

Effects of the Fibroblast-myocyte in Cardiac Electromechanical Coupling: A Preliminary Simulation Study

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The real heart consists of cardiac myocytes, vasculature cells and connective tissue cells, however, only the cardiac myocytes have been considered in the previous studies of cardiac electromechanical coupling. The electrophysiology of fibroblasts has been investigated, while the mechanics of the fibroblasts has rarely been studied so far. In this study, we present a preliminary simulation study about the effects of the fibroblasts on the cardiac mechanics. The fibroblasts are integrated into the electromechanical coupling, and the possible influences on the cardiac electrophysiology and mechanics are investigated.

The cardiac excitation propagation model is coupled with the passive fibroblast model to elucidate the cardiac electrical characteristics. On the cellular level, the ten Tusscher mathematical model of the human ventricular myocyte and the passive fibroblast model are combined for the electrophysiology, and the J. Jeremy Rice model of the contraction is taken for the mechanics model. On the two-dimensional tissue level, the excitation conduction is integrated with the elastic mechanics. Numerically, the finite difference method and the finite element method are used to solve the excitation propagation equations and the governing equations of tissue mechanics, respectively. The simulation results show that the fibroblasts decrease the cardiac excitation conduction velocity, and increase the mechanic contraction and distortion of the tissue around the fibroblasts. The preliminary study demonstrates that the fibroblasts are very important in the electromechanical coupling and should be further studied in the future.