Mechanics of the calcium movement inside cardiac myocytes and the effect on contractility

Choi-Hong Lai*†[1], Erwin George[2], and Nadarajah Ramesh[2]

[1]University of Greenwich – United Kingdom
[2]University of Greenwich – United Kingdom

Abstract

A computational model is constructed to study the mechanics of the calcium movement inside cardiac myocytes. The governing PDE model, closely resembling the physiological model, is based on the calcium-induced calcium release mechanism coupled with a time dependent vibration model representing the actin-myosin interaction and the force development in the sliding filaments. Constitutive equations relating primitive variables of the mechanism are used to formulate the problem. Suitable methods are used to gain information of the mathematical/physiological parameters whereas open-source data are used to retrieve these parameters to match the physics.
Two different systems are to be examined in this paper, one with buffers and dye to emulate in vitro calcium behaviour and the other without buffers and dye to emulate in vivo contraction behaviour as reported in the literature. The mathematical model used in the calcium-induced calcium release mechanism follows closely the physiological description as seen in the literature. Both deterministic and stochastic cases are examined. The stochastic case examined is realised by putting a stochastic mechanism into the model to activate release of calcium from Calcium Release Units.

Finally, a 2D curvilinear domain of size and shape resembling a typical cardio myocyte is used to demonstrate the contraction features.
Computational results match all experimental results as reported in the literature. Machine learning techniques are also included in the work. The computational model is able to provide reliable information about contractility of cardio myocytes.

*Speaker
†Corresponding author: C.H.Lai@gre.ac.uk