COMPLEX CASE STUDY

Catheter Ablation for D-TGA Related Atrial Flutter Using Intracardiac Guided Echocardiography

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Introduction

Individuals with complete transposition of the great arteries (D-TGA) following atrial redirective reconstructive surgery, such as a Mustard or Senning baffle, can develop a multitude of late complications. By the time individuals reach the second to fourth decade of life, systemic ventricular failure, baffle leaks or obstruction, atrial arrhythmias, ventricular arrhythmias, and sudden cardiac death (SCD) can result.1-3 Etiology of SCD has been attributed to tachyarrhythmias rather than bradyarrhythmias, given the observation that patients with D-TGA and pacemakers are not protected from SCD. Additionally, supraventricular tachycardia (SVT) is considered to be a risk factor for the development of ventricular arrhythmias and SCD. Data from implantable cardioverter-defibrillator (ICD) registries of D-TGA patients indicate that SVT often coexists or precipitates malignant ventricular arrhythmias leading to ICD therapy or SCD.4 Therefore, SVT suppression for individuals with atrial redirective reconstructive surgery with systemic ventricular failure is of extreme importance.

Advanced cardiac imaging, such as computed tomography (CT) and cardiac magnetic resonance imaging (MRI) merged with electroanatomic mapping, has been utilized to assist with complex ablations. More recently, a new imaging addition is the use of two-dimensional (2D) intracardiac echocardiography (ICE) image slices, which are manually reconstructed into three-dimensional (3D) images and merged with preprocedure cardiac CT or MRI. This allows for not only a real-time 3D image acquisition but can also provide needed anatomic details for certain ablations.5 Here, we present a patient with D-TGA, systemic ventricular failure, severely deformed atrial baffle, and recurrent near-syncpe related to sustained narrow complex tachycardia.

Case study

The patient is a 31-year-old man with D-transposition of the great arteries, status post Blalock-Hanlon septectomy and Mustard procedure performed at age 3. He had done well, until the development of his first episode of narrow QRS tachycardia at a cycle length of 260 ms. This was associated with palpitations, chest discomfort, shortness of breath, hypotension, and the sensation of "a near-death experience". Adenosine infusion revealed atrial flutter, confirming the clinical tachycardia was atrial flutter with 1:1 atrioventricular conduction (Figure 1). A cardioversion was required to terminate the arrhythmia. Evaluation included a contrast-enhanced MRI, which showed markedly misshapen and enlarged atrial baffles without leak or stenosis and a hypertrophied systemic ventricle with an ejection fraction estimated at 30%. Management for his tachycardia included a β blocker and amiodarone. Unfortunately, he developed acute pulmonary toxicity related to the amiodarone. He was managed on high-dose β blocker alone but had frequent recurrent breakthrough episodes of tachycardia associated with syncope. He was referred for catheter ablation.

We prospectively anticipated challenges in catheter manipulation related to the atrial baffle anatomy based on his MRI, which incompletely characterized the physiologic venous or right atrium (RA) and revealed a very abnormal physiologic systemic or left atrium (LA). Thus, the ablation was performed utilizing CARTO-Sound merge of MRI, ICE and contact mapping provided by a 3.5 cm-tip ThermoCool (Biosense Webster, Inc.,...
Diamond Bar, CA) ablation catheter. Diagnostic multipolar electrode catheters were placed via the femoral vein into the RA and pulmonary ventricle (PV) (Figure 2a,b). A 10F 5.5–10 MHz phased-array SoundStar ICE catheter (Biosense Webster) was positioned in the RA. Using CARTO-Sound image integration (Biosense Webster) and SoundStar ICE catheter in combination with our MRI-rendered image, a complete 3D reconstruction of the RA as well as the LA and baffle were created (Figure 3a,b). The RA was very small, the
baffle had a reversed C shape with the limbs connecting to the superior vena cava and inferior vena cava, and the body of the reversed C extended over the mitral annulus. The inferior atriotomy suture line was posterior to the coronary sinus (CS) ostium, such that the CS ostium remained with the tricuspid valve (TV) in the RA.

A ThermoCool mapping and ablation catheter was initially positioned in the RA, and a real-time electroanatomic map was used to register the MRI image using CARTO-merge. Programmed extrastimulation easily induced an atypical atrial flutter with a cycle length of 280–240 ms, with 2:1 and occasional 1:1 AV conduction; 1:1 AV conduction was associated with hypotensive systolic blood pressures ranging 50–60 mmHg. Activation mapping from the RA along the inferior vena cava, mitral annulus, baffle chamber, and connection to the superior vena cava yielded less than half of the tachycardia cycle length (TCL). Therefore, access to the physiologic LA and baffle was achieved in a retrograde aortic approach via the systemic ventricle (SV) and across the TV. The entire TCL was encompassed within the LA with a typical head-meets-tail activation converging on the apparent suture ridge from prior atriotomy (Figure 4a,b). Concealed entrainment with a postspacing interval of 272 ms, nearly equal to the TCL, was obtained from the apparent suture ridge (Figure 4c, indicated with arrow). Radiofrequency applications at the roof of the suture line terminated the tachycardia (Figure 4d and position of the ablation catheter in Figure 2a,b). A line of radiofrequency applications was placed from the roof of the atriotomy, through the site of tachycardia termination and connected to the tricuspid annulus (Figure 4a,b). Differential pacing from either side of the ablation line confirmed bidirectional conduction block.

**Follow-up**

Following ablation, the patient remained on β blocker therapy and eventually underwent implantation of an

**Figure 3**: Reconstructed real-time anatomic contact mapping of the major cardiac chambers in (A) right anterior oblique view and (B) superior right anterior oblique. AO: aorta; PA: pulmonary artery; PulmV: pulmonary vein; PV: pulmonary ventricle; SV: systemic ventricle; SVC: superior vena cava.
ICD for primary prevention. At 6-month follow-up the patient was clinically free from sustained arrhythmias.

Discussion

This case highlights the importance of adequate pre-procedure evaluation as well as real-time ultrasound-guided imaging with intracardiac electroanatomic mapping to guide ablation for individuals with complex anatomy, in this case related to congenital heart disease. Due to surgical- and time-altered anatomy, standard imaging utilizing intracardiac mapping systems in combination with fluoroscopy can be inadequate for satisfactory definition of cardiac structures in these cases. Often there are unanticipated ridges, folds, and pockets, making the required target tissue contact for mapping and ablation more challenging and decreasing the likelihood of a successful ablation. For individuals with TGA, intra-atrial reentrant tachycardias represent the most common arrhythmia. In one series, the majority of reentrant tachycardias were TV isthmus-dependent and utilized the TV as the central barrier. However, at least one-third of intra-atrial reentrant tachycardias after Mustard surgery will use other barriers, such as this case, in which the intra-atrial suture line served as the critical isthmus. The likelihood for successful ablation will be maximized if careful preprocedure planning and intraprocedure imaging guide the ablation effort. We found that the use of complementary real-time ICE with CMR-CARTO merge facilitated efficient and successful ablation for a malignant arrhythmia.

References

