CASE REPORT

Ablation of idiopathic ventricular tachycardia by bipolar radiofrequency current application between the left aortic sinus and the left ventricle

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Background Failure to ablate idiopathic ventricular outflow tract tachycardia by radiofrequency current is not uncommon and suggests that non-standard approaches may be required to map and suppress idiopathic ventricular tachyarrhythmias in some patients.

Methods and Results Left and right ventricular activation and pace mapping proved inadequate for radiofrequency application in a patient with idiopathic ventricular outflow tract tachycardia. Presystolic activity was recorded at the left aortic sinus of Valsalva, and the QRS complex recorded at this location during pacing showed few differences compared with that recorded during tachycardia. Radiofrequency current application at this site transiently suppressed the tachycardia. Following new mapping of the left ventricle outflow tract, radiofrequency application just below the aortic valve in close proximity to the previous aortic application site transiently abolished the arrhythmia. Finally, bipolar radiofrequency application between the distal electrode of the aortic catheter and the distal electrode of a second catheter placed in the left ventricular subaortic area permanently suppressed the tachycardia.

Conclusion Bipolar radiofrequency application between the aortic sinus of Valsalva and the left ventricle could be an alternative approach in occasional patients with idiopathic ventricular outflow tract tachycardia resistant to conventional left ventricular and aortic root unipolar radiofrequency application.

Key Words: Ventricular tachycardia, catheter ablation, electrophysiology, sinus of Valsalva, bipolar radiofrequency ablation.

Introduction

Failure to ablate idiopathic ventricular outflow tract tachycardia by radiofrequency current is not uncommon[1–3]. This contrasts with the high success rate of catheter ablation for most supraventricular tachycardias in the absence of structural heart disease[1] and suggests that non-standard approaches may be required to map and suppress idiopathic ventricular tachyarrhythmias in some patients[5,6]. This report presents an alternative to the standard approach for ablation of idiopathic ventricular tachycardia when no appropriate sites for radiofrequency application are found in the right or left ventricular outflow tracts.

Case history

A 66-year-old woman without apparent structural heart disease was admitted for symptomatic ventricular ectopy ablation. She had a 3-year history of recurrent palpitations resistant first to atenolol, and later to verapamil and flecainide. The patient had no coronary risk factors apart from mild systemic hypertension which was controlled with angiotensin-converting
Figure 1  Surface ECG from a patient with ventricular tachycardia (VT) and no apparent heart disease during VT, and during pace mapping from the left aortic Valsalva sinus (PM-Ao) and from the left ventricular outflow tract (PM-LV) at the eventually successful ablation sites.

Figure 2  Surface ECG leads I, aVF and V1 and local electrograms recorded from the His bundle area (HBEd), the right ventricular apex (RVa) and the ablation catheter (ABL 1–2: bipolar distal electrode pair recording; ABL 1–: unipolar distal electrode recording) at the eventual aortic (Ao) and left ventricular (LV) sites. Note the presystolic bipolar activity and the unipolar electrogram ‘QS’-like morphology at both sites.
enzyme. Physical examination was unremarkable except for frequent bigeminal pulse. Monomophic ventricular bigeminy and accelerated idioventricular rhythm with the same QRS morphology were demonstrated on several resting ECGs recorded on different days. The ectopic QRS complex exhibited a left bundle branch block pattern and a right inferior axis (Fig. 1). Routine biochemical and haematological analysis, chest X-ray and transthoracic echocardiography were normal except for degenerative mitral and aortic valve disease without significant valvular dysfunction. Echocardiography did not reveal any abnormalities of the right or left ventricle. A ventriculogram showed left ventricle dimensions and contractions to be normal. No anatomical abnormalities were shown on coronary angiography which suggested a mechanism other than myocardial ischaemia as the cause of ventricular ectopy and tachycardia.

At electrophysiological study, three catheters were introduced through the right femoral vein and placed in the high right atrium, His bundle area and right ventricular apex. Monomorphic ventricular bigeminy and short-lasting non-sustained ventricular tachycardia runs with the same QRS complex morphology were incessant but were transiently suppressed following rapid continuous ventricular stimulation (Fig. 1). A 7F tetrapolar ablation catheter was introduced through the right femoral vein and placed in the right ventricular outflow tract. Bipolar and unipolar recordings were obtained from the distal dipole and the distal electrode, respectively. Pacing was performed from the distal dipole. As neither presystolic activity nor adequate pace mapping were found in this area, the ablation catheter was relocated into the left ventricle through the right femoral artery. Presystolic activity of -5 ms was found just below the aortic valve but the ECG recorded during pacing at this location showed significant differences compared with that recorded during ventricular tachycardia and no radiofrequency current was delivered. The ablation catheter was then moved to the aortic root and placed into the left aortic sinus of Valsalva. Presystolic activity of -20 ms was recorded and the ECG recorded during pacing at this location showed a QRS complex

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**Figure 3** Right (a) and left (b) anterior oblique fluoroscopic images of the ablation catheter position at the radiofrequency application site demonstrated by angiographic injection through a Judkins catheter placed into the left aortic Valsalva sinus. Right (c) and left (d) anterior oblique fluoroscopic images of the two ablation catheters placed at the successful bipolar radiofrequency application sites in the left aortic Valsalva sinus and in the subaortic area of the left ventricle.

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similar to that recorded during ventricular tachycardia (Figs 1 and 2). At this point, and without removing the ablation catheter, a left coronary Judkins catheter was introduced through the left femoral artery and, to avoid inadvertent radiofrequency application to the origin of the main coronary trunk, was placed in the left coronary artery. Three radiofrequency current applications were delivered at progressively higher temperature settings (mean temperature up to 73°C and delivered power 25 W) and the incessant ventricular ectopy was abolished for up to 31 min (Fig. 3). However, due to late ventricular ectopy recovery, the catheter was again moved to the left ventricle, where a radiofrequency pulse was delivered to the site of the earliest bipolar local activation (−5 ms) just below the aortic valve in close proximity to the previous aortic application site (Figs 1 and 2). Radiofrequency application at this ventricular site transiently abolished ventricular ectopy which returned 3 min after energy pulse termination. Following new mapping, a second application (mean temperature 76°C and delivered power 33 W) at this site showed a similar outcome. Finally, the left coronary artery catheter was removed and replaced by a second ablation catheter that was moved to the initial application site in the left aortic sinus. Bipolar radiofrequency current was applied between the distal electrode of the catheter placed in the aorta and the distal electrode of the catheter placed in the left ventricle (Fig. 3). Ventricular ectopy terminated 14 s after the onset of energy delivery without further resumption. No ventricular arrhythmias were observed during the following 72-h ECG monitoring except for low-density polymorphic ventricular ectopy. The predischarge echocardiogram displayed no manifest changes in valvular anatomy or function. At 4-month follow-up, the patient had no arrhythmia-related symptoms, and 24-h ECG monitoring showed no ventricular arrhythmia recurrence. Transeosophageal echocardiography and magnetic resonance imaging at this time showed no apparent deterioration of left main coronary artery or aortic valve anatomy or function.

**Discussion**

Different factors explaining the relatively high failure rate of ablation of idiopathic ventricular outflow tract tachycardia have been suggested. Some authors have proposed an epicardial origin of the arrhythmogenic substrate in some of these cases[3]. Other authors have found that the arrhythmogenic substrate came from the left, rather than from the right, ventricular outflow tract in a small group of patients[7-9]. More recently, it has been reported that, in some patients, ablation can only be achieved by radiofrequency energy application from the aortic root[10,11]. This was the case of the present patient in whom the best activation and pace mapping sites were found in the left aortic sinus of Valsalva, suggesting a subaortic-epicardial or a mid-myocardial arrhythmogenic substrate origin (Fig. 4). In fact, a mid-myocardial, rather than an epicardial, origin was most likely in this case because ventricular ectopy was also transiently suppressed by radiofrequency application on the left ventricular endocardium (Fig. 4). Therefore, in this patient, the arrhythmogenic substrate was most likely to be located somewhere between the ventricular endocardial and the mid-myocardial aortic application sites, probably being closer to the latter than the former because ventricular ectopy suppression was achieved earlier and lasted longer during radiofrequency application at the latter site.

Unipolar and bipolar radiofrequency application close to the atroventricular rings or to the subpulmonary area have not been significantly associated with the development of valvular or coronary complications[2,4]. Similarly, radiofrequency current application in the left aortic sinus did not apparently damage the aortic valve or the left coronary artery in this patient. Nevertheless, the safety of this approach should be studied prior to recommending its widespread use.

In summary, bipolar radiofrequency application between the aortic sinus of Valsalva and the left ventricle could be an alternative approach in occasional patients with idiopathic ventricular outflow tract tachycardia resistant to conventional left ventricular and aortic root unipolar radiofrequency application.

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References