Discretizing a Hybrid Cardiac Reconstruction: A Novel Simulation of Sustained Fibrillation

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Acute cardiac arrhythmias are the No. 1 killer in industrialized countries; the mechanisms behind the onset and electrical dynamics are poorly understood, and mathematical modeling is limited by oversimplifying the human heart to a bidomain parallel circuit. The purpose of this work: (1) computer engineer a hybrid remodel of cardiac homo- and heterogeneities, (2) create a new cell model based on the new boundary condition, and (3) simulate chaotic spiral waves. This study developed a novel cellml model in OpenCOR to computationally manipulate the activation of sodium channels for the sustainment of fibrillation. The virtual tissue was designed amidst heterogeneous disruptions: intracellular clefts, fatty tissues, blood vessels, and scarring. The non-conformities were found to magnify induced depolarization of a fibrillating heart. Consequently, termination of sustained chaotic cardiac arrest was simulated, and a .33V low energy shock defibrillated the induced arrhythmia. Short term, this computational verification of low-energy defibrillation therapy can support the modernization of contemporary 3000V and $2000 USD automated external defibrillators (AEDs), and the novel methodology of bounding non-negligibly disruptive geometrical configurations can incorporate the non-uniform aspects of biology reality into solely- uniform mathematical models. Long term, my cell model's ability to simulate can be used in virtual reality surgery to calculate a personalized adjustment of conductivity in the human heart as an alternative to implementing a separate pacemaker, thus curing a faulty heart.

Awards Won:

Fourth Award of $500