Non-Invasive Dominant Frequency Characterization of Different Induced Arrhythmias in an Isolated Rabbit Heart Animal Model

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Introduction: Cardiac arrhythmias impose substantial health care and economic burden on health care systems and patients. Despite progress, invasive procedures remain the primary approach, imposing inherent patient risks. This study delves into the potential of non-invasive body surface potential mapping (BSPM), in comparison with optical and epicardial contact unipolar mapping, to investigate induced arrhythmias through an animal model.

Methods: New Zealand white rabbit hearts were retrograde perfused using the Langendorff technique to sustain cardiac function allowing the acquisition of epicardial unipolar contact electrical (4 kHz) and optical signals (500 Hz) acquisition. A custom torso-tank with 60 electrodes enabled the capture of high-density electrocardiograms. Simultaneously, voltage-sensitive optical mapping, the electrophysiological gold standard, provided a reference for analysing induced rhythms. Dominant frequency analysis (4 s segment, fstep: 0.05 Hz), employing the Fast Fourier Transform, elucidated frequency dynamics.

Results: This study encompasses two distinct rhythms. The first one is a sinus rhythm with atrioventricular blockage manifesting an optical average dominant frequency (DF) of 1.7±0.6 Hz in the atrial region (LA and RA), closely aligning with the tank's uniform average DF of 1.8±0.4 Hz. Conversely, an arrhythmia with atrioventricular node dissociation exhibits two distinct DF areas. In optical mapping, a posterior left ventricular region presents a higher average DF of 7.73±0.02 Hz, and an atrial area with 5.0±0.7 Hz. Non-invasive DF mapping unveils the two distinct regions, mirroring the optical signal, one with 8.1±0.4 Hz and the other with 4.9±0.4 Hz, underscoring the heterogeneous nature of cardiac regions in both methodologies.

Conclusion: This investigation underscores the potential of BSPM in comprehensively characterising cardiac arrhythmias, thereby validating our animal model for non-invasive tachyarrhythmia investigations. These findings pave the way for further research aimed at refining non-invasive mapping modalities and enhancing our understanding of arrhythmic mechanisms and their origins.