Improving Safety of Epicardial Ventricular Tachycardia Ablation Using the Scar Dechanneling Technique and the Integration of Anatomy, Scar Components, and Coronary Arteries Into the Navigation System

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A 54-year-old patient with a nonischemic cardiomyopathy, mild left ventricular dysfunction, and a nonsyncopal ventricular tachycardia was admitted for an ablation procedure. Preprocedural contrast-enhanced cardiac magnetic resonance (ce-CMR) was performed with a 3T clinical scanner (Magnetom Trio, Siemens Healthcare, Erlangen, Germany). A free-breathing 3-dimensional navigator and electrocardiographically gated inversion-recovery gradient-echo sequence was applied in the axial orientation, starting 5 minutes after an intravenous injection of 0.2 mmol/kg gadodiamide. Image acquisition parameters were set to allow a true isotropic 1.2×1.2×1.2-mm spatial resolution, and the acquisition time was targeted below 9 minutes to permit simultaneous evaluation of the coronary tree and myocardial enhancement. To minimize motion artifacts, the acquisition window was selected with a high-temporal-resolution 4-chamber cine view. The patient was instructed to maintain shallow and steady breathing during the acquisition. The full volume was recon-

Figure 1. A, Basal short-axis view of the contrast-enhanced cardiovascular magnetic resonance (ce-CMR). There is a subepicardial distribution of the hyperenhancement in the lateral wall (white arrow) that turns midmyocardial in the anterior wall (yellow arrow). B, Volume-rendered image of the ascending aorta and the coronary arteries derived from ce-CMR and visualized with the CARTO system. C, Left lateral view of the left ventricular epicardial voltage map. Normal tissue is coded in purple (>1.5 mV). Heterogeneous green (border zone) and red (core) areas of low voltage are visible in the basal aspect of the lateral wall. Blue dots indicate electrograms with isolated delayed components; red dots, ablation points. D, Three-dimensional ce-CMR reconstruction of the ventricles (right ventricle in blue, left in yellow), coronary arteries (gray), and scar tissue (border zone in green, core in red). Lack of perfect concordance between the ce-CMR–derived scar and the epicardial bipolar map (especially in the most anterior part) is explained by the presence of normal tissue interposed between the scar and the epicardial surface, as depicted in panel A (yellow arrow).
structured in the left ventricular short-axis orientation, and the resulting images were processed with self-customized software (TCTK [Tissue Characterization Tool Kit], Barcelona, Spain). An algorithm based on the pixel signal intensity was applied to characterize the hyperenhanced area as scar core or border zone. The processed images were imported into the CARTO system (Biosense Webster, Diamond Bar, CA). The study showed a subepicardial hyperenhancement in the anterolateral left ventricular wall (Figure 1A).

An electroanatomic map of the right and left ventricles was obtained and merged with the ce-CMR 3-dimensional volume-rendered reconstruction, which included cardiac chambers, coronary vessels, and characterized scar tissue (core and border zone; Figures 1B and 1D). The left ventricular endocardial voltage map showed no low-voltage areas or abnormal bipolar electrograms. The left ventricular epicardial voltage map showed a lateral and basal low-voltage area coincident with the scar location obtained from the ce-CMR (Figure 1C). Electrograms with isolated delayed components (E-IDCs) were present in the epicardial scar area, but also in areas with normal voltage range.

A potential complication of epicardial radiofrequency ablation is damage to coronary vessels. Using the described acquisition protocol, it is possible to obtain the distribution of the scar and epicardial coronary arteries together with the anatomy of the cardiac chambers from the 3T ce-CMR. Registration with the electroanatomic map provides a real-time localization of the arteries. In this case, E-IDCs were present just over an oblique marginal artery (Figure 2). The E-IDCs had an activation sequence from the edge to the center of the scar (Figure 2). Therefore, radiofrequency applications were delivered at the edge of the scar, over E-IDCs with the shortest isolated delayed component lateness (ie, entrance of late potential channels during sinus rhythm; Figure 2, electrogram A), as described previously.1 Finally, a remap was obtained to establish complete elimination of E-IDCs, including those over the coronary artery (Figure 3).

Prior reports showed that myocardial scar obtained by ce-CMR can be characterized and imported into a navigation system, which facilitates mapping and ablation.2,3 Coronary anatomy display into the CARTO system, obtained from computed tomography, improves the safety of epicardial ablation, avoiding the need for a coronary angiogram during the procedure.4 The present case shows how progress in the acquisition protocols and ce-CMR image postprocessing allows acquisition of not only the anatomy and scar components but also the distribution of
the main coronary arteries to guide ventricular tachycardia ablation.

Areas of E-ICDs have been related to critical reentry isthmuses and targeted for ventricular tachycardia substrate ablation. By analyzing the activation sequence of E-ICDs during sinus rhythm, it is possible to identify the late potential channel entrance into the scar.\textsuperscript{1} Targeting the conducting channel entrance during ablation reduces the extent of radiofrequency application, which improves the safety of epicardial ablation.\textsuperscript{1} The present case reveals how this ablation technique (scar dechanneling) can eliminate multiple remote E-ICDs that would otherwise be eliminated by applying radiofrequency just over the coronary arteries.

**Disclosures**

None.

**References**


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*Circulation*. 2012;125:e466-e468
doi: 10.1161/CIRCULATIONAHA.111.087858
*Circulation* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/125/11/e466

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