Accessing the inaccessible: Stereotactic radioablation of premature ventricular complexes originating in the right ventricle in a patient with a mechanical tricuspid valve

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Introduction

Stereotactic body radiation therapy (SBRT) for ventricular tachycardia is a treatment option for selected patients with substrate not amenable to classic approaches. We present a case of successful SBRT in a patient with premature ventricular complex (PVC)-induced cardiomyopathy originating in the right ventricle (RV) in whom access to the RV was limited by a mechanical tricuspid valve.

Case report

A 51-year-old man with Ebstein's anomaly and prior 33 mm mechanical tricuspid valve replacement (Master Series; St Jude Medical Inc, St. Paul, MN) at age 37 presented to the adult congenital cardiology clinic with a chief complaint of increased fatigue and dyspnea on exertion. He first noticed symptoms 1 month prior, when he could not complete mowing his lawn. On physical exam, he was well appearing. Cardiac auscultation detected premature beats and a mechanical click on S1.

A resting electrocardiogram (ECG) showed frequent PVCs with a left bundle morphology, superior axis, and late precordial transition (Figure 1A). In order to assess PVC burden, 48-hour ambulatory ECG monitoring was performed. The monitor showed a single dominant PVC with a burden of 21%. Transthoracic echocardiography was performed, which found unchanged RV dilatation from prior imaging and a new finding of reduced left ventricular ejection fraction of 30%. Metoprolol succinate was started and uptitrated; however, no clinical improvement occurred after 2 months.

The patient underwent noninvasive electroanatomic mapping of the PVC using the CardioInsight Mapping Vest (Medtronic Inc, Minneapolis, MN). Noninvasive mapping localized the PVC to the RV free wall (Figure 1B and 1C), with endocardial access to that chamber precluded by the mechanical prosthesis. Epicardial access was considered but was felt to be at high risk of failure owing to anticipated adhesions from prior sternotomy. As an alternate strategy, SBRT was planned, guided by noninvasive mapping and computed tomography imaging.

Stereotactic body radiation therapy was employed, with a single dose of 25 Gy delivered to the region within the RV free wall. The target volume was delineated by collaboration between electrophysiology cardiology and radiation oncology. The agreed-upon treatment volume was expanded by 5 mm to create a planning target volume. This volume was treated in a single outpatient treatment session. The patient tolerated the procedure well.

On follow-up, a repeat 48-hour ambulatory ECG monitor showed reduction of PVC burden, from 21% to a posttreatment value of 5%. A repeat transthoracic echocardiography

KEY TEACHING POINTS

- Adults with congenital heart disease commonly have lesions affecting the right ventricle. Premature ventricular contractions (PVCs) originating from the right ventricle may be a cause of PVC-induced cardiomyopathy in this patient population.
- The presence of a mechanical tricuspid valve limits entry to the right ventricle for catheter ablation. In this series, stereotactic radiation was used to target the "no-entry" right ventricle.
- Stereotactic radiation is an alternative therapy for ventricular tachycardia not amenable to traditional catheter-based approaches.

KEYWORDS Ablation; Ebstein's anomaly; Radiation; Right ventricle; Ventricular tachycardia
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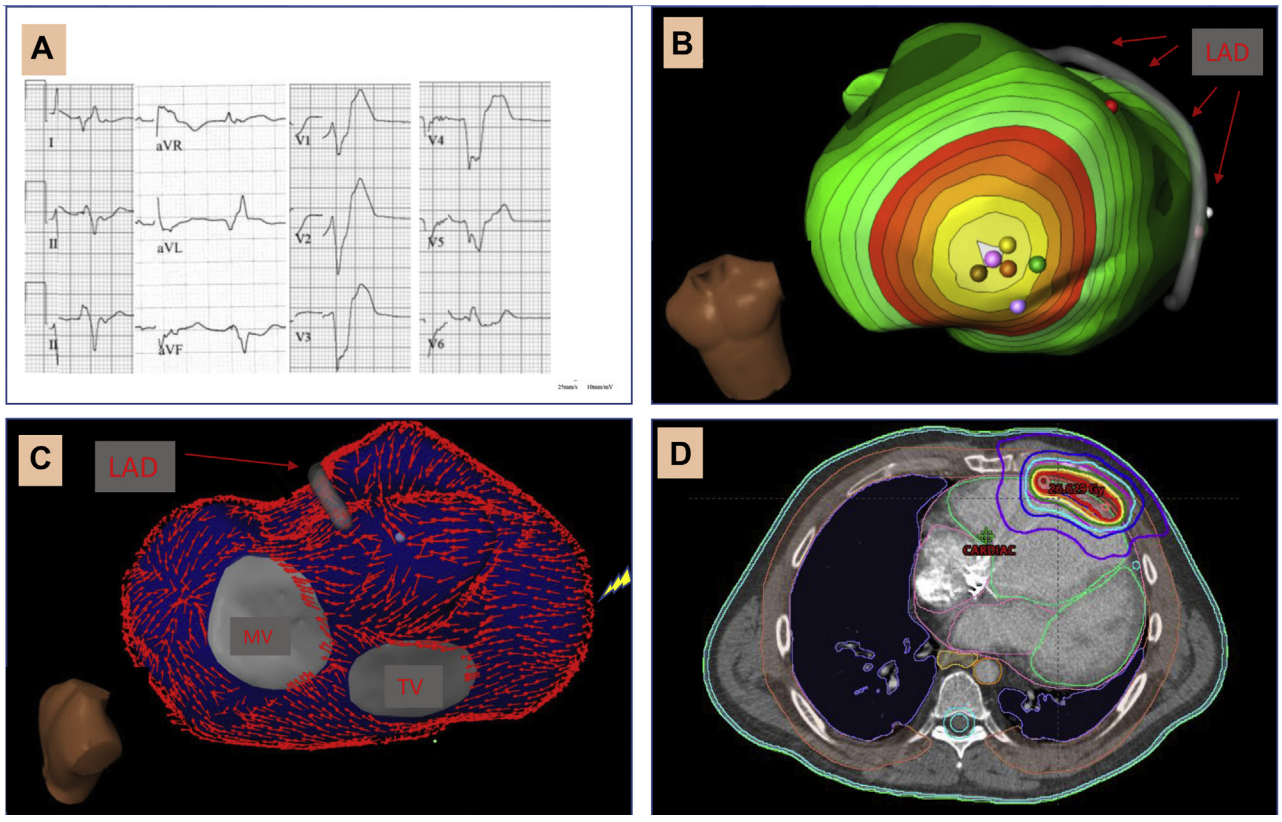

Figure 1 **A:** The clinical premature ventricular contraction (PVC) in a standard 12-lead electrocardiogram. **B, C:** Noninvasive electroanatomical mapping, demonstrating localization of the epicardial breakout of the clinical PVC at the right ventricle lateral wall. The left anterior descending artery (LAD) and the mitral (MV) and tricuspid valve annuli (TV) are included for orientation. **D:** Radiation treatment planning, targeting the region of interest (indicated by *red circle*).

showed left ventricular ejection fraction of 45%–50%. The patient's functional status improved, and he was able to perform daily tasks again (including mowing his lawn).

Discussion

We present a case of a PVC-induced cardiomyopathy owing to a PVC from the RV in a patient with Ebstein's anomaly and a mechanical tricuspid valve. The presence of a mechanical valve is a barrier to catheter-based interventions. Previous strategies to circumvent these barriers have included the use of a transapical approach,[1] direct ventricular puncture,[2] trans-interventricular septal puncture,[3] and transcoronary ethanol injection.[4] All of these methods have been used for access to the left ventricular endocardium; however, no equivalent approach has been reported for the RV. Epicardial approaches are theoretically possible but are fraught with difficulties in those with prior sternotomy owing to adhesions. The use of SBRT for the treatment of a right ventricular PVC has only been reported in 1 patient in the ENCORE-VT trial.[5]

In the typical adult population, PVC-mediated cardiomyopathies are typically mediated by left ventricular PVCs. In a large study of PVC-mediated cardiomyopathy in 37 patients, none had a PVC originating in the non–outflow tract RV.[6] Conversely, in the population of adults with congenital heart disease, right ventricular PVCs are a common but overlooked pathology.

This case represents the first report, to our knowledge, of SBRT to ablate a PVC focus in a chamber rendered inaccessible by a mechanical tricuspid valve. The clinical evidence in favor of SBRT as an alternative to standard ablations is limited but growing.[5,7–9] While the exact mechanism for cellular injury and death is not entirely understood, this modality holds promise for difficult or inaccessible ablation targets.

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