Comparative Characterization of Electrical and Panoramic Optical Mapping in Langendorff-Perfused Rabbit Hearts: From Sinus Rhythm to Fibrillation

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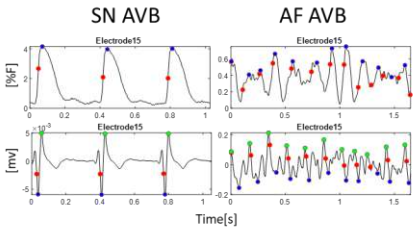
Introduction: Cardiovascular diseases are the leading causes of death globally. Comparative optical (gold standard) and electrical experimental setups have been developed to characterize the cardiac substrate and improve commercial medical equipment. Our aim is to characterize simultaneous optical and electrical signals obtained from the entire heart, atrium, or ventricle presenting differences between them using local activation time (LAT), cycle length (CL), frequency (F), and heart rate (bpm).

Methods: New Zealand rabbit hearts were Langendorff-perfused, and electrical activity was acquired simultaneously with optical mapping (three high-speed cameras) and contact electrical mapping setup (three arrays 4x4 electrodes), during sinus rhythm (SN), atrial tachycardia (AT), atrial fibrillation (AF), and ventricular fibrillation (VF), after ablation of the node AV (AVB). LAT was calculated using the first derivative, CL as the differences between two consecutive beats, and F as the inverse of CL. Comparison was conducted for each array electrode and with the corresponding pixel close to it.



Optical vs electrical signal

Results: Four rhythms were characterized: SN AVB (LA:162, V:42 bpm), AT AVB (LA:463, V:73 bpm), AF AVB (LA:428, V:0.4 bpm), and VF (LA 223 V:490 bpm). The difference in electrical and optical LAT was smaller in SN (RA:12.2±4.3 ms) than in AF (RA:100.3±69.2 ms). The difference in CL, F, and bpm was less than 0.1 unit for SN and increases in AF up to 27 ms, 0.6 Hz, and 43 bpm, respectively. Optical results showed lower deviation values compared to electrical whenever the fluorescence amplitude was greater than 1%.

Conclusion: Rhythms characterization and difference between electrical and optical results were presented.