First experience with hybrid thoracoscopic ablation and noncontact dipole density mapping in the setting of long-term persistent atrial fibrillation

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Introduction

The hybrid thoracoscopic ablation approach, which combines video-assisted epicardial radiofrequency (RF) ablation with endocardial catheter ablation, has proven to be useful in the treatment of persistent atrial fibrillation (AF).[1,2]

Standard electroanatomic mapping is based on direct contact to measure the electric field (voltage). Although used in everyday practice in AF ablation procedures, voltage-based mapping demands substantial time and technical ability of the operator. Noncontact, dipole density (DD) mapping fairly obviates the technical skill needed for high-density electroanatomic mapping. AcQMap (Acutus Medical, San Diego, CA) is a noncontact, high-resolution imaging and mapping system that provides heart chamber reconstruction using three-dimensional ultrasound overlaid with high-resolution maps of electrical activation either as (DD) or as voltage.[3,4]

KEY TEACHING POINTS

- The dipole density (DD) map might provide detail visualization of propagation patterns and potential therapeutic targets for ablation guidance.
- AcQMap (Acutus Medical, San Diego, CA) is a noncontact, high-resolution imaging and mapping system that provides heart chamber reconstruction using three-dimensional ultrasound overlaid with high-resolution maps of electrical activation either as DD or as voltage.
- Noncontact, DD mapping fairly obviates the technical skill needed for high-density electroanatomic mapping.

Case report

A 59-year-old woman, with recurrence of long-standing persistent AF following a standard pulmonary vein isolation procedure, underwent a second procedure using an AF hybrid thoracoscopic ablation approach. The right inferior pulmonary vein (RIPV) was found to be reconnected using a quadripolar catheter through 1 access point of the 3-port bilateral access.

Antral isolation of the RIPV was performed with 6 bipolar RF applications. Each application had a duration of about 15 seconds, with an output range between 10 and 15 W. While the RIPV was clamped, sinus rhythm was restored (Figure 1). Following RIPV ablation no atrial arrhythmia could be induced. A roofline (connecting the superior pulmonary veins) and an inferior line (connecting the inferior pulmonary veins) were performed epicardially using bipolar RF to achieve left atrial posterior wall (LAPW) isolation.

Subsequent endocardial pacing inside the LAPW was performed without capture of the atrium.

The AcQMap diagnostic recording catheter was introduced in the left atrium. When the catheter is deployed, a spheroid of 6 splines is formed, with each spline populated with 8 ultrasound transducers and 8 biopotential electrodes. The left atrial surface was sampled by the ultrasound subsystem to reconstruct the chamber anatomy. An inverse solution spatiotemporally processed the intracardiac voltages into DD (and voltage) at every point on the surface anatomy. DD represents the charge sources generated by the action of the cellular ion channels throughout the myocardium. A propagation history (PH) map displays a moving visualization of activation, with red representing the leading edge of the DD wavefront and preceding color bands

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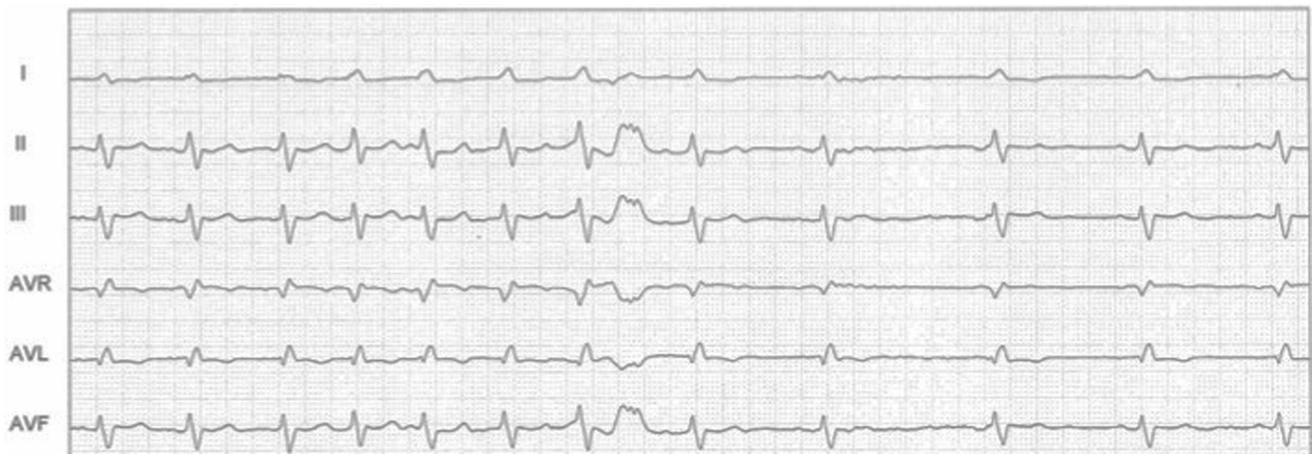

Figure 1 A 6-lead electrocardiogram (10 mm/mV, 25 mm/s) showing conversion to sinus rhythm during radiofrequency (RF) clamping of the right inferior pulmonary vein with a bipolar RF clamp.

showing earlier locations of the wavefront. The width of each color band conveys the conduction velocity of the wavefront, with wider bands indicative of fast conduction and narrow bands of slow conduction.

The PH map showed a small gap in the middle of the roofline during sinus rhythm. An irrigated ablation catheter was introduced into the left atrium and pacing was applied inside the LAPW, which resulted in atrial capture. Three RF applications of 30 seconds each were delivered at the gap. Repeated pacing from inside the LAPW did not result in atrial capture and atrial dissociation was observed. A new PH map confirmed block at the roofline (Figure 2, Video). The patient returned at 4 months without palpitations and the electrocardiogram was sinus rhythm.

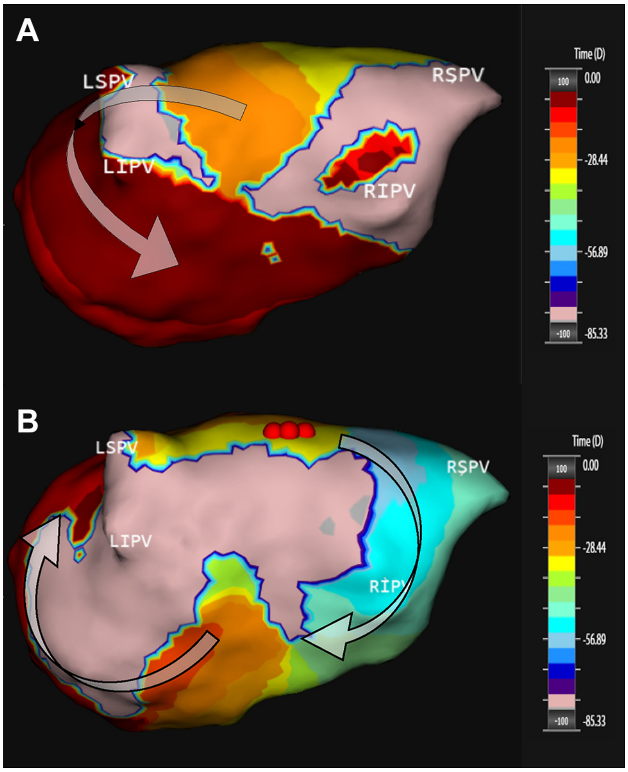

Figure 2 Propagation history maps (posteroanterior view). **A:** The initial mapping showed a gap with activation passing through the left atrial posterior wall (LAPW). **B:** Postablation mapping of the gap showed isolation of the LAPW. Three red dots indicate radiofrequency points. LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

Discussion

To the best of our knowledge, this is the first procedure with thoracoscopic ablation combined with the AcQMap system in the setting of long-standing persistent AF. The DD map provided detailed visualization of propagation patterns and potential therapeutic targets for ablation guidance.

This hybrid approach for left atrial access and mapping enabled visualization of a conducting gap, following delivery of the initial bipolar RF ablation strategy, and confirmation of achievement of the transmural endpoint, following localized endocardial RF delivery within the gap. The patient has been free from AF during 4 months of follow-up; however, further clinical studies over longer durations of follow-up are needed to establish clinical benefit.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2019.02.012.

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