1 Ablation of Ventricular Tachycardia Using a Non-ventricular Site

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1.1 Case Summary

A 49 year old man with idiopathic non-ischemic cardiomyopathy, a left ventricular ejection fraction of <30%, complete heart block after mechanical mitral valve replacement two decades prior for rheumatic heart disease, subsequent biventricular implantable cardioverter defibrillator (ICD) implantation, and permanent atrial fibrillation presented with ventricular tachycardia (VT). He had previously undergone VT ablation, with lesions applied entirely on the inferior wall. Months later, after presenting to the Emergency Department with recurrent symptomatic VT treated with ICD shock, he ultimately came to the electrophysiology lab for study and ablation.

In the EP lab, the patient went into VT spontaneously (VT1), but this rhythm was not hemodynamically tolerated, so it was terminated with overdrive ventricular pacing (Fig. 1.1). VT1 had a matching cycle length of 415 ms, and a far field electrogram morphology matching that of the clinical VT, as retrieved from the patient's device (not shown). With programmed stimulation, a total of six additional VT's were induced, and as each was hemodynamically unstable, pace termination or cardioversion was performed to terminate them.

Given this patient's comorbidities, what elements might one need to consider in planning the procedure regarding access to potential ablation targets? In patients with VT, what ablation strategies can be used effectively? What potential anatomical ablation targets could be considered to address VT1?

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1.2 Case Discussion

Procedural planning is the first vital step to any ablation procedure, including having an appreciation for potential limitations posed by individual patient scenarios in order to minimize risk and maximize success. As epicardial VT is common and well described in patients with non-ischemic cardiomyopathy [1], it would be important to recognize that, in this patient, prior mitral valve replacement may make epicardial access a strategy best performed in collaboration with a cardiac surgeon [2]. In this case, we therefore planned to first attempt an endocardial-only approach. Furthermore, when performing left ventricular (LV) VT ablation, the approach to the LV must be considered ahead of time, and in the context of a mechanical mitral valve, a transseptal approach requiring passage across the mechanical valve is contraindicated. Only a retrograde aortic approach (or surgical transapical approach) can be performed.

Understanding the mapping strategies used in ablation, including their benefits and detriments, is a second critical component to the success of a VT ablation procedure [3]. Entrainment is the gold standard mapping technique in defining reentrant tachycardia circuits, identifying portions of the circuit, and informing the best mechanism-based strategy for ablation [4]. Activation mapping during VT may also further help with VT localization, though in scar-based VT, is usually not helpful in identifying optimal ablation targets [5]. However, thorough entrainment and activation mapping require hemodynamic stability during the VT, which only occurs in the minority of patients. Where entrainment mapping is not possible, pace-mapping is another often used tool to direct ablation, although this technique is more reliable in idiopathic VT's [6]. Finally, targeting of fractionated potentials [7], late abnormal ventricular activity (LAVA) [8], and substrate modification are important mapping and ablation strategies in cases where sustained VT is not inducible or not tolerated [9, 10]. Approaches of pace-mapping and targeting reentrant substrate were used in this patient's ablation, as his VT's were unstable.

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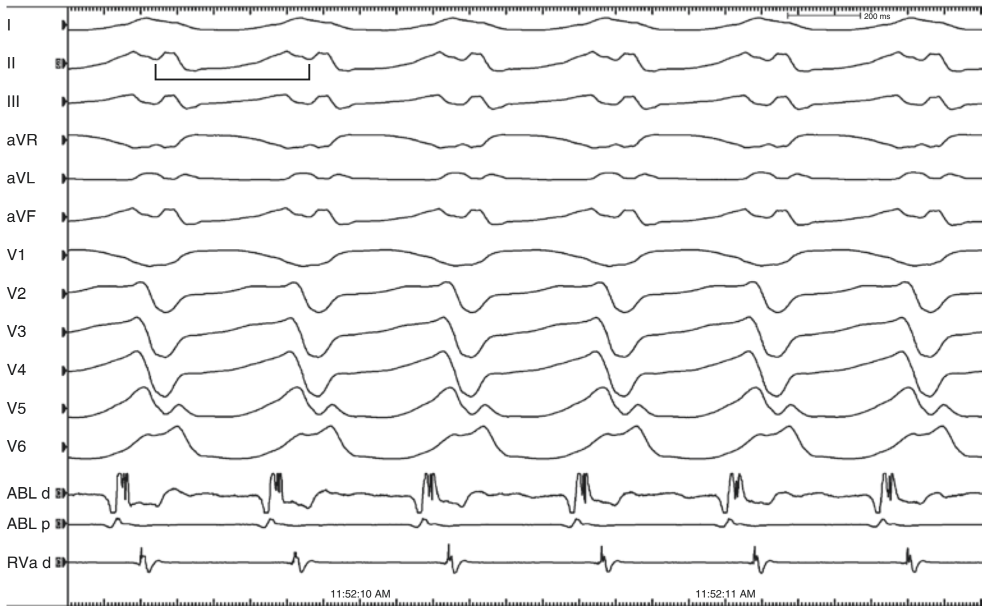

Fig. 1.1 Surface 12-lead electrocardiogram of spontaneous ventricular tachycardia occurring during electrophysiology study. Left bundle branch block, left inferior axis ventricular tachycardia, with a ventricular cycle length of 415 ms (bracket), which matched the cycle length of the patient's clinical ventricular tachycardia stored on his defibrillator

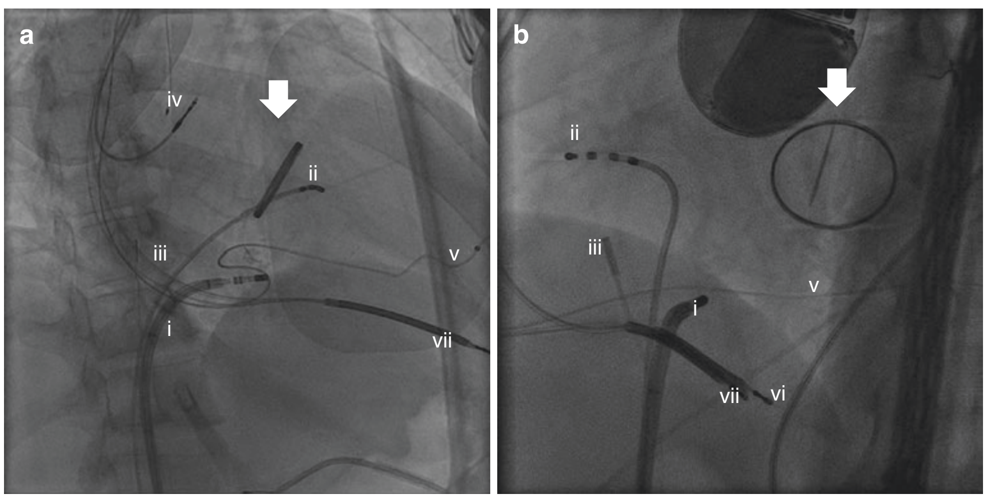

Fig. 1.2 Fluoroscopic images of catheter position to ablate the posterior superior process of the left ventricle from the right atrium. Right anterior oblique (**a**) and left anterior oblique (**b**) fluoroscopic views demonstrating the ablator (i) positioned in the right atrium, opposite the posterior superior process of the left ventricle, diagnostic quadripolar catheter (ii) in the lateral right atrial appendage, and intracardiac ultrasound catheter in the right atrium (iii). The patient's chronic right atrial (iv), coronary sinus (v), abandoned right ventricular (vi) pace-sense leads, and active right ventricular defibrillator lead (vii) are also pictured. There is a mechanical mitral valve in situ (arrows)

In this case, pace-mapping also yielded an interesting finding. The most common endocardial locations for VT ablation are within the right ventricular and left ventricular chambers, and with VT1 having a left bundle branch block-like morphology, its exit site would most likely have been in the RV or the LV side of the interventricular septum. However, after extensive pace-mapping in both the right and left ventricles, a good pace-map for VT1 remained elusive. The coronary vein network offers epicardial access without having to enter the pericardial sac, but the VT1 morphology was still not able to be replicated with pacing in the coronary sinus and middle cardiac vein. An uncommon additional target for VT ablation is the posterior superior process of the left ventricle [11], accessed via the right atrium by placing the ablation catheter anterior to the coronary sinus ostium, in the inferomedial right atrium (Fig. 1.2a, b). Pacing at this location resulted in an excellent pace-map of VT1 (Fig. 1.3a, b). As the tricuspid valve is displaced apically relative to the mitral valve, this small region within the low septal right atrium is directly opposite the extreme basal LV septum. It was from this location that the best pace-map for VT1 was achieved, and radiofrequency ablation was performed in this right atrial position to address this clinical ventricular tachycardia.

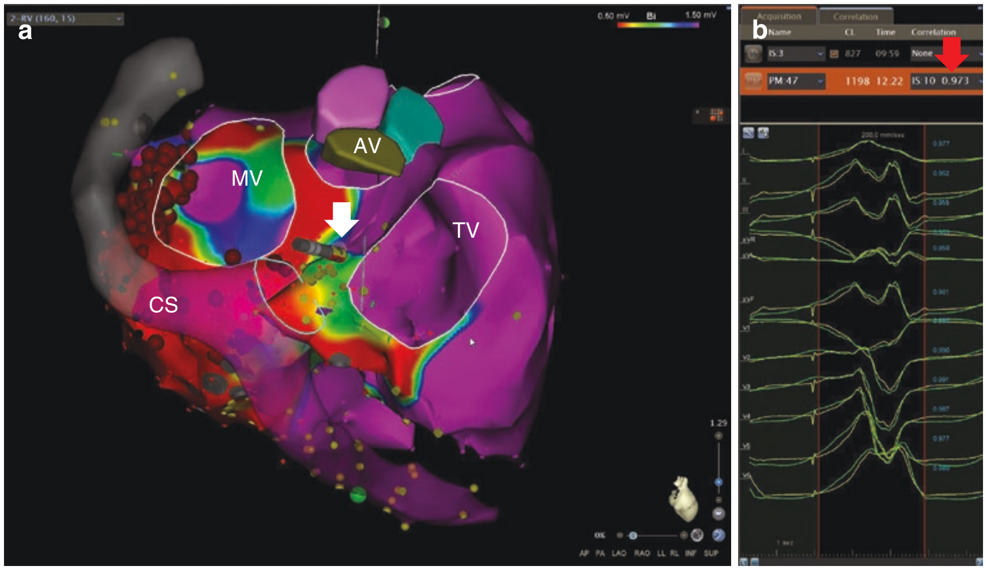

Fig. 1.3 Electrophysiologic mapping images and pace-map comparison to clinical ventricular tachycardia. Anatomic voltage map images from a right posterior view (**a**) and pace-map comparison (**b**) from the ablator (white arrow) positioned in the right atrium on the posterior superior process of the left ventricle. The pace-map match from this right atrial position for the clinical ventricular tachycardia was 97.3% (red arrow). Multiple radiofrequency ablation lesions were placed in this area, and radiofrequency lesions targeting abnormal ventricular myocardial substrate and excellent pace-maps for additional ventricular tachycardias are depicted (red tags). *AV* aortic valve, *CS* coronary sinus, *MCV* middle cardiac vein, *MV* mitral valve, *TV* tricuspid valve

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