Atrial Rotor Drifting Under Tissue Temperature Gradients

Research status and summary submitted to the Nicholas and Elizabeth Slezak Super Center for Cardiac Research and Biomedical Engineering at Tel Aviv University.

Spiral wave drifting and meandering are known measures for cardiac instability and arrhythmogenesis. This study was aimed to analyze spiral wave drifting due to temperature heterogeneity that is applied artificially. Our hypothesis is that spatial temperature gradients (STGs) will cause spatial excitability heterogeneity, which in turn will affect the spiral waves' dynamics. This may help to detect, map and distinguish cardiac spiral waves from ectopic foci, and improve the management of arrhythmias. During the grant year we modeled spiral waves in 2D computational models of atrial tissue at a reference temperature of 37°C. Temperature effect on the various gating rate constants was modeled by incorporating channel-specific Q_{10} factors for I_{Na}, I_{CaL}, I_{to}, I_{kur}, I_{kr} and I_{ks}. Two STG patterns were tested: a linear temperature gradient between T1=37°C (at x=15mm) and T2 (at x=0mm), and a regional 2X2mm temperature perturbation of ΔT=1°C. Our preliminary results showed that linear STG resulted in rotor drifting towards the colder region. The net drifting velocity exhibited a bi-phasic dependence on T2, initially increasing and then decreasing with the decreasing T2. The spiral wave tip velocity, however, decreased monotonically with the decreasing T2. The regional temperature perturbation generally yielded rotor drifting and anchoring around the perturbation. We plan to advance this study by establishing a method for controlling the trajectory of rotor drifting and for determining its source of origin, by using Doppler frequency shifts principles.

The work thus far was presented in two major conferences in the field of cardiac electrophysiology:

1. G. Malki, S. Zlochiver. Spiral wave drifting under applied spatial temperature gradients. 2014 Heart Rhythm Scientific Sessions, San Francisco, USA, 2014.

2. G. Malki, S. Zlochiver. Atrial spiral wave drifting under applied spatial temperature gradients, Proceedings of the 2014 Computing in Cardiology Conference, Cambridge, USA, 2014.