (LA), and there is a broad spectrum of unusual connections.[1] The cryoballoon (CB) is nowadays an established tool to perform PV isolation in patients with drug-refractory AF. Moreover, previous reports showed the feasibility and efficacy of the CB technique in isolating the SVC, as an added value for ablating non-PV AF triggers.[2]

## KEY TEACHING POINTS

- Ectopic foci arising from the pulmonary veins (PVs) are the predominant source for the initiation and maintenance of atrial fibrillation (AF). However, in some patients AF can be triggered by non-PV foci originating from thoracic veins such as the superior vena cava (SVC).
- Cardiac imaging of PV anatomy before the AF ablation procedure can detect partial anomalous pulmonary vein drainage (PAPVD), which may indicate a need to adapt the ablation strategy.
- Cryoballoon (CB) ablation is currently an established technique for PV isolation in patients with AF. In our case, we demonstrate the feasibility of an added SVC isolation with its associated PAPVD using the CB.

## Case report

We report the case of a 52-year-old man who underwent ablation with the second-generation CB for drug-refractory AF. A cardiac computed tomography scan was performed before the procedure and showed normal-sized atria, with a PV anatomy consisting of a left common PV and right inferior PV draining into the LA, and a PAPVD with 2 branches into the SVC, 5 cm above the right atrium (RA)-SVC junction (Figure 1A). No other structural or functional heart abnormalities, like atrial septal defect, traditionally associated with PAPVD were present in this patient. We decided to perform the procedure as scheduled with the CB. After having obtained LA access had been obtained through a steerable 15F sheath (FlexCath Advance; Medtronic Inc, Minneapolis, MN), a 28-mm CB (Artic Front Advance; Medtronic Inc, Minneapolis, MN) was advanced in the LA and an inner lumen mapping catheter (Achieve; Medtronic Inc) was positioned in each PV ostium. Optimal vessel occlusion was confirmed by contrast injection and fluoroscopic imaging. The cryoapplications could achieve real-time isolation at the left common PV and right inferior PV. Following the left-sided PV isolation, the CB was retrieved to the RA and the Achieve catheter was introduced

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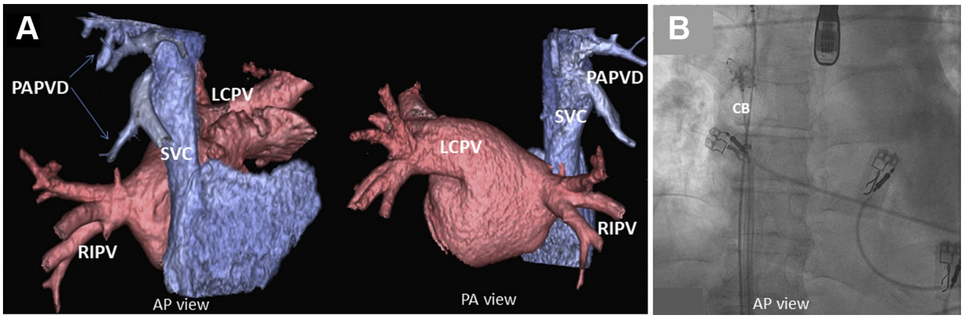


**Figure 1** **A:** Anteroposterior (AP) and posteroanterior (PA) view of the left (*red*) and right atrium (*blue*), derived from a computed tomography (CT) scan reconstruction. This cardiac CT imaging showed a partial anomalous pulmonary vein drainage (PAPVD) in the superior vena cava (SVC) with a superior and inferior branch, and a left common pulmonary vein (LCPV) and right inferior pulmonary vein (RIPV) with drainage in the left atrium. **B:** AP fluoroscopic image with the cryoballoon (CB) at the SVC ostium and a decapolar catheter in the SVC (partially seen).

into the SVC. Advancing the mapping into the separate PAPVD branches, potentials were still seen at the inferior part of the lower PAPVD branch, suggesting a high extension of the SVC myocardial sleeves. Afterward, in order to occlude the vessel, the Achieve mapping catheter was drawn back to the ostium of the SVC (Figure 1B), and the CB was inflated in the RA and advanced toward the ostium of the SVC. A full occlusion with the 28 mm CB could not be achieved in 1 shot, owing to the big caliber of the SVC and the presence of the 6F decapolar pacing catheter positioned through a femoral access and advanced in the SVC in order to monitor the phrenic nerve (Figure 1B). Applications of cryoenergy with the CB were performed at the RA-SVC junction in a segmental nonocclusive fashion. We gave in total 3 applications of 120 seconds duration with a minimum reached temperature of -35°C. During the third and last application, after 32 seconds, we obtained real-time SVC isolation (Figure 2). A waiting period of 15 minutes post SVC isolation was respected, whereafter entry and exit block were confirmed by pacing from the decapolar catheter in the RA and the Achieve catheter in the SVC, respectively. In order to avoid diaphragmatic palsy during cryoablation in the right-sided PVs and the SVC, a 6F decapolar catheter was placed distally in the SVC, and diaphragmatic stimulation was achieved by pacing the ipsilateral phrenic nerve with a 1200 ms cycle and a 22 mA output. Phrenic nerve (PN) pacing started once the temperature reached -20°C and continued during the freeze duration. No phrenic nerve injury occurred during this case.

## Discussion

To the best of our knowledge, we present the first case of a patient with AF and PAPVD treated with the CB, as previous published case reports were all using the point-by-point radiofrequency technique.[3,4] In our case, we could also note the presence of potentials up to the inferior part of the lower PAPVD branch, the SVC myocardial sleeves presenting therefore a length up to 5 cm. No potentials were recorded with the Achieve mapping catheter in the superior PAPVD branch. In contrast to what was reported in previous histological series by Douglas and colleagues,[5] this finding suggests the presence of myocardial sleeves partially involving the PAPVD. This prompted us even more to perform the SVC isolation in order to isolate all potential arrhythmic triggers.

Ablation of the SVC can be challenging to achieve owing to the vicinity of the right PN, which could cause an inadvertent nerve injury. This PN injury is known to be the most common complication related to the CB ablation technique. Different techniques, such as palpation of the diaphragmatic excursion during PN pacing and diaphragmatic compound motor action potential monitoring, have been proposed to avoid PN injury.[6] In our case, we monitored the excursion of the diaphragm by manually palpating the abdomen during PN pacing while ablating the right-sided PVs and the SVC.

**Figure 2** Right atrium–superior vena cava (SVC) potentials recorded at the ostium of the SVC with the Achieve mapping catheter (Medtronic Inc, Minneapolis, MN). Progressive delaying and real-time isolation of the SVC signals is shown by the arrows. Pacing artefacts during pacing from the decapolar catheter are observed at the right side of the image (started from -20° in order to monitor phrenic nerve function).

## Conclusion

In our case, we aim to highlight the feasibility of the CB to isolate the SVC and its associated PAPVD. Performance of cardiac imaging before the PV isolation procedure might be important in order to recognize the patient PV anatomy and evaluate the need to adapt the ablation strategy.

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