Simultaneous Endo-Epi Recording with Multi-Electrode Arrays and Optical Mapping of Atrial/Ventricular Tissue: A Feasibility Study in Pig Hearts

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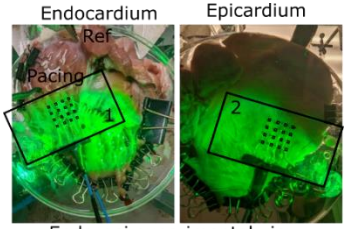
Introduction: One mechanism thought to drive the complex voltage dynamics driving atrial and ventricular fibrillation is endocardial–epicardial dissociation, where large numbers of intramural activations can be observed by breakthrough activations at either surface during fibrillation. To better understand the mechanism as it is measured in clinical equipment, we use an endo-epi system for simultaneous optical/multielectrode recordings in ex-vivo isolated pig hearts.

Methods: The right atrium and ventricle were isolated and coronary-perfused, and stained with transmembrane voltage-sensitive dye (Di-4-ANNEPS). Two green LEDs (525 nm) were used to excite the dye, while two EMCCD cameras, facing the endocardium and epicardium, measured the fluorescence at 500 Hz (MPIDS Multi Recorder). Simultaneously, electrical signals were measured at 4 kHz (Intan RHD2000 board) using two custom-made multi electrode arrays (MEAs), each comprised with 16 electrodes fixed on a transparent acrylic base that is in contact with the tissue.

Results: Figure shows the ventricular endo- and epicardial sides, with MEA1 and MEA2 highlighted in black. Measurements revealed a complex dynamic pattern, with no alternans observed on the epicardial side while significant 2:2 alternans on the endocardial side. This transmural gradient in repolarization is likely to be proarrhythmic, potentially leading to transmural phase-2 reentry and could be visible as a J wave on an ECG.



Endo-epi experimental view

Conclusion: The setup, tested in isolated pig hearts and capable of recording simultaneous electrical and optical data, allows us to better match and understand the spatial distribution during fibrillation as measured with clinical MEAs.