Catheter ablation in Brugada syndrome

Dr. Andrés R. Pérez Riera

There is strong evidence that the electrophysiological substrate in BrS is located mainly in the RVOT. While subtle wall-motion abnormalities are documented, RVOT dilatation has also been found on MRI. There is scant data on histological abnormalities in the RVOT to explain the electrophysiological substrate. By contrast, there are a number of series of RV biopsies showing histological abnormalities. This is most likely explained by the hazards of performing biopsy in the thin-walled RVOT and the lack of postmortem data series. These data challenge the concept that the BrS heart is structurally normal.

Cases of Brugada type ECGs after ajmaline provocation have been found in Chagas disease and ARVCD. Spontaneous type 1 ECGs have also been found in mediastinal masses compressing the RVOT. Therefore, the ECG finding in BrS may represent a common feature in several conditions, which affect RVOT. Histological features and viral genomes representative of myocarditis have also been detected in some patients. The finding of a myocarditic process in some patients raises the question of whether the syndrome may, in part, be acquired, which could explain the age-related presentation. The possibility that SCN5A mutations could cause structural abnormalities has also risen from studies of SCN5A mutant mice and from families with dilated cardiomyopathy, but is not certain for mutations associated with Brugada (**Li 2013**).

Prolonged electrograms localized to epicardial RVOT with variable low voltage were identified in all patients with BrS. J-point and ST-segment elevation correlated with greater transmural dispersion of late activation and was independent of total low-voltage area. Despite normalization of spontaneous type 1ECG pattern in all patients after ablation, recurrence was still observed, suggesting the ICD as the cornerstone therapy for BrS (**Zhang 2016**). The underlying electrophysiological mechanism in patients with BrS is delayed depolarization over the anterior aspect of the RVOT epicardium. Catheter ablation over this abnormal area results in normalization of the Brugada ECG pattern and prevents VT/VF, both during EPSs as well as spontaneous recurrent VT/VF episodes in patients with BrS (**Nademanee 20101**). In patients with BrS, there is a relationship between abnormal ECG pattern, the extent of abnormal epicardial substrate, and VT/VF inducibility. Ablation of the substrate identified in the presence of flecainide can eliminate the BrS phenotype and warrants further study (**Brugada 2013**)

The late activation zone (LAZ) on RVOT identified by noncontact mapping may serve as potential VF substrate in BrS patients with VF episodes. RFCA on LAZ normalized ECG, suppressed VF storm, and reduced VF recurrence. The procedure is safe and may prevent VF occurrence (**Sunsaneewitayakul 2012**).

Electroanatomical mapping may improve the prognostic accuracy of programmed ventricular stimulation (PVS). in patients with BrS. Letsas et al demonstrated that BrS patients with broad endocardial unipolar voltage abnormalities are more vulnerable to VF induction during PVS. On the contrary, subjects with normal electroanatomical maps were noninducible. Epicardial studies support the present findings (**Nademanee 2015**). After epicardial substrate elimination, patients with BrS become noninducible during PVS and the ECG normalizes. The prognostic significance of this novel electroanatomical marker in asymptomatic individuals with BrS remains to be prospectively validated in the setting of multiparametric risk stratification models.

Low endocardial unipolar voltage (UV) at sites with normal bipolar voltage (BV) may indicate epicardial scar. Currently applied UV cutoff values are based on studies that lacked epicardial fat information. Venlet et al, aimed to define endocardial UV cutoff values using computed tomography–derived fat information and to analyze their clinical value for RV substrate delineation. 33 patients underwent combined endocardial–epicardial RV electroanatomical mapping and ablation of RV scar–related VT with computed tomographic image integration, including computed tomography–derived fat thickness. Of 6889 endocardial–epicardial mapping point pairs, 547 (8%) pairs with distance <10 mm and fat thickness <1.0 mm was analyzed for voltage and abnormal (fragmented/late potential) electrogram characteristics. At sites with endocardial BV >1.50 mV, the optimal endocardial UV cutoff for identification of epicardial BV <1.50 mV was 3.9 mV (area under the curve, 0.75; sensitivity, 60%; specificity, 79%) and cutoff for identification of abnormal epicardial electrogram was 3.7 mV (area under the curve, 0.88; sensitivity, 100%; specificity, 67%). The majority of abnormal electrograms (130 of 151) were associated with transmural scar. 86% of abnormal epicardial electrograms had corresponding endocardial sites with BV <1.50 mV, and the remaining could be identified by corresponding low endocardial UV <3.7 mV. They concluded that for identification of epicardial RV scar, an endocardial UV cutoff value of 3.9 mV is more accurate than previously reported cutoff values. Although the majority of epicardial abnormal electrograms are associated with transmural scar with low endocardial BV, the additional use of endocardial UV at normal BV sites improves the diagnostic accuracy resulting in identification of all epicardial abnormal electrograms at sites with <1.0 mm fat (**Venlet 2017**).

In a tertiary referral center's experience, the complication rate of an epicardial approach was acceptable. Patients with nonischemic cardiomyopathies displayed a growing trend for a referral for epicardialablation. The long-term follow-up demonstrated that an epicardial ablation for idiopathic ventricular arrhythmias and BrS was associated with a better prognosis than that for the other etiologies (idiopathic dilated cardiomyopathy, ischemic cardiomyopathy) (**Lin 2018**)

Ablation approach to ventricular fibrillation (VF) (**Singh 2018**)

Trigger elimination	
Premature ventricular complexes (PVCs)	Fascicular Outflow tracts Papillary muscles Moderator band/false tendons
Accessory pathway	
Monomorphic ventricular tachycardia (VT)	
Substrate modification	
Brugada syndrome	Epicardial right ventricular outflow tract

Arrhythmogenic right ventricular cardiomyopathy**ARVC**	Right ventricular free wall (epicardial)
Ischemic cardiomyopathy	Subendocardial scar
Non-ischemic cardiomyopathy	Diffuse scar (epicardial annular left ventricle)
VF rotors	Novel strategy to target rotors mapped during VF

Finally, catheter ablation is a valid therapeutic choice for patients with BrS and paroxysmal AF considering the high success rates, the limitations of the antiarrhythmic drugs and the safety of the procedure, and it should be taken into consideration especially in those patients presenting inappropriate ICD shocks due to rapid AF (**Mugnai 2018**)

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