Center for Cardiovascular Bioinformatics & Modeling

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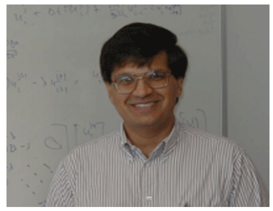

A Computational Study of Calcium Sparks in Cardiac Cell

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Abstract:

The primary function of the heart is to pump blood to and from the body by synchronized contraction and relaxation of the heart muscle. The process which enables the heart to do so is called excitation-contraction coupling. Excitation refers to the depolarization of the cell membrane that encapsulates heart muscles. During excitation, the opening of voltage-gated L-type calcium channels triggers calcium release from clusters of ryanodine receptors (calcium induced calcium release channels) in the sarcoplasmic reticulum (the intracellular calcium stores). Release from an individual cluster is called local and elementary release events are called calcium sparks. The calcium released during sparks sums up to form the global calcium transient that binds to the contractile proteins and initiates the contraction. Any imbalances in calcium levels can lead to contractile dysfunction, cardiac arrhythmia and heart failure. Therefore, due to the crucial role of calcium EC coupling, it is important to understand calcium dynamics at the elementary level of calcium sparks.

We have developed a three-dimensional model of calcium sparks to analyze the basic mechanisms of cardiac muscle contraction through integration of detailed biophysics and microanatomy including the effects of experimental measurement techniques on the observed results. This talk will be focused on the spread of calcium sparks and the existing discrepancy in spark width (full width, half-maximum, FWHM) between experimental results (~2.0 um) and computational models (1.0-1.2 um) under physiological conditions. It will be discussed how simplified assumptions about the morphology of the organelles and limitations of measuring techniques can significantly affect calcium spark spread of computational models.

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