

Recurrent polymorphic ventricular tachycardia initiated by Purkinje ectopy in a patient with cardiac sarcoidosis



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Introduction

Cardiac sarcoidosis (CS) is a granulomatous inflammatory disease known to be associated with increased risk of ventricular arrhythmias (VA) and sudden death (SD).¹ The dominant mechanism of VA in CS is thought to be scar-related reentry, which typically manifests as monomorphic ventricular tachycardia (VT).² Polymorphic VT (PVT) or ventricular fibrillation (VF) triggered by Purkinje premature ventricular contractions (PVCs) has been reported in patients with no apparent structural heart disease as well as in various cardiac pathologies.³ Although Purkinje-related mechanism of monomorphic VT has been previously documented in CS,⁴ no reports have implicated CS in Purkinje PVC-triggered PVT/VF.

We report a case of a patient with CS who presented with SD and VA mimicking “idiopathic” PVT/VF triggered by Purkinje PVCs.

Case report

The patient is a 58-year-old woman with a past medical history significant for hypothyroidism and alpha-1 antitrypsin deficiency who presented to our hospital following an episode of cardiac arrest. She had suddenly collapsed at home and was found to be in VF on arrival by emergency personnel. There were no antecedent symptoms or significant cardiac history prior to the event. On admission, the patient had multiple monitored episodes of PVT/VF that were triggered by narrow complex PVCs of right bundle branch block/superior axis morphology and with variable coupling intervals (Figure 1A and B). Otherwise, her 12-lead electrocardiogram (ECG) was normal (Figure 1B). An echocardiogram revealed no structural heart abnormalities and normal left ventricular (LV) systolic function. Her coronary angiogram showed normal coronaries. A chest radiograph was unremarkable. Cardiac magnetic

KEY TEACHING POINTS

- Cardiac sarcoidosis (CS) is known to be associated with increased risk of ventricular arrhythmias (VA) and sudden death, even in patients with preserved cardiac systolic function. Cardiac magnetic resonance (CMR) plays an important diagnostic and prognostic role in CS, whereas endomyocardial biopsy has limited diagnostic yield.
- The most common mechanism of VA in CS is believed to be intramyocardial scar-related reentry, which typically manifests as monomorphic ventricular tachycardia (VT).
- Polymorphic VT/ventricular fibrillation (VF) triggered by ventricular ectopy originating from the Purkinje tissue has been reported in patients with no apparent structural heart disease as well as in various cardiac pathologies. Our report suggests that CS can be a potential underlying etiology in patients presenting with this type of arrhythmia.
- Our report emphasizes the critical importance of CMR for the evaluation of apparently idiopathic polymorphic VT/VF. The presence of late gadolinium enhancement and abnormal myocardial perfusion areas that do not follow a coronary artery distribution should raise suspicion of CS.

resonance (CMR) demonstrated normal-sized right and left ventricles with normal global systolic function and hypokinetic anterior septum. There were resting myocardial perfusion abnormalities affecting epicardial basal anterior septum, subendocardial basal inferior septum, and basal-to-mid anterior and anterolateral wall (Figure 2A and B), as well as late gadolinium enhancement (LGE) of the basal-to-mid anterior septum (Figure 2C and D). These findings raised

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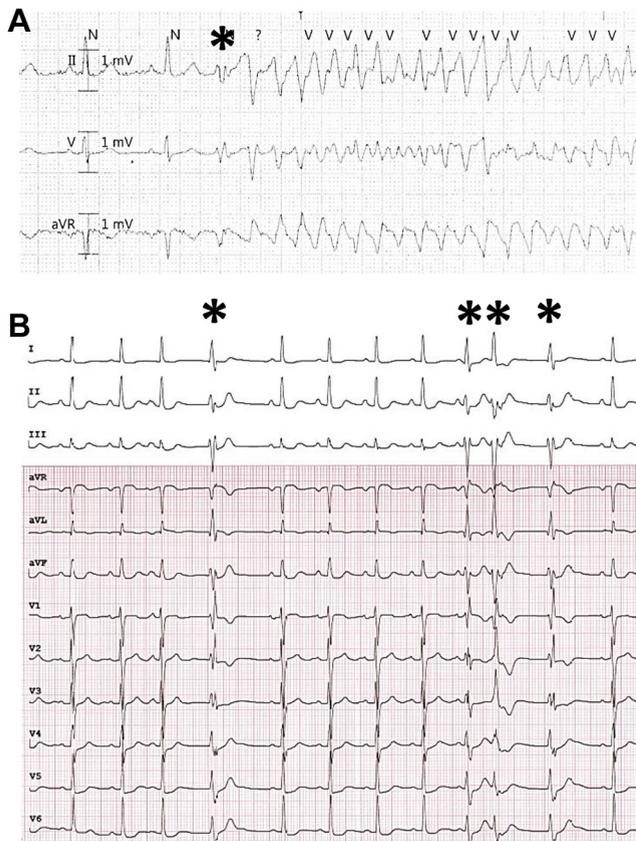


Figure 1 A: Telemetry tracing shows an episode of sustained polymorphic ventricular tachycardia triggered by a narrow complex premature ventricular contraction (PVC) (asterisk). B: Twelve-lead electrocardiogram shows frequent narrow complex PVCs (asterisks) of right bundle branch/superior axis morphology with variable coupling intervals and some alterations in the QRS morphology.

suspicion for CS. However, right ventricular septal endomyocardial biopsy (EMB) targeting an area labeled as abnormal on CMR was unrevealing. Because of recurrent drug-refractory PVT/VF requiring repeat defibrillation, she underwent urgent ablation. Activation mapping of triggering PVCs showed the earliest endocardial activation site in the basal mid posterior septum of the LV corresponding to the area of LGE on CMR (Figure 3A). At this site, PVCs and sinus beats were preceded by characteristic high-frequency presystolic Purkinje potentials with variable Purkinje-to-ventricle conduction times during PVCs (Figure 3B). Ablation guided by the Purkinje potentials abolished the culprit PVCs. Additional ablation was performed at the adjacent sites targeting Purkinje potentials in sinus rhythm. The patient underwent implantable cardioverter-defibrillator placement. A chest computed tomogram (CT) revealed multiple scattered bilateral lung nodules and mediastinal lymphadenopathy, while guided carinal lymph node biopsy was positive for noncaseating granulomas consistent with sarcoidosis. She was subsequently started on methotrexate and steroids. ^{18}F -fluorodeoxyglucose (^{18}F -FDG)-positron emission tomography (PET/CT) performed 4 months later showed a small solitary area of ^{18}F -FDG uptake in the basal portion of the septum corresponding to the abnormal LGE-CMR findings.

No further VA recurrences have been documented over the ensuing 12 months.

Discussion

In this report, we describe a patient with CS first presenting as aborted SD and recurrent episodes of Purkinje PVC-triggered PVT/VF.

The diagnosis of CS is commonly elusive. Definitive diagnosis of CS requires histologic documentation of noncaseating granulomatous inflammation of the myocardium. However, the diagnostic yield of EMB is low because of a typically patchy and commonly mid-myocardial/epicardial cardiac involvement pattern. Thus, the involved regions are frequently inaccessible with the conventional right-sided EMB approach. An alternative, clinical pathway, endorsed by the 2014 Heart Rhythm Society Expert Consensus Statement on the Diagnosis and Management of Arrhythmias Associated With Cardiac Sarcoidosis, requires histologic evidence of extracardiac sarcoidosis and 1 or more clinical cardiac manifestations consistent with CS.⁵ In our patient, the constellation of findings including mediastinal lymph node biopsy positive for noncaseating granulomas and a characteristic LGE pattern on CMR met the proposed clinical criteria for the diagnosis of CS.

This case emphasizes some critical issues related to the diagnosis and management of patients with CS. First, cardiac involvement can pose an increased risk of VA and SD even in patients with preserved global LV and right ventricular systolic function. Second, CS can present without evident extracardiac clinical manifestations. Finally, CMR plays an important diagnostic and prognostic role in CS.^{5,6} In our patient, the diagnosis would have been missed without CMR. On initial cardiac evaluation, there was no apparent clinical or laboratory evidence to suggest CS or some other cardiac pathology. In a recent study by Kouranos and colleagues,⁶ LGE-CMR showed superior sensitivity for determining cardiac involvement in patients with extracardiac sarcoidosis as compared to ECG and echocardiogram.⁶ Furthermore, growing evidence suggests that the presence of LGE on CMR is an important prognostic indicator of increased risk of VA and death in patients with CS.⁶⁻⁹

An interesting CMR finding in our patient was the presence of myocardial segments with resting perfusion abnormalities but without evidence of LGE. This finding has not been previously reported in patients with CS. Such regions of hypoperfusion may indicate myocardial involvement extending beyond the areas identified by LGE. Myocardial perfusion sequences are currently not performed routinely in patients undergoing CMR for the evaluation of CS. Whether hypoperfusion carries the same prognostic value as LGE in CS is unclear. Nevertheless, our findings suggest that myocardial perfusion sequences should be considered as a part of the CMR protocol evaluating for CS and resting perfusion abnormalities not following a coronary artery distribution should raise suspicion of CS.

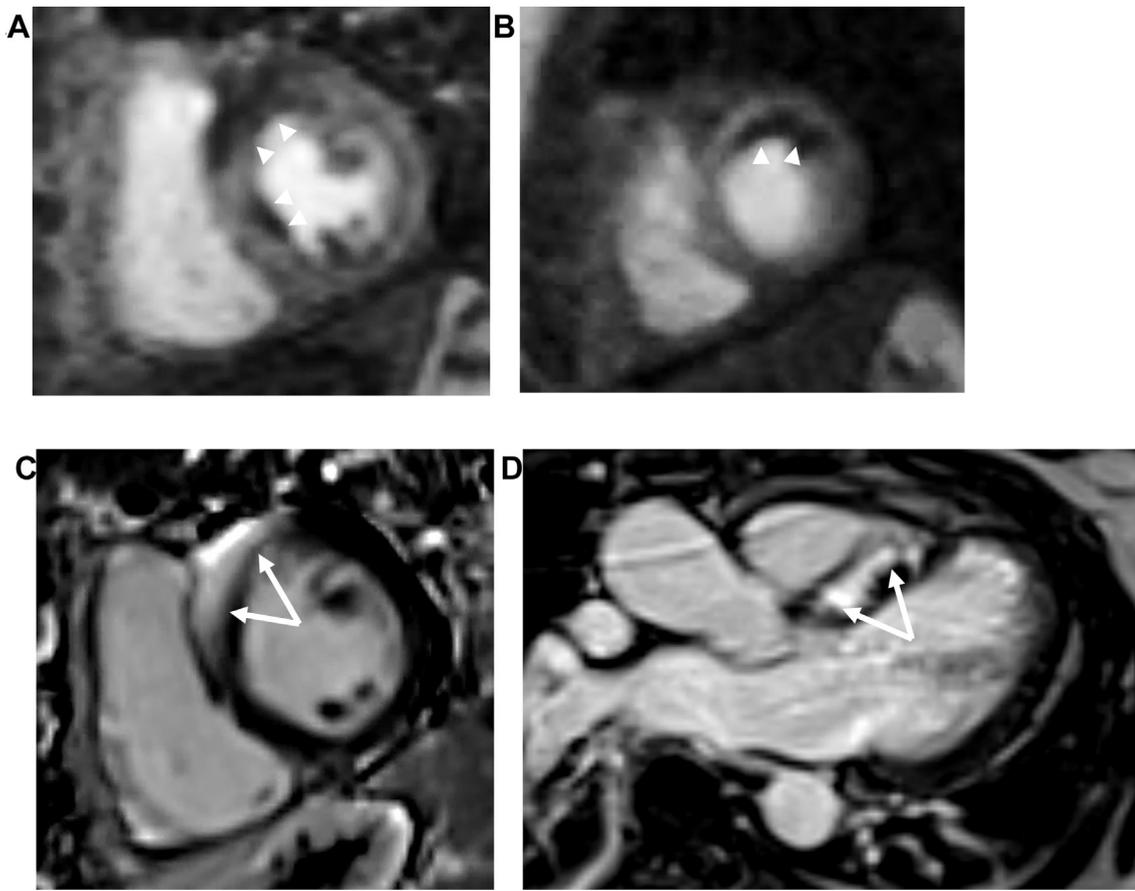


Figure 2 Cardiac magnetic resonance images. **A, B:** Short-axis slices show resting myocardial perfusion abnormalities involving epicardial basal anterior septum, subendocardial inferior septum, and subendocardial anterior wall (*arrowheads*). **C, D:** Delayed enhancement sequences show an extensive area of late gadolinium enhancement with the spared endocardial borders involving basal and mid segments of the interventricular septum (*arrows*).

¹⁸F-FDG PET/CT is another imaging modality primarily used as an adjunct to CMR for assessing the presence and severity of active myocardial inflammation in CS.¹⁰ Combining ¹⁸F-FDG-PET and CMR has been shown to provide complementary diagnostic and prognostic information.¹¹

Serial assessment of inflammatory myocardial burden using ¹⁸F-FDG PET in patients with CS is often used for guiding immunosuppressive therapy and monitoring response to treatment. However, data to support ¹⁸F-FDG PET-guided management strategy are limited.¹⁰ The benefit of

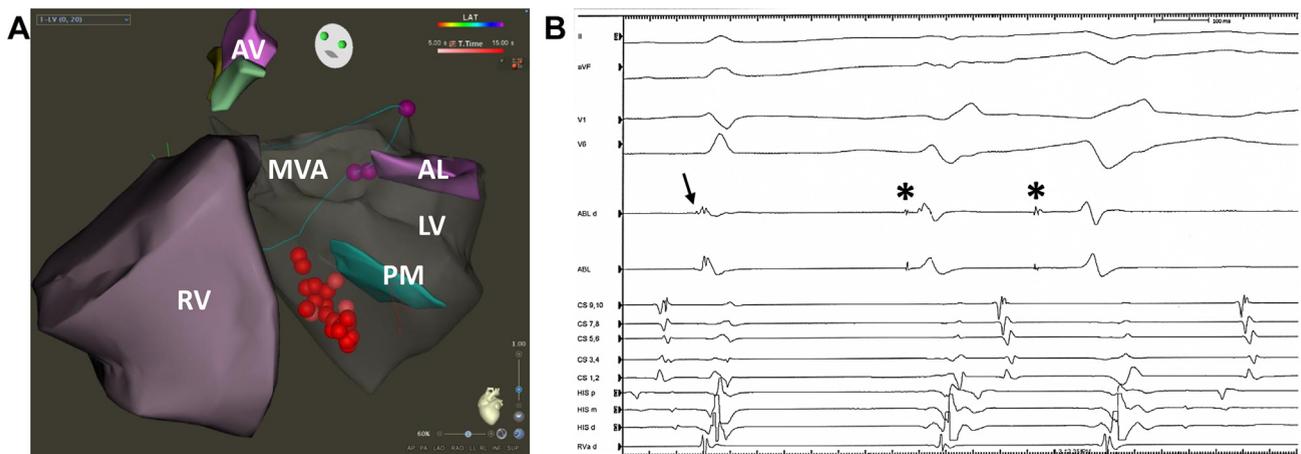


Figure 3 **A:** Ultrasound-based (CARTO-Sound, Biosense Webster, Irvine, CA) geometries of the left (LV) and right (RV) ventricles. Red spheres represent ablation lesions in the basal-mid LV septum. **B:** Surface electrocardiogram (ECG) leads II, aVF, V₁, and V₆ and endocardial electrograms from the ablation (ABL), coronary sinus (CS), His, and right ventricular (RVA) catheters. A sinus beat followed by 2 premature ventricular contractions (PVCs). Note high-frequency Purkinje potentials that precede the sinus beat (*arrow*) and PVCs (*asterisks*) with variable Purkinje-to-ventricle conduction times during PVCs. The latter may indicate different exit sites and can potentially explain variable coupling intervals as well as some alterations in the PVC QRS morphology noted on the surface ECG (*Figure 1B*). AL = anterolateral papillary muscle; AV = aortic valve; MVA = mitral valve annulus; PM = posteromedial papillary muscle.

immunosuppressive therapy for the treatment of VA in CS remains debatable.¹ In this regard, some evidence suggests that ¹⁸F-FDG PET may aid in the selection of appropriate candidates.¹² We were unable to test the response of the arrhythmia to immunosuppression in our patient because the ablation procedure had to be performed urgently.

PVT/VF triggered by PVCs originating from Purkinje tissue was initially described in patients with no apparent structural heart disease as a variant of idiopathic VF.^{13,14} The exact electrophysiological mechanism of this VA is not completely understood. It has been postulated that triggered activity (early or delayed afterdepolarizations) and/or microreentry in the Purkinje tissue can be potential electrophysiological mechanisms of the arrhythmia in these patients. It is important to note that no CMR or autopsy data were reported in the initial idiopathic PVT/VF series. Subsequent reports have also described Purkinje PVC triggers initiating PVT/VF in a number of different cardiac pathologies.³ To the best of our knowledge, this is the first report implicating CS in this type of VA. The most common mechanism of VA in CS is believed to be intramyocardial scar-related reentry, which typically manifests as monomorphic VT.² The finding that the culprit PVCs originated in the basal mid-septal region corresponding to the abnormal myocardial substrate on CMR strongly suggests a causative link between CS and the arrhythmia (Figures 2 and 3A). The underlying arrhythmogenic substrate is unclear and could be related to scar/fibrosis and/or active myocardial inflammation.

Notably, a characteristic high-frequency Purkinje potential preceded PVCs and sinus beats with variable Purkinje-to-ventricle conduction times during PVCs, suggesting different exit sites (Figure 3B). The latter finding can potentially explain variable coupling intervals and some alterations in the PVC QRS morphology noted on the 12-lead ECG (Figure 1B).

Antiarrhythmic medications are frequently ineffective in this type of arrhythmia. It has been shown that ablation of the initiating PVCs is highly effective in preventing recurrent arrhythmia.^{13–15} Similar to our case, ablation is usually guided by characteristic Purkinje potentials. An implantable cardioverter-defibrillator is usually indicated to

prevent SD regardless of underlying cardiac pathology, since data on the long-term outcome of ablation are limited.¹⁵

Conclusion

Our case suggests that CS can be a potential underlying etiology of PVT/VF triggered by Purkinje PVCs. CMR evaluation should be considered in all patients presenting with this type of arrhythmia.

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