Electroanatomical high-density mapping of different tachycardias in the right atrium after heart transplantation

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Introduction

After heart transplantation patients may develop different types of atrial arrhythmias in the recipient as well as in the donor atrium.1-3 This case report illustrates the use of a multipolar mapping catheter for fast, high-resolution mapping2 of different tachycardias occurring simultaneously in both atria.

Case report

A 43-year-old patient after orthotopic heart transplantation for dilated cardiomyopathy (anastomosis of left atrium, right atrium, pulmonary artery, and ascending aorta) as well as ablation of the cavitricuspid isthmus (CTI) for typical atrial flutter presented with symptomatic persistent supraventricular tachycardia (Figure 1). Echocardiography showed normal left ventricular function and dilated right atrium and right ventricle. A standard catheter was placed in the coronary sinus (CS), showing a regular atrial tachycardia (AT) with activation from proximal to distal CS. The CS catheter was then replaced in the high right atrium and a 20-pole high-density catheter (DuoDeca catheter 2-2-2, St Jude Medical, Fullerton, CA) was positioned on the CTI (distal poles at the atrioventricular junction, proximal poles at the connection of the isthmus with inferior vena cava; see also Figure 2 for this catheter position). Electroanatomical mapping was performed with Ensite NavX (St. Jude Medical, Fullerton, CA). The intracardiac signals revealed the presence of 3 distinct AT cycle lengths (CL): AT 1 shown on the CS catheter with a CL of 240 ms; AT 2 on the proximal DuoDeca catheter, CL 480 ms; and AT 3 on the distal DuoDeca catheter, CL 378 ms (Figure 1). Ventricular CL was 756 ms.

There were 3 different tachycardias in this patient with 3 different CL. AT 3 was to be a recurrence of typical isthmus-dependent atrial flutter conducted 2:1 in the ventricle, as was confirmed by post-pacing interval after entrainment maneuver from the distal DuoDeca catheter placed at the anterior CTI (donor part of the right atrium). As a result of ablating the CTI, AT 3 stopped and converted in sinus rhythm with 1:1 conduction in the ventricle without influencing AT 1 and 2 (Figure 3; now the DuoDeca catheter placed in the high right atrium and the CS catheter in the CS). Consequently, both the donor and the recipient atria were completely electrically isolated, which was also confirmed by the electroanatomical map (Figure 2) showing a scar area after transplantation (suture of both right atria).

CL of AT 1 was exactly half of the CL of AT 2. The electroanatomical map of the right atrium showed a low-voltage area between the high and low right recipient atrium, representing a zone of slow conduction where AT 1 was conducted 2:1 into the lower right recipient atrium (on pole 19/20 2:1 conduction, on pole 15/16 1:1 conduction, and on pole 17/18 both; Figure 1). The signal on pole 17/18 appears very fragmented, which strengthens the hypothesis of a zone of slow conduction.

Because the recipient’s atrium was electrically clearly separated from the donor’s atrium, we decided not to further ablate the AT in the recipient’s atrium.

Twelve-lead electrocardiogram after ablation shows sinus P waves in leads V1 to V6 and flutter F waves in lead II (Figure 3).

Discussion

Because modern heart surgery offers numerous options to treat even complex structural heart diseases, an increasing number of patients with challenging tachycardias present at the electrophysiology lab. Atrial flutter and atrial fibrillation occur in up to 20% of patients after heart transplantation and are associated with increased mortality.4 Atrial tachyarrhythmias may present in both the recipient’s and the donor’s atria, and, especially if they occur simultaneously,3 it is crucial to identify and treat the clinically relevant tachycardia. That done, a concomitant nonclinical tachycardia, if present in an

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electrically dissociated area without influence on the overall rhythm of the heart, can be left untreated.3,5

In our patient, AT (AT 1) persisted in the recipient part of the right atrium after successful ablation of typical atrial flutter and conversion to sinus rhythm in the donor part of the right atrium, proving electrical dissociation between the recipient’s and the donor’s right atria. This allows the hypothesis that it was not the suture between both right atria that constituted the arrhythmic substrate for AT 1, but anatomical structures of the recipient’s right atrium, such as, possibly, crista terminalis. A low-voltage area was identified between the high and low right recipient atrium with concomitant very fragmented signals at that site (Figure 2, left image), possibly representing a zone of slow conduction where AT 1 was conducted 2:1 into the lower right recipient atrium (as shown on intracardiac electrograms; Figure 1, right image). Although we have no proof that AT 2 resulted from a 2:1 conduction of AT 1 through a zone of slow conduction, the fact that the CL of AT 2 was exactly double the CL of AT 1 strongly suggests this hypothesis. The mechanism causing this supposed zone of slow conduction allowing a 2:1 conduction remains unclear; one possibility might be an additional scar owing to an incision during heart surgery.

Because the surgical report states that the recipient’s heart was excised at the level of the atroioventricular sulcus, we can only assume that most of the recipient’s right atrium (ie, posterior and lateral wall and therefore, presumably, crista terminalis, as well as high right atrium with the upper part of the anterior wall) was preserved. This assumption is also consistent with the voltage map of the right atrium, where scar tissue representing the suture of both right atria was detected in close proximity to the atroioventricular junction (Figure 2).

However, conversion in sinus rhythm after ablation of the CTI with ongoing tachycardia in the recipient’s part of the right atrium suggests sinus nodal tissue present in the donor part of the right atrium. Unfortunately, the surgical report available for our patient does not provide exact information regarding the amount and part of atrial tissue deriving from the donor.

Because the donor’s and recipient’s atria were clearly electrically dissociated (supposedly because of the suture), which was ultimately shown after successful ablation of the typical atrial flutter (AT 3), we assumed that mechanical dyssynchrony would be present with the recipient’s atrium in both tachycardia and sinus rhythm, which further contributed

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**KEY TEACHING POINTS**

- Complex arrhythmias may occur especially after heart surgery.
- Precise and differentiated mapping is crucial to identify and ablate complex tachycardias.
- High-density mapping is made possible by the use of multipolar catheters.

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**Figure 1** Baseline electrocardiogram and intracardiac tracings of different atrial tachycardias. There are 3 different cycle lengths of 240, 480, and 378 ms acquired from atrial tachycardia (AT) 1, AT 2, and AT 3, respectively. Coronary sinus (CS) catheter placed in the high right atrium, DuoDeca catheter placed on the cavotricuspid isthmus (for catheter position see also Figure 2).
Figure 2  Left: Catheter position in the 3-dimensional map, right anterior oblique projection of the right atrium (RA) map. Enlarged RA can be seen. Red dots indicate cavotricuspid isthmus (CTI) ablation line; the DuoDeca catheter is placed on the CTI (with the distal pole next to the tricuspid valve and the proximal pole next to the inferior vena cava). The donor’s part of the atrium shows normal voltage (defined above 0.2 mV in purple); the supposed suture between donor and recipient atrium shows scar tissue (below 0.2 mV in gray). The red arrow indicates the site of the fractionated electrogram, which represents the zone of slow conduction where atrial tachycardia 1 was conducted 2:1 to the lower right atrium. Right: Activation map of the typical atrial flutter, right anterior oblique view.

Figure 3  Sinus rhythm in the donor’s atrium, atrial tachycardia in the recipient’s atrium with intracardiac tracings and electrocardiogram. Coronary sinus (CS) catheter placed in the CS, DuoDeca catheter placed in the high right atrium.
to our decision to leave the AT in the recipient’s atrium untreated.

Conclusion

Former heart operation is a favoring condition for developing arrhythmias along scar tissue. The presence of 2 different tachycardias in both the recipient’s and the donor’s atria after heart transplantation is a challenging electrophysiological situation demanding precise evaluation, as made possible by an electroanatomical reconstruction with a 3-dimensional mapping system. Multipolar catheters can be used to perform high-density mapping and detect simultaneously occurring arrhythmias in a limited space.

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