Sub-cellular description of cardiac action potential propagation with gap junctions dynamics.

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We study the propagation of the cardiac action potential in a one-dimensional fiber, where cells are electrically coupled through gap junctions (GJs) [1]. We integrate the dynamical equations at the sub-cellular level. We consider gap junctional gate dynamics that depend on the intercellular potential. We find that different GJs in the tissue can end up in two different states: a low conducting state and a high conducting state. We first present evidence of the dynamical multistability that occurs by setting specific parameters of the GJ dynamics. Subsequently, we explain how the multistability is a direct consequence of the GJ stability problem by reducing the dynamical systems dimensions. The conductance dispersion usually occurs on a large time scale, i.e., thousands of heartbeats [2, 3]. That is highly relevant in studying diseases that develop on a large time scale compared to the basic heartbeat. As in the brain, plasticity and tissue remodeling are crucial parameters in determining the action potential wave propagations stability.

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