# Subvalvular catheter ablation of the cavotricuspid isthmus in a patient with Ebstein's anomaly and tricuspid valve replacement

Roberto G. Gallotti, MD,* Kevin M. Shannon, MD,*† Jeremy P. Moore, MD, MS, FHRS*†

*From the *Division of Pediatric Cardiology, UCLA Medical Center, Los Angeles, California, and †Ahmanson/UCLA Congenital Heart Disease Center, Los Angeles, California.*

## Introduction

Ebstein's anomaly (EA) is a congenital malformation of the tricuspid valve that often requires tricuspid valve replacement (TVR). EA patients have a high burden of atrial tachycardia owing to a combination of prior surgical incisions and abnormal atrial hemodynamics. Catheter ablation for atrial tachycardia, especially when the cavotricuspid isthmus (CTI) is a critical component of the circuit, may be quite challenging due to positioning of the bioprosthetic valve over various portions of this isthmus.[1,2] Here we present a case of successful catheter ablation that required needle puncture to reach an otherwise inaccessible portion of the CTI for a patient with EA after surgical TVR.

## Case report

A 36-year-old man with EA who underwent initial TVR at age 6 years and then a second TVR at age 16 (#35 Hancock porcine valve; Medtronic Inc, Minneapolis, MN) developed symptomatic intra-atrial reentrant tachycardia (IART) at the age of 20 years. Although the surgical details at the time of the initial bioprosthetic valve were not available, a computed tomography angiography showed that the valve was at the level of the true atrioventricular valve annulus with the right coronary artery coursing along its perimeter. He underwent attempted catheter ablation of CTI-dependent IART at the age of 27 years, which proved to be ineffective owing to an inability to achieve conduction block despite >100 irrigated radiofrequency lesions. He continued to experience episodes of atrial flutter requiring synchronized cardioversion multiple times per year. He subsequently developed bioprosthetic valve stenosis in the setting of depressed right ventricular (RV) systolic function, and returned to the catheterization lab for a repeat attempt at catheter ablation as well as transcatheter TVR. The etiology of the RV dysfunction was unclear, but was felt to represent irreversible RV remodeling from many years of tricuspid regurgitation in combination with repeated episodes of atrial tachycardia.

## Description of procedure

Right and left femoral venous access was obtained via the Seldinger technique and 8 French and 7 French sheaths were placed. A complete right heart catheterization prior to catheter ablation revealed an elevated mean right atrial pressure of 16 mm Hg and a mean gradient of 8 mm Hg across the stenotic bioprosthetic valve. Electroanatomic mapping was performed via the CARTO system using a PentaRay catheter (Johnson & Johnson, New Brunswick, NJ). Two distinct focal atrial tachycardias with cycle lengths of 280 ms and 320 ms were localized posterior to an atriotomy scar. Both were successfully ablated using a ThermoCool FJ curve SmartTouch catheter (Johnson & Johnson, New Brunswick, NJ), prior to a third tachycardia being induced, which was consistent with CTI-dependent IART based on surface electrocardiography and was later confirmed by activation mapping and entrainment techniques. Catheter ablation of the CTI was assisted with a steerable Agilis sheath (St. Jude Medical, Saint Paul, MN), but despite termination of tachycardia on multiple occasions near the bioprosthesis and demonstration of bidirectional block, isthmus conduction invariably recovered. Pacing on either side of the lesion set with activation mapping was consistent with residual conduction through an area of protected atrial myocardium closely related to the bioprosthetic valve. The mapping catheter was advanced into the right ventricle and was used to explore the inferior portion of the annulus[3]; however, no atrial myocardium was encountered in this location (Figure 1).

A RAMP sheath (St. Jude Medical, Saint Paul, MN) was positioned in the right atrium against the bioprosthetic valve at the site of the previously created CTI line in a left anterior oblique view, and a BRK needle was (St. Jude Medical, Saint Paul, MN) advanced to the inferior edge of the valve ring. Under fluoroscopic guidance, the BRK needle was advanced as far as possible, using contrast to delineate the valve and to

**KEYWORDS** Congenital heart disease; Intra-atrial reentrant tachycardia; Catheter ablation; Ebstein's anomaly; Tricuspid valve replacement (Heart Rhythm Case Reports 2017;3:336–339)

**Address reprint requests and correspondence:** Dr Jeremy P. Moore, Department of Pediatrics, Division of Cardiology at the UCLA Medical Center, 200 Medical Plaza Dr, Suite 330, Los Angeles, CA 90095. E-mail address: jpmoore@mednet.ucla.edu.



http://dx.doi.org/10.1016/j.hrcr.2017.04.008

## KEY TEACHING POINTS

- Without preoperative or intraoperative catheter ablation, cavotricuspid isthmus (CTI)–dependent atrial flutter can develop after tricuspid valve replacement for patients with congenital heart disease.
- Owing to segments of protected atrial myocardium, catheter ablation may not be possible from either the atrial or the ventricular aspect after surgical bioprosthetic valve placement.
- Subvalvular puncture is challenging, but can be performed in order to gain access to otherwise inaccessible tissue and achieve permanent bidirectional CTI block in this situation.

ensure placement of the needle as close as possible to the bioprosthesis (Figure 2). The sheath was then advanced into the defect created by the transseptal system, allowing placement of the mapping catheter through the outermost portion of the sewing ring of the bioprosthetic valve and into a region of viable atrial myocardium. Two 60-second lesions of irrigated energy (peak energy 47 watts, mean of 41 watts) at this location resulted in complete and permanent bidirectional block (Figure 3).

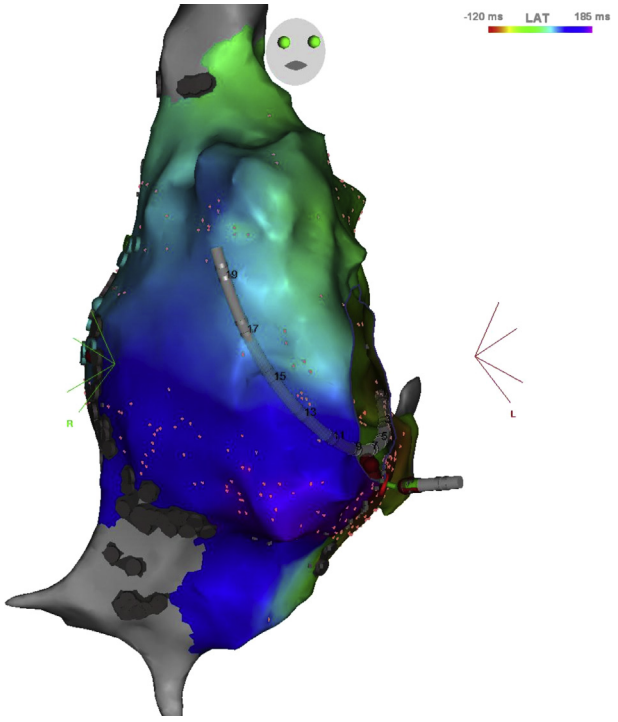


**Figure 1** Representative CARTO map showing the ablation catheter advanced into the right ventricle and retroflexed below the tricuspid valve annulus. Atrial myocardium was not accessible using this approach.

At this point, the patient underwent a tricuspid valve-in-valve replacement with a 26 mm Sapien 3 valve (Edwards Life Sciences, Irvine, CA). During this portion of the case, 2 further focal tachycardias were noted with cycle length 490 ms and 600 ms. After transcatheter valve placement, these were mapped using the PentaRay catheter just medial to the previously described atriotomy scar. Further energy application resulted in the elimination of both tachycardias. At the end of the case there were no inducible arrhythmias with atrial stimulation, both with and without isoproterenol. Now 8 months after the procedure, the patient remains free from tachycardia recurrence.

## Discussion

Supraventricular tachycardia in adult patients with congenital heart disease is highly prevalent secondary to surgical incisions, prosthetic material, and altered hemodynamics. When concomitant surgical ablation has not been performed at the CTI, TVR may pose a nearly insurmountable obstacle to catheter ablation of late arrhythmias that are prone to develop in this location. Likewise, commonly employed surgical valve repairs such as the Carpentier method and the Cone operation both involve posterior longitudinal plication of the atrialized right ventricle and portions of the right atrium, which can potentially result in inaccessible tissue in

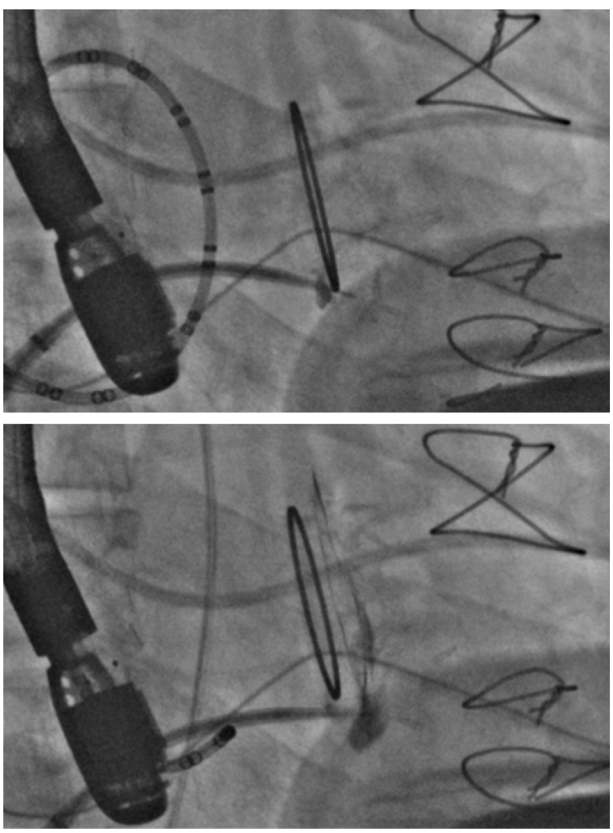

**Figure 2** Right anterior oblique view showing the relationship of the transseptal system to the porcine valve. The BRK needle is unsheathed and has punctured the valve ring, followed by contrast staining of the bioprosthesis (the valve struts are faintly outlined by contrast in this view).

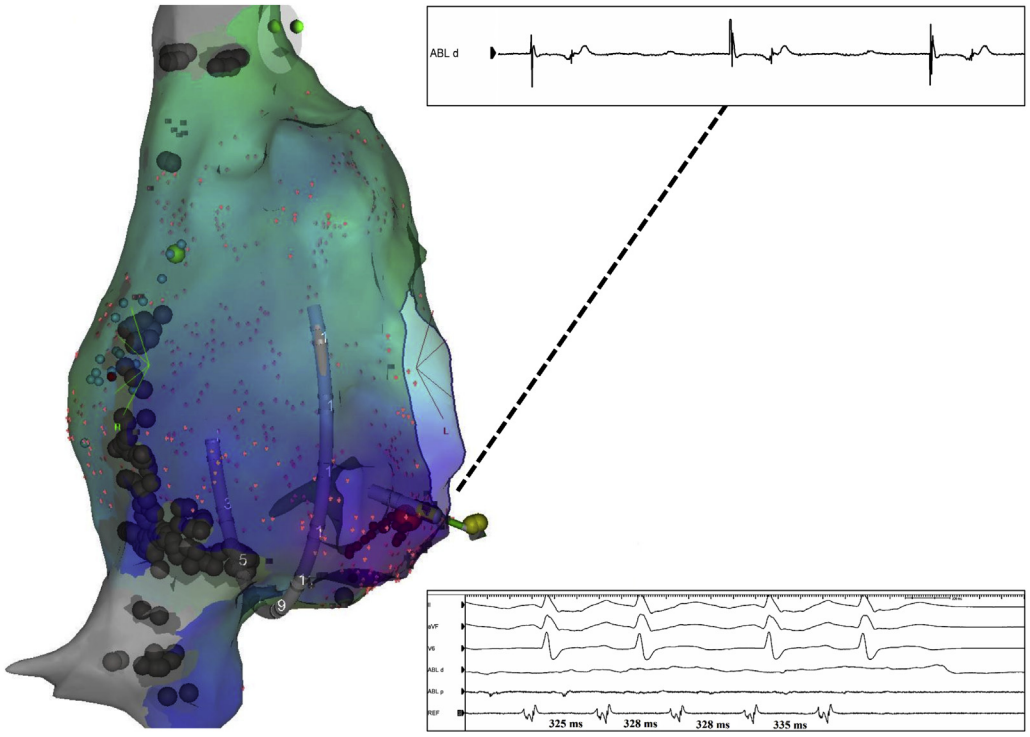


**Figure 3** Representative CARTO image of the cavotricuspid isthmus (CTI)–dependent intra-atrial reentrant tachycardia (IART) with additional lesions below the bioprosthetic valve from inside a newly created iatrogenic channel. The catheter shadow is shown at the final successful ablation site, which is distal to the earlier lesions. *Large red marker* indicates location of previous transient isthmus block. *Yellow markers* indicate location of ineffective lesions placed at the ventricular aspect of the valve. **Upper insert:** An intracardiac tracing demonstrates the pacing stimulus followed by sharp atrial and then far-field ventricular electrograms below the valve before ablation. **Lower insert:** There is cycle length prolongation and attenuation of the local electrogram prior to termination of the CTI-dependent IART during energy application below the bioprosthetic valve.

the CTI, along the true atrioventricular valve annulus for accessory pathways, or when targeting ventricular tachycardia substrates.[4,5] For patients with prior TVR, prior case reports have described successful catheter ablation of the CTI after TVR, most commonly from the atrial aspect[6,7] or less commonly from the ventricular aspect of the valve.[3] The present case is unique in that the culprit atrial myocardium was completely protected by the bioprosthetic valve and could not be approached from either aspect. Successful interruption of the isthmus ultimately required entry of the mapping catheter into an iatrogenic channel within the outermost portion of the valve ring.

To our knowledge this is the first description of the use of a transseptal puncture system to complete CTI ablation below a bioprosthetic valve in a patient with congenital heart disease. In the present case, collateral damage to the valve was not a significant concern, as irreversible dysfunction had already supervened and there were plans to replace the valve during the same procedure. Inadvertent puncture and damage to the right coronary artery was also considered. The transseptal needle was therefore advanced as close as possible to the outside edge of the valve ring, in order to avoid dissection into the atrial myocardium. Contrast injection stained the valve and confirmed a safe site of puncture and subsequent catheter ablation. This new technique may be considered in similar situations in which the CTI is bounded by a bioprosthetic tricuspid valve with an inability to interrupt the isthmus using a more conventional approach.

## Conclusion

TVR may pose considerable challenges for catheter ablation of late atrial tachycardia for patients with congenital heart disease. Here, we demonstrate that CTI block can be safely achieved with the use of a transseptal system to gain access to protected myocardium below a bioprosthetic valve. Not only should preoperative electrophysiology study be considered, but empiric surgical ablation of the CTI at the time of bioprosthetic valve replacement is proposed for all cases in order to preempt this potential problem.

## References

1. Bridgewater BJ, Levy RD, Hooper TL. Mitral valve prosthesis disk embolization during transeptal atrioventricular junction ablation. J Interv Cardiol 1994; 7:535–537.
2. Mandawat MK, Turitto G, el-Sherif N. Catheter entrapment in the mitral valve apparatus requiring surgical removal: an unusual complication of radiofrequency ablation. Pacing Clin Electrophysiol 1998;21:772–773.
3. Traykov VB, Pap R, Bencsik G, Makai A, Forster T, Saghy L. Ventricular location of a part of the right atrial isthmus after tricuspid valve replacement for Ebstein's anomaly: a challenge for atrial flutter ablation. J Interv Card Electrophysiol 2009;25:199–201.
4. Silva JP, Baumgratz JF, Fonseca L, Afiune JY, Franchi SM, Lopes LM, Magalhaes DM, Vila JH. Ebstein's anomaly: results of the conic reconstruction of the tricuspid valve. Arq Bras Cardiol 2004;82:212–216.

5. Carpentier A, Chauvaud S, Mace L, Relland J, Mihaileanu S, Marino JP, Abry B, Guibourt P. A new reconstructive operation for Ebstein's anomaly of the tricuspid valve. J Thorac Cardiovasc Surg 1988;96:92–101.
6. Li CH, Lin YJ, Chen SA. Cavotricuspid isthmus ablation guided by electroanatomic mapping in a patient with a mechanical tricuspid valve replacement after a total correction of tetralogy of Fallot. J Cardiovasc Electrophysiol 2011; 22:938–940.
7. Goto E, Nakamura K, Sasaki T, Naito S. Successful ablation of cavotricuspid isthmus-dependent atrial flutter guided by contact force vector in a patient after a tricuspid valve replacement. Indian Pacing Electrophysiol J 2014;14:306–308.