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Case Report
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Ablation of Ventricular Tachycardia Arising from the Great Cardiac Vein – A Rare Cause of Coronary Artery Injury

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We herein report a case of coronary artery injury during epicardial ablation of ventricular tachycardia (VT), and describe an effective method to combat such an injury. A male patient presented with recurrent palpitations which was refractory to medications, with a history of clinically documented VT during the symptomatic episodes. The ablation procedure was performed at the great cardiac vein/anterior interventricular vein (GCV/AIV) junction, in part because pace mapping showed a 12/12 match, and activation map of VT demonstrated the earliest activation site at GCV/AIV junction. During the initial radiofrequency energy application at 18 watts at a flow rate of 17ml/min, there was ST elevation in the anterior leads. Coronary angiogram revealed damage to the left anterior descending artery due to heat penetration, which was immediately after the flow rate was increased to 25 ml/min and the ST elevation disappeared in the anterior leads.

Key Words: Catheter ablation • Coronary artery complications • Ventricular tachycardia

INTRODUCTION

Epicardial ventricular tachycardias (VT) are amenable to ablation from the coronary sinus and its branches. However, there are concerns regarding intramural venous thrombus formation, vein rupture and coronary artery injury during ablation. We report a rare case of coronary artery injury, and an effective method to combat it.

CASE REPORT

A 30-year-old male patient presented with recurrent palpitations for 1 month, which was refractory to medications. The patient had a structurally normal heart (cardiac magnetic resonance imaging – normal), with documented episodes of ventricular tachycardia. The morphology of this VT was QRS 180 ms, right bundle branch block, R wave II, III, aVF, rS in 1 and aVL, the absence of q in V1, R/S in V1 > 2, and the maximal deflection index (MDI) was 0.6 with no QRS transition (Figure 1, Panel A). Previously, the patient had undergone a failed endocardial ablation at another hospital. After informed written consent was obtained, a second electrophysiology study and ablation was performed. Under fluoroscopic guidance, multielectrode catheters were inserted percutaneously through the femoral vein into the right ventricle, and geometry was constructed using a Carto 3 System (Biosense Webster, South Diamond Bar, CA, USA). A 7-Fr quadripolar irrigated catheter (Thermocool) with a 4-mm distal electrode, embedded thermistor, interelectrode spacing of 2-5-2 mm, and deflectable tip was used for mapping and ablation. Right ventricular extrastimuli (RVS1S2) was used to induce the clinical ventricular tachycardia. Initially, the left ventricular outflow tract

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(LVOT) and aortic cusps were mapped and the earliest activation site was not present. Based on the morphology, epicardial ablation through the coronary sinus was considered. Coronary angiogram was done prior to the ablation, which revealed patent coronaries and the ablation catheter was 6 mm away from left anterior descending artery (LAD). The pace mapping at the great cardiac vein/anterior interventricular vein (GCV/AIV) junction showed 12/12 match and activation map of VT also demonstrated the earliest activation site at GCV/AIV (Figure 1, Panel B). Initial radiofrequency (RF) energy delivered was 18 watts at a flow rate of 17 ml/min and temperature was limited to 40 °C. There was slight ST elevation in leads V1, V2 and V3 with ST depression followed by a wide-based T wave in the inferior leads, and a drop in impedance of around 10 ohms (Figure 1, Panel C) during ablation. Repeat coronary angiogram (Figure 2) revealed LAD spasm probably due to heat penetration. As the patient had Type IV LAD, i.e. wrapping around left ventricular apex, damage to the LAD led to ST-T changes in the inferior and anteroseptal leads. As the GCV/ AIV junction showed a good pace map and activation map, ablation was continued and immediately the flow rate was increased to 25 ml/min and the ST-T changes disappeared (Figure 1, Panel D). A subsequent angiogram showed the patent LAD and absence of spasm. Overall, the VT was successfully ablated. VT was not inducible with isoproterenol infusion and RVS1S2 pacing. After three years of ablation, patient is asymptomatic and doing well. In view of the absence of symptoms, neither stress test nor repeat coronary angiogram was done.

DISCUSSION

When there is lack of earlier signals at the aortic

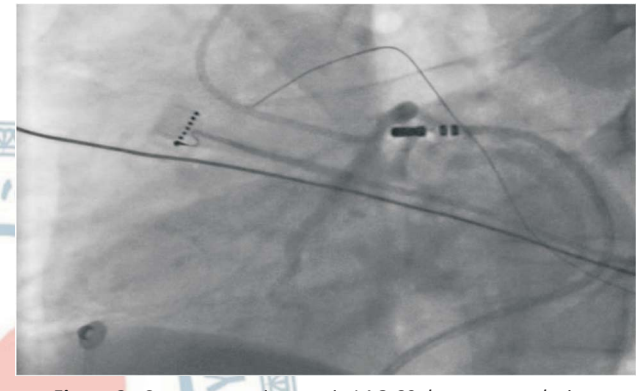

Figure 2. *Coronary angiogram in LAO 60 degrees angulation.*

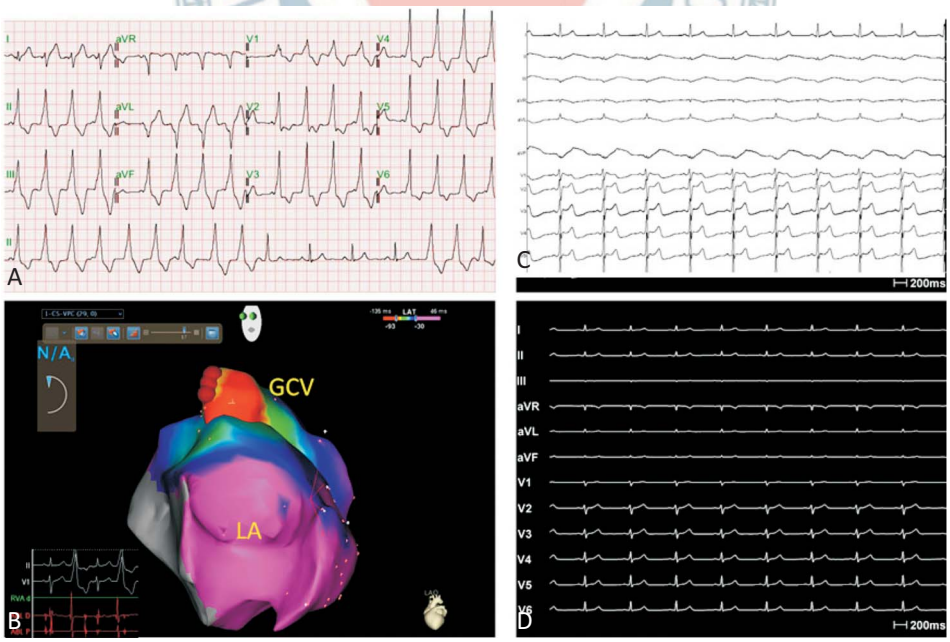

Figure 1. *Panel A: Figure shows surface electrocardiography (ECG) of ventricular tachycardia. Panel B: Figure reveals activation map of ventricular tachycardia from great cardiac vein with electrogram on ablation catheter. Panel C: Figure demonstrates ST elevation in leads V1, V2 and V3 with ST depression followed by wide-based T wave in inferior leads. Panel D: Figure discloses surface ECG with normalization of ST segment after adjustment of flow rate of irrigated catheter.*

cusps, coronary sinus is the best route for ablation of LVOT VT. However, coronary angiogram should be performed to assess the proximity of the coronary arteries to the proposed ablation site and to delineate coronary veins in the levo phase.[1] To avoid futile applications of RF energy, and to reduce the possibility of any potential complications from radiofrequency catheter ablation delivered from the left sinus of Valsalva or within the coronary venous system, it is important to assess whether or not idiopathic ventricular tachycardias can be ablated from the left sinus of Valsalva, or the left ventricular outflow tract endocardium, or from the coronary venous system. A detailed analysis of 12-lead ECG during VT would be helpful in localizing the origin. An S wave in lead I, tall R wave in the inferior leads, MDI > 0.55 and precordial transition zone near leads V1-3 have been reported as the electrocardiography (ECG) findings of idiopathic ventricular tachycardias arising from the distal portion of coronary venous system.[2] In such a setting, the earliest ventricular activation is always recorded within the coronary venous system, as in our case. According to Santangelli et al., the three ECG criteria for successful epicardial ablation are: 1) absence of q in V1, 2) R/S > 2 in V1, and 3) Q in aVL/aVR > 1.85. The presence of at least two criteria was associated with successful epicardial ablation, with 100% sensitivity and 72% specificity.[3] The VT of our patient fulfilled the first two criteria, and ablation was successful within the coronary sinus.

There are concerns about the possibility of venous thrombosis, venostenosis, vein rupture and coronary artery injury during catheter ablation within the coronary sinus. The transition point of GCV and AIV are in close proximity to coronary arteries, especially LAD. Left anterior descending artery runs in close proximity to AIV.[4] The presence of perivascular fat would tend to mitigate against damage to coronary arteries by RF (radiofrequency) ablation, but nevertheless it is prudent to minimize RF energy. At the same time, heat dissipation can occur to adjacent coronary artery if flow rates are reduced, as in our case. Increasing rate of irrigation flow may be necessary to permit the desired power delivery without heating the electrode tip. At high flow rates, tip and tissue temperatures will diverge more widely and will actually reduce tissue temperatures.[5]

CONCLUSIONS

The coronary sinus approach of radiofrequency ablation must be considered for failed endocardial ablation cases. Coronary artery injury should be anticipated during ablation of GCV close to (Left Ventricle) LV summit, and must be done at low energy settings and appropriate flow rates.

TEACHING POINTS

1. Coronary sinus approach should be considered for failed cases of ventricular tachycardia ablation arising from great cardiac vein.
2. During ablation of LV summit ventricular tachycardia from coronary sinus, one must be aware of likely coronary artery injury.
3. The flow rates should be adjusted according to the ablation site and the energy applied.

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