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CASE REPORT

Right atrial abnormalities in a patient with arrhythmogenic right ventricular cardiomyopathy without ventricular tachycardia

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Atrium

Summary We describe a 59-year-old woman with sick sinus syndrome (SSS) and arrhythmogenic right ventricular cardiomyopathy (ARVC). Diagnosis of SSS was made because she had frequent episodes of sinus arrest with prolonged ventricular asystole. Cardiac images showed a dilated right atrium (RA) and a right ventricle (RV). Electroanatomical mapping of the RA showed extensive scarring with no recordable electrical potentials. Although she had frequent premature ventricular contractions, neither spontaneous ventricular tachycardia (VT) nor induced VT was observed. Microscopic examination of the RV indicated fibrofatty myocardium. Atrial arrhythmias associated with SSS may be the cause of symptoms in some cases of ARVC.

Introduction

Arrhythmogenic right ventricular dysplasia/cardiomyopathy (ARVC) is a myocardial disease that primarily affects the right ventricle (RV) with replacement of the myocardium by fatty and fibrous tissues [1—8]. The predominant presenting symptoms are due to ventricular arrhythmias, including palpitation, ventricular tachycardia (VT), or uncommonly, sudden cardiac death. This report describes a case of atrial abnormalities in a patient with ARVC without VT.

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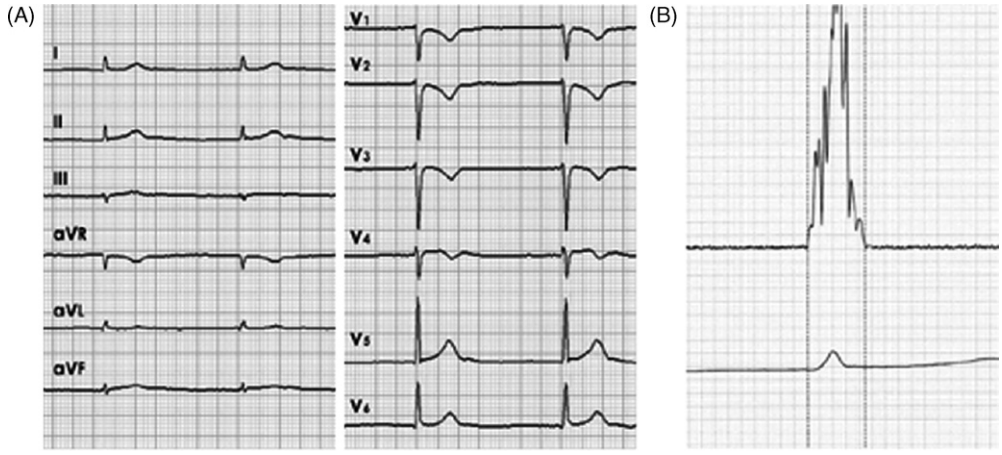

Figure 1 (A) Twelve-lead surface electrocardiogram. The tracing shows narrow QRS rhythm. There are no clear P waves. The T waves are inverted in lead V_{1-4}. (B) Signal-averaged electrocardiogram shows negative late potentials. Filtered QRS duration 108 ms, root mean square voltage of the last 40 ms of the QRS complex 17.7 μV.

Case report

A 59-year-old woman was admitted to hospital because of bradycardia, faintness, and dyspnea on effort. Her family history was negative for cardiac arrhythmia and sudden cardiac death. Laboratory examination showed atrial natriuretic peptide (ANP) 14.4 pg/ml (normal range <43.0 pg/ml) and brain natriuretic peptide (BNP) 43.0 pg/ml (normal range <18.4 pg/ml). A chest X-ray showed increased cardiothoracic ratio of 59% without pulmonary infiltrate. A 12-lead electrocardiogram (ECG) showed no clear P wave preceded narrow QRS rhythm, and T wave inversion in leads V_{1-4} (Fig. 1A). Signal-averaged ECG (SAECG) showed negative late potentials (Fig. 1B). Diagnosis of sick sinus syndrome (SSS) was made because of multiple 24-h Holter ECGs showed frequent episodes of sinus arrest with prolonged ventricular asystole (>5.0 s). Although she also had frequent episodes of premature ventricular contractions (PVCs), VT was not observed. Transthoracic echocardiography showed dilated right atrium (RA) and RV. The echocardiographic left ventricular (LV) end-diastolic diameter was 42 mm, and the LV ejection fraction (EF) was 71%. Technetium-99m cardiac blood pool scan revealed an enlargement of RV cavity with an EF of 32%. Cardiac magnetic resonance image also showed the dilated RA and the RV (Fig. 2).

During the electrophysiological study, although the P wave morphology was unclear, the patient was in atrial rhythm with atrio-His intervals of 280 ms and His-ventricular intervals of 50 ms, respectively. The RA was electrically silent with no capture during electrical stimulation at all sites, except for small areas in the lower RA. Sinus node recovery time could not be evaluated because of atrial overdrive pacing was difficult, however, frequent spontaneous atrial arrest with a maximum interval of 3.5 s was observed. Endocardial mapping was performed using an electroanatomical mapping system (CARTO, Biosense Webster, Diamond Bar, CA, USA) during the coronary sinus high output pacing since the patient's atrial rhythm was unstable (Fig. 3A). A voltage map of the RA showed extensive scarring with no recordable electrical potentials and small areas of low-voltage potentials (<0.1 mV). The voltage map also showed areas of low-voltage and delayed potentials in the RV. Programmed ventricular stimulation using two sites (RV apex and RV outflow tract), three extrastimuli, and burst pacing failed to induce VT.

A cardiac biopsy was performed. Microscopic examination of the RV septum indicated fibrofatty replacement of the myocardium (Fig. 3B). After confirmation of the diagnosis of SSS and ARVC, a permanent pacemaker implantation was performed. A single chamber ventricular pacemaker (ENPULSE E2SR01, Medtronic Inc., Minneapolis, MN, USA) was implanted due to poor sensing and high pacing threshold in the RA. The pacing lead (5076, Medtronic) was positioned in the RV septum. The sensed R wave was 4.0 mV, and the pacing threshold was 0.7 V at a pulse width of 0.5 ms. The pacing mode was programmed to VVIR pacing at 60—110 beats/min. The postoperative course was uneventful and the patient was discharged without symptoms. After 4 months of VVIR pacing, she remained clinically well, and her laboratory examination showed ANP 5.0 pg/ml and BNP 23.8 pg/ml.

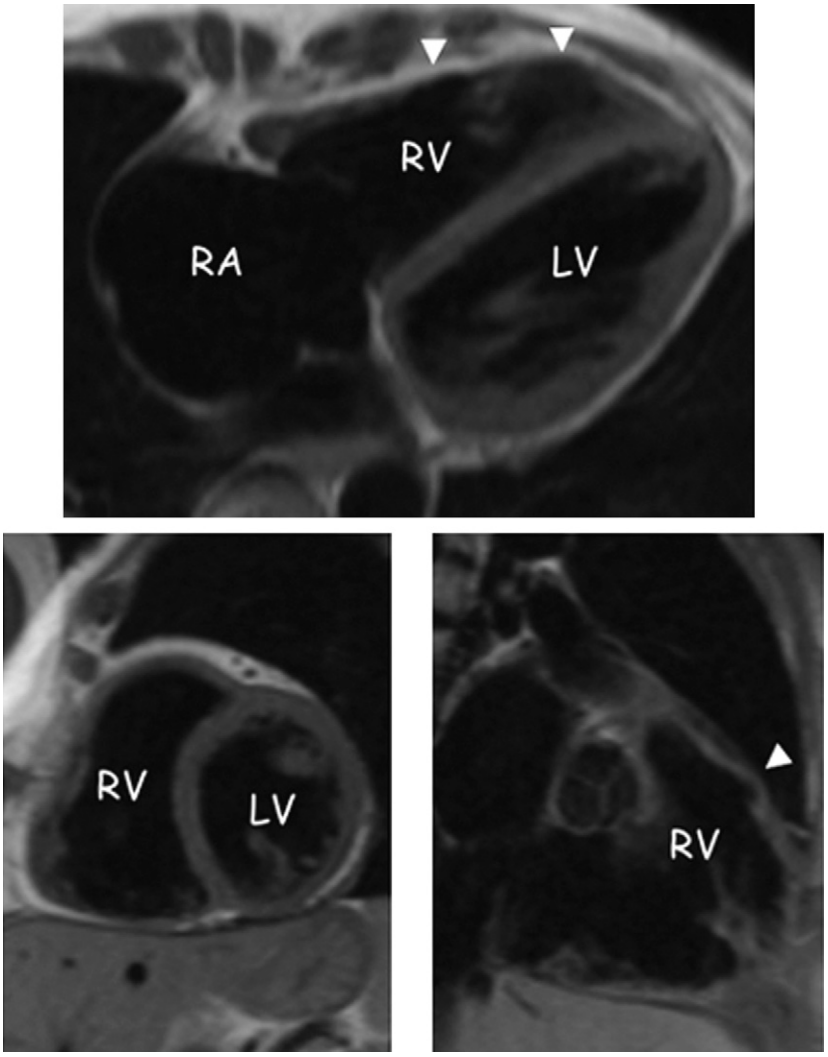

Figure 2 Cardiac magnetic resonance imaging. Cardiac magnetic resonance imaging showing right ventricular dilatation and small aneurysmal formation (arrows). The right atrium is also dilated. The left ventricle is normal. LV, left ventricle; RA, right atrium; RV, right ventricle.

Discussion

This patient had enlarged RV and reduction of the RVEF with no LV impairment, inverted T waves in right precordial leads, frequent PVCs and fibrofatty infiltration of the myocardium, which were enough to make a diagnosis of ARVC according to the TASK Force Criteria [1]. ARVC is a disease in which normal myocardium is replaced by fibrofatty tissue, causing thinning and scaring, predominantly in the RV. However, the most remarkable feature of this case was the morphological and electrophysiological abnormalities in the RA.

There are some reports that the atrial diameter are enlarged in patients with ARVC [4,5]. In addition, fibrofatty replacement of the RA with associated SSS in patients ARVC has been demonstrated [9,10]. However, the mechanisms for atrial abnormalities in patients with ARVC are not well understood. On the other hand, electroanatomical mapping system can be used to estimate both the electrophysiology and the anatomical morphology. In this patient, electroanatomical map of the RA presented a better understanding of the unique electrical anatomy of the arrhythmia substrate. The map highlights the predisposition of the RA to develop the SSS and the enlargement. The bipolar voltage map of the RA in this patient showed extensive scarring with no recordable electrical potentials. Previous electroanatomical studies have shown that the mean RA bipolar voltage amplitude during atrial pacing in patients with sinus node disease was 1.1 ± 0.2 mV [11]. The authors speculate that this case shows exclusive RA abnormality, which is occasionally involved in ARVC.

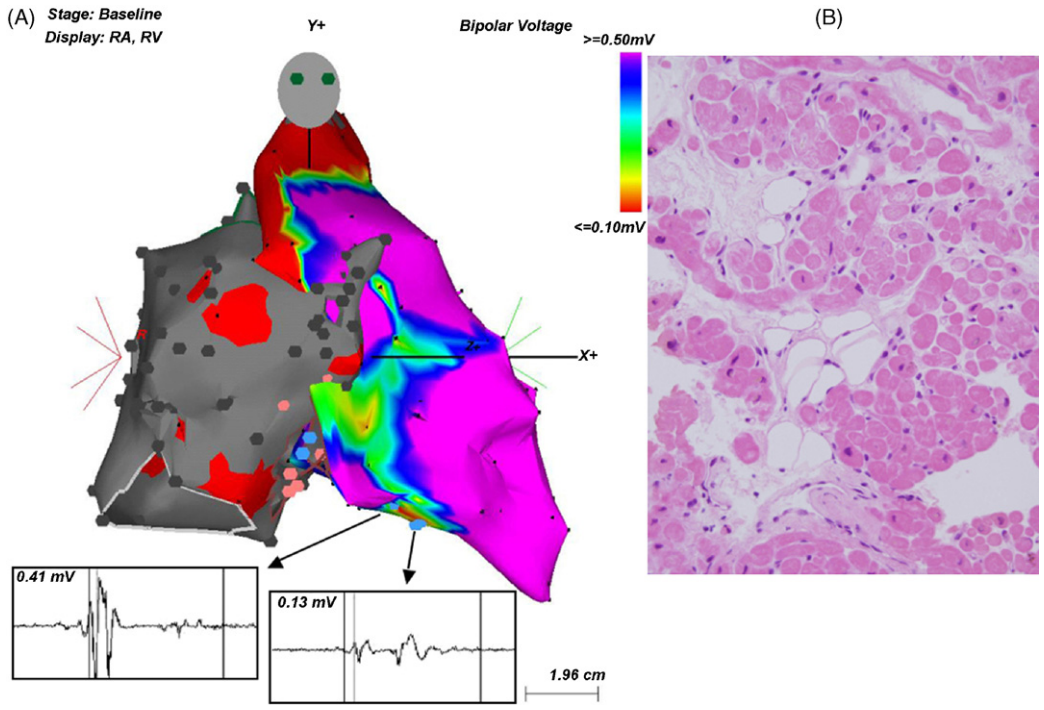

Figure 3 (A) Electroanatomical bipolar voltage map of the right atrium (RA) and right ventricle (RV) during coronary sinus pacing. The right anterior oblique view is shown. Red regions on the map represent scars (voltage <0.1 mV) and gray regions represent the no potential zone. As demonstrated by the color-coded key, purple represents voltage >0.5 mV. The RA map showing extensive scarring with no recordable electrical potentials and small areas of low voltage potentials. Scar in the RV is located in basal RV and RV outflow tract. Low voltage and delayed potentials are recorded in basal RV (turquoise blue dots). (B) Endomyocardial biopsy. Endomyocardial biopsy specimen obtained from the right ventricular septum (hematoxylin and eosin stains, magnification $\times$40). Fibrofatty replacement of the myocardium is seen.

In the present case, the plasma BNP concentration was higher than normal range. Previous report have indicated that RVEF is inversely correlated with BNP and ANP [12]. In addition, such high levels of BNP is reported in ARVC [2]. On the other hand, this patient plasma ANP concentration remained relatively low despite the enlarged RA. Although ANP is produced by atrium secondary to atrial stretch, previous studies suggest that loss of atrial myocytes or atrial fibrosis leads to reduced ANP production capacity [13,14]. Indeed, it was shown that atrial standstill or atrial fibrillation with long history is characterized by low levels of ANP [14,15]. Normal ANP level in our patient may be associated with atrial structural abnormalities due to ARVC.

In this case, histopathological examination of the RA was not performed. Therefore, the precise pathologic mechanism of the SSS in this case was not determined. However, atrial arrhythmias associated with SSS may be the cause of symptoms in some cases of ARVC. Vigilant attention should be paid to the evaluation of SSS.

Detailed electroanatomical mapping is helpful in defining the pathologic substrate and in reconstructing VT circuits in ARVC [3,6,8]. Although, the SAECG in this patient showed negative late potentials, the electroanatomical mapping demonstrated delayed potentials in the RV. On the other hand, neither spontaneous VT nor induced VT was observed in this case. The absence of VT might suggest that the arrhythmia substrate in the RV was insufficient for the initiation and perpetuation of VT. Furthermore, the SAECG may not be sensitive enough to demonstrate areas of localized conduction delay in the RV.

The treatment of ARVC is individualized. An implantable cardioverter defibrillator (ICD) is essential for the survivors of sudden death or patients with refractory VT. Efficacy of prophylactic ICD therapy has been shown to prevent sudden cardiac death in ARVC [7]. Since our patient had no spontaneous VT and the VT study was negative, we decided to use the permanent pacemaker as implantable arrhythmic device. However, because ARVC is a progressively degenerative disease, she

remains under close observation for possibility of VT in the future.

References

[1] McKenna WJ, Thiene G, Nava A, Fontaliran F, Blomstrom-Lundqvist C, Fontaine G, et al. Diagnosis of arrhythmogenic right ventricular dysplasia/ cardiomyopathy. Task Force of the Working Group Myocardial and Pericardial Disease of the European Society of Cardiology and of the Scientific Council on Cardiomyopathies of the International Society and Federation of Cardiology. Br Heart J 1994;71:215—8.

[2] Matsuo K, Nishikimi T, Yutani C, Kurita T, Shimizu W, Taguchi A, et al. Diagnostic value of plasma levels of brain natriuretic peptide in arrhythmogenic right ventricular dysplasia. Circulation 1998;98:2433—40.

[3] Boulos M, Lashevsky I, Reisner S, Gepstein L. Electroanatomic mapping of arrhythmogenic right ventricular dysplasia. J Am Coll Cardiol 2001;38:2020—7.

[4] Tandri H, Calkins H, Nasir K, Bomma C, Castillo E, Rutberg J, et al. Magnetic resonance imaging findings in patients meeting task force criteria for arrhythmogenic right ventricular dysplasia. J Cardiovasc Electrophysiol 2003;14:476—82.

[5] Yoerger DM, Marcus F, Sherrill D, Calkins H, Towbin JA, Zareba W, et al. Echocardiographic findings in patients meeting task force criteria for arrhythmogenic right ventricular dysplasia: new insights from the multidisciplinary study of right ventricular dysplasia. J Am Coll Cardiol 2005;45:860—5.

[6] Corrado D, Basso C, Leoni L, Tokajuk B, Bauce B, Frigo G, et al. Three-dimensional electroanatomic voltage mapping increases accuracy of diagnosing arrhythmogenic right ventricular cardiomyopathy/dysplasia. Circulation 2005;111:3042—50.

[7] Dalal D, Nasir K, Bomma C, Prakasa K, Tandri H, Piccini J, et al. Arrhythmogenic right ventricular dysplasia: a United States experience. Circulation 2005;112:3823—32.

[8] Satomi K, Kurita T, Suyama K, Noda T, Okamura H, Otomo K, et al. Catheter ablation of stable and unstable ventricular tachycardias in patients with arrhythmogenic right ventricular dysplasia. J Cardiovasc Electrophysiol 2006;17:469—76.

[9] Morimoto S, Sekiguchi M, Okada R, Hiramitsu S, Yamada K, Mizuno Y. Two autopsied cases of arrhythmogenic right ventricular dysplasia. J Cardiol 1990;20:1025—36 (in Japanese with English abstract).

[10] Nogami A, Adachi S, Nitta J, Taniguchi K, Marumo F, Aonuma K, et al. Arrhythmogenic right ventricular dysplagiea with sick sinus syndrome and atrioventricular conduction disturbance. Jpn Heart J 1990;31:417—23.

[11] Sanders P, Morton JB, Kistler PM, Spence SJ, Davidson NC, Hussin A, et al. Electrophysiological and electroanatomic characterization of the atria in sinus node disease: evidence of diffuse atrial remodeling. Circulation 2004;109:1514—22.

[12] Tulevski II, Groenink M, van Der Wall EE, van Veldhuisen DJ, Boomsma F, Stoker J, et al. Increased brain and atrial natriuretic peptides in patients with chronic right ventricular pressure overload: correlation between plasma neurohormones and right ventricular dysfunction. Heart 2001;86:27—30.

[13] Nagata M, Hiroe M, Yu ZX, Sekiguchi M, Hirosawa K, Koyanagi H, et al. An integrated study employing histopathological, immunohistocytochemical and radioimmunoassay analyses of atrial natriuretic peptide in the right and left atria in patients with mitral valve disease. Jpn Circ J 1988;52:1453—6.

[14] Yoshihara F, Nishikimi T, Sasako Y, Hino J, Kobayashi J, Minatoya K, et al. Plasma atrial natriuretic peptide concentration inversely correlates with left atrial collagen volume fraction in patients with atrial fibrillation: plasma ANP as a possible biochemical marker to predict the outcome of the maze procedure. J Am Coll Cardiol 2002;39:288—94.

[15] Sumimoto T, Hamada M, Nagae A, Kazatani Y, Hiwada K. Low levels of atrial natriuretic factor in patients with atrial standstill. Am Heart J 1990;120:210—1.