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CASE REPORT
Cardiac imaging

Cardiac sarcoidosis masquerading as arrhythmogenic right ventricular cardiomyopathy: a case report

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Background Cardiac sarcoidosis (CS) and arrhythmogenic right ventricular cardiomyopathy (ARVC) are rare causes of ventricular arrhythmias and are associated with sudden cardiac death. Differentiation between both is important for proper management.

Case summary We present a 56-year-old man with sudden cardiac arrest and was diagnosed to have ARVC based on cardiac magnetic resonance imaging (MRI). He developed gradually worsening shortness of breath over the next 1 year. CS was unmasked after a cardiac positron emission tomography (PET). Patient was treated with methotrexate. A repeat cardiac PET scan showed improvement.

Discussion The distinction between ARVC and CS is challenging. Both these entities have a patchy involvement and can have similar presentations. ARVC has a predominant right heart involvement. It is diagnosed with the help of an MRI, which shows regional right ventricular wall motion abnormality. These findings can have an overlap with CS. It is important to note that, even though sarcoidosis is a pathologic diagnosis, cardiac biopsy is rarely done owing to its patchy involvement. Cardiac PET scan has a high sensitivity and specificity to diagnose this entity. Once diagnosis is made, patients should be treated with immunosuppressants and should be closely followed. Repeat imaging should be considered at intervals to monitor disease progression. This case highlights the importance of multimodality imaging and tissue diagnosis to unmask the diagnosis of CS, a treatable infiltrative disorder which shares features with a potentially untreatable ARVC.

Keywords Sarcoidosis • Ventricular arrhythmias • Positron emission tomography • Epsilon waves • Implantable cardioverter-defibrillator • Case report

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Learning points

- Diagnosing cardiac sarcoidosis (CS) early in the course of the disease is very difficult as it has varied presentations including ventricular arrhythmias, heart blocks, and cardiomyopathy.
- The distinction between arrhythmogenic right ventricular cardiomyopathy (ARVC) and CS is challenging, as both diseases may manifest with sudden onset ventricular arrhythmias.
- Multimodality imaging including cardiac magnetic resonance imaging and positron emission tomography scan along with tissue biopsies of the involved organs can help distinguish ARVC from CS.

Introduction

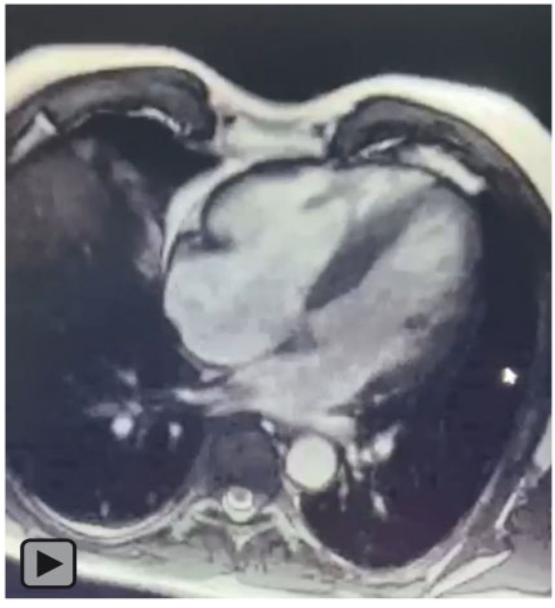
Sarcoidosis is a systemic disease resulting from abnormal autoimmune response and is rarely restricted to the heart.[1] Cardiac sarcoidosis (CS) and arrhythmogenic right ventricular cardiomyopathy (ARVC) are rare causes of ventricular arrhythmias and are associated with sudden cardiac death (SCD). SCD is the presenting manifestation in upto 14% CS cases[2] and 23% of ARVC cases.[3] Even though both these entities are very distinct from each other, multimodality approach is needed to differentiate and arrive at a specific diagnosis.

Timeline

Day 1	• A 57-year-old male patient presents after ventricular fibrillation cardiac arrest. Electrocardiogram showed epsilon waves. Intubated and admitted to intensive care unit due for airway protection. • Coronary angiography: unremarkable
Day 2	• Intermittent bradycardia and complete heart block on telemetry • Extubated
Day 3	• Cardiac magnetic resonance imaging showed features suggestive of arrhythmogenic right ventricular cardiomyopathy • Started on Sotalol
Days 4–5	Implantable cardioverter-defibrillator placed and discharged home
1 year later	• Cardiac positron emission tomography (PET) suggestive of sarcoidosis • Lymph node biopsy granuloma • Treatment started with methotrexate
2 years later	Follow-up PET scan showed improvement

Case presentation

A 56-year-old Caucasian male was found unresponsive while going for an outdoor run. On emergency medical service arrival, he was found to be in ventricular fibrillation. He was DC cardioverted into sinus rhythm in the field and was admitted to the hospital. He was a non-smoker, without any significant medical disorders and he did not have any family history of cardiac diseases including early onset heart failure, coronary artery diseases, or SCDs. At admission, his blood pressure was 130/90 mmHg, cardiac auscultation revealed normal S1 and S2 without any murmurs. The patient was having agonal respirations and was intubated for airway protection. Electrocardiography (ECG) showed 1st degree heart block with epsilon waves in v1–v3 leads (*Figure 1*) and heart rate of 96 beats/minute. Two-dimensional transthoracic echocardiography showed normal left and right ventricular (RV) function, mildly dilated right ventricle, and concentric left ventricular hypertrophy. Left heart catheterization was unremarkable. A computed tomography (CT) imaging of the chest was obtained which did not reveal any pulmonary embolism or lymph node enlargement. He did not require any ionotropes and was extubated on the second day as his mentation improved significantly. During the hospital stay, intermittent bradycardia and complete heart block were observed. Cardiac magnetic resonance imaging (MRI) revealed late gadolinium enhancement in the RV free wall as well as septum (*Figure 2*, Supplementary material online, *Figure S1*). There was



Video 1 This shows dyskinetic right ventricular inferior wall and right anterolateral free, with right ventricular ejection fraction of 31%.

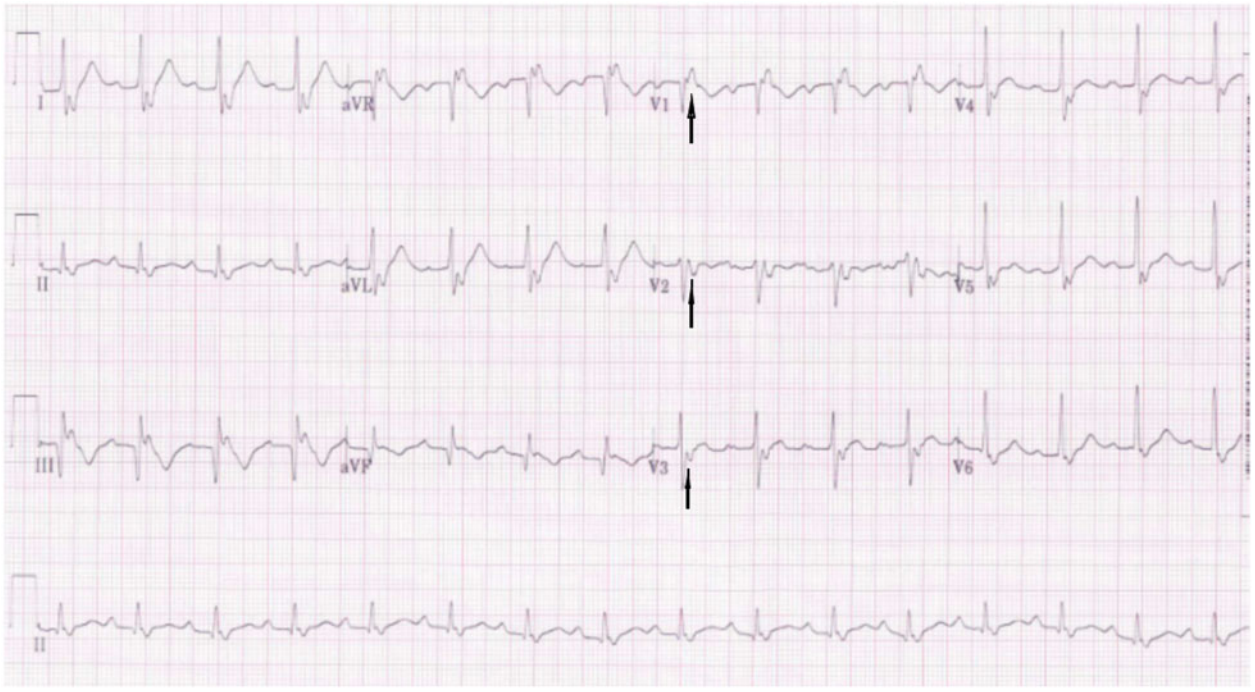


Figure 1 Electrocardiogram showing Epsilon waves in v1, v2, and v3.

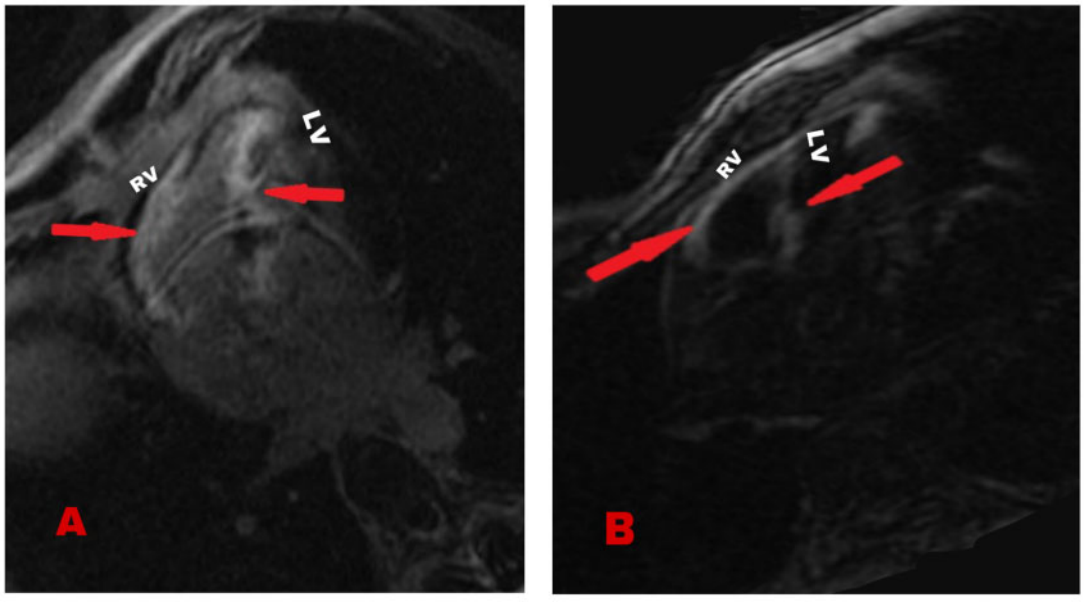


Figure 2 Cardiac magnetic resonance imaging. (*A*) Four-chamber view and (*B*) three-chamber view show late gadolinium enhancement in the right ventricular free wall as well as septum. LV, left ventricle; RV, right ventricle.

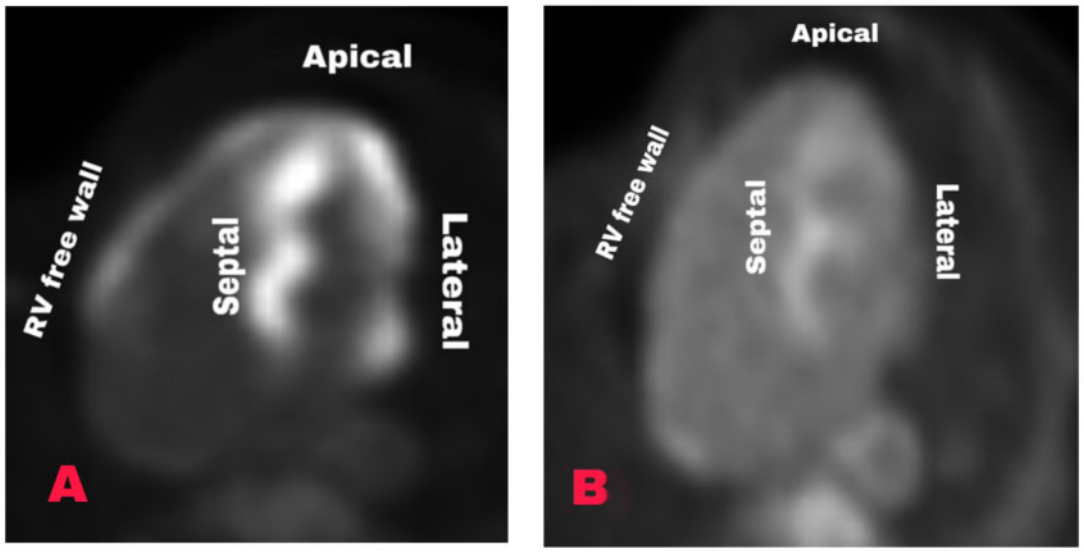


Figure 3 Cardiac positron emission tomography scan horizontal long axis. (*A*) At the time of diagnosis shows enhancement of the left ventricular lateral wall, septum, apex, and right ventricular free wall. (*B*) After 1 year of treatment shows decreased inflammation.

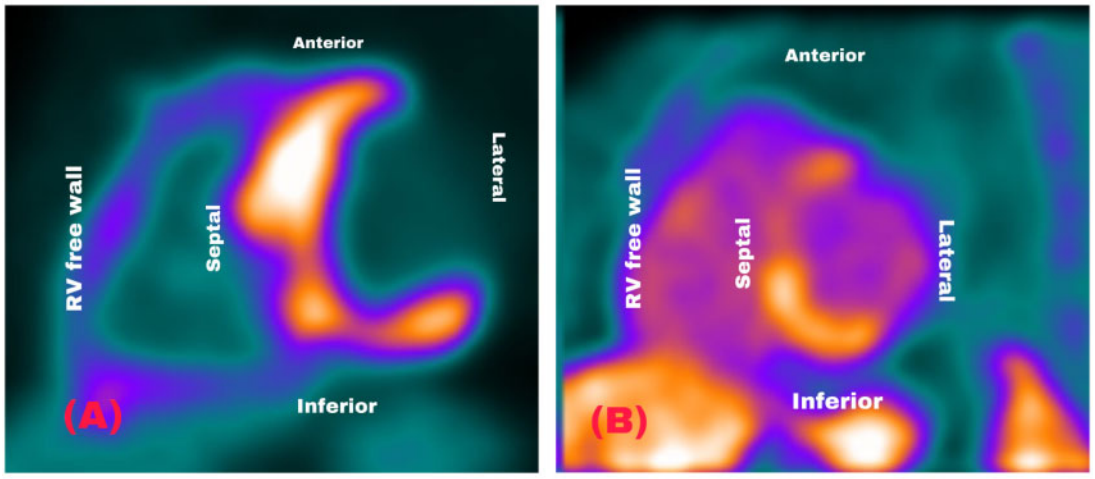


Figure 4 Cardiac positron emission tomography scan short axis. (*A*) At the time of diagnosis shows enhancement of the anterior, inferior left ventricular walls, and septum. (*B*) After 1 year of treatment shows decreased inflammation.

inferoseptal and inferior wall delayed myocardial enhancement of the left ventricle which. The RV inferior wall and right anterolateral free wall were dyskinetic with RV ejection fraction of 31% (*Video 1*). The RV end-diastolic volume (RVEDV) was noted to be 222 mL and the RVEDV to body surface area ratio was 113 mL/m^2. Diagnosis of ARVC was made, an implantable cardioverter-defibrillator (ICD)[4] was placed and he was discharged home with sotalol (80 mg twice daily). Genetic testing was negative. At 6-month follow-up visit, his device interrogation showed 13% atrial fibrillation burden, however with CHA_2DS_2-Vasc score of 0, he was not anticoagulated. He developed progressive dyspnoea on exertion and decreased exercise capacity over a period of 1 year. A chest radiograph done at this time showed a small smoothly marginated opacity within the left upper lung zone. Due to the worsening symptoms and signs, alternative diagnoses including CS were considered and hence a cardiac positron emission tomography (PET) scan was obtained which showed marked active inflammation of the right ventricle, septum, inferior, apical, and anterior walls (*Figures 3A* and *4A*). Hilar lymphadenopathy was also noted. Biopsy of the lymph node showed non-necrotizing

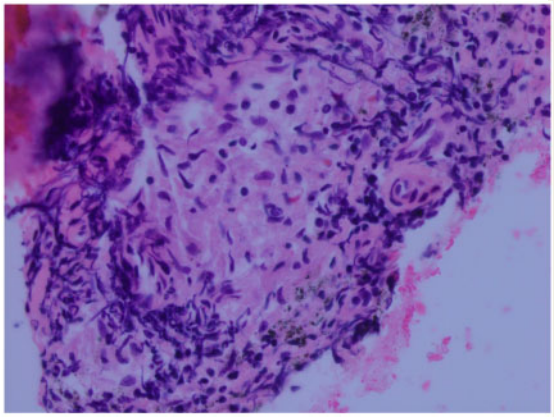


Figure 5 Lymph-node biopsy: non-caseating granuloma.

granulomas and diagnosis of sarcoidosis was made (*Figure 5*). He was treated with methotrexate (20 mg/week) with significant symptom improvement. Follow-up PET scan after 1 year showed good response to therapy (*Figures 3B* and *4B*).

Discussion

The distinction between ARVC and CS is challenging, as both diseases may manifest with sudden onset ventricular arrhythmias. ARVC is an inherited cardiomyopathy where patchy RV scarring is noted owing to fibrous/fatty replacement of the heart muscle.[5] Studies from early 2000 by Corrado *et al.*[6] showed that this condition is found in up to 20% of young adults who have SCD and it has a 1 in 5000 prevalence in general adult population. Autosomal dominant inheritance is the most common form and is secondary to mutations in desmosomal proteins. Patients typically present with symptoms related to ventricular arrhythmias such as palpitations, syncope, or cardiac arrest. Symptoms of right heart failure are less common. Left heart involvement is very rare and can be confused as viral cardiomyopathy.[7] The most common arrhythmia is a ventricular tachycardia of RV origin. Epsilon wave, which is a small positive deflection at the end of QRS complex, can be seen in up to 30% of patients with ARVC. Our patient fulfilled the 2010 revised Task Force criteria for ARVC with two positive major criteria including MRI evidence of RV dyskinesia with <40% ejection fraction and presence of Epsilon waves on ECG.[8] To date, there is no specific ARVC targeting treatment other than antiarrhythmic agents and ICD.[4] ARVC should be differentiated from other conditions presenting with either similar clinical features, EKG findings, and/or imaging features like Brugada syndrome, RV outflow tract tachycardia, and CS.

Sarcoidosis is a multisystem granulomatous disease due to activation in the inflammatory cascade. Okada *et al.* found that the rate of isolated CS without involvement of other organs is up to 25% among.[9] Due to the fact that the lung is generally affected in sarcoidosis, it is important that radiologists are aware of atypical disease patterns, in order to interpret these accurately and effectively. Even though MRI is as affective as a CT scan in identifying lymph nodes, special focus is needed while performing cardiac MRI.

CS has varied presentations including arrhythmias (30%), heart block (up to 44%), SCD (up to 14%), and cardiomyopathy depending on location of involvement in the heart.[10] CS is classically a pathologic diagnosis, but in clinical practice endomyocardial biopsies are unreliable owing to its patchy involvement. Cardiac PET has been shown to have pooled sensitivity and specificity of 89% and 78%, respectively and is the preferred imaging modality of choice for diagnosis and treatment monitoring.[11] Our patient had a lymph node biopsy proven granuloma and hence fulfilled the Heart Rhythm Society expert consensus for diagnosing CS.[12] Treatment with high-dose steroids initially and adding or switching to steroid sparing agents like methotrexate depending on the severity of the CS is recommended. In the current case, improvement of inflammation on PET image post-treatment confirmed that the initial findings on MRI were due to CS and not due to ARVC.

Conclusion

This case highlights the importance of multimodality imaging and tissue diagnosis to unmask the diagnosis of CS, a treatable infiltrative disorder which shares features with a potentially untreatable ARVC.

Lead author biography

Dr Vishal Parikh is currently an Advanced Heart Failure physician with Rochester Regional Health in New York. Areas of interest include mechanical circulatory support, transplant, pulmonary hypertension, amyloidosis, sarcoidosis, and exercise haemodynamics. They have trained all over the USA. They started from medical school at University of Missouri-Columbia to residency at Cedars Sinai in LA to Tampa General Hospital/USF for cardiology fellowship and lastly at Texas Heart Institute/Baylor for heart failure fellowship. Outside of medicine, They have interests in travelling, sports, and trying new food experiences.

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 authors have obtained verbal consent from the patient for submission and publication of this case report including images and associated text as per hospital policy (due to COVID-19, all the necessary consents are being obtained verbally).

Conflict of interest: None declared.

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