Noninvasive Electrocardiographic Mapping for Prediction of Tachycardia Mechanism and Origin of Atrial Tachycardia Following Bilateral Pulmonary Transplantation

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ECG Mapping for Atrial Tachycardia. **This is a case of atrial tachycardia 2 years after pulmonary transplantation. After excluding right atrial involvement, tachycardia origin was located in a scar region medial to the anastomosis of the left inferior pulmonary donor vein. Tachycardia mechanism was microreentry. Noninvasive electrocardiographic mapping performed before the ablation procedure matched with results of invasive Carto mapping and predicted both tachycardia mechanism and origin. We discuss arrhythmia mechanism found after pulmonary transplantation and benefit of noninvasive electrocardiographic mapping for procedure planning.** *(J Cardiovasc Electrophysiol, Vol. 23, pp. 553-555, May 2012)*

atrial tachyarrhythmias, catheter ablation, electroanatomical mapping, noninvasive electrocardiographic mapping, pulmonary transplantation

Introduction

After heart surgery involving the atria different kinds of arrhythmias can be observed. In planning an ablation procedure, it is helpful to know beforehand whether tachycardia origin is in the left or right atrium and whether it is a macroreentrant or focal/microreentrant tachycardia. Noninvasive electrocardiographic mapping is a promising tool for diagnosis of both tachycardia origin and mechanism.[1]

Case Report

Bilateral pulmonary transplantation was performed in a 53-year-old man because of severe, obstructive lung emphysema. Extracorporeal circulation was established by atriocaval and aortic cannulation. Both ipsilateral superior and inferior donor pulmonary veins were prepared as single venous cuffs and sewed into the corresponding regions of the receiver heart. A postsurgical episode of atrial fibrillation was responsive to amiodarone. Left ventricular function and pulmonary arterial pressure were normal. The patient recovered well without major complications.

During routine follow-up 2 years later asymptomatic atrial flutter with cycle length 230 milliseconds and 2:1 atrioventricular conduction was diagnosed (Fig. 1A). Anticoagulants were prescribed and beta blocker begun for rate control. In an electrophysiological study, entrainment mapping excluded cavotricuspid isthmus and right atrium to be part of tachycardia circuit. Shortest postpacing intervals were obtained in the midcoronary sinus. After exclusion of left atrial thrombi, a second procedure with transseptal puncture was done. Beforehand, electrocardiographic mapping[1] with ecVUE (CardioInsight Technologies, Cleveland, OH, USA), a noninvasive electrocardiographic mapping platform that generates electroanatomic maps of epicardial activation, was performed. Electrocardiographic mapping showed a focal origin of tachycardia located medial to the left inferior pulmonary vein (Fig. 2). Carto activation mapping of the left atrium during the second electrophysiology procedure confirmed origin of the tachycardia medial to the left inferior pulmonary vein, spreading centrifugally throughout the left atrium (Figs. 3A and 4). Left atrial voltage map demonstrated signals with normal amplitude throughout the body of the left atrium and very low amplitude, far-field potentials within the donor pulmonary vein cuffs, behind the suture lines (Fig. 3B). Mapping of donor pulmonary veins with the lasso catheter showed no electrical reconnection. Tachycardia originated from the border of the suture line, and fractionated, low amplitude potentials were recorded at that site (Fig. 1B,C). More than 75% of tachycardia cycle length was recordable within a few millimeters favoring scar-related microreentry as the tachycardia mechanism. Ablation at the site of fractionated signals immediately terminated tachycardia, which thereafter was noninducible.

Discussion

Atrial arrhythmias are common after lung transplantation with rates up to 32%.[2] Arrhythmias occurring later than 1 year after surgery are mainly atrial tachycardias and are found in 11% of patients. Mechanism of atrial tachycardias

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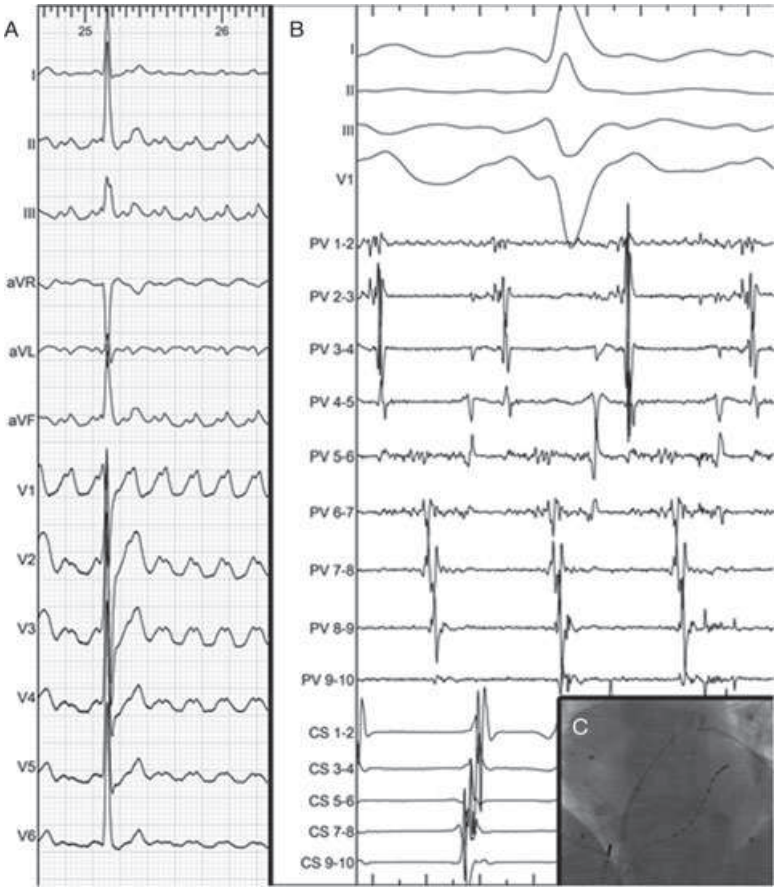

Figure 1. *A: Twelve-lead ECG of atrial tachycardia. B: Electrocardiograms from leads I, II, III, and V1 and intracardiac electrograms of a lasso catheter (PV 1–10) and coronary sinus catheter (CS 1–10). C: The lasso catheter is at the antrum of the left inferior pulmonary vein. On electrodes PV 5–6 and PV 6–7 of the lasso catheter fragmented potentials covering more than 75% of tachycardia cycle length are recorded simultaneously.*

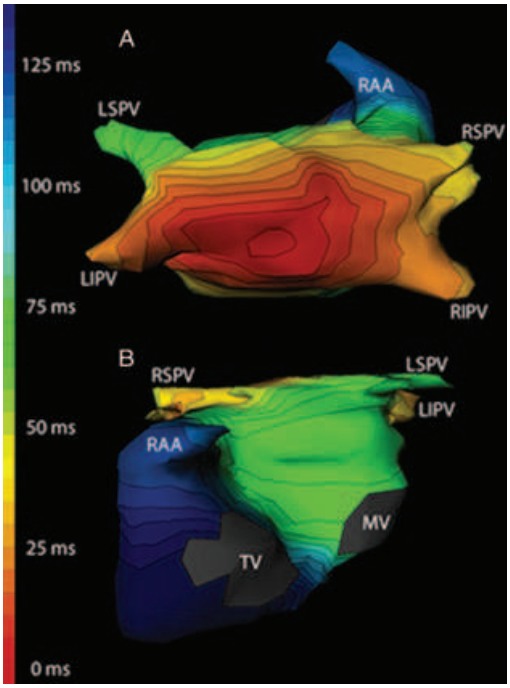

Figure 2. *Electrocardiographic mapping demonstrating left and right atrial activation during tachycardia. Origin of tachycardia is medial to the left inferior pulmonary vein (darkest red area) and spreading centrifugally from that site. Right atrium is activated last. A: Posterior view. B: Right anterior oblique view. Color bar shows coding of activation time. LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; MV = mitral valve; RAA = right atrial appendage; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein; TV = tricuspid valve.*

can either be focal atrial tachycardia originating from the pulmonary vein/left atrium anastomoses or macroreentrant tachycardia.[2] The latter can involve left atrial roof, mitral isthmus, or right atrium especially in case of right atrial cannulation/atriotomy during surgery. Atrial tachycardia originating from the donor pulmonary vein with conduction across suture lines has also been described.[3] Therefore, different tachycardia mechanisms and both left and right atrial tachycardias can be encountered after pulmonary transplantation.

With noninvasive electrocardiographic mapping it is possible to generate a detailed map of cardiac electrical activity for each heartbeat. The electrocardiographic mapping system consists of a multielectrode sensor array that records 250 electrocardiograms from the torso and uses the anatomy of the epicardial surface obtained from a computed tomography scan to reconstruct the signals on atrial or ventricular epicardial electroanatomic maps.[1] In the atria, electrocardiographic mapping has been used to map sinus rhythm activation,[4] focal atrial tachycardia,[5] macroreentrant atrial tachycardia,[6] and atrial fibrillation.[7]

In this case, a first electrophysiology procedure was done and right atrial origin of tachycardia excluded. This procedure could have been avoided if electrocardiographic mapping would have been performed initially. Focal left atrial origin of tachycardia was demonstrated by electrocardiographic mapping and confirmed by invasive mapping. Although discrimination of true focal tachycardia from microreentry may not be easy with electrocardiographic mapping, this is less important as both tachycardias can easily be ablated once tachycardia origin is identified. Macroreentrant atrial tachycardia can also be illustrated by

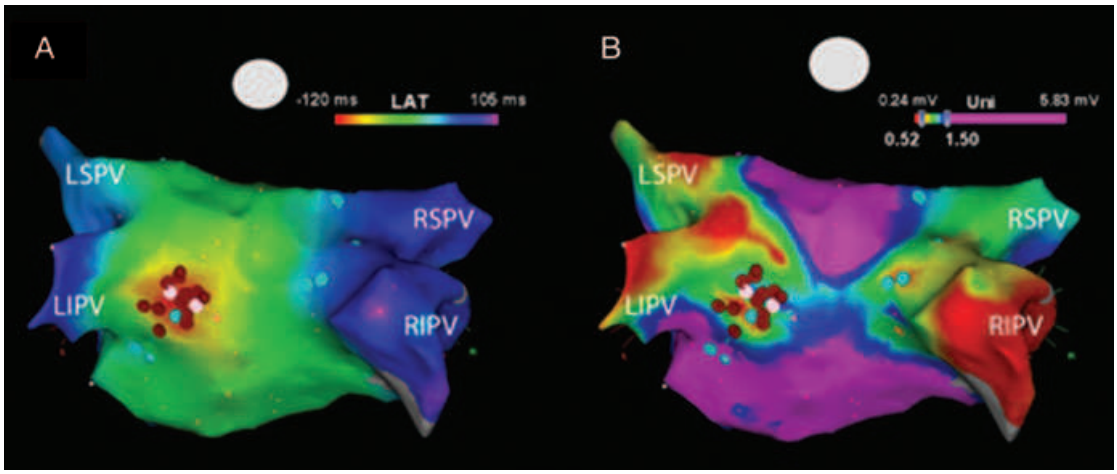

Figure 3. *Carto maps of left atrium, posterior view. A: Activation map showing earliest activation medial to the left inferior pulmonary vein and spreading centrifugally. Brown dots represent ablation points. B: Voltage map with areas of normal voltage (>1.5 mV) in pink. The suture lines where the veins of the pulmonary transplant have been sutured to the receiver heart can be imagined at the transition from pink to blue color. Within the donor pulmonary vein ostia only low amplitude, far-field potentials were recorded. At the origin of tachycardia medial to the left inferior pulmonary vein fragmented scar potentials were recorded (blue dots). LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.*

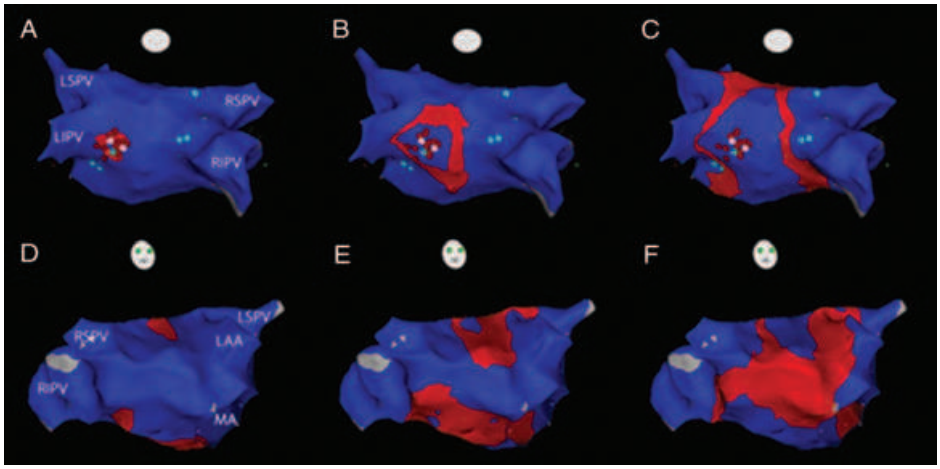

Figure 4. *Carto propagation map of left atrium. A–C: posterior view. D–F: right anterior oblique view. Activation origin is medial to the left inferior pulmonary vein (A) and propagates superiorly and inferiorly to activate the anterior part of the left atrium. LAA = left atrial appendage; LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; MA = mitral annulus; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.*

electrocardiographic mapping and differentiated from focal atrial tachycardias.[6]

In this case, tachycardia mechanism was microreentry from a scar region at the medial anastomosis of the left inferior pulmonary vein because more than 75% of tachycardia cycle length was recordable within few millimeters. We saw no evidence of reconnection between the donor pulmonary vein and recipient heart. In conclusion, electrocardiographic mapping is a useful tool for procedure planning as it can identify tachycardia mechanism and origin.

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