

CASE REPORT

BEGINNER

CLINICAL CASE

Out-of-Hospital Cardiac Arrest Due to a Concealed Diagnosis



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ABSTRACT

This case outlines the dynamic and often concealed electrocardiographic findings associated with Brugada syndrome and explores its important relationship with early repolarization syndrome as part of a spectrum of inherited J-wave syndromes. (**Level of Difficulty: Beginner.**) (J Am Coll Cardiol Case Rep 2019;1:339–42) Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

A 59-year-old Vietnamese-American man suddenly collapsed at his home following a visit to the dentist. Earlier that day, the patient noticed facial swelling due to a tooth abscess that required emergent dental extraction under local anesthesia with 1% lidocaine. When he arrived home after the procedure, the patient suddenly lost consciousness. Cardiopulmonary resuscitation was performed by family members until emergency medical services (EMS) arrived. EMS staff noted ventricular fibrillation (VF), which was shocked 6 times by an automated external defibrillator before return of spontaneous circulation. The patient was subsequently intubated to maximize ventilation/oxygenation and was started on an induced-hypothermia protocol. His initial 12-lead electrocardiogram (ECG) upon presentation at the emergency department is shown in **Figure 1**. No previous ECGs were available for comparison.

PAST MEDICAL HISTORY

The patient had a history of hypertension, hyperlipidemia, and type 2 diabetes mellitus. There was no family history of sudden cardiac death.

INVESTIGATIONS

After the patient's arrival to the hospital, the differential diagnosis for an out-of-hospital cardiac arrest was considered. There was initial concern for an acute coronary syndrome complicated by VF, given the patient's age, sex, and other risk factors for ischemic heart disease. However, his initial ECG revealed sinus bradycardia with no evidence of ischemia or infarct. Osborn waves were incidentally noted in leads V₃ to V₅ (**Figure 1**). Cardiac biomarkers were also minimally elevated, and, as a result, emergent coronary angiography was delayed. When ultimately performed, coronary angiography revealed no significant coronary obstruction or anomaly.

LEARNING OBJECTIVES

- To recognize the distinct ECG patterns associated with BrS and ERS.
- To understand that the presence of an ERP in patients with BrS confers a higher risk of arrhythmic events.

MANAGEMENT

After the induced-hypothermia protocol was complete, the patient was rewarmed, and his ECG spontaneously revealed coved ST-segment elevations in the right precordial leads (**Figure 2**). These findings

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**ABBREVIATIONS
AND ACRONYMS**

- BrS** = Brugada syndrome
- ERP** = early repolarization pattern
- ERS** = early repolarization syndrome
- ECG** = electrocardiogram
- EMS** = emergency medical services
- ICD** = implantable cardioverter-defibrillator
- VF** = ventricular fibrillation
- VT** = ventricular tachycardia

were reviewed with a cardiac electrophysiologist who confirmed the presence of a type I Brugada ECG pattern. Transthoracic echocardiography demonstrated a structurally normal heart. Given the patient's presentation of an aborted cardiac arrest due to VF, the diagnosis of Brugada syndrome (BrS) seemed most likely, and the need for an implantable cardioverter-defibrillator (ICD), the only proven effective treatment for the disease, was clear (1).

DIFFERENTIAL DIAGNOSIS

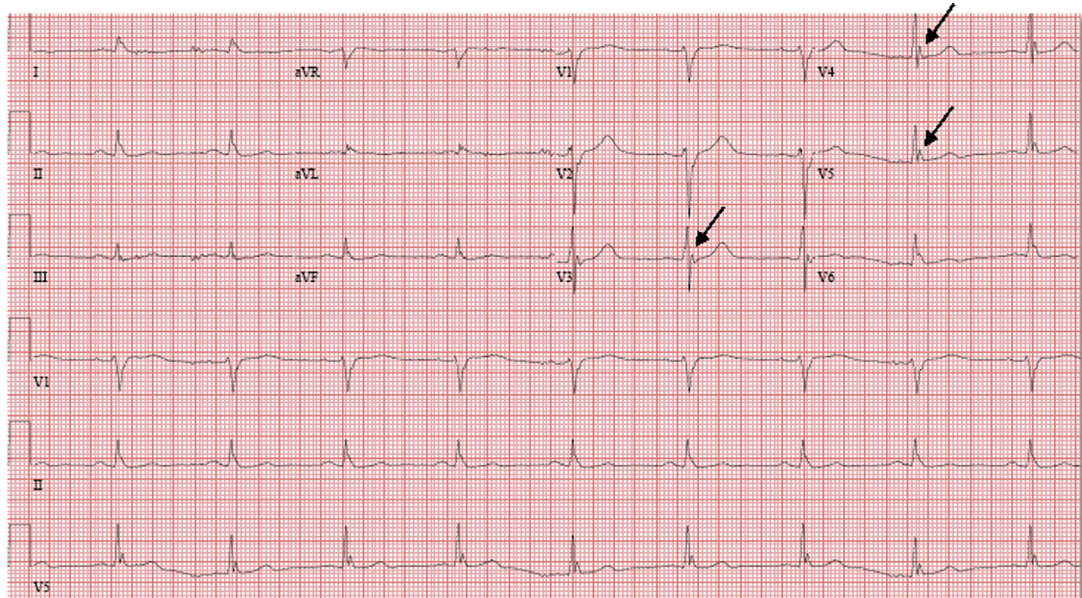
This clinical presentation of out-of-hospital cardiac arrest demonstrates the dynamic and often concealed qualities of BrS. In a middle-aged patient, the differential diagnosis for out-of-hospital cardiac arrest is broad but can be quickly honed, based on serial ECGs, as well as the presence (or absence) of structural heart disease. Besides BrS, potential etiologies include ventricular tachyarrhythmias related to ischemic heart disease or systolic heart failure, hypertrophic cardiomyopathy, arrhythmogenic right ventricular cardiomyopathy, Wolff-Parkinson-White syndrome, early repolarization syndrome (ERS), short/long

QT syndrome, catecholaminergic polymorphic ventricular tachycardia (VT), and other cardiac channelopathies (1-3).

DISCUSSION

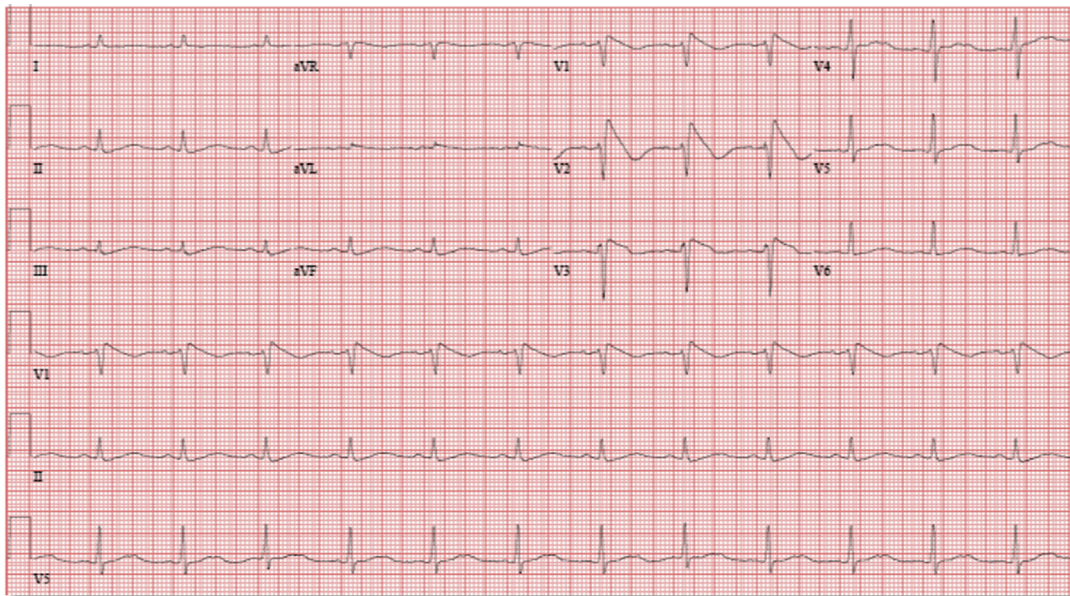
When BrS is considered to be a potential cause for out-of-hospital cardiac arrest, it is important to perform a focused history and physical examination and to have a high clinical suspicion for the diagnosis, especially among the Southeast Asian population (1-3). Indeed, the initial 12-lead ECG may not contain 1 of the 3 recognized repolarization patterns that suggest the diagnosis, particularly as numerous factors may influence the ECG and arrhythmic manifestations of BrS (1). Although the SCN5A gene mutation that encodes the α -subunit of the cardiac sodium channel has been linked to BrS (accounting for >75% of genotype-positive cases), most cases (>65%) are genetically elusive (2). Still, febrile illness, autonomic imbalance, hypokalemia, hyperkalemia, hypocalcemia, concomitant glucose and insulin use, alcohol and cocaine intoxication, and a growing list of pharmacologic agents are known to modulate the cardiac sodium channel, induce a type I Brugada ECG pattern, and cause polymorphic VT and/or VF with cardiac arrest (1-4).

FIGURE 1 The Patient's Initial 12-Lead ECG in the Emergency Department Following His Out-of-Hospital Cardiac Arrest



Osborn waves (arrows) are seen in leads V₃ to V₅, which are associated with hypothermia due to targeted temperature therapy. Osborn waves in hypothermia are typically associated with sinus bradycardia and prolonged QT interval. Interestingly, Osborn waves, which are caused by intracellular calcium overload, may have arrhythmogenic potential similar to Brugada syndrome.

FIGURE 2 12-Lead ECG After Rewarming



During the rewarming phase of the induced-hypothermia protocol, the patient's 12-lead ECG demonstrated a type I Brugada pattern with coved ST-segment elevations followed by negative T waves in leads V₁ to V₃.

In this patient with BrS, an unclear inciting event following a visit to the dentist triggered VF. A red herring may be the local anesthesia—lidocaine—that the patient received during tooth extraction. A Class IB antiarrhythmic agent, lidocaine used as a dental anesthetic is unlikely to be absorbed in systemic amounts to influence the cardiac sodium channel or induce a type I Brugada ECG pattern. However, supratherapeutic doses of Class IB antiarrhythmic agents are associated with a Brugada ECG pattern and sudden cardiac death (5). It is also possible that the patient's tooth abscess resulted in pyrexia, which subsequently caused VF.

The ECG changes associated with BrS are often transient. In this patient, the induced-hypothermia protocol masked the type I Brugada ECG pattern, which was only apparent upon rewarming, and confirms the temperature dependence of the ionic mechanisms of the syndrome (4). With a spontaneous type I Brugada ECG pattern, the patient met diagnostic criteria for BrS and had a Class I indication for ICD implantation: an aborted cardiac arrest (6). Thus, a high index of suspicion is needed when considering the diagnosis of BrS.

Although this case is certainly illustrative of BrS, the patient's initial ECG demonstrated >0.2 mV of J-point elevation in the inferior and lateral leads. This early repolarization pattern (ERP) is more prevalent

among idiopathic VF survivors as compared with age- and sex-matched controls and is now recognized as an arrhythmogenic condition that can result in VT/VF (7). Recently, such findings have been categorized as ERS and are recognized as part of a larger spectrum of inherited J-wave syndromes, which include BrS (8-10). BrS, most commonly affecting the right ventricular outflow tract, is considered the right ventricular form of J-wave syndromes. ERS, on the other hand, is often localized to the inferior myocardium and is the clinical manifestation of ERP when associated with VT/VF. ERS has 3 major ECG patterns that are distinguished by the location of the ST-segment elevations; all 3 types are characterized by a distinct J-wave or J-point elevation, notch, or slur of the terminal part of the QRS complex (8,10). Type I has ST-segment elevations in the lateral leads, type II in the inferolateral leads, and type III in the inferolateral plus the anterior or right ventricular leads. The ERP can also be acquired, as has been seen during conditions of hypothermia or myocardial ischemia (9,10). And, although ERS and BrS do share several important clinical features, the ionic and cellular mechanisms that govern the physiologic basis for each syndrome remain controversial (2,3,10).

In the case of this patient, the ECG following rewarming and during the remainder of his hospitalization were most consistent with a type I Brugada

ECG pattern. ERP was only seen on the initial 12-lead ECG during induced hypothermia. However, recent data suggest that patients with BrS and ERP are at high risk for future arrhythmic events. Indeed, the presence of ERP is a common finding in BrS and appears to be highly arrhythmogenic. Patients with BrS and ERP also demonstrate a higher risk of arrhythmic events compared with those without ERP, and patients with inferolateral location of the ERP are at an even higher risk in relation to those exhibiting only inferior or lateral locations (8). For this patient, the initial ECG with ERP indicated a worse prognosis than the type I Brugada ECG pattern alone seen later (3,6). As a result, treatment with implantation of an ICD was especially critical in this patient.

FOLLOW-UP

The patient was initially hesitant to have an ICD placed and was instead discharged home with a wearable defibrillator. Five months later, the patient finally agreed to ICD placement and is currently doing well with no recurrent episodes of VT/VF. Subsequent ECGs on follow-up were only notable for normal sinus

rhythm, and the patient chose not to undergo genetic testing. Unfortunately, ECGs were not available for first-degree relatives.

CONCLUSIONS

The ECG changes associated with BrS are dynamic and may sometimes be concealed, particularly in the setting of an out-of-hospital cardiac arrest. Although the SCN5A “loss-of-function” gene mutation has been linked to BrS, the disease is genetically elusive in most patients (2). Recently, BrS and ERS have been recognized as 2 distinct phenotypic manifestations in a continuous spectrum of J-wave syndromes that share several clinical features, and likely have similar ionic, cellular, and genetic mechanisms (10). When ERP is seen in patients with BrS, it is also important to recognize the adverse prognostic significance.

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KEY WORDS Brugada syndrome, early repolarization pattern, early repolarization syndrome, ventricular fibrillation, ventricular tachycardia