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SPOTLIGHT

Isolation of the superior vena cava by ultra-low temperature cryoablation

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A 53-year-old man with non-ischemic dilated cardiomyopathy (ejection fraction 35%), received recurrent shocks from his dual-chamber implantable cardioverter-defibrillator (ICD) because of episodes of atrial fibrillation (AF), 7 years after an extensive radiofrequency ablation including pulmonary veins (PVs) isolation, left atrial roof, endocardial coronary sinus, mitral and cavotricuspid isthmus as well as complex fractionated electrograms at the base of left atrial appendage and left septum.

Redo ablation was performed with ultra-low temperature cryoablation (ULTC) using an Adagio cryoablation catheter (Adagio Medical, Inc)[1] which we were evaluating, supported by a three-dimensional electroanatomic mapping (CARTO, Biosense Webster) (Figure 1A,B). The PVs were found to be isolated, all lines from the previous procedure were found to be blocked, and no sustained arrhythmia was inducible.

Mapping of the right atrium (RA) showed fractionated electrical potentials (Figure 1C) extending 3 cm into the superior vena cava (SVC). After placing a deflectable catheter high in the SVC to stimulate the phrenic nerve, the Adagio catheter was positioned at the RA-SVC junction with a pre-shaped 20 mm J-tip stylet creating a loop into the SVC. With phrenic stimulation and abdominal palpation to monitor phrenic nerve function (Figure 1A), UTLC was applied, giving clear isolation of the SVC without loss of phrenic response (Figure 1D). Nine UTLC applications of 30 s each were used, with a slight rotation of the catheter after each application, reaching a nadir temperature between −115 and −125°C. The first 5 UTLC applications delayed the SVC potentials; complete isolation of SVC was then achieved and persisted for more than 30 min. At 12 months after ablation, the patient is not receiving antiarrhythmic drugs and his ICD has not detected any arrhythmia since the procedure, or any problem with the function of the leads or change in the burden of atrial pacing.

In addition to the PVs, the vein of Marshall, the coronary sinus, and the SVC have been identified as sites responsible for AF initiation.[2,3] Ablation in and around the SVC endangers the phrenic nerve and the sinus node; the use of radiofrequency energy also risks creating venous stenosis.[4] We took precautions for the phrenic nerve when treating the right pulmonary veins. Sinus node function was not a concern because of the availability of atrial sensing and pacing from the patient's dual-chamber ICD.

The efficacy of cryotherapy in the SVC has been demonstrated using cryoballoon therapy[2,3,5] but not previously with ULTC. To the best of our knowledge, we present the first case of SVC isolation using ULTC. Isolation required several deliveries of cryotherapy, perhaps in part because of our inexperience with the technique. No problem occurred with the leads of the patient's ICD but there are no data on the safety or otherwise of cryotherapy administration close to leads. This and other poorly quantified risks make it difficult to recommend SVC isolation for widespread use.

Compared to using a cryoballoon, ULTC has the advantage of shorter delivery time (recommended 30–60 s for PVs compared to 180–240 s for the Arctic Front), and unlike a cryoballoon, it does not obstruct the SVC during delivery of therapy.

The Adagio catheter has the potential advantage that the catheter used to stimulate the phrenic nerve can be passed within the loop of the cryo catheter, whereas with cryoballoon therapy any catheter passed from the inferior veins to the region of the phrenic nerve must lie between the balloon and the surface of the SVC. The loop format of the Adagio catheter avoids the dilemma of potentially impeding therapy delivery by placing a catheter between the myocardium and

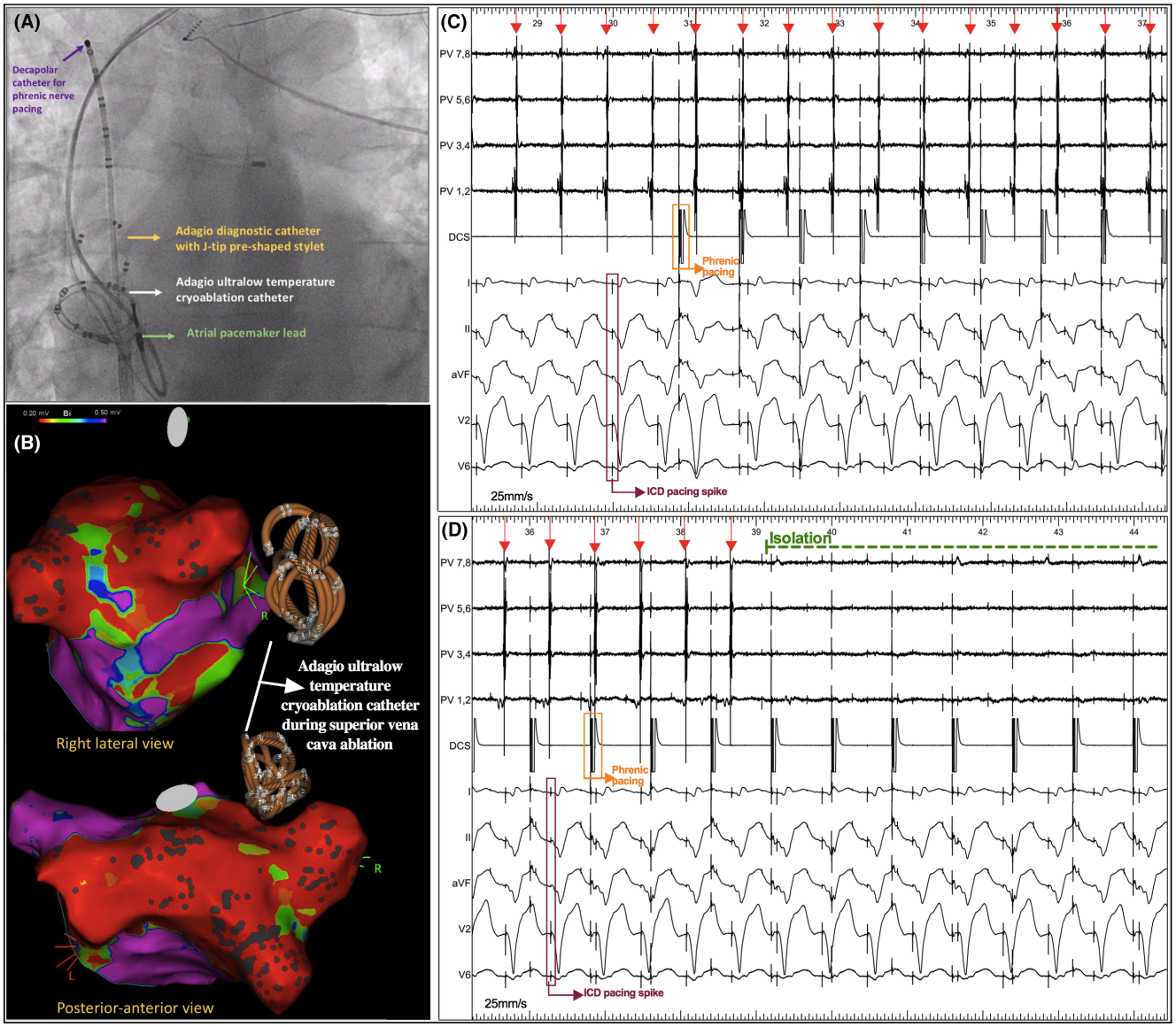

FIGURE 1 (A) Fluoroscopic view demonstrating superior vena cava (SVC) and catheter positions. ICD, implantable cardioverter-defibrillator. (B) Corresponding views of CARTO mapping during cryoablation. (C, D) Intracardiac electrograms with Adagio diagnostic catheter (labeled PV) registering fractionated electrograms (red arrows) in the SVC, following real-time isolation of SVC during cryoablation (green dash line). The distal electrode pair of decapolar catheter in the SVC is used to deliver phrenic nerve stimulation and is labeled DCS.

the source of cryotherapy or taking the risk of using additional jugular or subclavian access to approach the phrenic nerve from above.

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CONFLICT OF INTEREST STATEMENT

Authors declare no conflict of interests for this article.

ETHICS STATEMENT

Ethics committee approval was not applicable to this report.

CONSENT FOR PUBLICATON

The patient has consented to the publication of this report.

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