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Case Report

Cryoablation of parahisian premature ventricular contractions with an HD Grid multipolar mapping catheter: a case report

Juan Chan[1], Ruikun Jia[1], Min Xu[2], Kaijun Cui[1]

[1]*Department of Cardiology, West China Hospital, Sichuan University, Chengdu, Sichuan, China;* [2]*Department of Cardiology, Sichuan Mianyang 404 Hospital, Mianyang, Sichuan, China*

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Abstract: Catheter ablation of premature ventricular contractions (PVCs) arising from the parahisian region poses considerable technical challenges due to the proximity of the His bundle, increasing the risk of atrioventricular (AV) block. We report the case of a 69-year-old woman with symptomatic, high-burden parahisian PVCs refractory to beta-blocker therapy. After structural heart disease was excluded through standard clinical evaluations, a combined approach using high-density mapping and cryoablation was adopted. Using an HD Grid multipolar mapping catheter, the earliest ventricular activation site was precisely identified near the His bundle, with a local activation time of -26 ms. After confirming safety with a test freeze, cryoablation was performed at -75°C for 480 seconds. The PVCs were successfully eliminated without any AV conduction disturbances. At the 12-month follow-up, the patient remained asymptomatic, and the PVC burden had decreased by more than 95%. This case demonstrates the safety and efficacy of combining HD Grid mapping with cryoablation for treating parahisian PVCs.

Keywords: High-density mapping, multipolar catheter, cryoablation, premature ventricular contraction

Introduction

Isolated premature ventricular contractions (PVCs) are generally considered benign; however, a high PVC burden can cause significant symptoms and even lead to cardiac dysfunction. Several studies have reported that a PVC burden of ≥10% is associated with reduced cardiac function and symptomatic deterioration. First-line treatment typically involves medical therapy, including beta-blockers or antiarrhythmic drugs. However, symptomatic or high-burden PVCs that are refractory to medical management often require catheter ablation [1, 2].

Ablation of PVCs originating from the parahisian region remains technically challenging due to its close proximity to the His bundle and atrioventricular (AV) conduction system. Radiofrequency ablation in this area carries a substantial risk of inducing AV block. Consequently, alternative energy sources such as cryoablation capable of generating controlled and reversible lesions with well-defined borders are considered safer options [3].

Recent advances have shown that high-density mapping with the HD Grid multipolar catheter facilitates precise localization of ventricular arrhythmias, including those arising from anatomically complex regions such as the parahisian area [4-6]. The catheter's electrode configuration, with 3 mm interelectrode spacing, enables broad myocardial coverage and allows for simultaneous pacing and recording from multiple directions without repositioning the catheter. Despite these advancements, a standardized approach for parahisian PVC ablation has not yet been established.

We present a case of symptomatic parahisian PVC successfully treated using a combination of high-density mapping with an HD Grid multipolar catheter and cryoablation. From a clinical perspective, this case underscores a novel and effective strategy for managing parahisian PVCs, which are typically associated with substantial procedural risk. The HD Grid catheter allows for high-resolution mapping and precise localization of the arrhythmic focus, while cryo-

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ablation minimizes the risk of AV conduction injury by enabling reversible lesion formation. To our knowledge, few reports have documented the successful application of this dual-modality approach in the parahisian region. This case highlights its potential as a safe and effective alternative for the ablation of ventricular arrhythmias arising near the His bundle.

Case report

A 69-year-old woman presented to the Department of Cardiology, West China Hospital with a nearly 10-year history of palpitations that had progressively worsened and were unresponsive to beta-blocker therapy. A 24-hour Holter monitor recorded more than 25,000 PVCs, accounting for over 20% of total beats. Blood biochemical tests, chest X-ray, and transthoracic echocardiography showed no abnormalities, effectively ruling out structural heart disease.

A 12-lead ECG during sinus rhythm revealed PVCs with a QRS duration of 132 ms, a monophasic R wave in lead I, a QS wave in lead aVR, and an R wave in lead aVL, demonstrating "aVR-aVL polarity reversal". Lead V1 showed a QS wave, and the precordial transition occurred after lead V2 (**Figure 1A**). These findings suggested the PVC originated near the His bundle and tricuspid annulus [7, 8].

Given the anatomical complexity and procedural risks associated with parahisian PVCs, we employed an HD Grid multipolar mapping catheter (Abbott Medical, USA) in conjunction with the EnSite Precision™ navigation system for electroanatomic mapping, and a cryoablation catheter (Medtronic, USA) for ablation. This mapping system was selected for its ability to generate detailed electroanatomic maps and precisely localize the arrhythmic focus. The HD Grid catheter, with evenly spaced electrodes and multidirectional mapping capability, provided extensive myocardial coverage and allowed for pacing and recording from multiple vectors without repeated repositioning. This precision was critical given the proximity to the conduction system and the need to minimize complications while maximizing efficacy [4, 5].

Cryoablation was chosen as the energy source because of its ability to create reversible lesions and achieve cryoadhesion, which helps stabilize the catheter during energy delivery. This strategy aimed to enhance both procedural safety and effectiveness [3].

All antiarrhythmic medications were discontinued for at least five half-lives prior to the procedure. The ablation was performed under local anesthesia. Surface ECGs and intracardiac electrograms were continuously recorded using a multichannel system. A three-dimensional electroanatomic map was created using the EnSite Precision™ system. After vascular access was obtained via the right femoral vein, a sheath was inserted, and programmed electrical stimulation was used to induce PVCs. The HD Grid catheter was advanced into the right ventricle to reconstruct the electroanatomic map of the right heart and tricuspid annulus and identify the PVC origin.

The earliest activation site, located near the His bundle with a timing offset of -26 ms, was marked on the map with yellow dots (**Figure 1B**, **1C**). Detailed activation mapping was thenperformed using the cryoablation catheter to further define the target site (**Figure 1D**). Based on prior experience and published protocols [3], an initial test freeze at -30°C was performed for 30 seconds. Elimination of PVCs without AV conduction disturbance confirmed the safety of the site. Full cryoablation was then delivered at -75°C for 480 seconds. The PVCs were completely eliminated, and noninducibility was confirmed post-ablation. The blue dots in **Figure 2A**, **2B** indicate the successful ablation site.

Post-procedural ECG showed resolution of the PVCs and the appearance of a new right bundle branch block morphology, without evidence of AV block (**Figure 2C**). The patient was monitored for 48 hours post-procedure and discharged without complications. At the 12-month follow-up, the patient remained free of palpitations, and Holter monitoring recorded fewer than 100 PVCs in 24 hours-reflecting a reduction of over 95% compared with baseline (**Figure 2D**).

Discussion

Catheter ablation of PVCs originating from the parahisian region remains a major procedural challenge due to the anatomical proximity to the AV conduction system, which increases the risk of unintended injury [1, 2]. In the present

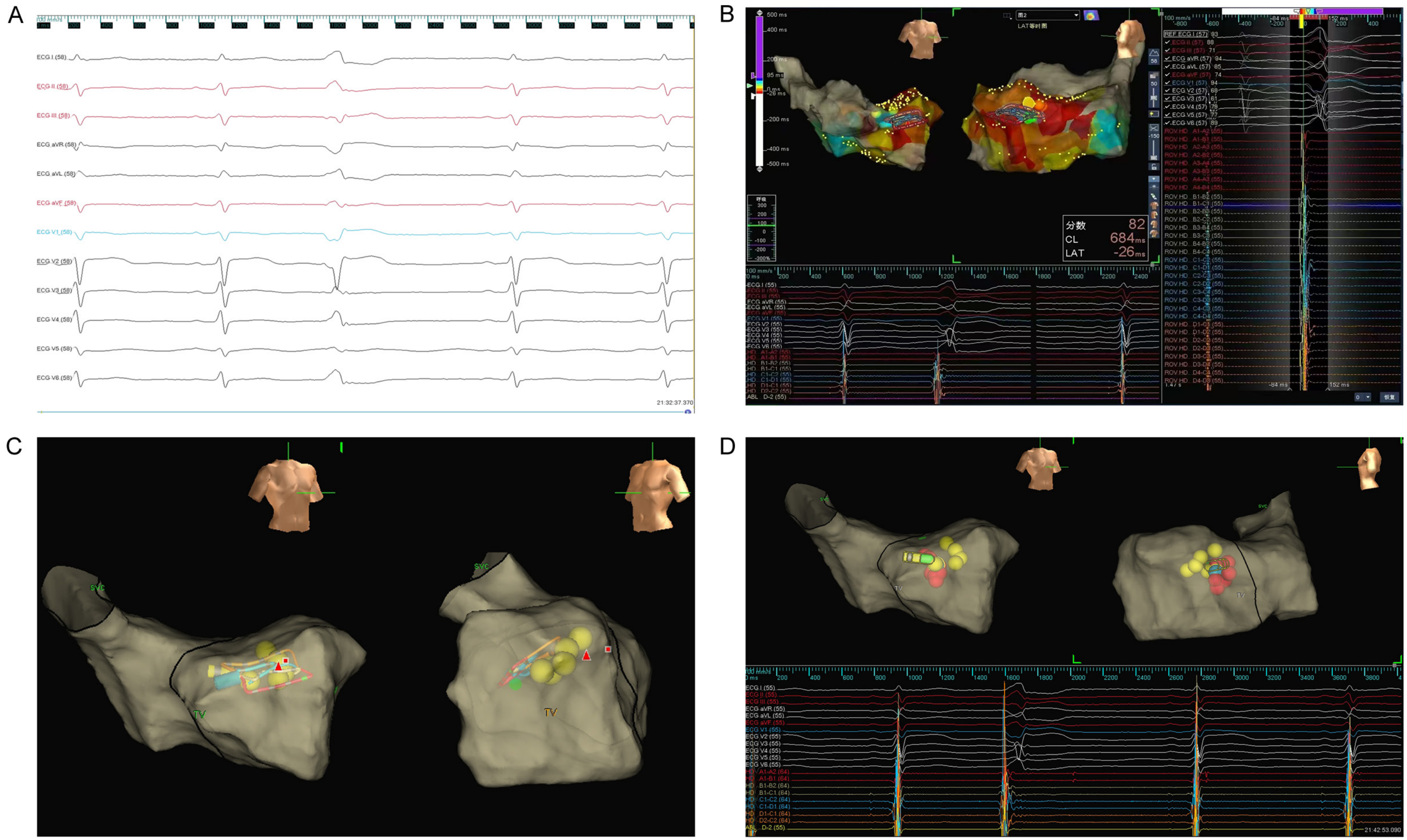

Figure 1. A. Electrocardiogram recordings during sinus rhythm. B. Activation map using HD Grid Mapping catheter. The earliest activation site of the right ventricle was near the His bundle with a timing offset of -26 milliseconds. C. The HD Grid Mapping catheter is visualized in the 3D electroanatomical map in the site of earliest ventricular activation (yellow dots represent Hisian electrograms). D. Detailed activation map using HD Grid Mapping catheter and cryo-catheter. The black auxiliary line indicates the anatomical position of the tricuspid annulus.

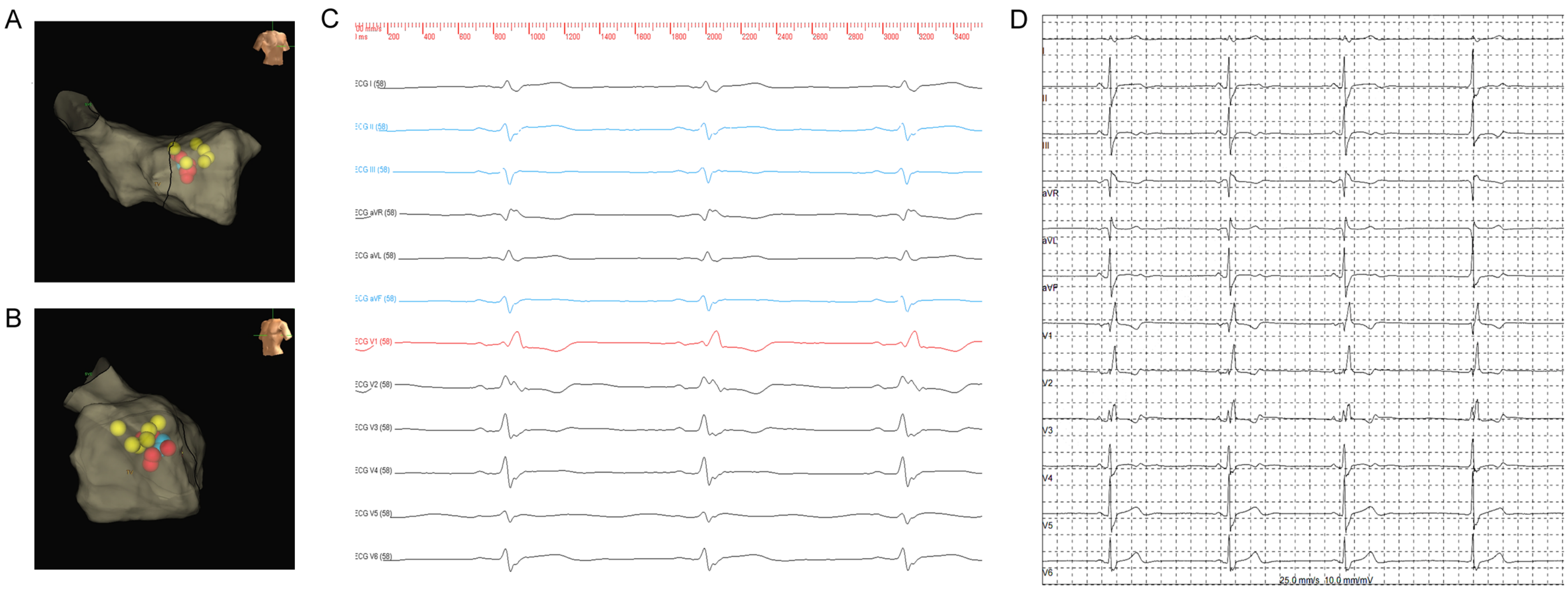

Figure 2. A, B. Successful cryoablation of parahisian premature ventricular contraction (yellow dots: Hisian electrogram; red dots: sites of ablation; blue dot: site of successful cryoablation). C. Post-ablation twelve-lead ECG demonstrating elimination of premature ventricular contractions and the presence of a right bundle branch block pattern without atrioventricular block. D. An episode from the last 24-hour holter electrocardiogram.

case, the patient exhibited a high PVC burden and disabling symptoms that were refractory to pharmacologic therapy, warranting an interventional approach. However, the parahisian origin raised significant concerns regarding both precise localization and safe ablation [9].

A critical aspect of the procedure was the use of the HD Grid multipolar mapping catheter in conjunction with the EnSite Precision™ mapping system. This configuration enabled accurate localization of the PVC origin, with the earliest ventricular activation recorded 26 ms before the onset of the QRS complex, in close proximity to the His bundle. The orthogonal electrode layout allowed for the simultaneous acquisition of signals from multiple directions, facilitating clear differentiation between near-field His potentials and far-field signals - an essential step in avoiding AV nodal injury. Compared to traditional linear or circular mapping catheters, the HD Grid's uniform interelectrode spacing and enhanced stability enabled comprehensive mapping without excessive repositioning, which was particularly valuable in this anatomically constrained region [4, 5].

Another key factor was the choice of cryoablation as the energy source, given its favorable safety profile in high-risk areas. Cryoablation permits a reversible test freeze (typically at -30°C), allowing the operator to evaluate for AV conduction impairment before proceeding with full lesion delivery. In this case, no conduction abnormalities were observed during the test freeze, and full ablation at -75°C successfully eliminated the PVCs without inducing AV block. This outcome supports the use of cryothermal energy for managing arrhythmias near the His bundle [3, 10].

By integrating high-resolution mapping with cryoablation, we achieved both efficacy and safety in a highly sensitive anatomical zone. The HD Grid catheter allowed for precise identification of the PVC focus, and cryoablation minimized the risk of collateral conduction system damage. At the 12-month follow-up, the patient remained asymptomatic, with a PVC burden reduced by more than 95%, demonstrating the long-term effectiveness of this combined strategy.

This case underscores the importance of tailoring catheter and energy source selection to the specific anatomical and electrophysiological context. It adds to the growing body of evidence that HD Grid-guided mapping combined with cryoablation offers a safer and more effective approach for parahisian PVC ablation.

This case demonstrates the successful cryoablation of a parahisian premature ventricular contraction using an HD Grid multipolar mapping catheter. The integration of high-density electroanatomic mapping and cryothermal energy delivery provides a safe and effective catheter-based ablation strategy for ventricular arrhythmias arising from high-risk anatomical regions near the His bundle.

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Disclosure of conflict of interest

None.

Address correspondence to: Dr. Kaijun Cui, Department of Cardiology, West China Hospital, Sichuan University, No. 37 Guoxue Alley, Chengdu, Sichuan, China. Tel: +86-028-85422114; E-mail: cuikaijunscu@163.com

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