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Strategies for Catheter Ablation of Premature Ventricular Contractions and Ventricular Tachycardia With Intramural Origins

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Introduction and Challenges

Catheter ablation of premature ventricular contractions (PVCs) or ventricular arrhythmias with intramural origins is not infrequently performed,[1] and the procedure may be more challenging because of the inability to record local electrograms directly in the intramural space. Inadequate presystolic activity, absent QS morphology on unipolar electrograms or diffuse areas of early activation in the endocardium or on epicardial surfaces are often signs of PVCs or ventricular arrhythmia with intramural origins. Other indications of PVC or ventricular arrhythmia with intramural origins could also include suboptimal pace-mapping from the endocardium or epicardial space and lack of PVC suppression—or rather, late suppression—with early recurrence of ventricular arrhythmia or PVC following ablation. This brief review discusses the contemporary technical strategies for catheter ablation of PVCs or ventricular arrhythmias arising from the intramural space.

Current Approaches and Recent Developments

Intramural-origin PVCs and ventricular arrhythmias often require mapping at multiple or opposite sites.[2,3] Common intramural sites of ventricular arrhythmia or PVC origin include an upper septal area between the left ventricular outflow tract, the right and left coronary cusp, and the high septal side of the posterior right ventricular outflow tract. Premature ventricular contractions originating from these sites may manifest with a left bundle morphology with early precordial transition and positive lead l. Activation-mapping of this PVC requires multiple sampling sites, such as the posterior right ventricular outflow tract, above and below the pulmonic cusps as well as at the opposite side of the left and right coronary cusp junction, to help ascertain the earliest site of activation to guide the subsequent ablation strategy. Intracardiac echocardiograms are a helpful visual aid to guide the mapping strategy (Fig. 1).

When ablation is performed at the earliest site of activation, the QRS morphology may change because of an alteration in the preferential conduction to the mappable surface/outflow tract region. Repeat ablation at the same site rarely eliminates the PVC and often requires remapping of the new PVC morphology with the patient in a different anatomic position.

Mapping inside the septal perforators, especially venous perforators, using insulated wires can help clinicians better understand a unipolar signal in the intramural space.[4,5] In outflow-tract ventricular arrhythmias, which could arise

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from areas in close proximity to major coronary arteries, ablation can still be performed safely using an anatomic approach. When ablation is performed in the anatomically adjacent site, a distance less than 12.8 mm between the earliest site of activation within the coronary venous system and the ablation target site predicted success.[6]

Intramural ventricular arrhythmias can also arise from the inferoseptal area or the posterior superior process of the left ventricle (bounded by the septal leaflet of the tricuspid heart valve and the mitral valve annulus, the ostium of the left ventricle, and the noncoronary cusp). To avoid creation of iatrogenic Gerbode defects, this area could be used as an alternative access site from the right atrium to the left ventricle when patients have mechanical aortic and mitral valves (ie, an iatrogenic Gerbode defect could safely be created to facilitate an entry point into the left ventricle for ablation). Ablation in the left ventricle–right atrium junction has been shown to successfully eliminate ventricular arrhythmias from this site.

Abbreviations and Acronyms

PVC premature ventricular contraction

Ventricular arrhythmias can also originate from the midseptum; ablation at this site confers a higher risk of conduction system injury. Targeting ventricular arrhythmias in this region with a direct approach could injure the conduction system as a result of the posterior drift of the catheter with inspiration and lack of stability with physiologic tricuspid valve annulus anteroposterior displacement in systole. Approaching this site by looping the ablation catheter beneath the tricuspid valve's septal leaflet would shield the conduction system from the ablation catheter and provide more stability, which may largely overcome the issue of systolic and respiratory catheter drift, and may help prevent accidental injury to the His bundle.

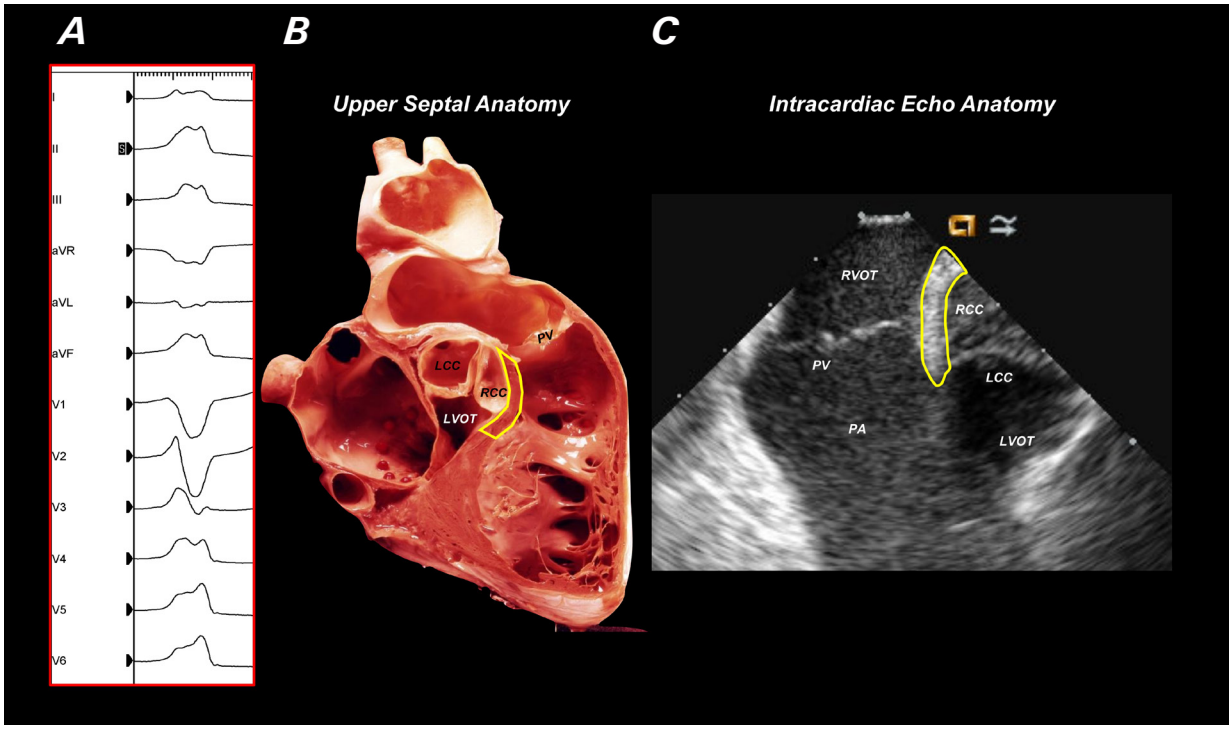

Fig. 1 The anatomic relationship between different left and right ventricular structures when mapping intramural PVCs arising from the upper septum. **A**) A clinical PVC arises from the posteroseptal RVOT-RCC junction. **B**) Heart dissection shows the posteroseptal RVOT-RCC junction area, marked in yellow. **C**) Intracardiac echocardiogram shows the posteroseptal RVOT-RCC junction area, marked in yellow. Intracardiac echocardiography is important for clarifying anatomic relationships and determine optimal mapping and ablation vantage points.

LCC, left coronary cusp; LVOT, left ventricular outflow tract; PA, pulmonary artery; PV, pulmonic valve; PVC, premature ventricular contraction; RCC, right coronary cusp; RVOT, right ventricular outflow tract.

Bailout approaches to target intramural ventricular arrhythmias, including prolonged unipolar radiofrequency ablation (3 to 5 minutes, typically with moderate power of 30 W to 35 W and while carefully monitoring the impedance trend), may lead to success in some cases. Use of lower-ionic-strength irrigants with half normal saline and alcohol septal ablation have also been reported as strategies to target intramural substrate.[7]

Conclusion

Ablation of ventricular arrhythmias or PVCs with intramural origins can be challenging because of both diagnostic mapping difficulty and inadequate energy delivery penetration. Some diagnostic surrogates for intramural-origin ventricular arrhythmias and PVCs, which most commonly arise from the upper septum, midseptum, or inferoseptum, have been described. Cardiac imaging, such as intracardiac echocardiography, is critical to appreciating adjacent anatomic structures and guiding ablation strategy, which often requires mapping of multiple adjacent anatomic sites. Ablation in the midseptum is associated with a higher risk of conduction system injury, and an approach using a reverse loop of the ablation catheter on the ventricular side of the tricuspid valve annulus to ablate on the ventricular side of the tricuspid valve septal leaflet may prevent accidental injury.

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