Experimental electrophysiology and ventricular fibrillation

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The mammalian heart depends on its precise electrical activity to properly pump blood throughout the body. When this activity is lost or becomes chaotic, the heart pumps little or no blood, and the result is ventricular fibrillation (or VF). Often, ventricular fibrillation has deadly consequences, and in humans, can only be halted with emergency medical action. It is estimated that over 300,000 Americans alone die as the result of ventricular fibrillation.

Despite its wide spanning death toll, ventricular fibrillation still lacks full understanding by those that study it. It has become such an intriguing topic that researchers from all fields, from doctors to mathematicians, have devoted time to its study.

To study VF in the Bioelectric Computing Research Lab here at VCU, we use specialized optical mapping techniques on prepared rabbit hearts. VF is induced in the hearts and video images are taken using a high-speed camera. In these types of studies, activation rates are typically observed over the images of the heart surface, and analyzed using the Fast Fourier Transform (FFT) Peak detection algorithm. Using the FFT method to display a frequency spectrum, we can determine the dominant frequency of activation rates at a given point of the heart. While this popular method is well tested and used extensively, new experiments demonstrate that the FFT method may be inadequate to illustrate certain details of the frequency spectrum. Instead we observe that a *continuous* Fourier Transform, which has been widely accepted in the field of digital signal processing, increases precision and may preserve certain features that are lost using the normal FFT algorithm.

In addition, it has been suggested that large levels of noise can alter the results for both types of Fourier Transforms. To test this idea, computer simulations are run with varying levels of noise, and a statistical analysis was performed.