Mapping the Transmural Scar and Activation for Patients with Ventricular Arrhythmia

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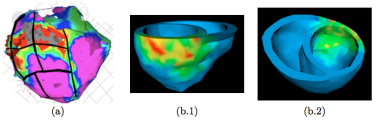
Myocardial scar is the common substrate for malignant arrhythmia and cardiac arrest. As myocardial scar is often complex with shapes varying with the depth of the myocardium, radiofrequency ablation is still subject to limited success because of the inadequate assessment of scar substrates that currently relies on electrophysiologic (EP) map acquired on heart surfaces. We present a validation study of a noninvasive EP imaging method that combines body-surface potential (BSP) mapping and image-derived anatomic data to compute EP and scar details *not only on heart surfaces but also transmurally along the depth of the myocardium*. A generic, macroscopic model of transmembrane potential (TMP) dynamics was combined with probabilistic estimation theory to produce a Bayesian *maximum a posteriori* estimation of subject-specific TMP dynamics corresponding to the given BSP data. Scar masses were then delineated from the abnormal EP pattern in comparison to the generic pattern.

Experiments were performed on 4 patients referred for ablation associated with myocardial infarction. Scar imaging and segment-based quantification were validated with sinus-rhythm substrate voltage maps acquired by CARTO electroanatomic mapping, showing accurate results as the example in Fig 1. Estimated activation maps of ICD-pacing were validated with the CARTO activation maps, giving normalized mutual information $= 0.82 \pm 0.11$. As shown, the presented computational EP imaging is able to provide substrate and activation map on heart surfaces consistent with state-of-the-art EP mapping techniques, and to offer additional information along the transmural dimension that is current untapped in surface mapping techniques.



CARTO substrate map (a) vs. Results of scar imaging (b)