Ablation Catheter Entrapment in the Mitral Valve Apparatus During Ablation of Premature Ventricular Complexes

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Abstract

Entrapment of the ablation catheter in the mitral valve apparatus during transaortic ablation of premature ventricular complexes is a rare complication that usually requires surgical removal. Random rotating and pulling of the catheter exacerbate the extent of the entrapment, causing chest pain and a drop in blood pressure. The catheter can be loosened by changing the direction of the vector at the tip of the catheter, pulling in the reverse direction and rotating. We describe the case of the thought process and catheter maneuvers used to diagnose, loosen, and remove a trapped catheter.

Introduction

Radiofrequency catheter ablation is an effective therapy that is increasingly performed in patients with symptomatic premature ventricular complexes (PVCs). Catheter entrapment is a rare complication involving circular and high-density mapping catheters, decapolar catheter entrapment in chiari networks, thebesian valve, pulmonary vein and mitral valve (MV) apparatus. Herein, we describe the case of an ablation catheter entrapment in the MV apparatus during an electrophysiological procedure for PVCs.

Case

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A 66-year-old man with recurrent palpitations was referred to our institution. A 12-lead electrocardiogram (ECG) showed normal sinus rhythm and frequent PVCs with right bundle branch block morphology, transition in V1, rS pattern in lead I, inferior axis and negative QRS in leads aVR and aVL (Figure 1A). A high PVC burden of 29% (28054/95641 beats) with four runs of non-sustained ventricular tachycardia detected during routine 24-hour electrocardiogram recording. Preprocedural transthoracic echocardiography and chest radiography revealed no structural heart disease or anatomical anomalies.

An electrophysiological study was performed under conscious sedation after written informed consent was obtained. According to the morphology of the PVCs, a single 3.5-mm ablation catheter (ThermoCool SmartTouch, Biosense Webster Inc., Diamond Bar, CA) was advanced via the right femoral artery to the aortic root and the geometry of the aortic cusp was reconstructed using the 3-dimensional electroanatomic mapping system (CARTO 3, Biosense Webster Inc., Diamond Bar, CA).

Radiofrequency current was delivered (irrigation rate 17 mL/min; 43) with a power of 30–40 W) at the earliest activation site (EAS), which preceded the surface ECG by 14ms in the left coronary cusp (LCC). PVCs were not eliminated. The ablation catheter was then advanced across the aortic valve to map the subvalvular endocardium. Since the site of early activation was not obtained in the subvalvular region, radiofrequency energy was applied to the corresponding site of the earliest activation marked in the LCC and resulted in brief suppression. The right ventricular outflow tract (RVOT) was mapped and showed no early activation. The ablation catheter was advanced further into the great cardiac vein (GCV) and failed to reach the distal end of the GCV. The left ventricular outflow tract was remapped and a fractionated presystolic potential preceded the surface ECG by 16ms and a steep negative morphology in the unipolar electrograms at the aortic-mitral continuity (AMC) using the reversed C-curve method via the aortic retrograde method. Radiofrequency current was applied at this site and PVCs were eliminated within 4 seconds (Figure 1).

However, with counterclockwise rotation to maintain the catheter on the ablation target, the catheter suddenly shifted in reverse and became entrapped (Figure 2). Further repetitive gentle retraction and advancement with clockwise and counterclockwise rotation maneuvers under the mapping system and fluoroscopy encountered resistance and failed to release the catheter. During this attempt, the patient presented chest pain, diaphoresis, palpitations and shortness of breath. The patient’s blood pressure dropped from 107/53 to 54/29 mmHg and heart rate increased from 55 to 98 beats per minute. The ECG revealed sinus rhythm with ST segment elevations in the leads aVR, V1 and V2, depressions in inferior leads and V3 to V6. Dopamine was immediately injected while cardiac fluoroscopy was performed, showing no pericardial effusion, and invasive coronary angiography was performed simultaneously, showing no significant stenosis or spasm.

With dopamine discontinued, the patient’s blood pressure gradually stabilized and the chest pain was mildly relieved, possibly due to the absence of traction on the catheter. Emergency transthoracic echocardiography revealed mild mitral regurgitation without pericardial effusion. The tip of the catheter was inserted into the MV apparatus using a special reversed alpha curve and directed toward the base of the ventricle.

The catheter was advanced to provide additional support and to bring the catheter tip toward the apex. The catheter tip was then rotated clockwise with gentle traction from a special reversed alpha curve to a reversed C-curve. Then apply more traction with a clockwise rotation to straighten and release the catheter tip. Visual inspection revealed that the proximal part of the catheter body and the tip of the 8F sheath were folded, and the tip of catheter was uncovered by tissue (Figure 2). Repeat echocardiography showed no MV injury or pericardial effusion. A few minutes later, the ST segment returned to the isoelectric line and the chest pain relieved.

After 3 months follow-up, the patient was asymptomatic and a 24-hour Holter monitor detected a PVC burden 0.3% (292/112764 beats) without any antiarrhythmic medication.

Discussion

We report a rare complication of ablation catheter entrapment in the MV apparatus released by catheter manipulation during PVCs ablation. Most case reports describe multipolar catheters, such as circular map-
ping or PentaRay (Biosense Webster) catheter becoming entrapped during pulmonary vein isolation, usually requiring cardiac surgery to remove the catheter.\textsuperscript{2,3} The first report of catheter entrapment in the MV apparatus was released by straightening and pulling the catheter tip with echocardiographic guidance during ablation of a left-sided accessory pathway.\textsuperscript{4} In a previously reported case\textsuperscript{5}, an ablation catheter became entrapped in the chordae tendineae of the MV due to multiple maneuvers during ventricular tachycardia ablation via a transaortic approach with the catheter tip attached to the base of the left ventricle, and multiple manipulations of the catheter failed to remove it, which ultimately required cardiac surgery to remove.

In our case the head of the short sheath was folded as it passed subcutaneously, causing the body of the catheter to be folded as well. During the subaortic manipulation, counterclockwise torque was applied to maintain the catheter at the target, which ultimately resulted in the tip of the catheter falling in the opposite direction into the MV apparatus. It is preferable to use a long sheath when performing subaortic valve specimens to provide more support and facilitate catheter manipulation.

Once catheter entrapment is identified, the catheter should not be rotated or pulled randomly as this may exacerbate the degree of entrapment or damage the MV structure\textsuperscript{6} and catheter integrity.\textsuperscript{5} In addition, forceful traction may cause chest pain and transient drop in blood pressure.\textsuperscript{4} In our case, the integrity of the catheter was not compromised after withdrawal, there was no tissue adhering to the catheter tip, and echocardiography in the immediate postoperative period and during follow-up suggested no damage to the MV.

The direction of catheter entanglement should be carefully analyzed under fluoroscopy and echocardiography. If gentle traction of the catheter is ineffective, advancing may change the force vectors on the catheter and may help release the entrapped catheter. Subsequently, the catheter is loosened by manipulating the catheter in the reverse direction, loosening the loop entanglement to a half-loop, then the half-loop to a straight line, and finally extracting the catheter. Surgery is required if the tip of catheter becomes knotted\textsuperscript{7} or difficult to extract.\textsuperscript{8,9}

Conclusions

This report highlights the need for gentle manipulation of the catheter during the procedure and the potential risks involved in subaortic valve manipulation, preferably with the support of a long sheath. Methods for removing a catheter include gentle pulling and advancing while rotating the catheter in the reverse direction, rather than randomly pulling and rotating the catheter after it becomes stuck.

Reference


baseline EAS at AMC EAS in LCC EAS below LCC EAS in RVOT

Figure 1 Baseline morphology of PVCs (A) in which the EAS potential recorded at the AMC preceded the onset of the QRS complex by 16ms(B), which was earlier than that for the EAS potential recorded in the LCC(C) and its corresponding location in the subvalvular region (D) and in the RVOT (E). The catheter tip was located on AMC using the reversed C-curve method via the aortic retrograde method (F and G). The deep blue circle represents the EAS at the LCC. The pink circle represents the EAS at the AMC. The red circle represents the site of the ablation at the LCC (upper red circle) and at the AMC (lower red circle). premature ventricular complexes= PVCs; EAS=earliest activation site; AMC=aortic-mitral continuity; MAP1-2=ablation catheter distal electrode pair; MAP1=unipolar; LCC=left coronary cusp; RVOT=right ventricular outflow tract; RAO=right anterior oblique; LAO=left anterior oblique.
Figure 2 The catheter tip deflected in the reverse direction and became entrapped in the MV in a special reversed alpha curve (A-D). The catheter tip was rotated clockwise with gentle traction from a special reversed alpha curve to a reversed C-curve (E and F). Visual inspection revealed that the proximal part of the catheter body and the tip of the 8F short sheath were folded (G). The white circle represents the site of the left main coronary artery. The deep blue circle represents the EAS at the LCC. The olive green circle represents a relatively early activation site. The red circle represents the site of the ablation at the LCC (upper 4 red circles) and at the AMC (lower red circle). MV = mitral valve; EAS = earliest activation site; LCC = left coronary cusp; AMC = aortic-mitral continuity; RAO = right anterior oblique; LAO = left anterior oblique.