Cryoballoon ablation from above, through a prosthetic patch atrial septal defect repair

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Introduction

Pulmonary vein isolation to treat atrial fibrillation (AF) is challenging where the usual femoral route is not possible.[1–5] Interruption of the inferior vena cava (IVC) is a rare anatomic variant, with or without azygos venous system drainage of the lower body into the superior vena cava (SVC).[6,7] This anatomy necessitates an alternative approach for transseptal puncture to allow catheter access to the left atrium, and has been described for both radiofrequency and cryoballoon ablation strategies for AF ablation.[2,3,5] We present the first published case of prosthetic material (Dacron) atrial septal defect (ASD) repair puncture, utilizing transjugular access for cryoballoon ablation of AF.

Case report

A 57-year-old woman attended with recurrent symptomatic paroxysmal AF despite treatment with sotalol and flecainide at different times. Her cardiac history was significant for a Dacron (polyethylene terephthalate) ASD closure performed at the age of 16 years. A recent computed tomography (CT) scan showed a dilated azygos venous system with polysplenia. The right and left atrial appendage anatomy appeared normal, with no signs of left atrial isomerism or anomalous pulmonary or systemic venous drainage. Other than the heterotaxy evident with polysplenia, the heart and abdominal organs were normally aligned. Long-term amiodarone was an unattractive option owing to the side-effect profile so the decision was made to perform an AF cryoballoon ablation.

KEYWORDS Atrial fibrillation; Atrial septal defect repair; Cryoballoon ablation; Dacron patch; Interrupted inferior vena cava; Pulmonary vein isolation; Transjugular access; Transseptal puncture
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KEY TEACHING POINTS

- Heterotaxy syndromes with associated abnormalities of the inferior vena cava and abdominal or thoracic organs present challenges to access for left atrial ablation, and these can be overcome by other routes such as transhepatic or, as in this case, internal jugular access, but further anatomical challenges may also be present.
- This is the first description of prosthetic atrial septal defect repair puncture (Dacron, in this case) using the jugular approach to successfully perform cryoballoon ablation of atrial fibrillation.
- Various challenges for entering the pulmonary veins with mapping catheters or the cryoballoon may present, but these can be overcome with modification of technique to achieve good occlusion with low temperature, which should lead to pulmonary vein isolation.

Owing to the likely absence of a continuous IVC with this anatomy and the lack of local team experience with the transhepatic approach for electrophysiology procedures, preprocedure planning was for an initial superior approach. Venography was performed from right common femoral vein access at the commencement of the case to confirm the CT findings. Figure 1 shows selected surface electrocardiogram leads with intracardiac coronary sinus catheter signals in the presenting rhythm and 3-dimensional reconstructions of the CT showing the access issues: the interrupted IVC with dilated azygos system joining the SVC and the ASD patch.

Left axillary vein access was obtained under fluoroscopy and a 6F sheath was inserted, through which a 6F Dynamic XT deflectable decapolar catheter (Boston Scientific) was placed into the coronary sinus. Right internal jugular vein

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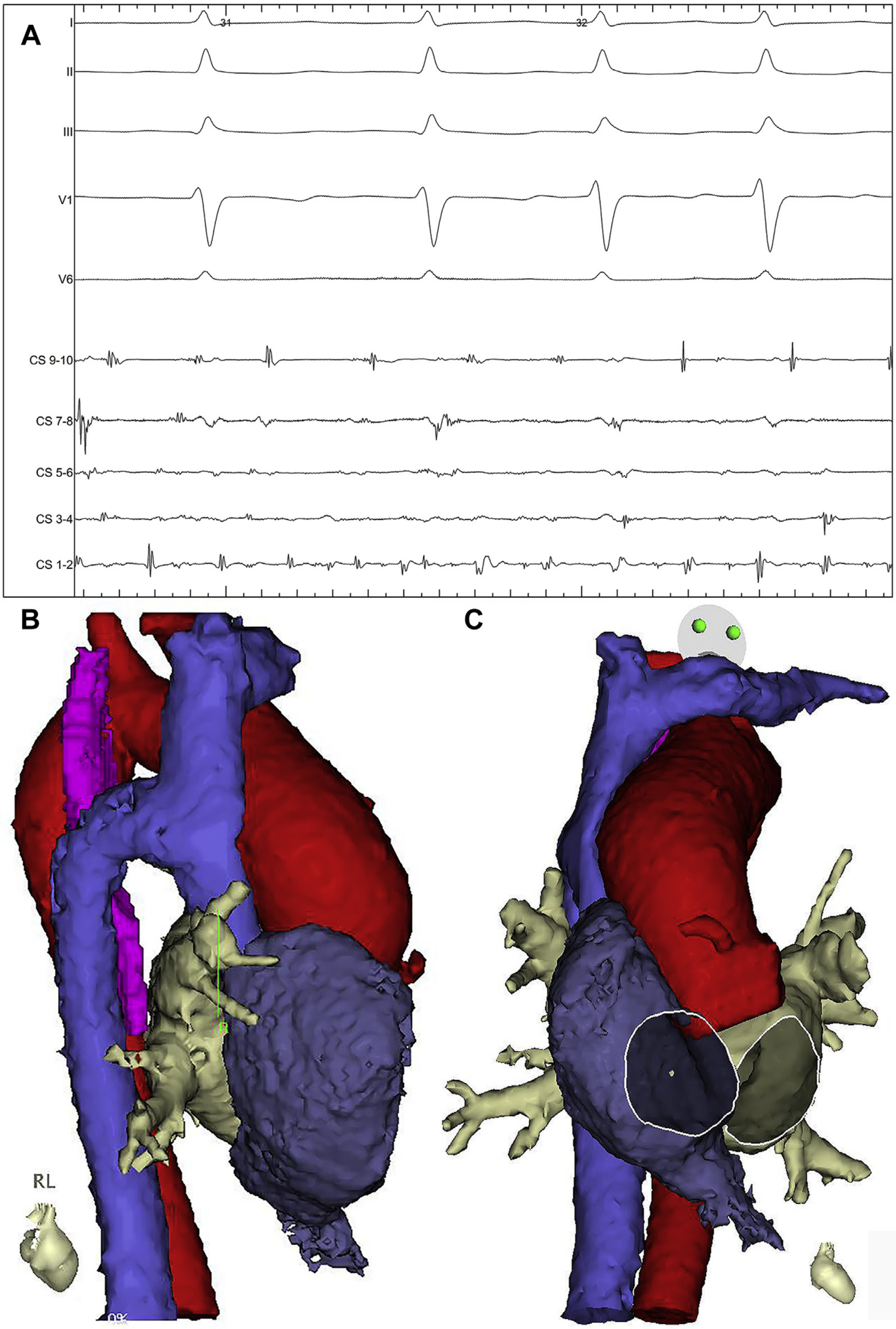


Figure 1 **A:** Electrophysiology system (Labsystem PRO; Boston Scientific, Lowell, MA) recording of selected limb leads and coronary sinus catheter intracardiac electrograms showing atrial fibrillation. **B:** Computed tomography (CT) of azygos vein system draining into superior vena cava. **C:** CT with modified right anterior oblique view with cutaway revealing interatrial septum area occupied by atrial septal defect surgical patch closure.

(IJV) access was obtained using 6F and 11F sheaths. A 6F nondeflectable quadripolar catheter (Abbott, St Paul, MN) was passed through the 6F sheath to the SVC/left subclavian vein for phrenic pacing. Transseptal access was attempted initially with a 63 cm SLO (Abbott) sheath and 71 cm transseptal needle (Cook Medical, Bloomington, IN) that we curved to 150 degrees. This combination did not enable the tip of the sheath and needle to be positioned into the fossa ovalis region. We then used a 92 cm HeartSpan steerable sheath (Merit Medical Systems, South Jordan, UT) with a

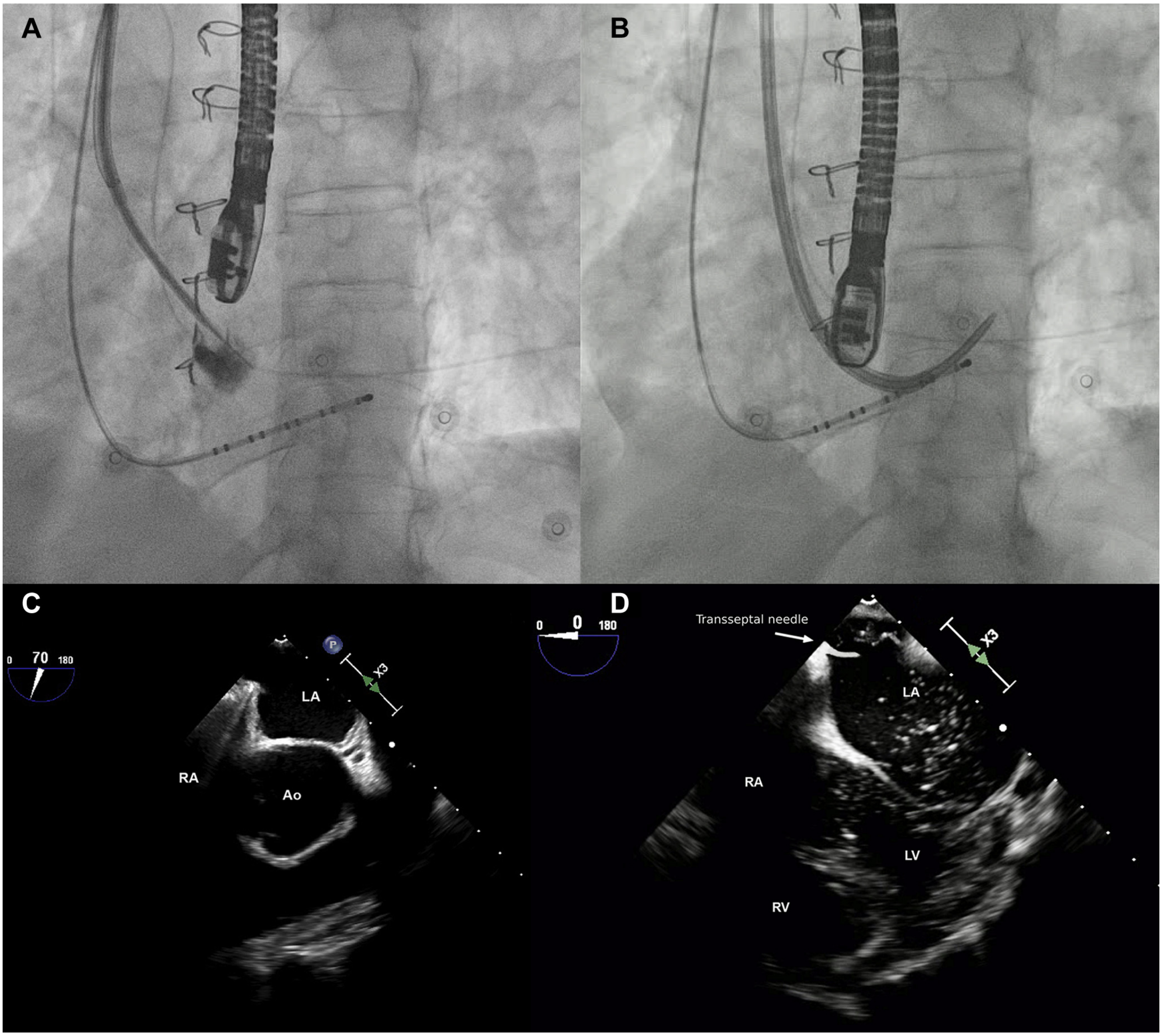
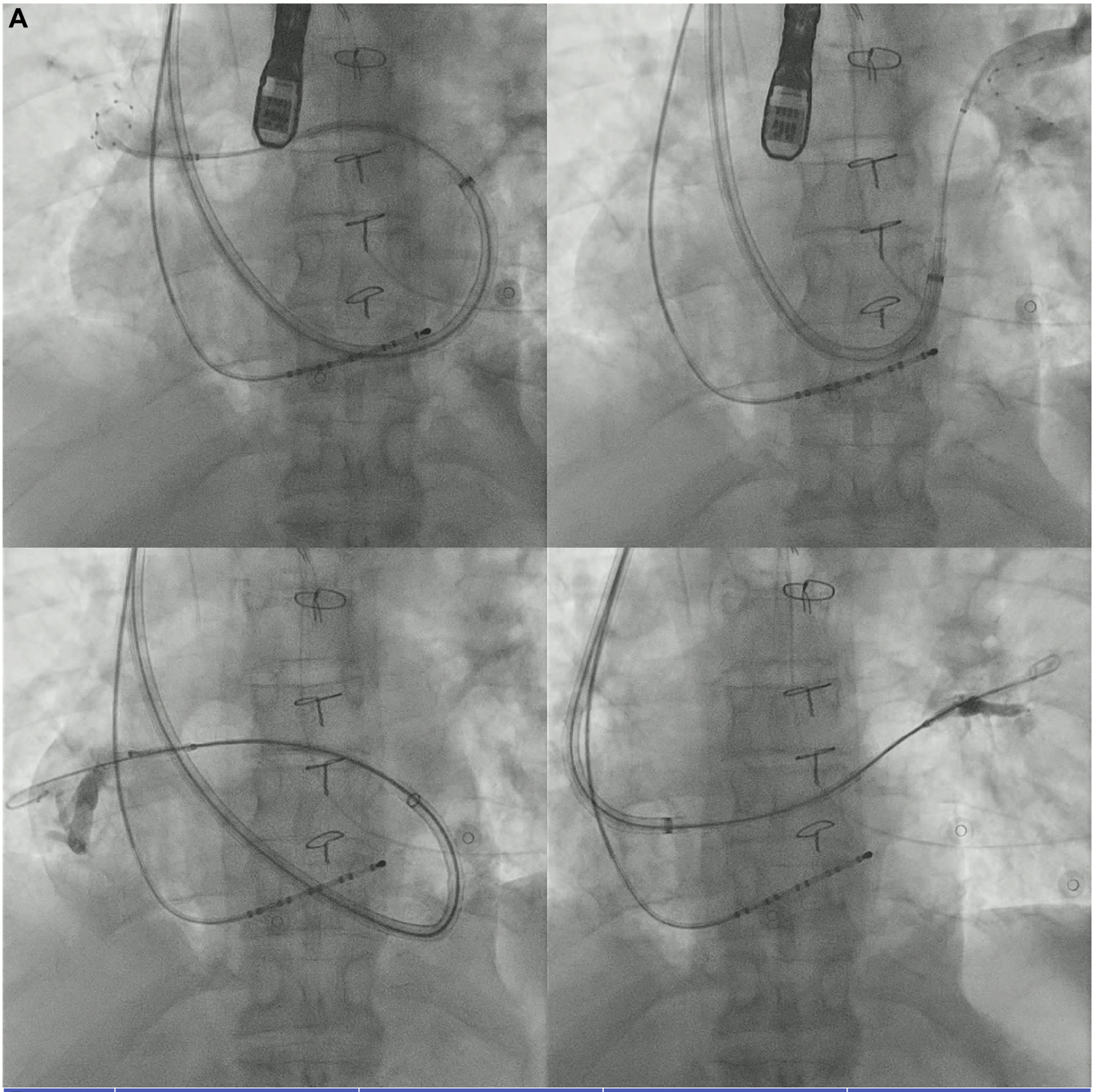


Figure 2 **A:** Fluoroscopy imaging of transseptal needle position at puncture with contrast staining of interatrial septum. **B:** Fluoroscopy imaging of sheath position after successful transseptal puncture. **C:** Transesophageal echocardiogram image of transseptal needle tenting septum. **D:** Transesophageal echocardiogram image of transseptal needle through and with radiofrequency-induced microbubbles. Ao = aorta; LA = left atrium; LV = left ventricle; RA = right atrium; RV = right ventricle.

98 cm 86-degree-curve HeartSpan transseptal needle (Merit Medical Systems), which was also manually curved to 150 degrees, but again this combination did not allow adequate positioning. Following this, an Agilis NxT (Abbott) medium-curve steerable sheath was used with the same transseptal needle. Figure 2A and B shows fluoroscopy with septal staining and sheath position after crossing, and Figure 2C shows the transesophageal echocardiogram imaging with tenting of the repaired interatrial septum. Firm forward pressure with the needle was not sufficient to puncture, and with a SafeSept transseptal guidewire (Pressure Products, San Pedro, CA) passed through the needle, the septum still could not be punctured. We then used short bursts of radiofrequency (RF) energy applied to the hub of the transseptal needle (up to 3 seconds; 10, then 20 watts) when it was firmly engaged on transesophageal echocardiogram imaging and this allowed access to the left atrium. Figure 2D shows microbubbles visible during RF application, clearly seen in the left atrium, indicating successful puncture.

On gaining access to the left atrium, the Agilis sheath was exchanged for a FlexCath Advance steerable sheath (Medtronic, Inc., Minneaoplis, MN) and through this a 28 mm Arctic Front Advance cryoballoon (Medtronic, Inc.) and 20 mm Achieve circular mapping catheter (Medtronic, Inc.) were passed. The superior pulmonary veins could be successfully entered with the Achieve mapping catheter, but the catheter would not pass into the inferior pulmonary veins (likely owing to the anterior nature of the transseptal puncture). The Achieve was then exchanged for a 145 cm, 0.035 inch Rosen



B	Freeze 1		Freeze 2		Freeze 3		Freeze 4	
	Temperature	Duration	Temperature	Duration	Temperature	Duration	Temperature	Duration
LSPV	-49°C	240 s	-58°C	180 s				
LIPV	-35°C	240 s	-30°C	240 s	-35°C	300 s	-66°C	120 s
RIPV	-32°C	58 s	-47°C	240 s	-50°C	240 s		
RSPV	-52°C	240 s	-52°C	180 s				

Figure 3 **A:** Cryoballoon positioning with venograms. **B:** Table showing cryoballoon freeze temperatures and durations. LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

wire (Cook Medical), which could be passed into the inferior veins, and this provided sufficient support for good cryoballoon position. Figure 3 shows fluoroscopy of each pulmonary vein occlusion and the details of temperatures and durations of freezes applied. During manipulation the sheath passed back into the right atrium, and freezing the cryoballoon onto the ostium of the left inferior pulmonary vein provided sufficient support to readvance the sheath through the transseptal puncture. Despite the inability to show definite isolation of the 2 lower pulmonary veins using the Achieve catheter, we were confident isolation was achieved, as in our experience this is the case when excellent occlusion is seen with low balloon temperatures (although multiple freezes were performed to achieve this). The right phrenic nerve was paced during right-sided pulmonary vein cryoablation, and there was no phrenic nerve palsy. Over 10 months of relatively close follow-up there has been no symptomatic recurrence, off antiarrhythmic medications, with the patient having access to her own Kardia/AliveCor device (AliveCor Inc., Mountain View, CA) to use if this occurs.

Discussion

A small number of other cases in the literature with a similar superior approach for AF ablation have shown this approach to be feasible, when necessary.[1–5,8] The IVC is formed from anastomosis of 3 pairs of veins during the fifth to seventh weeks of gestation, with 5 segments contributing to its final structure.[6] Interruption or stenosis of this structure has been found in <1% of cases in imaging series, and is asymptomatic in cases where the azygos system is well developed, which occurs in roughly half of these.[6] The polysplenia and interrupted IVC were relatively isolated findings in this case of heterotaxy, with no associated left isomerism noted in the atria (although appendage assessment on CT is known to be challenging),[9] bronchi, or other abdominal organs. This organ arrangement is testament to the challenges of classification and frequent rule exceptions found in contemporary imaging series of the heterotaxy syndromes.[9] Regarding echocardiographic imaging for transseptal puncture, case series suggest improved safety with additional imaging where anatomy is challenging,[10,11] as it was in this case. Transesophageal echocardiography was chosen owing to ease of access through a standard approach and operator familiarity, and it provided invaluable additional information to fluoroscopy. RF energy use, either with electrocautery application to a standard transseptal needle or with a specialized needle, has been shown to require less force to achieve transseptal puncture, and theoretically reduces the risk to surrounding structures.[12,13] In this case, RF application to the transseptal needle enabled crossing where careful image guidance of a transseptal needle with visualized tenting of the Dacron ASD patch, and attempts at SafeSept wire crossing, did not.

Manipulation of the sheath and cryoballoon from the superior approach to isolate the superior pulmonary veins in this case was relatively straightforward, and the Achieve catheter could be passed into these veins. The more anterior position of the septal puncture made access to the inferior veins more difficult, requiring a Rosen wire to support the balloon. This enabled positioning of the cryoballoon to achieve satisfactory occlusion and low temperatures, resulting in likely successful isolation of the inferior veins.

This case illustrates the possibility of overcoming significant anatomical challenges to left atrial access enabling application of cryoballoon ablation for AF utilizing a superior approach and puncturing synthetic material. The use of transesophageal imaging, a steerable transseptal sheath, RF to the transseptal needle, and the use of a guidewire to position the cryoballoon into inferior veins were all necessary steps to enable successful isolation of all 4 pulmonary veins. Although the superior approach for both cryoablation and radiofrequency ablation have been previously described, to our knowledge this is the first such case documented with the additional challenge of prosthetic patch puncture.

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