Impact of Septal Radiofrequency Ventricular Tachycardia Ablation Insights From Magnetic Resonance Imaging

Benjamin Berte, MD; Frederic Sacher, MD, PhD; Saagar Mahida, MD, PhD; Seigo Yamashita, MD, PhD; Han S. Lim, MBBS; Arnaud Denis, MD; Nicolas Derval, MD; Mélèze Hocini, MD; Michel Haïssaguerre, MD, PhD; Hubert Cochet, MD, PhD; Pierre Jaïs, MD, PhD

We present the case of a 38-year-old woman with no past medical history and structurally normal heart with recurrent drug-refractory septal ventricular tachycardia (VT). Despite treatment with flecainide, celioprolol, and sotalol, she experienced breakthrough episodes of VT (Figure 1B). She had undergone 5 failed attempts at VT ablation. She was therefore referred for a further attempt at ablation. Cardiac multidetector computed tomography and late gadolinium enhancement (LGE) MRI were performed before VT ablation. MRI demonstrated nontransmural subendocardial LGE on either side of the septum, which corresponded to previous ablation sites (Figure 2A, Movie I in the online-only Data Supplement).

Consecutive Unipolar Ablation Procedures
Given the multiple failed attempts of endocardial ablation, we used a simultaneous endocardial and epicardial approach. VT was not inducible despite the use of isoproterenol and atropine. The ablation site was then targeted based on substrate mapping and pacemapping. Epicardial mapping did not show any abnormal voltage areas, and pacemap did not match the VT morphology. Endocardial mapping was then performed and radiofrequency energy was delivered at sites with good pacemaps (40 W, Thermocool Smarttouch, Biosense Webster) on the left and right ventricular midseptum. Radiofrequency delivery (40 W, 15g of contact force) at the right ventricular septum resulted in a steam pop after 34 seconds. A postprocedural MRI demonstrated the presence of a septal intramural hematoma without transmural scar (Figure 2B).

Bipolar Ablation Procedure
Because of VT recurrence, she was referred for a seventh attempt at ablation. Preprocedural MRI demonstrated resolution of the intramural hematoma and persistence of the nontransmural lesions (Figure 2C). During the procedure, VT was not inducible. Bipolar ablation was then performed at the optimal pacemap site, between left and right ventricular septum (Figure 3). The 2 catheters (Thermocool) were connected to the dual-catheter ablation box (Stockert, not CE marked). We delivered up to 60 W between both distal tips with close monitoring of temperature and impedance for 120 seconds. On day 1 postablation, MRI demonstrated myocardial swelling and transmural heterogeneous midseptal LGE (Figure 4A). Three months later, she was free of VT without any antiarrhythmic therapy. MRI demonstrated septal wall thinning and transmural LGE (Figure 4B).

Discussion
This case illustrates how MRI can offer new insights into scar formation after unipolar ablation, steam pop, and bipolar ablation. In the present case, before the first ablation, the transmurality of scar was minimal, despite repeated procedures. After steam pop, MRI demonstrated an intramural hematoma that disappeared at 3 months, with no significant impact on scar transmurality. After bipolar ablation, the acute LGE observed could also be related to an edematous response to ablation. However, MRI at 3 months clearly indicated a permanent septal lesion.

From the Hôpital Cardiologique du Haut-L’évêque, l’Université Victor Segalen Bordeaux II, Institut LYRIC, Bordeaux, France. The online-only Data Supplement is available with this article at http://circ.ahajournals.org/lookup/suppl/doi:10.1161/CIRCULATIONAHA.114.010175/-/DC1.

Correspondence to Benjamin Berte, MD, Hôpital Cardiologique du Haut L’évêque, Avenue de Magellan, 33604 Bordeaux-Pessac, France. E-mail Bertebenjamin@hotmail.com

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Figure 1. Twelve-lead ECG of sinus rhythm and clinical tachycardia. **A**, Sinus rhythm. **B**, Ventricular tachycardia with left superior axis, relatively small QRS, and a transition around V3.

Figure 2. MRI data before and after sixth ablation procedure. **A**, LGE images acquired on the day before the procedure show subendocardial enhancement related to a nontransmural scar from previous ablations, on both sides of the interventricular septum and on the inferior RV wall (yellow arrows). **B**, LGE images acquired on day 1 after the procedure show an intramural hematoma in the septum at the site of steam pop (pink arrows). Images also show pericardial enhancement related to an inflammatory response to pericardial access during the procedure, but no pericardial bleeding. **C**, LGE images 2 years after the procedure show a complete resolution of the hematoma (blue arrows), and the persistence of a nontransmural scar on both sides of the septum. LGE indicates late gadolinium enhancement; and RV, right ventricular.
Figure 3. Bipolar ablation. Left, illustration of the procedure setup. Two ablation catheters are connected to a dual-catheter ablation box to deliver radiofrequency on both sides of the septum at the power of 30 to 60 watts over 120 seconds, with close monitoring of the temperature and impedance. Middle, superior view of the EAM substrate map without bipolar low-voltage area and fluoroscopic AP view showing catheter tips on both sides of the interventricular septum. Right, Pacemap from the tip of the LV ablation catheter on the ablation site: 12-lead ECG of a sinus beat and 2 paced beats with a good pacemap. AP indicates anteroposterior; EAM, epicardial electroanatomical mapping; and LV, left ventricular.

Figure 4. MRI data after bipolar ablation (seventh procedure). A, LGE images on day 1 after bipolar ablation show myocardial swelling and transmural heterogeneous enhancement on the interventricular septum at the midventricular and apical levels (green arrows). B, LGE images 3 months after bipolar ablation show myocardial thinning and intense transmural enhancement on the interventricular septum (top, blue arrows). First-pass perfusion imaging demonstrates severe microvascular dysfunction in the same area (bottom left, blue arrows). Myocardial T1 mapping before and after gadolinium administration indicates very dense scarring, with a calculated extracellular volume fraction of 85% (bottom center and bottom right, blue arrows). LGE indicates late gadolinium enhancement.
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