In-Silico Pace-mapping Outperforms ECGi in Identifying Focal Origins

Fernando O. Campos, Mark K. Elliott, Nadeev Wijesuriya, Marina Strocchi, Sofia Monaci, John Whitaker, Gernot Plank, Christopher A. Rinaldi and Martin J. Bishop

King's College London
London, UK

Background: Electrocardiographic imaging (ECGi) presents a non-invasive method for strategizing catheter ablation therapy for ventricular tachycardia (VT). Nevertheless, its scope is restricted to reconstructing epicardial surface activations. In contrast, in-silico pace-mapping (iPM) integrates a tailored computational model with clinical ECG recordings to produce a comprehensive virtual 3D pace map.

Objective: To assess the ability of ECGi and iPM in identifying the site of focal origin during pacing.

Methods: ECGi recordings were collected during LV (endo: N=5, epi: N=1) and RV (N=12) pacing, along with non-contrast CT images (1x1x0.7mm). Personalized CT-based torso-ventricular computational models were created and aligned with the ECGi vest electrodes (Fig A-C). iPM involved pacing the heart at 1000 random sites and computing ECG signals from corresponding body-surface locations (red dots in Fig C). Correlation analysis compared acquired and simulated ECGs for each of the 1000 pacing sites (Fig D, left panel). The average of the top 10 coefficients across leads was calculated and corresponding correlation (pace) maps reconstructed (Fig D). The distance (d) between the pacing electrode (ground truth) and the location with the strongest correlation was determined (Fig D); for ECGi, the earliest site in the reconstructed activation time map was used.

Results: As shown in Fig E, iPM outperformed ECGi in locating the sites of focal origin. During LV pacing, d was 17.1±9.8mm using iPM compared with 33.1±12.2mm when using ECGi. During RV pacing, d=26.2±10.9mm (iPM) and 33.9±21.2mm (ECGi).

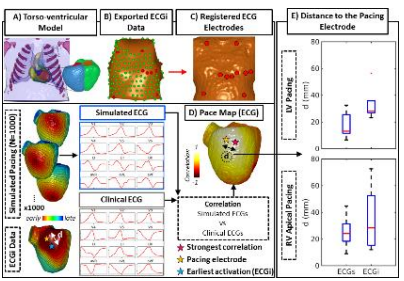

Figure: iPM pipeline and Results

Conclusion: iPM is more accurate than ECGi in detecting the first site of activation during focal pacing. An in-silico model of a virtual pace-mapping procedure may provide an ideal testbed to investigate a wide range of pacing locations rapidly and without risk to the patient.