Synchronization of sinoatrial node cells: the effect of gap junctions

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There are several mathematical models that describe the electrical activity and ion exchange in the sinoatrial (SA) node. The response of the cell to an externally applied current is to change the timing of the subsequent action potential. This change is dependent on the nature of the applied current, and also the phase, (time, relative to the unperturbed cycle), at which the perturbation is applied. Using a model SA node cell, based on a Hodgkin-Huxley formalism (Dokos *et al.*, 1996) we explored the effects of coupling cells *via* direct, gap junction connections. The simulation was implemented using Mathlab. A 4^{th} Runga-Kutta integration method used to solve the coupled differential equations. The otherwise identical cells were initialised over the entire range of initial phase differences, and connected *via* gap junctions with conductances in the range of 0-500 pS. The membrane potential of the coupled cells quickly synchronized, and preliminary results of the relationship between the time taken to synchronize *versus* both initial phase difference and gap junction conductance suggests an optimal value of gap junction conductance minimizing the synchronization time. Whilst the effect of gap junction connectivity is the major determinant in synchronization in these cells, other factors also play a role. These include electrical field effects and the effect of a shared interstitial space between the cells.

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