Ventricular Tachycardia in Cardiac Sarcoidosis Controlled by Radiofrequency Catheter Ablation

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Abstract

We report a case of a 78-year-old woman with cardiac sarcoidosis with a history of syncope and palpitation. Further assessment with echocardiography, gadolinium-enhanced cardiovascular magnetic resonance (CMR) and histology led to a diagnosis of cardiac sarcoidosis. As the patient suffered from ventricular tachycardia (VT) despite active corticosteroid therapy, an implantable cardioverter-defibrillator (ICD) was positioned. She was also administered a beta blocker, but an electrical storm appeared every several days requiring ICD therapy. The drug-refractory VT was finally controlled with a catheter ablation session, during which we could detect the VT focus in the right ventricular outflow tract next to the aneurysm by using an electroanatomic mapping system (CARTO). Referring to echocardiographic and CMR images proved very useful in detecting the aneurysm using the CARTO system.

Key words: ventricular tachycardia, cardiac sarcoidosis, catheter ablation, implantable cardioverter-defibrillator

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Introduction

Sarcoidosis is a systemic inflammatory granulomatous disease that may involve multiple organs. Though sarcoidosis has been recognized for over 100 years, since Jonathan Hutchinson first described cutaneous sarcoid lesions in 1869, its cause is still unknown. Histologically, the epithelioid cell granulomas without caseous necrosis are formed in various organs such as the lungs, lymph nodes, skin, eyes, heart, and muscles. Cardiac involvement in sarcoidosis was not recognized for 60 years. Autopsy cases have revealed that up to 40% of patients with sarcoidosis have extensive infiltration of the myocardium and pericardium by sarcoid, and its clinical presentation includes conduction disturbances and arrhythmias, congestive heart failure, mitral insufficiency, myocardial infarction, recurring pericardial effusion and sudden death. However, cardiac sarcoidosis has been clinically reported in only 10% of all sarcoidosis patients. Considering the adverse prognosis of cardiac sarcoidosis, early diagnosis is important to improve patient outcomes. Reported here is a case of cardiac sarcoidosis in an elderly woman who suffered from severe ventricular arrhythmias.

Case Report

A 78-year-old woman presented to our hospital with a complaint of recurrent syncopal episodes. She had a history of chronic bronchitis and had received outpatient treatment at a nearby clinic for years. She had neither coronary risk factors nor a family history of cardiac diseases. Two years prior to presentation, she experienced loss of consciousness for the first time. An initial electrocardiogram at a nearby hospital revealed complete right bundle branch block and left anterior fascicular block, but neither ischemic ST-T changes nor critical arrhythmias were observed (Fig. 1A). Chest X-ray showed a small bilateral pleural effusion. She also complained of myalgia that continued for months, and
Figure 1. (A) A twelve-lead electrocardiogram on admission showed sinus tachycardia and mild left atrial overloading in addition to the known bifascicular bundle branch block. (B) A twelve-lead Holter electrocardiogram showed clinical ventricular tachycardia (VT) with a left bundle branch block pattern and inferior axis. (C) A twelve-lead electrocardiogram during induced VT showed the same morphology as the clinical VT. (D) Pacing at the earliest activation site of the induced VT perfectly matched the clinical VT morphology.

Her serum creatine phosphokinase (CK) was significantly elevated to as high as 6,035 IU/L. As elevated serum CK is a potential side effect of medications for chronic bronchitis, these were all discontinued, but serum CK concentrations remained high. The patient was then transferred to another hospital and underwent cardiac catheterisation. Cardiac angiography showed no evidence of occlusion or significant stenosis of the coronary arteries, and myocardial biopsy revealed mild myocardial degeneration and mild infiltration of inflammatory cells but no disease-specific findings. Based on these results her diagnosis was uncertain and she was therefore treated conservatively as having chronic heart failure. However, she again felt faintness and presented to our hospital.

Physical examination was not significant except for a systolic regurgitant murmur at the base, and electrocardiogram revealed sinus tachycardia and mild left atrial overloading in addition to the known bifascicular bundle branch block. Chest X-ray showed a small bilateral pleural effusion without pulmonary congestion. Hematology and blood chemistry profiles showed abnormally high values: CK of 164 IU/L, CK-MB of 16 IU/L, brain natriuretic peptide of 282.9 pg/mL, and angiotensin-converting enzyme of 46.6 U/L. Thyroid function was within the normal range. She was diagnosed with congestive heart failure and admitted to our hospital. Transthoracic echocardiogram revealed basal thinning of the interventricular septum, aneurysmal change of the anteroseptal transient portion of the right ventricle, left ventricular (LV) dilatation and diffuse hypokinesis with an ejection fraction of 35% (Fig. 2A). Holter electrocardiogram showed no evidence of severe brady or tachy arrhythmia leading to syncope.

Standard therapies for congestive heart failure were administered, and after improvement of her general condition, she began oral beta-blocker therapy and underwent further examination. 67Ga-citrate scintigraphy showed no abnormal accumulation, but 201Tl-Cl showed a patchy defect of cardiac perfusion. Gd-DTPA-enhanced cardiac magnetic resonance imaging (CMR) showed LV wall thinning, an aneurysmal change of the anterior right ventricular outflow tract (RVOT) (Fig. 2B), and spotty enhancement of the lateral, inferior and septal walls. Cardiac angiography showed no evidence of occlusion or critical stenosis of the coronary arteries. Histological examination of a myocardial biopsy revealed partial degeneration and mild fibrosis. No sarcoïd nodules were observed, but there was a giant cell in the myocardium.
Based on these results, she was diagnosed with cardiac sarcoidosis. Oral administration of prednisolone was started at a dose of 30 mg/day and gradually tapered thereafter.

After six months of oral steroid therapy, the patient was readmitted to our hospital complaining of palpitations. An electrocardiogram revealed frequent premature ventricular contractions and non-sustained ventricular tachycardia (NSVT) showing a left bundle branch block pattern and inferior axis (Fig. 1B). Mexiletine (150 mg/day) and intravenous lidocaine were administered to suppress NSVT. Also, therapies for the worsening of congestive heart failure (furosemide 10 mg/day, spironolactone 25 mg/day, telmisartan 20 mg/day) were administered, but electrical storm appeared every several days and she required intermittent intravenous lidocaine. An electrophysiological study (EPS) was then performed. The basic intervals were as follows: AA, 720 ms; AH, 86 ms; HV, 69 ms. Although HV interval was prolonged, atrial pacing at rate of 170 bpm resulted in 1 : 1 atrioventricular conduction. Furthermore, sustained VT (SVT) was induced by program stimulation and she lost consciousness (Fig. 1C). Considering the patient’s history of syncopal episodes, existence of cardiac sarcoidosis, and induction of VT by EPS program stimulation, an implantable cardioverter-defibrillator (ICD) was positioned in April, 2011.

Figure 2. (A) Echocardiography showed an aneurysmal lesion of the right ventricular outflow tract (RVOT) (red arrow) corresponding to the dense scar lesion in the electroanatomical voltage map. The blue arrow indicates the successful ablation site around the aneurysm. (B) Cardiac magnetic resonance imaging showed the aneurysmal lesion (red arrow) with the anteroseptal portion (blue arrow) in the RVOT. This lesion seemed to be the focus of the refractory ventricular tachycardia (VT) and was successfully ablated. (C) An electroanatomic activation map of the right and left ventricular outflow tracts during sustained VT shows that the earliest excitation site was the anteroseptal portion in the RVOT. (D) An electroanatomic voltage map of the right and left ventricular outflow tracts during sustained VT shows the normal endocardium (amplitude ≥1.5 mV) represented by purple areas with dense scar depicted in red (red arrow, amplitude <0.5 mV). The blue arrow indicates the ablation site around the earliest activation site.
In 2009, she was also administered a beta blocker (carvedilol at a dose of 10 mg/day), but electrical storm similarly appeared every several days and she was still in need of intermittent lidocaine administration after ICD implantation. While intravenous injection of lidocaine was relatively effective for the VT, some of the VT were terminated by the anti-tachycardia pacing of ICD. As almost all NSVT showed the same morphology (a left bundle branch block pattern and inferior axis) on monitor ECG and 12-lead Holter ECG (Fig. 1B), we performed myocardial ablation for this VT by using an electroanatomic mapping system (CARTO).

Electroanatomic activation maps of the right and left ventricular outflow tracts during SVT showed that the earliest excitation site was the anteroseptal junction of the RVOT (Fig. 2C), which corresponded to the aneurysmal lesion of the RVOT that had already been identified by echocardiography and CMR (Fig. 2A, 2B). This site was located at the border zone between the dense scar (red) and normal myocardium (purple) on the electroanatomic voltage map (Fig. 2D). A pacemap at the anteroseptal junction of the RVOT showed exactly the same sequence as that of clinical VT (Fig. 1D), and VT was entrained and the post-pacing interval was almost equal to the cycle length of clinical VT (Fig. 3), so we ablated this lesion. After catheter ablation, almost all of the spontaneous VT disappeared (Fig. 4) and the LV ejection fraction improved to 50%.

**Discussion**

In patients with cardiac sarcoidosis, VT is associated with significant morbidity and is an independent predictor of mortality (1). While steroid therapy has been reported to ameliorate electrocardiographic abnormalities, arrhythmias and conduction abnormalities (2), steroid-resistant ventricular arrhythmias have also been reported (3). A recent study suggested that early treatment with corticosteroids might improve atrioventricular conduction disturbances whereas sustained VT is not closely linked with disease activity and frequently develops during the advanced stages of disease (3). In the present case, VT progressively developed during the inactive phase of cardiac sarcoidosis after steroid therapy. At first, VT was not sustained. However, we elected to use an ICD because sustained VT was induced by programmed ventricular stimulation, which might identify patients with cardiac sarcoidosis at high risk for future arrhythmic events (4). The present patient developed electrical storm with incessant VT requiring ICD therapy. The majority of patients with sarcoid-related VT have been reported to have inducible VT with multiple morphologies (5, 6). Fortunately, our patient had bimorphic VT and one of them occupied more than 90% of VT; thus we performed radiofrequency catheter ablation using the CARTO system. In our electrophysiologic study, we found that the VT origin was located in anterior attachment of interventricular septum of the RVOT next to an aneurysm in the free wall from the activa-
tion maps during induced VT and perfect pacemap. As previous reports showed that the most frequent VT circuit in cardiac sarcoidosis was reentry in the peritricuspid area (5, 6), the VT origin in the RVOT of our case is relatively rare. Although we could not accurately identify the VT reentry circuit using the activation mapping of CARTO system, we could detect the VT focus in the RVOT next to the aneurysm. We thought the mechanism of VT in this patient was not automaticity but reentry because VT could be initiated and terminated by programmed stimulation and transient entrainment was demonstrated during VT. Previous studies have reported a high possibility that the mechanism of VT in patients with sarcoidosis is reentry (7, 8). The mechanism of VT in the present case may be the micro-reentry or the contribution of epicardium as critical parts of the circuit.

One explanation for the favorable catheter ablation results is that the present patient had preserved left ventricular function. The arrhythmogenic substrate might therefore be relatively localized, leading to almost the same morphology of VT and making ablation more feasible. Another reason for the positive result in this case might come from the origin of the VT in the right ventricle. Because the right ventricular wall is thinner than that of the left ventricle, the effect of ablation might be more likely to extend to the epicardium. In fact, in a recent study the success rate was higher for cases of VT with left bundle branch block morphology than for those with right bundle branch block morphology (6).

We did not use amiodarone, a possibly efficacious preventive approach to sudden arrhythmic death, in addition to beta blocker when the subject developed incessant VT. However, we performed catheter ablation for VT because 1) we identified that the VT was almost monomorphic, 2) there were no prospective studies evaluating the effects of amiodarone in patients with cardiac sarcoidosis, and 3) the patient chose catheter ablation therapy rather than amiodarone because of the possible risk of severe extra-cardiac side effects.

When detecting the aneurysm using the CARTO system it was very useful to refer to the echocardiographic and gadolinium-enhanced CMR images. In practice, the sensitivity and specificity for cardiac sarcoidosis using CMR have been shown to be 100% and 78%, respectively (9). However, as in the present case, the most significant drawback of CMR is that a patient with a pacemaker or ICD will not be able to take advantage of it. On the other hand, transthoracic echocardiography was reported to detect abnormalities in only 14% of patients with systemic sarcoidosis and cardiac involvement (10), which is less sensitive than CMR.

The possibility of the complete atrioventricular block as the mechanism of syncope in the present case was not fully ruled out but less likely, because the frequent Holter electrocardiograms showed no evidence of severe bradycardia and EPS showed normal atrioventricular nodal conduction in spite of the prolonged HV interval.

Ablation therapy was reported to be only effective in controlling a minority of arrhythmia cases for long-term follow up (5). Arrhythmia related to cardiac sarcoidosis may be difficult to control by radiofrequency ablation for long-term because of diffuse and heterogenous granulomatous involvement of ventricles. The present case must receive additional ablation therapy or anti-arrhythmic medication if another VT occurs in the future.

In conclusion, in the present case of a patient with sarcoidosis and cardiac involvement, radiofrequency catheter ablation of VT refractory to immunosuppressive therapy was effective in eliminating VT.

The authors state that they have no Conflict of Interest (COI).
References