

Development of High Precession Dominant Frequency Mapping in Isolated Heart Model

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Perpetuating pumping of blood by THE HEART delivers adequate support of nutrients and oxygen to sustain the organs. Normal heartbeat requires precise synchronization of electrical impulses passing through portions of the heart tissue. When regular and rhythmic impulses are broken, cardiac arrhythmias occur. And ventricular tachycardia (VT) and ventricular fibrillation (VF) are the most lethal arrhythmias of them all. However, the understanding of these arrhythmias is still limited. In particular, the true three-dimensional (3D) mechanisms are still largely missing experimentally. Computer analysis on images recorded inside and on the surface of the heart has been routinely applied to infer 3D mechanism of the VF. The outcomes in some cases are misleading at least.

The goal of this project is to develop new computing techniques namely, high-precession dominant frequency (HPDF) mapping, and epicardial break-through (BT) profiling using epicardial optical mapping data (videos) available in our laboratory (Bioelectrical Computing Research Laboratory, BCRL) at Virginia Commonwealth University. In an isolated rabbit heart model, we will acquire epicardial fluorescence images (high speed videos) at different anatomical areas. HPDF technique and BT analysis will be done on these acquired images. Dominant frequencies (DF) at different domains and conduction patterns will be studied based on this new computational method. DF gradients and distribution of boundaries will be carefully observed. The characteristics of gradient DF will be studied in the context of its implication on VF propagation. This study has major implication how should VF be terminated by only affecting locally the core of mother rotor. A big electrical counter shock to the chest could be omitted during VF in the future.

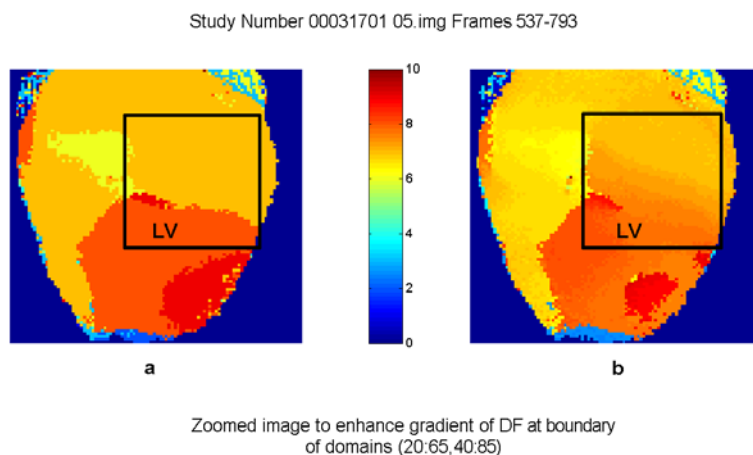


Illustration of DF gradient with HPDF map. Panel a: DF map of the anterior heart using standard N -point Fast Fourier Transform (FFT). Simple ratios can be found between adjacent domains. Panel b: HPDF map of the same data using zero-padded FFT (ZP-FFT) to give 10 times more frequency samples with striated bands of DF domains on left ventricular free wall. The same is not seen in Panel a primarily due to inadequate precision (1 Hz). (LV = Left Ventricle).