Simultaneous Recording of Electrical and Panoramic Optical Mapping From In-vivo Isolated Rabbit Hearts: From Sinus Rhythm to Induced Arrhythmia

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Introduction: The accurate identification of the type and location of arrhythmia mechanisms remains a significant challenge for electrophysiologists, and commercial systems may influence the process. This study presents the initial results of a novel in vivo model for customizing electrophysiology metrics and maps.

Methods: New Zealand isolated rabbit hearts were Langendorff retrogradely perfused (Tyrode solution, 38°C, pH 7.4 and 15 ml/min, (-)-Blebbistatin 1.71 µM). We acquired epicardial electrical activity simultaneously during sinus rhythm, pacing, and induced atrial arrhythmia using panoramic optical mapping (dye: Di-4-ANBDQPQ; excitation: high-power deep-red LEDs, aspheric condenser lens, and band-pass filters 650/40 nm; emission: long pass filters 715 nm, and a CMOS cameras with 1000x1264 pixels, 500 fps). We also used epicardium contact electrical mapping (two in-house build MEAs of PET with 16 silver electrodes each, 64-channel amplifier, Fs: 4 kHz). An in-house 3D heart reconstruction system (driver DRV8825, JK35HS34-1004, Labview GUI), allows obtaining 3D silhouette from 2D heart images taken every 5° until a 360° full rotation (i.e 72 images). The signals were pre-processed and post-processed offline, and the electrical and optical local activation time (LAT) was compared between them in regular and irregular rhythm protocols.

Results: 7 out of 10 experiments were performed (3.80±0,17 Kg). 3D reconstruction of atria allowed building optical vs. electrical potential and local activation times (LATs) maps (DF and phase being performed). Far-field electrical mapping causes divergences in the temporal evolution of local activation times (LATs) during sinus rhythm (-3.1 ± 10.9 ms), pacing (-6.7 ± 1.4 ms), and arrhythmia (-1.9 ± 4.1 ms).

Conclusion: This study proposes a highly complex animal model and presents a preliminary analysis. In the near future, it will be possible to customize electrophysiology metrics and maps from electrical mapping based on those obtained simultaneously by optical mapping, using a signal and image processing pipeline.