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CASE REPORT

INTERMEDIATE

CLINICAL CASE

Transient, Marked ST-Segment Elevation During Successful Epicardial Substrate Ablation in a Patient With Brugada Syndrome

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ABSTRACT

A 37-year-old man with Brugada syndrome and frequent appropriate implantable cardioverter-defibrillator shocks received an epicardial substrate ablation. During the procedure to eliminate delayed potentials, transient, marked ST-segment elevation in lead V_2 was observed, particularly in the anterior right ventricle with a borderline between normal and low-voltage areas. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2019;1:301–5)

Implantable cardioverter-defibrillators (ICDs) are essential for patients with severe Brugada syndrome (BrS). These patients need additional therapy when they have frequent appropriate ICD shocks. In addition, if medications are ineffective, epicardial ablation is considered to reduce ICD shocks. In 2011, Nademanee et al. (1) impressively showed that substrate-based epicardial ablation of BrS in patients with frequent episodes of ventricular fibrillation (VF) is effective, and many abnormal potentials located in the right ventricular outflow tract (RVOT) anterior epicardial region can be recorded.

LEARNING OBJECTIVES

- To be able to see the time course of the 12-lead ECG and LP after the epicardial ablation of BrS.
- To confirm a new effective marker of a successful ablation in BrS.

HISTORY OF PRESENTATION

A 37-year-old man was admitted to our institution with a cardiopulmonary arrest during sleep at home. Spontaneous circulation was restored due to bystander cardiopulmonary resuscitation performed by his wife.

MEDICAL HISTORY

The patient had no history of any previous cardiovascular disease or family history of sudden cardiac death.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis included coronary spastic angina and J-wave syndrome.

INVESTIGATIONS

On admission, a typical type 1 Brugada-electrocardiogram (ECG) pattern was observed in leads

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ABBREVIATIONS AND ACRONYMS

BrS = Brugada syndrome

CRBBB = right bundle branch block

DP = delayed potential

ECG = electrocardiogram

ICD = implantable cardioverter-defibrillator

LP = late potential

RF = radiofrequency

RFA = radiofrequency ablation

RV = right ventricular

RVOT = right ventricular outflow tract

VF = ventricular fibrillation

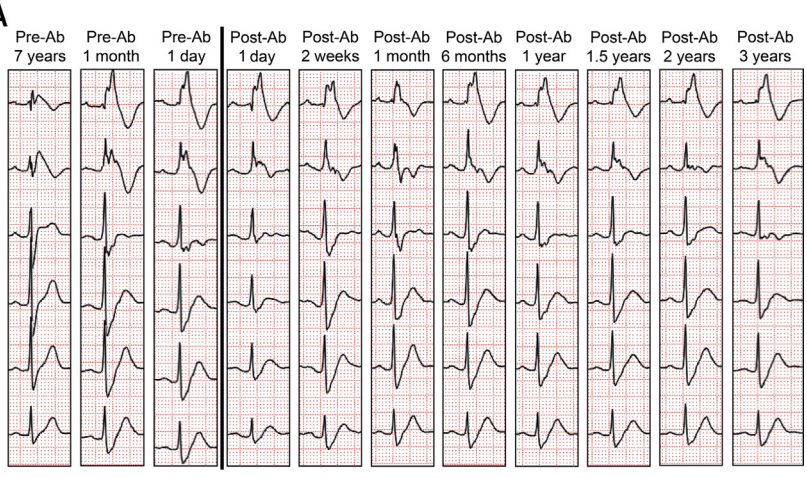
V_1 to V_3 of the 12-lead ECG (Figure 1A), and positive ventricular late potentials (LPs) were also detected in the signal-averaged ECG (Figure 1B). The other general physical examinations were normal. In addition, he had a gene variation with an amino acid substitution at SCN5A exon 28.

MANAGEMENT

A single-chamber ICD implantation in August 2009 was performed. After implantation of the ICD, appropriate shocks due to VF were observed 2 to 3 times per year. From February 2011, a fixed complete right bundle branch block (CRBBB) was additionally recorded on the 12-lead ECG (Figure 1A). All his VF events occurred during midnight between 23:00 to 3:00 while sleeping, and a few premature ventricular contractions were detected just before the occurrence of all VF episodes. However, 24-h Holter ECGs were frequently performed, but no premature ventricular contractions were detected. VF episodes were recorded on the ICD and there were 16 episodes recorded in total over 77 months after implantation of the ICD. Of those, appropriate shocks were identified for 14 episodes, and the ICD recorded 2 transient VF episodes. His VF attacks increased from November 2015, and the authors judged that the bepridil (100 mg/day) he had been taking since May 2013 was not providing

FIGURE 1 Time Course of the Precordial Leads From the 12-Lead ECG and Ventricular LPs Recorded by the Signal-Averaged ECG

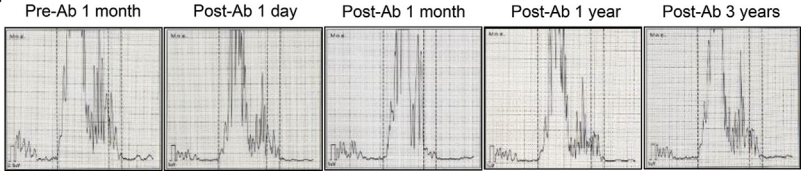
A



B

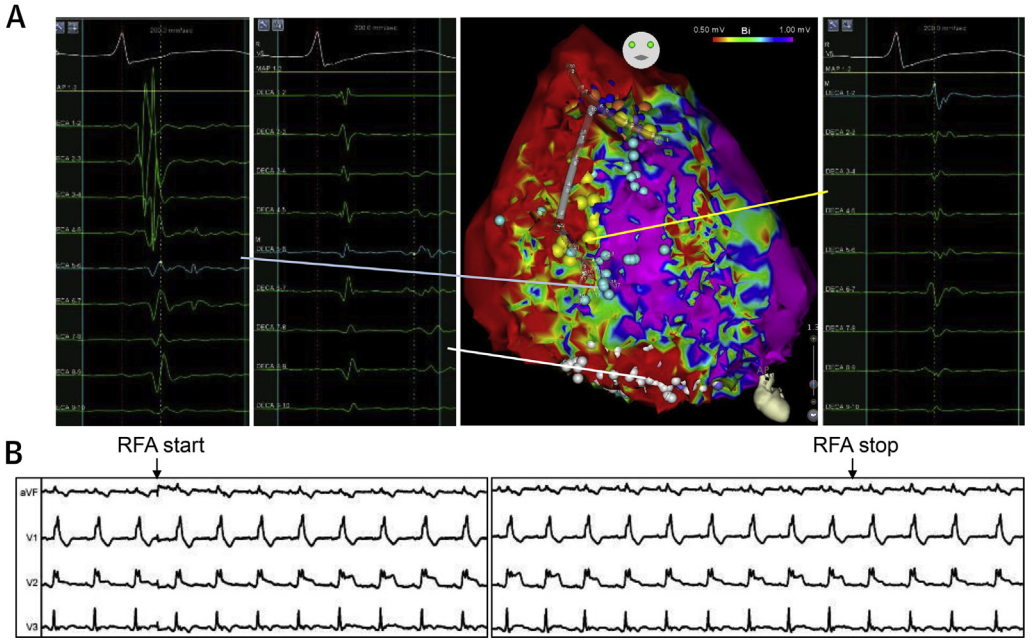
	Pre-Ab 1 month	Post-Ab 1 day	Post-Ab 2 weeks	Post-Ab 1 month	Post-Ab 6 months	Post-Ab 1 year	Post-Ab 2 years	Post-Ab 3 years
fQRSd (msec)	212	204	195	171	216	201	211	213
RMS40 (μV)	5.0	9.5	9.2	2.6	4.8	6.1	5.3	5.7
LAS40 (msec)	129	121	115	63	133	119	129	131

C



(A) A typical type 1 Brugada-electrocardiogram (ECG) pattern with fragmented QRS complexes and a complete right bundle branch block (CRBBB) morphology were seen before ablation (Pre-Ab). Note that the CRBBB morphology disappeared temporarily 1 month later (Post-Ab 1 month). **(B)** The fQRSd, RMS40, and LAS40 during the follow-up after the ablation are shown. **(C)** The real signal-averaged ECG recordings at selective times are demonstrated. The late potentials (LPs) were consistently recorded before and after ablation except at post-Ab 1 month when the CRBBB morphology temporarily disappeared.

FIGURE 2 **Bipolar Voltage Map and Abnormal Potentials in the Epicardial RV and ST-Segment Elevation in Lead V_2**



(A) An epicardial bipolar voltage map of the right ventricle is shown before the epicardial ablation, with a voltage range from 0.5 to 1.0 mV from the CARTO3 system. The epicardial right ventricular voltage map identified a wide low-voltage area in the anterior and inferior right ventricle and anterior right ventricular outflow tract (RVOT). In the **left 2 panels**, fractionated, delayed potentials and a prolonged duration are identified at the anterior right ventricle and RVOT **(light blue tag)** and inferior right ventricle **(white tag)**. **(B)** Transient, marked ST-segment elevation in lead V_2 was recorded during ablation, particularly at the border zone (e.g., the **yellow tag** on the CARTO map at the time of starting and stopping ablation). RFA = radiofrequency ablation.

any protective effect. Because he and his wife had severe anxiety and hoped to have children, an epicardial ablation (per the patient's wishes) was planned in January 2016, when he was 37 years old.

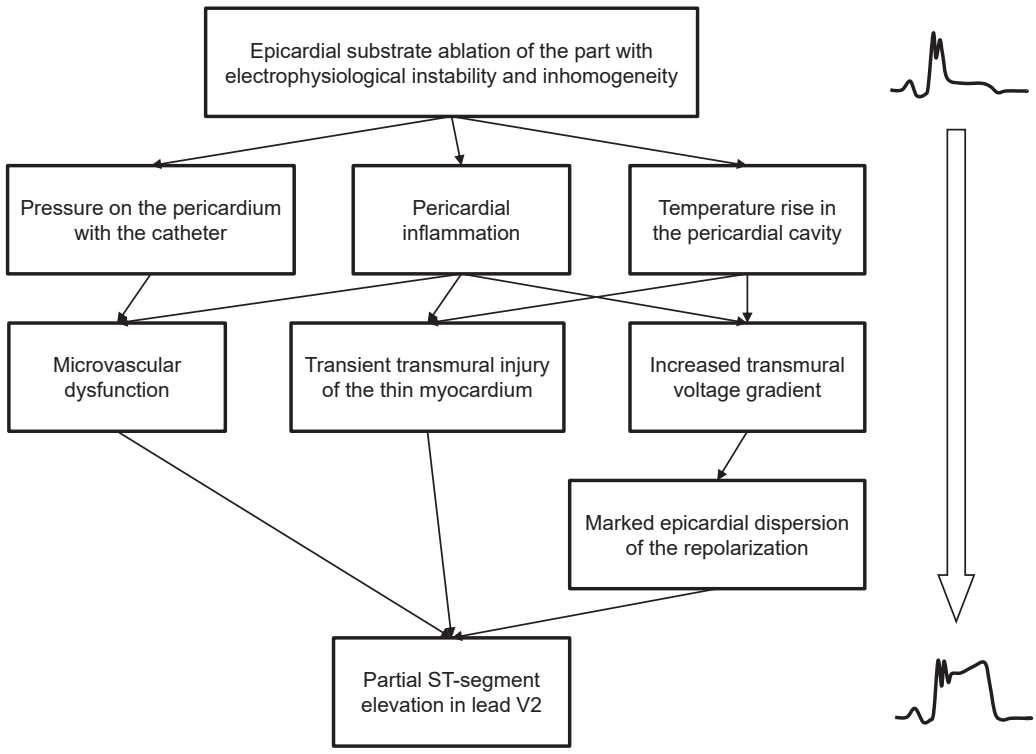
First, endocardial right ventricular (RV) mapping guided by 3-dimensional cardiac mapping (CARTO 3, Biosense Webster Inc., Diamond Bar, California) was performed. His unipolar and bipolar voltage maps were normal. Next, smooth epicardial mapping was performed through a pericardial puncture using a 7-F D-curve decapolar catheter (DECANAV, Biosense Webster Inc.) under deep sedation with propofol and dexmedetomidine. Many low-voltage areas were observed on the RV free wall, inferior region, and RVOT, and many delayed potentials (DPs) were recorded at the borderline between the normal and low-voltage areas (**Figure 2A**). Three epicardial maps in total were created and ablated all 48 DPs and 72 sites around those areas. A ThermoCool SmartTouch D/F-curve catheter (Biosense Webster Inc.) was used for the epicardial ablation with radiofrequency (RF) energy in all at 35 W.

Impressively, the authors repeatedly identified transient, marked ST-segment elevation in lead V_2 during ablation at a total of 12 sites (yellow tag, **Figure 2B**), which mainly were located on the RV free wall. Upon terminating the application, the ST-segment elevation spontaneously reverted a few seconds later. This phenomenon was never observed in other leads. The patient's coronary angiography was normal, and neither stenosis nor spasms were observed.

DISCUSSION

The patient was eventually diagnosed as having severe BrS. ECG findings such as a fragmented QRS (2) and CRBBB (3) and seasonal distribution of VF (4) support this diagnosis. In this case, although clear ECG changes in lead V_2 after the epicardial ablation was observed, the Brugada-ECG pattern did not normalize as in previous studies (1,5). Lead V_1 did not change, and the fragmented QRS in leads V_2 and V_3 remained as shown in **Figure 1A**. These findings

FIGURE 3 Possible Mechanisms of the ST-Segment Elevation During Radiofrequency in Lead V_2



indicated that DPs may still have remained on the patient's epicardium. However, in fact, no appropriate ICD shocks and/or short VF episodes have been identified for >3 years. The authors confirmed that all DPs had disappeared by the third epicardial map and no ventricular arrhythmias could be induced, and we finished the procedure.

In this procedure, an interesting and characteristic ST-segment elevation was transiently observed during the specific site ablation. Those sites were located around lead V_2 and did not have any DPs (**Figure 2A**). Strangely, ST-segment elevation during the RF at many sites near those sites could not be identified. As a common factor, the fractionated potentials and/or DPs and sites with ST-segment elevation were mainly recorded in those borderline areas. A previous study reported that border areas tend to be breakout sites and/or origins of ventricular arrhythmias (6). Without DPs, a part of the borderline areas may have been arrhythmia substrates due to dispersion of the epicardial potentials. Finally, the authors considered that the possible mechanisms of the ST-segment elevation during the RF were caused by a combinatorial effect as shown in **Figure 3**.

To the authors' knowledge, this is the first description of a recording with a transient, marked ST-segment elevation during an RF delivery in a patient with BrS. In patients with BrS, ST-segment elevation during epicardial substrate ablation may be better proof of ablation success than a normalized Brugada-ECG in the near future. Of course, it is certain that the disappearance of the epicardial DPs is the main reason that VF does not occur (1). Even if the Brugada-ECG pattern does not improve and normalizes, as in this patient, a good prognosis can be expected in patients with BrS and ST-segment elevation during RF deliveries. When the Brugada-ECG pattern and fragmentation do not disappear on the ECG, patient support should be continued.

FOLLOW-UP

After the ablation, although fragmented QRS complexes and CRBBB morphology in the precordial leads were still observed, the Brugada-ECG pattern was gone, as shown in the ECG at 1 month when the CRBBB morphology temporary disappeared

(Figure 1A). Currently, the patient has been doing his favorite exercise without appropriate ICD shocks for >3 years.

CONCLUSIONS

The authors describe a patient with BrS and CRBBB, in whom transient ST-segment elevation in lead V_2 was recorded at specific sites during epicardial ablation and various ECG changes in the same lead were identified during follow-up.

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KEY WORDS 3-dimensional imaging, ablation, electroanatomic mapping, electrocardiogram, ventricular fibrillation