A Mathematical Model of Action Potential in the Rat Atrial Cells

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Aim: Atrial fibrillation (AF) is a common cardiac arrhythmia associated with cardiac morbidity and mortality. Though several computational models have been developed to investigate mechanisms of atrial fibrillation in many species, there is no such model for adult rat atrial cells. In order to investigate the mechanisms of AF in rats, a biophysically detailed computational model of action potentials in rat atrial cell is presented in this study.

Methods: A mathematical model of the action potential of the rat atrial cells was developed based on experimental data from rat right atrial cells. Conductance of I_{to}, I_{Kur}, I_{Kr}, I_{Ks}, I_{K1} as well as the time constant of I_{to} activation (τ_s) were modified to fit I-V curve of potassium current. Conductance, voltage dependent activation and inactivation of I_{CaL} were modified to fit I-V, activation and inactivation curves of I_{CaL} current. I-V, activation and inactivation curves of I_{Na} current were fitted similarly.

Results: The simulation results demonstrate that I-V, activation and inactivation curves of calcium, sodium and potassium currents are consistent with experimental data from the rat atrial cells. The action potential from the computational model are comparable to the action potential recorded from rat atrial cells. The resting membrane potential, action potential amplitude and APD_{50} are -67.4 mV, 85.7 mV and 18 ms, respectively.

Conclusion: This study, for the first time, developed a computational model of action potentials of adult rat atrial cells. The model can be used to further explore pathological mechanisms of atrial fibrillation.