

Usefulness of a multi-spline duodecapolar catheter with smaller electrodes and closer spacings for mapping and ablation of Purkinje-related premature ventricular contraction and triggered ventricular fibrillation



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Introduction

Purkinje fibers serve as triggers and perpetuators of ventricular fibrillation (VF).¹ Although catheter ablation can be an effective therapy for Purkinje-related premature ventricular contractions (PVCs) and triggered VF, it is essential to detect the exact site of the origin of the PVCs by mapping Purkinje potentials (PPs) precisely.^{2–5} Here, we report a case of Purkinje-related PVCs/VF successfully treated with catheter ablation guided by mapping using a PentaRay catheter.

Case report

A 64-year-old man was admitted due to a recent myocardial infarction and underwent a successful percutaneous coronary intervention of the proximal portion of the left anterior descending coronary artery. One week later, PVCs gradually increased and then repeatedly triggered VF. The patient developed an electrical storm, requiring 23 DC shocks. VF still occurred under medication with amiodarone and deep sedation supported by a mechanical ventilator. We thus performed catheter ablation therapy targeting the PVCs under the support of percutaneous cardiopulmonary bypass. A 12-lead electrocardiogram of the trigger PVC exhibited a superior and left axis deviation, relatively sharp and narrow QRS, and a right bundle branch block-type configuration in the precordial leads suggesting a left ventricle (LV) origin (Figure 1). The coupling intervals of the PVCs were 398–407 ms. Using a catheter with 5 radiating splines with 10 pairs of 3F, 1-mm-tip and 2-mm center-to-center-spaced electrodes (PentaRay, Biosense Webster Inc, Diamond Bar, CA), local electrograms of the LV during sinus beats (SBs) and the PVCs could be recorded. Then broad and detailed distribu-

tions of PPs preceding the QRS during both the PVC and SBs were observed with voltage and activation maps, guided by an electroanatomic mapping system (CARTO 3, Biosense Webster Inc, Diamond Bar, CA). The trigger PVC was diagnosed as originating from the Purkinje system at the border zone of an LV anterior infarction scar. By mapping with the PentaRay, we found discrete local electrograms with the earliest Purkinje fiber excitation (E-PFE) during the PVC preceding the QRS onset by 145 ms, where preceding PPs were also found during SBs (Figures 2 and 3). On the LV muscle activation map of the PVC, the E-PFE site was determined to be located relatively remote from the suspected breakout site (Figure 2). Multiple discrete potentials preceding the ventricular potential were observed on the MAP 15,16 electrodes and adjacent electrodes, suggesting an initial preferential conduction and a potential substrate of VF within the Purkinje network. After tagging the E-PFE site during the PVC and SBs, we positioned a linear 7F, 3.5-mm-tip and 3.25-mm center-to-center-spaced ablation catheter (Thermocool Smart Touch, Biosense Webster Inc, Diamond Bar, CA) exactly on the E-PFE site. However, an E-PFE potential could not be recorded during the PVC, and only a PP could be recorded during SBs. Therefore, we repositioned the ablation catheter carefully on and around the E-PFE site repeatedly with a contact force of 1–15g. However, we could not record any E-PFE potentials during the PVC, which was reproducibly recorded with the PentaRay catheter (Figure 3). We delivered 30 W of radiofrequency currents to the tagged E-PFE site, and consequently all PVCs were eliminated. Additionally, we delivered radiofrequency energy at and around the E-PFE site along the scar border zone for a VF substrate modification. After the session, no further PVCs or VF occurred during 6 months of follow-up.

KEYWORDS Purkinje potential; Ventricular fibrillation; Premature ventricular contraction; Catheter ablation (Heart Rhythm Case Reports 2017;3:255–258)

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Discussion

We here report a case of Purkinje-related PVCs/VF after a recent myocardial infarction successfully treated with catheter ablation guided by mapping using a PentaRay catheter.

KEY TEACHING POINTS

- In order to treat Purkinje-related ventricular arrhythmias by catheter ablation therapy, it is important to map Purkinje potentials (PPs) precisely and detect the critical site.
- Discrete PPs and earliest Purkinje fiber excitation potentials during premature ventricular contraction that could not be recorded by a large-tip mapping and ablation catheter were reproducibly recorded using a PentaRay catheter.
- The PentaRay catheter is useful and sometimes essential for mapping and ablation of ventricular arrhythmias originating from the network of Purkinje fibers.

All VF-triggering PVCs had relatively long coupling interval of 398–407 ms, suggesting that PVCs appeared due to triggered activity with delayed afterdepolarizations from Purkinje fiber networks. Haissaguerre and colleagues^{2,3} first reported the effectiveness of catheter ablation therapy for idiopathic VF by eliminating trigger PVCs. It is well accepted that ablating the earliest ventricular activation site is of little value and it is essential to detect and target the E-PFE site by mapping the PPs precisely and broadly.^{4,5} However, this therapeutic approach is sometimes difficult using a large-tip ablation or mapping catheter. The advantages of using a PentaRay catheter in this case were considered to be as follows: First, the 20 electrodes along the 5 radiating splines quickly enabled a broad and precise PP mapping. Second, the 3F, 1-mm-tip and 2-mm center-to-center-spaced electrodes allowed recording fine potentials that might have been missed with larger electrodes.⁶ Third, the fine and flexible 5 radiating splines with electrodes facilitated better mapping along the trabeculations of the ventricles and the network of Purkinje fibers than with linear larger-tip mapping and ablation catheters.

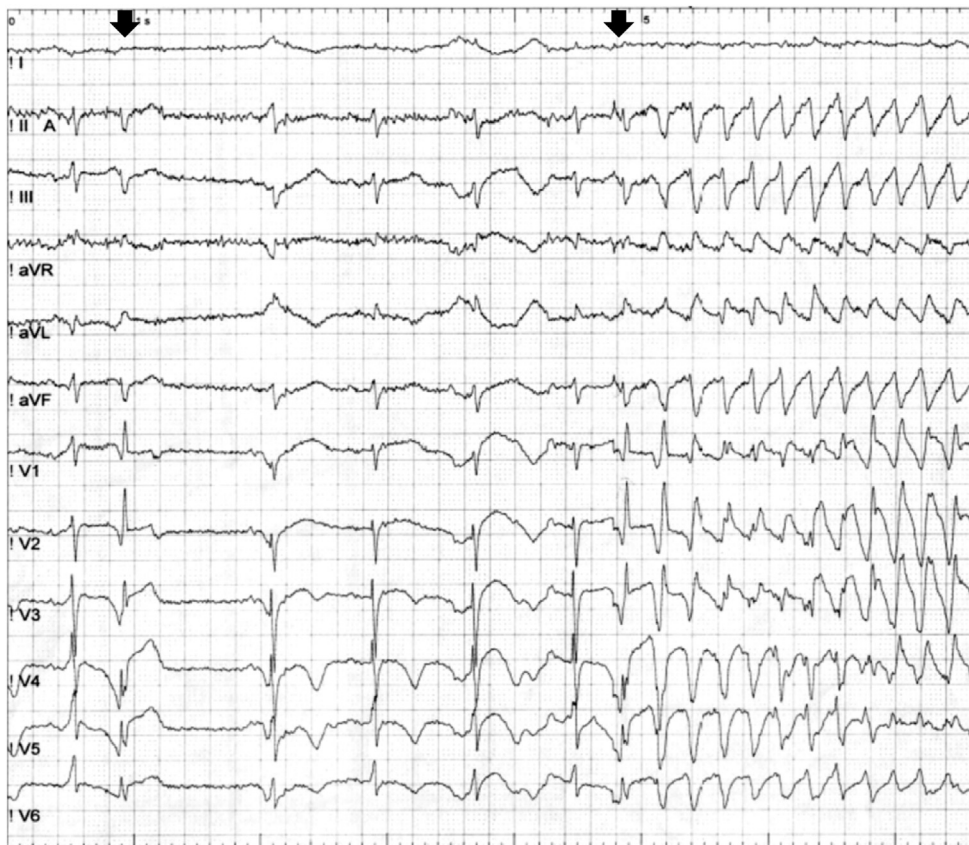


Figure 1 A 12-lead electrocardiogram showing a premature ventricular contraction (*black arrow*) and triggered ventricular fibrillation.

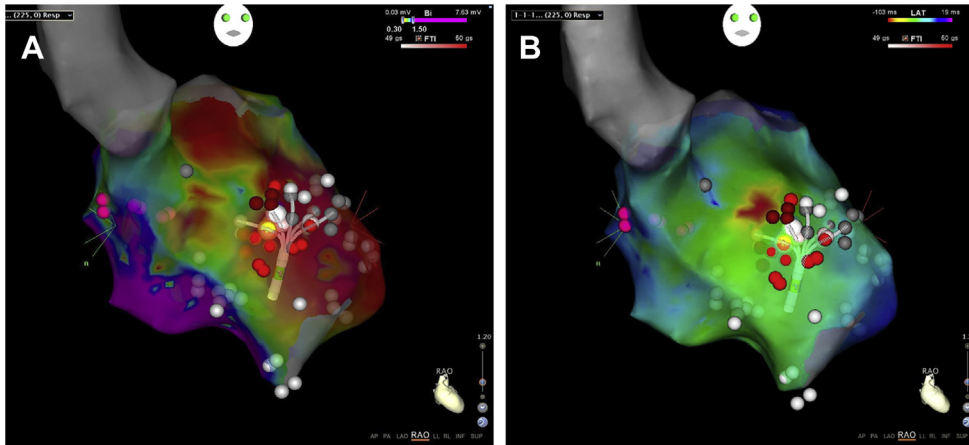


Figure 2 **A:** Right anterior oblique (RAO) view of a voltage map during sinus beats showing a scar ($<0.3\text{ mV}$) and low-voltage area ($<1.5\text{ mV}$) in the anterior wall of the left ventricle. The light gray dots indicate the sites where Purkinje potentials (PPs) were recorded during sinus beats. The purple dots indicate the His-bundle site. **B:** RAO view of ventricular muscle activation map during the trigger premature ventricular contraction. The gray dots indicate the sites where the PPs were recorded during premature ventricular contraction. The larger yellow dot indicates the earliest Purkinje fiber excitation (E-PFE) site during the premature ventricular contraction, and the neighboring white dot indicates the E-PFE site during a sinus beat. The E-PFE site was determined to be located relatively remote from the suspected breakout site to ventricular muscle.

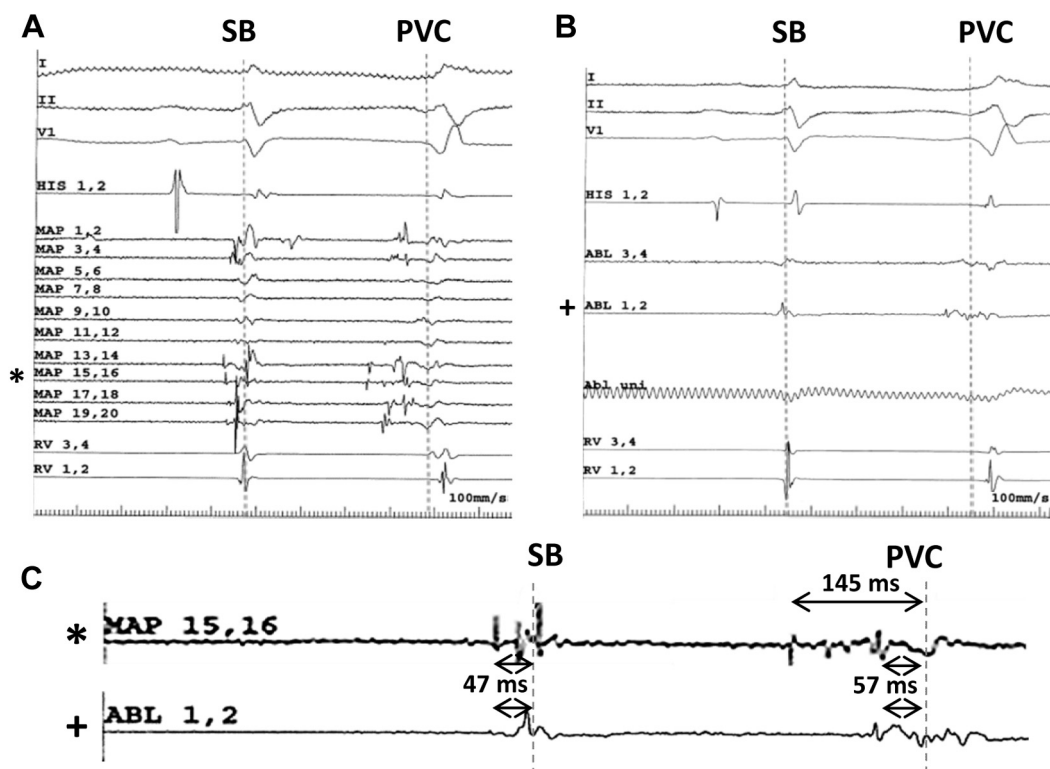


Figure 3 Intracardiac electrograms during the trigger premature ventricular contraction (PVC) and sinus beat (SB). **A:** Intracardiac electrograms recorded with a PentaRay catheter (MAP 1–20). The earliest Purkinje fiber excitation (E-PFE) site was located at MAP 15,16 (asterisk). Multiple discrete potentials preceding the ventricular potential were observed at MAP 15,16 and the adjacent electrodes, suggesting the initial preferential conduction was within the Purkinje network. **B:** Intracardiac electrograms recorded with a Thermocool SmartTouch catheter (ABL1–4) located at the E-PFE site (cross). **C:** Magnification of the comparison of the local electrograms at the E-PFE site. During the sinus beats, the PentaRay (asterisk) recorded discrete Purkinje potentials (PPs) while the Thermocool Smart-Touch (cross) recorded only tiny PPs preceding the QRS onset by 47 ms. During the premature ventricular contraction, a potential preceding the QRS onset by 57 ms was recorded by both the PentaRay and Thermocool catheters; however, only the PentaRay catheter detected an E-PFE potential preceding the QRS onset by 145 ms, and multiple PPs around the E-PFE sites.

Conclusion

As demonstrated in this report, the PentaRay catheter easily and reproducibly detected discrete PPs and E-PFE potentials that could not be recorded by a linear 7F mapping and ablation catheter. Therefore, the PentaRay catheter is expected to be useful and sometimes essential, especially for mapping and ablation of ventricular arrhythmias, which requires precise mapping of the LV endocardial trabeculations and the Purkinje fiber network.

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