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Noninvasive Real-Time Mapping of an Incomplete Pulmonary Vein Isolation using Electrocardiographic Imaging (ECGI)

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Establishing entrance and exit block from pulmonary veins is an endpoint for pulmonary vein isolation (PVI) procedures (1). Reestablished pulmonary vein connection is a common cause of atrial fibrillation (AF) recurrence in patients who have previously undergone PVI. Here we provide images from a noninvasive cardiac electrophysiology imaging system (ECGI) performed during PVI.

The ECGI procedure has been described previously (2) (3). 250 carbon electrodes were applied to the patient's torso before a pre-procedural contrast-enhanced CT scan, which provided torso-electrode positions and atrial geometry in the same reference frame. The electrodes were removed, then replaced on the day of the PVI procedure in the same configuration, and remained on the patient throughout the procedure. ECGI performed during the procedure noninvasively generated epicardial isochrone activation maps.

After circumferential ablation around the antrum of the right pulmonary veins, a lasso catheter in the right inferior pulmonary vein (RIPV) demonstrated entrance block. However, high-output pacing from within the RIPV captured the atrium, revealing incomplete exit block.

Notes: First two authors contributed equally to the manuscript.

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Dr Rudy chairs the scientific advisory board of and holds equity in CardioInsight Technologies. CardioInsight Technologies does not support any research conducted by Dr Rudy, including that presented here.

Panel A displays the real-time ECGI isochrone map during RIPV pacing, showing earliest activation in the superior-posterior antrum of the RIPV (red is earliest), with radial spread across the posterior LA. A 60-ms delay is seen from the pacing breakthrough (red) to posterior LA (green) activation, consistent with incomplete line of block created by the ablation.

The invasive electroanatomic map (Panel B) shows the final ablation lesion set and the additional ablation necessary for exit block from the RIPV (pink marker). This location on the invasive electroanatomic map corresponds closely to the exit site determined by ECGI in Panel A.

Panel C shows an ECGI isochrone map during high-output pacing from within the RIPV after the complete ablation. Pacing failed to capture the atrium, and the earliest LA activation in sinus rhythm was near Bachmann's bundle (red). Posterior LA activation is limited superiorly and inferiorly with lines of block (white dotted lines) corresponding to the ablation lines on the LA roof and posterior wall seen in panel B. Three PV's also demonstrate electrical isolation (blue). Although the RSPV in Panel C appears to have electrical connection in sinus rhythm, the appearance of activation is due to far-field signal from the posterior right atrium in close proximity. Invasive testing of the RSPV demonstrated entrance and exit block.

Rigorous prospective study is needed, but if real-time ECGI can accurately identify areas of incomplete PVI isolation, it may shorten procedure time and improve long-term success rates by pinpointing sites of incomplete linear ablation.

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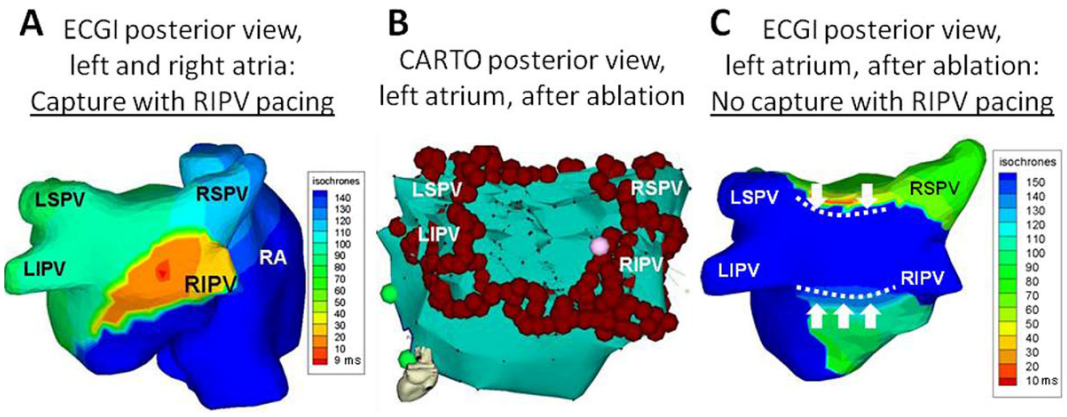

Figure 1.