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CASE REPORT
Arrhythmias/electrophysiology

Single-shot cryoablation of an epicardial inferoparaseptal accessory pathway: a case report

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Background Catheter ablation (CA) of epicardial accessory pathways (APs) can be performed via the coronary sinus (CS) system. Variable CS anatomy with complications of former CA procedures inside the CS venous system may require using alternative CA approach and technology.

Case summary We report the case of a 23-year-old man with Wolff–Parkinson–White syndrome and history of aborted sudden cardiac death (SCD) and unsuccessful previous AP radiofrequency ablation (RFA). CS venography during the redo procedure revealed an early CS trifurcation with cardiac veins stenosis, thus with difficulties in maintaining cardiac veins' access and catheter manoeuvring inside CS venous system. The last office visit with electrocardiogram (ECG) performance was in 3 months after the CA. Neither delta wave on the ECG nor any complaints/adverse health effects was detected at that time.

Discussion Successful CA of epicardial AP in patients with a high risk of SCD is essential. However, CS complex anatomy and changes after former RFA inside it may lead to CS venous system access limitations. Alternative CA approach and technology should be considered to ensure CS venous system cannulation and epicardial AP CA performance.

Keywords Accessory pathway • Cryoablation • Coronary sinus • Assisting wire technique • Freeze cycle • Case report

Learning points

- Post-ablation cardiac veins' stenosis is a limitation for the traditional femoral approach.
- In cases of coronary sinus (CS) venous system access limitations, an additional assisting wire in CS main trunk can be useful to secure cardiac veins' access while manipulating near the CS ostium.
- Overdrive pacing (cycle length 400 ms) increases cardiac blood flow and venous return via the CS. It prevents the cryocatheter temperatures' drop up to -80°C caused by restricted intravenous blood flow.

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Introduction

Catheter ablation (CA) of an accessory pathway (AP) is an effective and safe treatment option for symptomatic patients with Wolff–Parkinson–White (WPW) syndrome, especially for those with a high risk of sudden cardiac death (SCD).[1] Nevertheless, its performance can be challenging due to AP localization and the complexity of cardiac anatomy.[2] Single-point cardiac cryoablation catheters are useful and safe in patients with septal APs.[3] Cryoablation in the coronary venous system is feasible in young patients.[4] However, there are limited data on AP cryoablation inside the coronary sinus (CS) venous system in adults. Here, we present a case of AP cryoablation inside CS via the superior vena cava (SVC) approach.

Timeline

At 3 years of age	Detection of Wolf–Parkinson–White pattern (delta wave) on the electrocardiogram (ECG)
At 9 years of age	Episodes of brief palpitations without further verification
One month before ablation—October 2018	The patient was transferred to the local hospital due to presyncope and syncope episodes. ECG revealed atrial fibrillation with rapid atrial conduction over the accessory pathway (AP). A cardiac arrest episode during a hospital stay treated with defibrillation.
First ablation procedure—November 2018	Radiofrequency ablation (RFA) of inferoparaseptal AP. Unsuccessful endocardial applications in the right and left paraseptal area (via transseptal approach); epicardial applications' attempt inside the coronary sinus (CS) with temporary effect during RFA.
Second ablation procedure—March 2019	Successful single-shot cryoablation via superior vena cava approach inside the CS system.
Three months after cryoablation	ECG without delta wave, no episodes of tachyarrhythmias

Case presentation

A 23-year-old man with WPW syndrome, history of aborted SCD, palpitations, accompanied by dizziness and presyncope, and a failed AP radiofrequency ablation (RFA), was admitted to our clinic for a redo procedure. Low-dosage (200 mg daily) amiodarone therapy, administered after the unsuccessful RFA, was discontinued a month before admission. He reported no family history of the WPW syndrome/cardiac arrhythmias. The physical examination was unremarkable: the blood pressure was 115/70 mmHg, heart rate 70 b.p.m., respiratory rate 16, and oxygen saturation 100% on room air. Normal first and second sounds were detected during cardiac auscultation. Lungs were clear to auscultation with no crackles and wheezes. Routine workup did not reveal any structural heart disease apart from delta waves in the electrocardiogram (ECG; *Figure 1*).

The electrophysiological (EP) study reported short AP anterograde (210 ms) and retrograde (240 ms) effective refractory periods (ERPs) and increased vulnerability to atrial fibrillation with rapid antegrade conduction over AP.

A decapolar catheter with a lumen (7 Fr, St Jude Medical, USA) was placed in the CS via the left subclavian vein. Coronary sinus venograms were obtained, which showed CS ostium with early branching, middle cardiac vein stenosis with a post-stenotic dilatation, and posterior cardiac vein stenosis (*Figure 2A*). Then a 9-Fr left ventricular (LV) electrode delivery system was inserted into the CS. A stiff 0.035-inch J-tip wire (Starter™ 180 cm, Boston Scientific, USA) was advanced further in the main trunk of the CS for supporting the delivery system at the ostium and permitting cardiac vein cannulation with a coronary artery guidewire (Miracle 3, Asahi Intecc, Japan) (*Figure 2B*). After middle cardiac vein cannulation (*Figure 2B*) and coronary artery balloon dilatation (Sprinter Legend RX 2.5 mm × 20 mm, Medtronic, USA) (*Figure 2C*) a catheter for cryoablation (Max Freezor, Medtronic, USA) was inserted into the vein via the SVC (*Figure 2D*).

An early local pre-excitation (-35 ms to delta wave) was recorded from the ablation catheter at the aneurysm, but the attempt of cryoablation failed due to the cryocatheter's rapid extremely low-temperature drop (< -80°C). Ablation was performed at the middle cardiac vein ostium with the interruption of AP conduction within 52 s. However, AP conduction recovered immediately after ablation.

Following this, a posterior cardiac vein stepwise balloon dilatation was performed with 2.75 mm × 20 mm (Emerge, Boston Scientific, USA) and 3.0 mm × 20 mm (Sprinter Legend RX, Medtronic, USA) coronary artery balloons (*Figure 3A–C*). The Freezor catheter was inserted in the posterior cardiac vein and positioned 5–7 mm distal to vein ostium (*Figure 3D*).

Recordings from the ablation electrode showed the earliest local ventricular activation (-65 ms) (*Figure 4A*). There was no discreet A and V signal on the mapping catheter, unlike the electrogram (EGM) patterns at the local pre-excitation site in the right and left inferoparaseptal region (*Figure 4B and C*). Signals, recorded 1 cm inside the CS (*Figure 4B*) and at 6 o'clock position of mitral annulus (*Figure 4C*), showed atrial-to-ventricularEGM ratio 1:2 and 1:3, respectively. An application was performed with AP destruction within 10 s (*Figure 5*). In the 110th s of application, the delivery of freezing agent was cancelled due to the extremely low temperatures (< -80°C). During the next two applications (300 ms), cardiac pacing with cycle length 400 ms was used to ensure complete applications.

Within 30 min after ablation, an EP study showed anterograde and retrograde conduction over the atrioventricular node with an ERP of 500–260 ms and an atrioventricular node Wenckebach point 460 ms. The patient was discharged in 2 days with ECG without delta waves. No specific antiarrhythmic therapy was administered. The last office visit with ECG performance was in 3 months after the CA. Neither

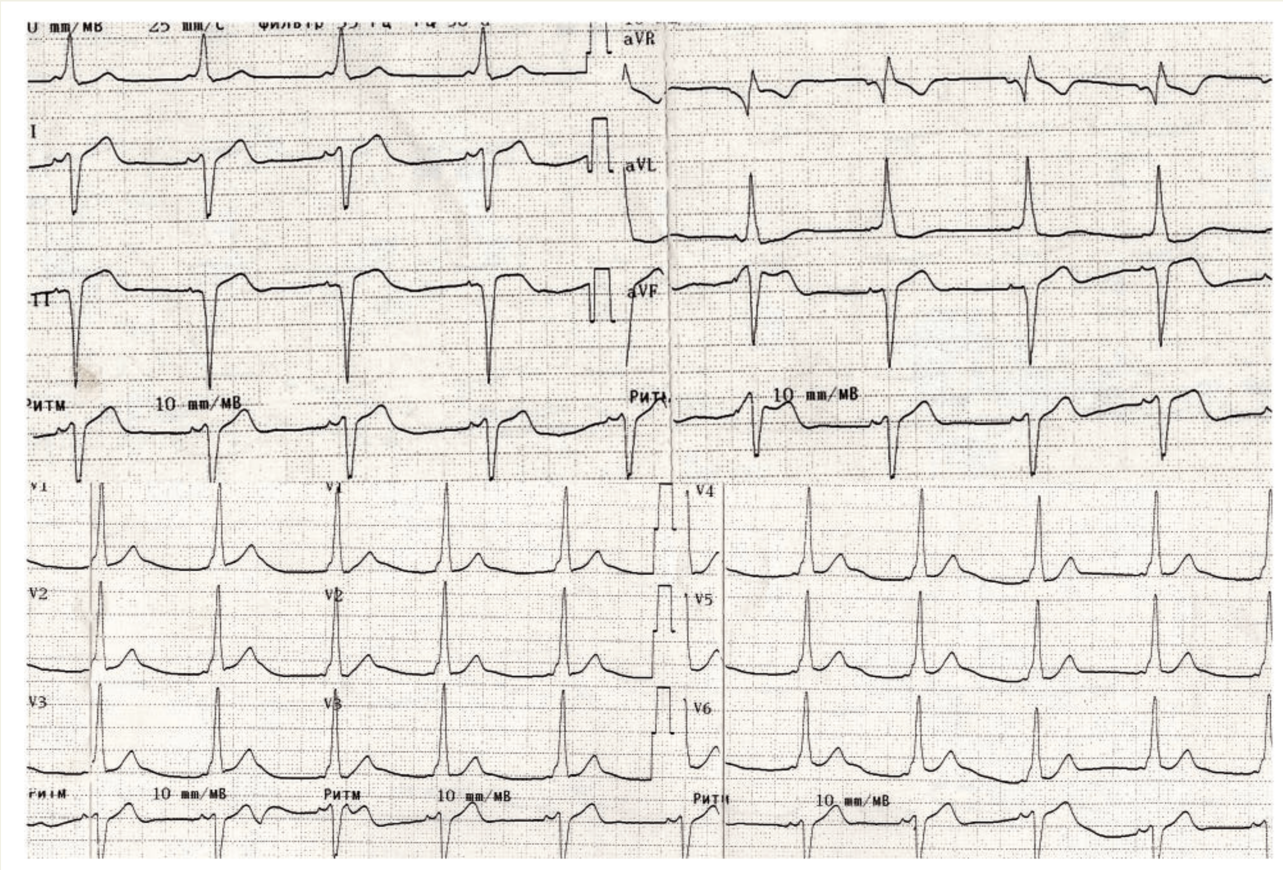

Figure 1 Electrocardiogram with a delta wave. The negative delta wave in inferior leads indicates the inferoparaseptal localization of the accessory pathway.

delta wave on the ECG nor any complaints/adverse health effects was detected at that time.

Discussion

Although WPW syndrome is known to be a benign condition,[5] the overall estimated risk of SCD in young males with short AP AERP is 0.3% per year.[6] In our case, the patient was fortunate enough to survive an SCD episode and a successful AP destruction was crucial to prevent future incidents. Due to the failure of a previous RFA, alternative ablation technology was considered for the second procedure. Cooled tip RFA of the epicardial arrhythmogenic substrate through the CS venous system is feasible and effective.[7] Although surface cooling reduces the risk of boiling and coagulation, it can still cause superheating leading to pop lesion formation and CS perforation. Besides, healing processes after RFA in vessels may result in stenosis formation, as in our case. The visualization of middle and posterior cardiac veins' stenosis with an early branching of the CS trunk in the venography established the necessity of using the SVC approach. Cannulation via the SVC allows for a more stable catheter-tissue contact and has been recommended in challenging right-sided and septal/paraseptal AP CA cases.[2]

Moreover, in this case, the early branching of the CS with cardiac veins' stenosis required the use of an additional assisting wire to secure the access of cardiac veins while manipulating near the CS ostium. The so-called 'buddy wire' technique, first described by Perzanowski and Gilliam[8] was used to ensure LV electrode implantation in patients with the need for biventricular pacing and challenging CS anatomy. However, it is feasible for CA performance too.

Owing to adhesion and higher stability of cryoablation catheter, absence of coagulation formation and lower incidence of thrombogenesis,[9] the use of cryoablation technology inside CS seems to be appropriate, albeit challenging. Rapid and very low (< -80°C) cryocatheter temperature drops due to restricted intravenous blood flow led to the reset of the application. We overcame this problem using temporary cardiac pacing with a cycle length of 400 ms to increase cardiac blood flow and venous return via the CS, therefore, preventing temperature drop to very low levels. However, the reported high rate of arrhythmia recurrences after successful CA remains the primary concern for AP cryoablation within CS. A multicentre study on a paediatric population and young adults shows an arrhythmia recurrence rate of 40% with the median time to recurrence 17 days (range 1–120 days).[4] This fact emphasizes the necessity of carrying on regular follow-up visits to perform ECGs.

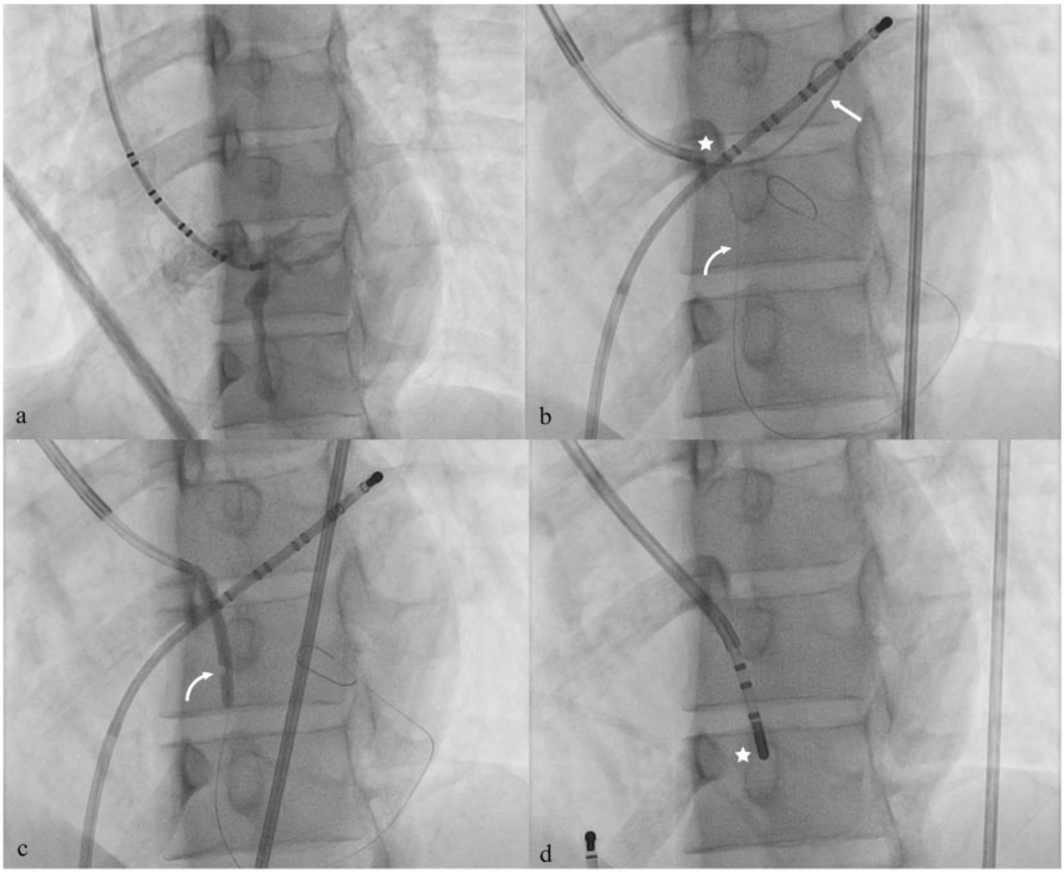

Figure 2 Coronary sinus anatomy visualization and middle cardiac vein cannulation. (*A*) Early branching of the coronary sinus with middle and posterior cardiac veins stenosis, (*B*) coronary sinus main trunk cannulation with a 0.035-inch wire (arrow) to support delivery system at ostium (star) and middle cardiac vein cannulation (curved arrow), (*C*) middle cardiac vein balloon dilatation (curved arrow), and (*D*) catheter Max Freezor inside middle cardiac vein (star).

Conclusion

An SVC approach and the use of supporting assistant wire inside CS should be considered to overcome CS venous system access limitations in cases of epicardial AP CA. The increase of coronary venous return via CS by cardiac pacing can be useful for preventing conflicts with cryoablation system and completing applications.

Lead author biography

Dr Karapet Davtyan is a cardiac surgeon specialized in interventional treatment of cardiac arrhythmias in adults and children. He works as a Head of Department of Heart Rhythm and Conduction Disorders at National Medical Research Center for Preventive Medicine in Moscow. He and his team perform more than 800 ablation cases per year and have the biggest experience of cryoablation in Russia (over 300 cases of single shot and cryoballoon ablation per year).

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: K.V.D. serves as a proctor for Medtronic and Abbott. A.A.K. is a consultant for Abbott. And other authors have no conflict of interest to declare.

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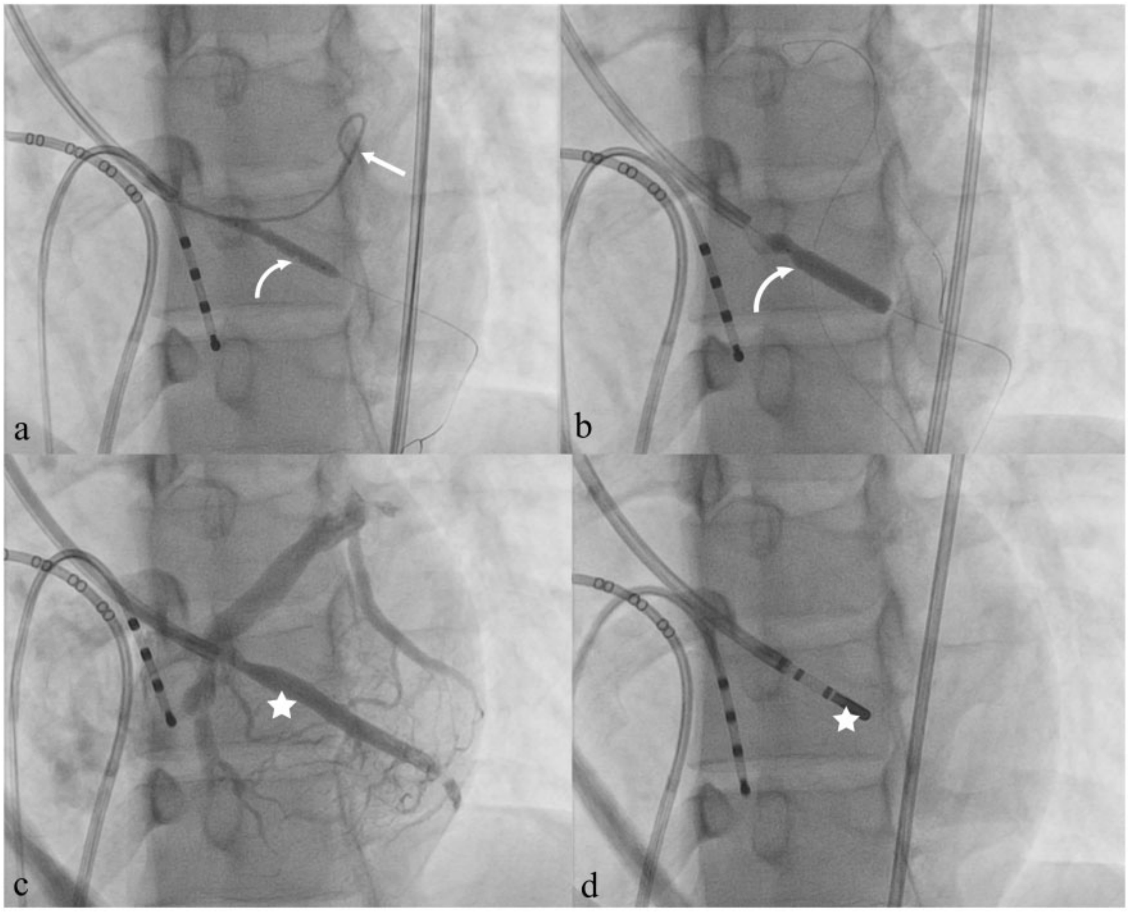

Figure 3 Posterior cardiac vein (*A–C*) stepwise dilatation (curved arrow), 0.035-inch wire is in the coronary sinus main trunk, (*C*) cryocatheter in the posterior cardiac vein (star).

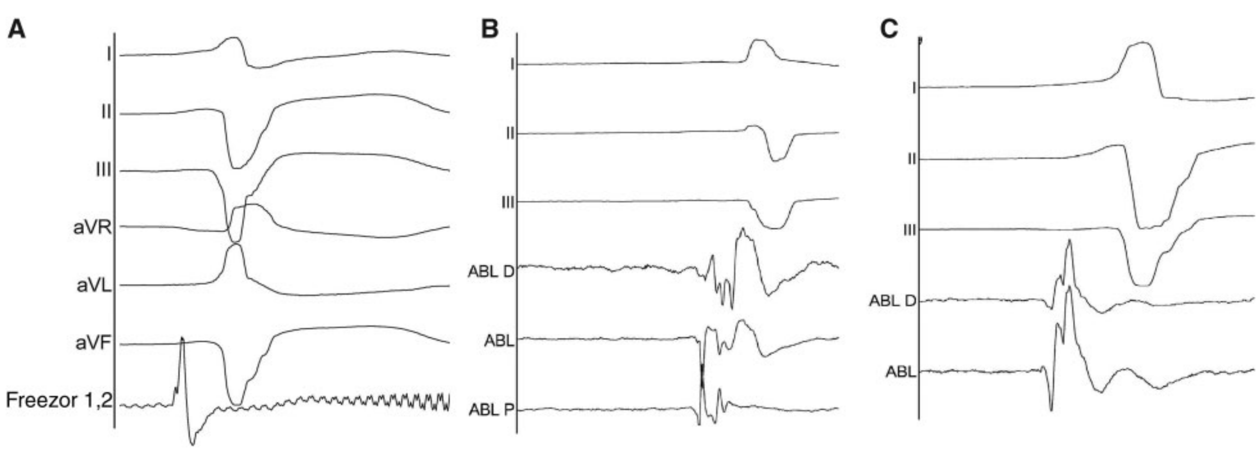

Figure 4 Zoomed electrocardiogram tracings and intracardiac electrograms from the mapping catheter (*A*) in the posterior cardiac vein, (*B* and *C*) inferoparaseptal region. (*A*) The maximal preexcitation results in the absence of discreet A and V signal on the mapping catheter at the successful ablation site in the posterior cardiac vein. (*B*) A local pre-excitation on the mapping catheter placed 1 cm into the coronary sinus with atrial-to-ventricular electrogram amplitude ratio of 1:2, (*C*) a local pre-excitation on the mapping catheter at the left endocardial inferoparaseptal region with A:V ratio of 1:3.

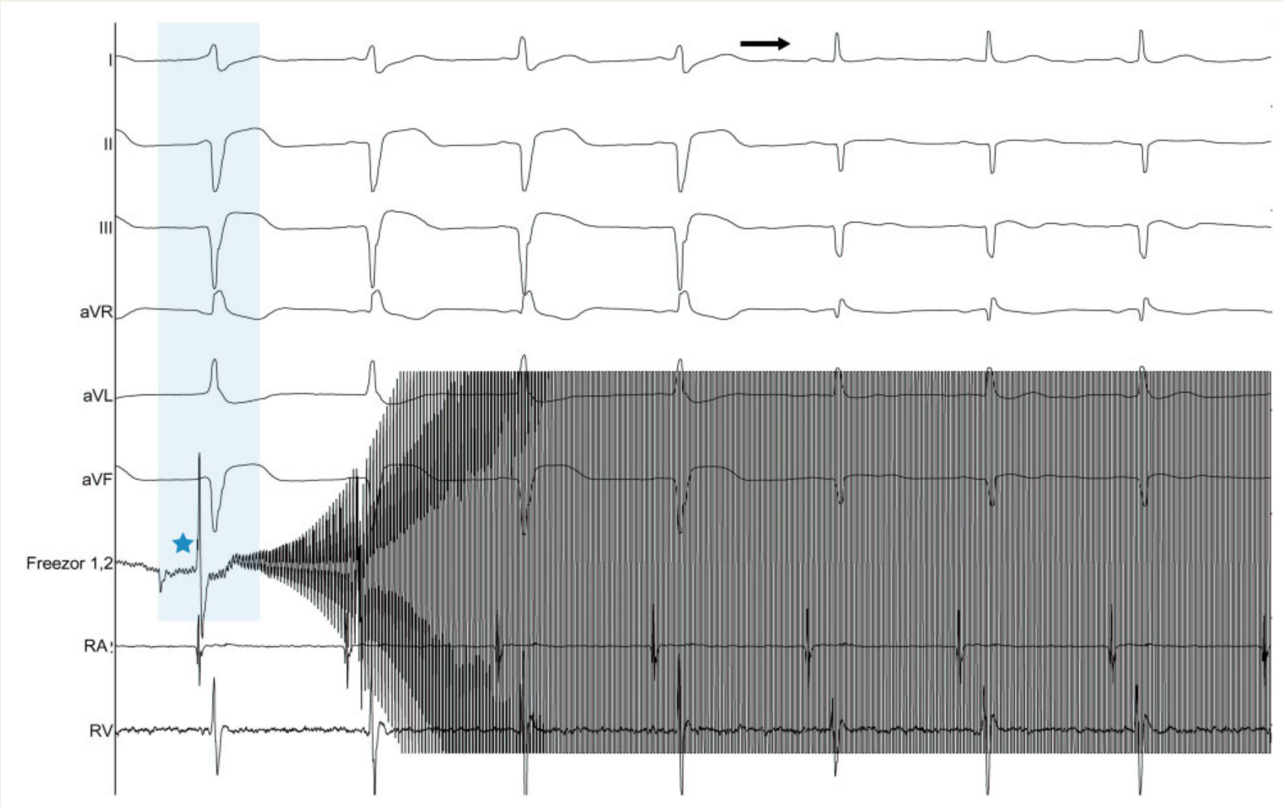

Figure 5 Effective cryocatheter ablation of accessory pathway. Electrocardiogram and intracardiac electrograms from the ablation catheter (Freezor 1,2—blue star), right atrium, and right ventricle. The first four QRS complexes presented with delta waves. Within 10 s, conduction over the accessory pathway was interrupted (the three narrow QRS complexes after arrow).

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