Isolated, premature ventricular complex–induced right ventricular dysfunction mimicking arrhythmogenic right ventricular cardiomyopathy

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Introduction

We present the case of a 23-year-old woman with palpitations and frequent premature ventricular contractions (PVCs) with left bundle branch block morphology and superior axis. Structural heart disease was ruled out initially but, after a 2-year follow-up, new T-wave inversions appeared in inferior and precordial leads on the 12-lead electrocardiogram (ECG), and echocardiography showed dilatation of the right ventricle (RV) with posterior akinesia. Formally, these findings fulfilled the definite diagnosis of arrhythmogenic right ventricular cardiomyopathy (ARVC). Catheter ablation of the PVCs was performed, showing an unusual site of origin for idiopathic etiology (lateral subtricuspid region of the RV free wall). Successful PVC ablation resulted in complete normalization of electrocardiographic and echocardiographic parameters, suggesting that a pure PVC-induced RV cardiomyopathy should be considered before establishing the final diagnosis of ARVC based only on Task Force criteria (TFC).

Case report

A 23-year-old woman was admitted to our hospital owing to mild palpitations and ventricular bigeminy on ECG. The 12-lead ECG showed frequent PVCs with left bundle branch block morphology and superior axis (Figure 1A). During the index admission, 24-hour Holter monitoring revealed a PVC burden of 47% (monomorphic), without nonsustained ventricular tachycardia episodes. Transthoracic echocardiography revealed no abnormalities and preserved left ventricle (LV) and RV function. The patient had no syncope, no family history of sudden cardiac death, and no history of participation in any competitive sport. A decision was made in favor of conservative treatment and beta-blocker therapy was initiated.

At 1-year follow-up, the PVC burden on 24-hour Holter monitoring was 35%. Cardiac magnetic resonance imaging

KEY TEACHING POINTS

- The present case shows a new clinical entity consisting of isolated right ventricle (RV) cardiomyopathy induced by frequent premature ventricular contractions (PVCs), mimicking arrhythmogenic right ventricular cardiomyopathy (ARVC).
- The diagnosis of pure PVC-induced RV cardiomyopathy can fully overlap with that of ARVC. This new entity may fulfill enough Task Force criteria to be misdiagnosed as a “definite” ARVC.
- Pure PVC-induced RV cardiomyopathy should be considered in cases of RV systolic dysfunction and a high burden of PVCs arising from the RV, especially for those located in the free wall. Marked mechanical and electrical dyssynchrony of the RV are postulated as likely mechanisms for this entity.
- Successful PVC ablation in cases of pure PVC-induced RV cardiomyopathy results in complete normalization of electrocardiographic and echocardiographic parameters that mistakenly fulfilled the Task Force criteria for ARVC.

KEYWORDS Arrhythmogenic right ventricular cardiomyopathy; Catheter ablation; Premature ventricular complex; PVC-induced cardiomyopathy; Right ventricular dysfunction; Task Force criteria (Heart Rhythm Case Reports 2018;4:222–226)

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(MRI) was performed, showing normal chamber dimensions with preserved biventricular function. No late gadolinium enhancement or regional motion abnormalities were found in the LV or RV. The patient remained oligosymptomatic despite frequent PVCs, and beta-blocker therapy was maintained. At 2-year follow-up, PVC burden remained high (45%) on 24-hour Holter. New T-wave inversions appeared in inferior and precordial leads on the 12-lead ECG (Figure 1B). For the first time, echocardiography showed a slightly dilated RV (right ventricular outflow tract diameter of 34 mm in parasternal long-axis and of 36 mm in short-axis view) with posterior akinesia. The LV size and function remained within normal limits. Formally, the presence of 1 major (RV dilatation with posterior akinesia) and 2 minor criteria (frequent PVCs, inverted T wave) fulfilled the definite diagnosis of ARVC.

Taking into account the impairment of the RV systolic function and unsuccessful conservative treatment, the patient was scheduled for catheter ablation of the PVCs. During activation mapping, the PVC earliest activation site was identified at the lateral subtricuspid region of the RV free wall (Figure 2). Considering that this was an unusual site of origin for idiopathic PVCs and that the patient met diagnostic criteria for ARVC, it was decided to perform endoepicardial voltage mapping of the RV. Despite the normal endocardial bipolar voltage map, a few discrete, low-voltage areas could be seen in the unipolar map near (but not related to) the region of PVC origin (Figure 3). Consistently, the epicardial bipolar map showed a low-voltage area at the subtricuspid region of the RV free wall (Figure 3). No abnormal electrograms (ie, electrograms with delayed components) were identified in endocardial

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**Figure 1** Electrocardiography recordings. **A**: At first admission, with premature ventricular contraction (PVC) bigeminy showing left bundle branch block morphology and superior axis. **B**: At 2-year follow-up, with a new appearance of T-wave inversion in inferior and precordial leads and fragmented QRS in lead III. **C**: After successful ablation (upright T waves, no PVCs).
and epicardial maps, thus unsupporting the diagnosis of ARVC. Ablation at the earliest endocardial activation site was successful, achieving a complete abolition of the PVCs.

One year after the procedure, follow-up echocardiography revealed normal RV dimensions without any wall motion abnormalities. Both echocardiographic and ECG parameters appeared completely normalized after successful PVC ablation, suggesting that ARVC had been an overdiagnosis (Figure 1C). A 3-year follow-up cardiac MRI also showed no abnormalities.

Discussion
To our knowledge, this case is the first description of PVC-induced isolated RV cardiomyopathy with a complete normalization of ECG and echocardiographic abnormalities after successful PVC ablation. The concept of LV dysfunction in the presence of frequent PVCs with improvement in LV function after PVC elimination is well recognized.1–3 However, isolated RV systolic dysfunction induced by frequent PVC has not been previously described. The finding of a reduced RV function in combination with frequent PVCs, especially from a non–outflow tract origin in the RV, raises the suspicion of ARVC as the underlying pathology. The diagnosis of ARVC is currently based on 2010 TFC, considered to have improved diagnostic sensitivity and specificity for early and family ARVC forms in comparison with TFC 1994.4 Liu and colleagues5 validated the effect of the 2010 TFC on diagnosis and showed that 9.2% of patients fulfilling 1994 TFC for ARVC received a diagnosis other than ARVC, and 4.4% of the diagnoses were potential ARVC mimics. Similarly, Vermes and colleagues6 showed an improved specificity, but not sensitivity, of diagnostic criteria for ARVC. Even when the diagnostic work-up is guided by the 2010 TFC (with presumably increased specificity), however, physicians still face a diagnostic dilemma: a possibility of under-recognition of early disease on one hand and overdiagnosis on the other. Not only does a correct identification of the “concealed phase” of ARVC remain challenging, but certain clinical entities produce ECG changes and RV morphologic abnormalities that could mimic ARVC and be misinterpreted.

According to the 2010 TFC, a definite diagnosis of ARVC can be made with 2 major criteria, 1 major and 2 minor criteria, or 4 minor criteria from 6 different categories.4 Applying the current guidelines to our patient, frequent PVCs in the RV and RV impairment in combination with T-wave inversion was sufficient for the diagnosis of ARVC. The absence of sustained ventricular arrhythmias (VA), as in the present case, is also frequent in patients with a definite diagnosis of ARVC. In a recent study,7 among 65 index patients without sustained VA at presentation, during a median 7-year follow-up, sustained VA were observed only in 48%. This would imply that, among patients without sustained VA at the moment of ARVC diagnosis, arrhythmic progression can be slower than previously thought, at least in a not negligible proportion of cases. On the other hand, an early involvement of the LV in ARVC, which may course with pan T-wave inversions but normal LV function, has

Figure 2  Activation mapping. The earliest activation site appears in the subtricuspidal lateral region. Red dots indicate radiofrequency applications.
already been reported\textsuperscript{8,9} and could have explained the T-wave inversions in inferior and precordial leads in the present case. In fact, only 18% of all patients with ARVC and LV involvement (as seen in MRI) show reduced LVEF.\textsuperscript{10}

Back to our case, successful PVC ablation led to recovery of RV function and the diagnosis of ARVC could be ruled out after morphologic and electrical normalization of the pathologic findings, suggesting that frequent PVCs had induced an ARVC pattern in our patient. It should be noted that frequent PVCs induced an isolated RV dysfunction in this case. No LV function or size abnormalities were observed throughout the entire follow-up period. To our knowledge, this condition has not been previously described in literature. Although we cannot provide a definitive explanation of isolated RV dysfunction, it remains possible that the specific PVC origin (subtricuspid region of RV free wall) could have contributed to the worsening of RV function by inducing mechanical and electrical dyssynchrony of the RV.

We should bear in mind that overdiagnosis of ARVC may have considerable consequences in terms of further disease management, such as indication for implantable cardioverter-defibrillator therapy. Thus, our patient with 4 minor criteria (RV dilatation, young age, T-wave inversion

Figure 3  Electroanatomical mapping. \textbf{Above:} Endocardial (Endo) voltage mapping shows discrete unipolar low-voltage areas (red indicates <0.5 mV bipolar and <5.5 mV unipolar) in the subtricuspidal lateral and apical regions. \textbf{Below:} Epicardial (Epi) voltage mapping shows bipolar electroanatomical border zone (amplitude 0.5–1.5 mV on the left and 0.5–1.0 mV on the right) in the lateral wall below the tricuspid annulus.
in inferior and precordial leads, fragmented QRS) had a class IIb implantable cardioverter-defibrillator indication.11

A substantial number of previously described ARVC mimics (categorized as cardiac displacement, RV overload conditions, and myocardial scarring) should be ruled out before ARVC is definitively established. The role of cardiac MRI in the recognition of ARVC mimics with a structural basis has been elucidated by previous investigators.12–14 However, the imaging techniques were not useful in our case to provide an alternative diagnosis to ARVC. It was the normalization of structural, functional, and electrocardiographic parameters after PVC ablation that enabled the diagnosis of PVC-induced RV cardiomyopathy mimicking ARVC.

Some authors have reported the importance of additional information derived from electroanatomical mapping.15,16 In our patient, only discrete low-voltage areas were detected by unipolar mapping in the subtricuspid region of the RV free wall. Epicardial mapping was also performed, and the bipolar electrograms showed discrete low-voltage areas but without characteristics suggesting scarring (ie, delayed components). Despite the absence of abnormal electrograms that would contribute to ARVC diagnosis, the patient received close follow-up after the ablation procedure.

Conclusion
The present case shows a new clinical entity, isolated RV cardiomyopathy induced by frequent PVCs that mimics ARVC. Successful PVC ablation resulted in complete normalization of electrocardiographic and echocardiographic parameters after PVC ablation that enabled the diagnosis of PVC-induced RV cardiomyopathy mimicking ARVC.

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