ESC European Society of Cardiology

European Heart Journal - Case Reports (2020) **4**, 1–5
doi:10.1093/ehjcr/ytaa056

**CASE REPORT**
*Arrhythmias/electrophysiology*

# The hidden skills of the cryoballoon: occlusion of cardiac perforation in a patient with persistent left superior vena cava—a case report

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*Received 22 August 2019; first decision 31 October 2019; accepted 14 February 2020; online publish-ahead-of-print 26 March 2020*

**Background** Cardiac tamponade is one of the most serious complications when performing cardiac interventions. Although most of the patients can be treated effectively using pericardiocentesis, urgent surgery can be necessary in case of continuous bleeding and patients' haemodynamic impairment.

**Case summary** With this unique clinical case report we describe an acute endovascular occlusion of a cardiac perforation utilizing the inflated 28 mm cryoballon at the transseptal puncture site close to the superior part of the coronary sinus ostium in a patient with persistent left superior vena cava (PLSVC) and severe post-procedural tamponade. Prior to this maneuver, 1200 mL of haemorrhagic effusion has been aspirated. Forty-five minutes after cryoballoon-guided occlusion we deflated the balloon and no additional blood could be aspirated over the following 20 minutes.

**Discussion** Cryoballon-guided occlusion of the perforation site saved the patient from immediate cardiac surgery and resulted in stable haemodynamic conditions. This bailout approach was transferred from coronary interventions where occlusion of a perforated vessel using balloon devices is a common technique to achieve acute hemostasis.

**Keywords** Atrial fibrillation • Persistent left superior vena cava • Cryoballoon • Cardiac tamponade • Case report

## Learning points

- If cardiac perforation occurs during cyroballoon-guided pulmonary vein isolation for atrial fibrillation occlusion of the perforation site using the compliant balloon device can be considered as an emergency bailout option to save the patient from acute open cardiac surgery.
- This innovative approach was transferred from coronary interventions where occlusion of a perforated vessel using balloon devices is a common technique as a bridge to definitive haemostasis.
- Caution has to be taken performing the transseptal puncture to avoid a puncture site within the massively dilated coronary sinus.

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Handling Editor: Nikos Papageorgiou

Peer-reviewers: Christian Fielder Camm and Robert Schönbauer

Compliance Editor: Mark Philip Cassar

Supplementary Material Editor: Peysh A. Patel

## Introduction

Persistent left superior vena cava (PLSVC) has an estimated prevalence ranging from 0.3% to 0.5% in the general population.[1] However, its true incidence is unknown because PLSVC usually remains clinical silent until it is detected incidentally during cardiovascular imaging, pacemaker implantation, or catheter ablation.[2] Embryologically, the left superior cardinal vein regresses to become the ligament of Marshall. A PLSVC results if this regression fails.[3] This anatomical variant is usually asymptomatic but can lead to serious complications during atrial fibrillation (AF) ablation using a transseptal approach. Consequently, caution has to be taken performing the transseptal puncture to avoid a puncture site within the massively dilated coronary sinus (CS). In this context, there is limited data describing catheter ablation of AF in patients with PLSVC and these are mainly focused on radiofrequency-based ablation.[4,5] Recently, Santorro *et al.* demonstrated that the cryoballoon (CB) represents an alternative, safe and effective device for AF ablation in patients with PLSVC. In contrast to radiofrequency-guided procedures, where a relatively high rate of procedure-related complications, was observed,[6] no evidence of pericardial effusion was reported from CB-guided ablation in PLSVC. However, the risk of right phrenic nerve palsy might be higher in this subset of patients.[7] In this context, cardiac perforation with tamponade is the most frequent potentially fatal complication of cardiac catheter ablation, with an incidence of 0.2–6%.[8,9] This unique case report demonstrates that CB-guided occlusion of a cardiac perforation at the transseptal puncture site as an interventional rescue strategy can be transferred to AF ablation procedures and its related major complications.

## Timeline

| | |
|---|---|
| First diagnosis of paroxysmal atrial fibrillation (AF) | March 2016 |
| Diagnosis of persistent left superior vena cava (PLSVC) from preprocedural imaging using cardiac magnetic resonance imaging. | June 2019 |
| The patient with history of a PLSVC admitted for pulmonary vein (PV) isolation due to drug-refractory symptomatic paroxysmal AF. | At presentation |
| Cryoballoon (CB)-guided PV isolation was successfully performed. Perforation of the coronary sinus ostium at the transseptal puncture site resulted in a severe post-procedural pericardial tamponade. Acute endovascular occlusion of the perforation site using the inflated CB was performed as a bridge definitive haemostasis. | During procedure 05 June 2019 |
| No evidence for further pericardial effusion. | Day 1 after the ablation procedure |
| Hospital discharge without any sequelae related to the ablation procedure. | Day 2 following the ablation procedure |
| Until today no arrhythmia recurrence has been reported. | Follow-up data |

## Case presentation

A 58-year-old male patient without any other past medical history and a CHADS-VASc score of 0 was referred to CB-guided catheter ablation due to a 3-year history of drug-refractory paroxysmal AF. Preprocedural transthoracic echocardiography revealed a severely dilated CS raising the suspicion of a PLSVC. This diagnosis was confirmed from cardiac magnetic resonance imaging the day before the procedure (*Figure 1*). The patient was informed and enlightened about the anatomical variant and its related elevated risk in the context of AF ablation. Catheter ablation was performed under deep sedation and continuous monitoring. Invasive blood pressure monitoring was performed during the entire procedure. A steerable multipolar 6-Fr catheter was positioned in the CS. Afterwards, an angiography of the CS was assessed to visualize the PLSVC and to guide transseptal puncture (*Figure 2*). A single transseptal puncture was performed with fluoroscopic guidance using a modified Brockenbrough technique and an 8.5-Fr transseptal sheath (SL1, St. Jude Medical, St.Paul, MN, USA). The transseptal sheath was exchanged over a wire for a 15-Fr steerable sheath (Flexcath Advance, Medtronic, Eatontown, NJ, USA) (*Figure 3*). Heparin was administered to target an activated clotting time of >300 s. Thereafter, selective PV angiography was performed to identify the individual PV ostia. An antral isolation of the pulmonary veins (PVs) by using a 28 mm Arctic Front Advance Balloon (Medtronic) was performed without complications.

After retracting the 15-Fr sheath into the right atrium, consistent clinical signs suggestive for a cardiac tamponade were observed within minutes: the movement of the left-sided heart margin in left anterior oblique projection became depressed and afterwards absent, accompanied by a rapid drop in blood pressure measurement, compensatory sinus tachycardia, and blood flow stasis in the internal jugular vein. Cardiac tamponade was confirmed by immediate transthoracic echocardiography.

Urgent pericardiocentesis and placement of a 7-Fr pigtail catheter into the epicardial space were performed and initially 800 mL of haemorrhagic pericardial effusion were aspirated. Autotransfusion was performed by a filter system via right femoral vein access. Despite aggressive fluid and inotropic therapy, the patient continued to deteriorate rapidly. Within 10 min, 1200 mL of haemorrhagic pericardial effusion were aspirated and the effusion remained unchanged indicating a massive perforation. Consequently, the patient was presented for urgent cardiac surgery. An immediately performed angiography of the CS revealed the perforation site by a leakage of contrast agent. As a last resort strategy, we advanced the 15-Fr steerable

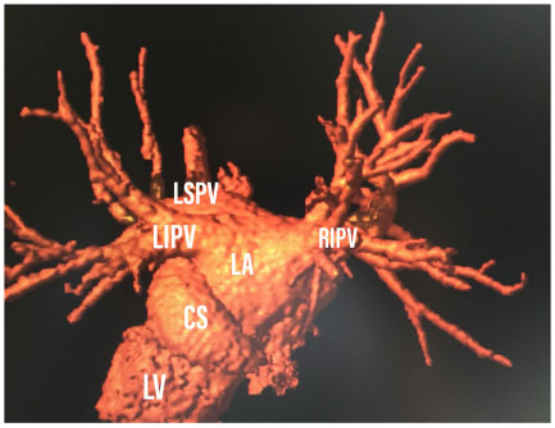


**Figure 1** Three-dimensional reconstruction of the individual cardiac anatomy from magnetic resonance imaging demonstrating the huge dilatation of the distal coronary sinus and the relationship between the left ventricle, left atrium, and the pulmonary veins (LIPV, left inferior pulmonary vein; RIPV, right inferior pulmonary vein; RSPV, right superior pulmonary vein). CS, coronary sinus; LA, left atrium.

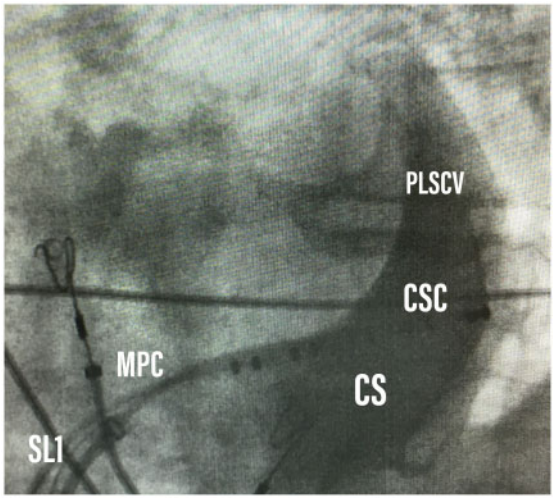


**Figure 2** Angiography of the coronary sinus in a left anterior oblique 40° projection to visualize the persistent left superior vena cava and the related anatomical variants. CS, coronary sinus; CSC, CS catheter; MPC, multipurpose catheter; PLSCV, persistent left superior vena cava; SL1, standart sheath SL-1.

Flexcath Advance sheath (Medtronic) to the CS ostium followed by introduction of the 28 mm CB (Arctic Front Advance, Medtronic). The balloon was carefully railed over the achieve catheter to the anatomical location of the suggested perforation and inflated at the superior aspect of the CS ostium. Contrast agent was applied by the Flexcath sheath and the tip of the balloon in order to visualize a wedge position of the inflated balloon at the transseptal puncture

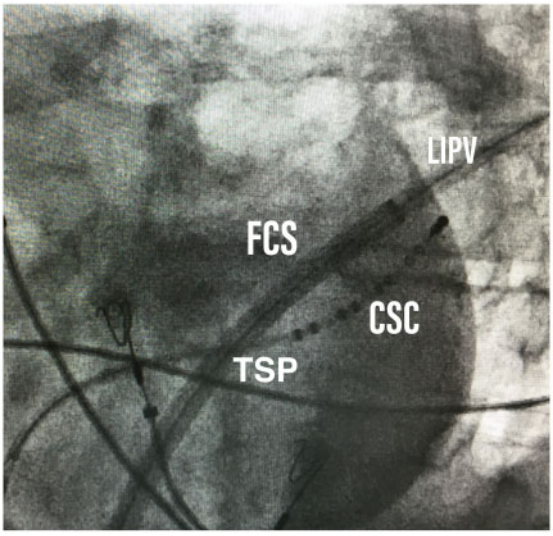


**Figure 3** Transeptal puncture site at the superior part of the coronary sinus ostium and wire-guided transseptal crossing of the Flexcath Advance sheath (left anterior oblique 40° projection). The wire was placed in the left inferior pulmonary vein. CSC, coronary sinus catheter; FCS, FlexCath sheath; LIPV, left inferior pulmonary vein; TSP, transseptal puncture site.

site. Angiography with contrast agent showed a complete occlusion of the perforation site and incomplete occlusion of the CS, which assured a sufficient venous flow for cardiac reperfusion (*Figures 4* and *5*). After 45 min of CB-guided occlusion, we deflated the balloon and no additional blood was aspirated over the following 20 min. Afterwards, 5000 IE of protamine sulfate were injected via the femoral vein to antagonize the effects of periprocedural anticoagulation and all sheaths except the pericardial 7-Fr pigtail catheter were removed. Sedation was stopped and the patient woke up at the end of the procedure. The patient was transferred to intensive care unit for 24-h-monitoring. Serial echocardiograms confirmed the absence of any further pericardial fluid. Four hours after, oral anticoagulation had been initiated, we removed the pigtail catheter. Two days later, the patient was discharged without any sequelae. At the time of follow-up, the patient was free from an AF episodes as well as from any other symptoms suggestive for arrhythmia recurrence.

## Discussion

Life-threatening cardiac tamponade is one of the most serious complications of cardiac interventions. The prevention of such ablation-related cardiac tamponades, their early detection and prompt management are of critical importance for the patient's outcome.[9,10] Although most of these circumstances can be treated effectively by the use of pericardiocentesis, urgent surgical drainage might become necessary in cases with continuous bleeding and patients' haemodynamic impairment. Recently, Metzner *et al.*[11] demonstrated that the combination of a balloon device to occlude the base of the left atrial appendage (LAA) and an epicardial suture device

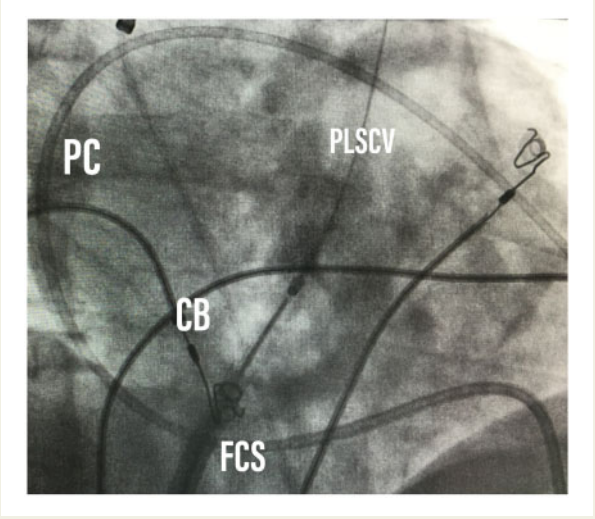


**Figure 4** Angiography of the coronary sinus, left atrium, and persistent left superior vena cava in a right anterior oblique 30° projection to correctly place the inflated cryoballoon in the transseptal puncture site where the perforation was suspected. CB, cryoballoon; FCS, FlexCath sheath; PC, pigtail catheter; PLSCV, persistent left superior vena cava.

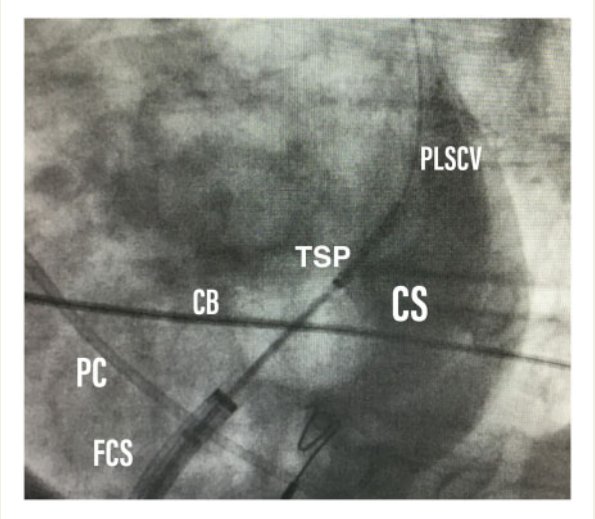


**Figure 5** Angiography of the cryoballoon in a wedge position (left anterior oblique 40° projection). The inflated balloon device was placed at this position for 45 min. CB, cryoballoon; CS, coronary sinus; FCS, FlexCath sheath; PC, pigtail catheter; PLSCV, persistent left superior vena cava; TSP, transseptal puncture site.

can be an emergency bailout option in patients with a periprocedural perforation of the LAA. One might speculate that this innovative approach can be transferred to other types of procedure-related complications based on perforation and continuous bleeding. In this context, it is important that the CB achieves a wedge-position to occlude the perforation site with an adequate amount of pressure and stability (i.e. CS, LAA and PVs). With this unique clinical case report, we describe an acute endovascular occlusion of a cardiac perforation at the transseptal puncture site in a patient with PLSVC and severe post-procedural tamponade. This manoeuvre saved the patient from immediate cardiac surgery and resulted in stable haemodynamic conditions after minutes. This bailout approach was transferred from coronary interventions where occlusion of a perforated vessel using balloon devices is a common technique as a bridge to definitive haemostasis. However, even if the definitive haemostasis cannot be achieved during the procedure, the acute endovascular occlusion of the perforation site using the CB will stabilize the patient and allows a safe transfer to surgery. Instead of the CB, other compliant balloon devices can also potentially be utilized for this bailout approach.

## Conclusion

Cryoballon-guided ablation for AF in patients with PLSVC is feasible and effective but the risk for complications is relatively high due to the anatomical variant. In case of procedure-related severe bleeding which results in pericardial effusion or tamponade, the balloon device can be used to occlude the perforation site as an emergency bailout strategy to avoid surgery.

## Lead author biography

Dr Christian Sohns was trained in Electrophysiology at the University Medical Center in Göttingen (Germany) and the King's College London (UK). He worked as a senior consultant for Electrophysiology at the St. Georg Hospital in Hamburg (Germany). Today, Dr Sohns works as deputy director at the Clinic for Electrophysiology at the Heart and Diabetes Center NRW in Bad Oeynhausen (Germany) together with his colleagues Dres El Hamriti and Bergau as well as the director of the Clinic, Professor Philipp Sommer.

## Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

**Slide sets:** A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

**Consent:** The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

**Conflict of interest:** none declared.

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