Parahisian pacing to unmask Brugada pattern with concomitant left bundle branch block and to document epicardial ablation endpoint in Brugada syndrome

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Introduction

Brugada syndrome, traditionally described as a channelopathy affecting transmembrane sodium current, has been recognized as a structural disease affecting the epicardial right ventricular outflow tract (RVOT).1–3 This observation has been the basis for successful arrhythmic substrate ablation in these patients, with resolution of the Brugada pattern in the anterior precordial leads reported as a reliable procedural endpoint.4,5 However, the typical precordial electrocardiogram (ECG) pattern is obscured in patients with concomitant left bundle branch block (LBBB),6 making this a challenging observation in such patients. In this report, we describe parahisian pacing as a strategy to unmask Brugada pattern in a patient with concomitant LBBB, with resolution of the ST-segment elevation in the anterior precordial leads after epicardial ablation.

Case report

Patient history

A 76-year-old man with history of Brugada syndrome and recurrent ventricular fibrillation (VF) episodes is referred for ablation. He was diagnosed in 1999 in the setting of resuscitated cardiac arrest with ECG revealing spontaneous type 1 Brugada pattern (Figure 1A), for which he received a secondary-prevention implantable cardioverter-defibrillator (ICD). Over the past 2 decades, he experienced 13 episodes of recurrent VF leading to ICD shocks, with increasing frequency in the preceding months (Figure 1B). Quinidine successfully prevented recurrent episodes, but had to be discontinued owing to thrombocytopenia. Upon evaluation, ECG revealed a wide LBBB (Figure 1C) that obscured the expected Brugada pattern, and genetic testing confirmed a pathogenic mutation affecting the SCN5A gene (Gln59Ter, termination codon replacing glutamine leading to truncation at codon 59). Echocardiogram and cardiac magnetic resonance imaging showed a structurally normal heart without areas of scar.

Procedural findings

Programmed ventricular stimulation was performed at baseline, with reproducible induction of polymorphic ventricular tachycardia from the right ventricular apex. In an attempt to establish an additional procedural endpoint despite the presence of LBBB at baseline, parahisian pacing was performed at the start of the procedure to overcome the LBBB and unmask the underlying Brugada pattern. This maneuver successfully revealed coved-type ST elevation and T-wave inversion in the anterior precordial leads (Figure 2A).
and 2B), consistent with spontaneous type 1 Brugada pattern documented 20 years prior.

Endocardial right ventricular voltage map was performed under conscious sedation with an open irrigated ablation catheter (ThermoCool SmartTouch, Biosense Webster, Diamond Bar, CA), showing no bipolar or unipolar abnormalities (Figure 3A). Subxiphoid percutaneous epicardial access was obtained under general anesthesia with an inferior approach and epicardial voltage map was performed with a deflectable decapolar catheter (DecaNav; Biosense Webster). Bipolar abnormalities were observed on the epicardial RVOT region, characterized by fractionated, multicomponent late electrograms (EGMs, Figure 3B). Repeat epicardial voltage map after epicardial warm saline infusion, as well as after intravenous procainamide infusion (10 mg/kg), did not show a significantly wider area of EGM abnormalities. Coronary angiography was performed to ensure safe distance between the epicardial area of abnormal EGMs and coronary vessels, using the mapping catheter as the fluoroscopic reference. Epicardial ablation was performed at 30 W for 20–30 seconds, targeting the abnormal areas on the epicardial RVOT until complete elimination of the targeted signals. Following that, repeat epicardial voltage map showed elimination of these EGMs (Figure 3C), and repeat programmed stimulation failed to induce ventricular arrhythmias.

Figure 1  A: Remote spontaneous type 1 Brugada pattern electrocardiogram (ECG) with ST elevation and T-wave inversion in V1, documented during hospitalization for resuscitated sudden cardiac death in September 1999. B: Device interrogation showing 3 episodes of implantable cardioverter-defibrillator shocks in the preceding months, with representative episode showing polymorphic ventricular tachycardia successfully defibrillated. C: Preprocedural ECG from December 2019 showing wide left bundle branch block (QRS 188 ms) obscuring any Brugada-type ECG abnormality in the anterior precordial leads. Note the absence of any ventricular premature depolarizations (VPDs) in the preprocedural ECG (C), in contrast with frequent VPDs from remote ECG (right bundle rightwards axis, V4 transition with discordant inferior lead deflections [negative II, positive III]) (A), likely originating from the anterolateral papillary muscle and unlikely to be a ventricular fibrillation trigger.

Figure 2  Nonselective parahisian pacing shows change in morphology from wide left bundle branch block (LBBB) (A) to narrower QRS (B), revealing ST elevation in anterior precordial leads (dotted lines) and T-wave inversions consistent with type 1 Brugada pattern electrocardiogram (ECG). The same maneuver is repeated after ablation, again revealing a narrower QRS but without significant ST deviation (dotted lines) or T-wave inversions in anterior precordial leads, suggestive of resolution of the Brugada pattern ECG (C). In both instances, nonselective His-bundle capture shortens the QRS duration from 188 ms to 132 ms. Note that the postablation LBBB QRS morphology is unchanged before and after ablation (D).
Following epicardial ablation, repeat parahisian pacing was performed and documented reduction of the ST elevation in the anterior precordial leads, consistent with resolution of the Brugada pattern as a procedural endpoint (Figure 2C and 2D).

Follow-up
Prior to discharge, the patient underwent noninvasive programmed stimulation and had no inducible ventricular arrhythmias with single, double, and triple extrastimuli during drive trains of 600 ms and 400 ms. The patient had no recurrent ventricular arrhythmias or ICD shocks after 13 months of follow-up with no antiarrhythmic drug use.

Discussion
Brugada syndrome, originally recognized based on the typical electrocardiographic pattern of ST elevation in the anterior precordial leads, has traditionally been described as an autosomal dominant channelopathy since the identification of mutations involving the SCN5A gene, which encodes the alpha-subunit of the sodium channel. Current guidelines recommend ICD implantation for selected patients (such as cardiac arrest survivors) and suggest quinidine for patients with recurrent arrhythmias, in addition to lifestyle changes that prevent sudden death. Despite quinidine being an effective therapy, it has potentially serious side effects and induced thrombocytopenia in our patient. Catheter ablation, which received a class of recommendation IIb in current guidelines, is then reserved for patients with arrhythmic storm or with repeated appropriate ICD shocks, such as our patient.

The first attempt at VF ablation in Brugada syndrome was aimed at ventricular premature depolarizations (VPDs) triggering VF, targeted mostly from the endocardial RVOT. Such strategy, however, is not feasible in patients who do not present in VF storm, in whom frequent VPDs triggering VF can be easily observed. In recent years, an abnormal substrate has been described in patients with Brugada syndrome, characterized electrophysiologically by slow conduction and low-voltage areas localized to the anterior epicardial RVOT. Based on such observations, catheter ablation in these patients has evolved from VF-trigger ablation, typically from the endocardial RVOT, into elimination of abnormal substrate from the epicardial RVOT. A dramatic finding reported with such strategy is the resolution of the Brugada-pattern ECG, with normalization of the ST segment in the anterior precordial leads corroborating elimination of the arrhythmogenic substrate and supporting our current understanding of Brugada syndrome as more than a channelopathy.

Since Brugada syndrome is usually diagnosed in relatively young patients without structural heart disease, concomitant LBBB in this population is an unlikely finding. As previously reported, this rare coexistence can make diagnosis extremely challenging because the Brugada pattern can be masked by the LBBB. In our patient, there was no diagnostic dilemma given the remote ECG with typical features, as well as corroborating genetic testing and recurrent ventricular arrhythmias despite different imaging modalities showing a structurally normal heart. Still, determining clear procedural endpoints could be difficult in our patient owing to concomitant LBBB. While late EGMs in Brugada syndrome have been characterized by low voltage and duration often exceeding the QRS duration, these abnormal EGMs in our patient were never recorded after the QRS complex owing to very delayed left ventricular depolarization from LBBB. Additionally, despite being easily and reproducibly inducible for sustained ventricular arrhythmias at the start of the procedure, transitioning from conscious sedation to general anesthesia at the time of epicardial puncture could affect inducibility regardless of elimination of the arrhythmogenic substrate.

The contemporary experience with conduction-system pacing has demonstrated the ability to overcome LBBB by pacing the His bundle region, corroborating the idea of longitudinal dissociation within the His bundle that suggests LBBB much more proximally than historically believed. In our patient, these concepts were the basis for performing parahisian pacing at the start of the procedure in an attempt to unmask the Brugada pattern. Interestingly, but not surprisingly, repeat parahisian pacing after catheter ablation...
eliminated the arrhythmogenic substrate, demonstrating resolution of the Brugada pattern previously revealed. Therefore, in addition to repeat voltage mapping showing successful substrate homogenization and noninducibility following ablation, we were reassured by this additional procedural endpoint that would have been impossible to observe if not for parahisian pacing.

Conclusion
In summary, this case report documents for the first time the ability to unmask Brugada pattern ECG with parahisian pacing in a patient with concomitant LBBB. In addition to informing an important ablation endpoint in the rare patient with concomitant Brugada syndrome and LBBB, this might be a useful diagnostic maneuver in patients with LBBB and suspected Brugada syndrome undergoing invasive electrophysiologic studies.

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