Investigating the Impact of Parameter Selection on Reentry Characteristics in a 3D Slab Simulation

Background: Cardiac computational modeling has been extensively employed to investigate the mechanisms underlying various cardiac arrhythmias. This study aims to explore the influence of parameter selection on reentry characteristics in a 3D slab simulation.

Methods: A 3D tissue model (4 cm × 4 cm × 0.04 cm) was created using a tetrahedral mesh to study tissue-scale properties. The single cell model published by Tomek et al. was integrated into the 3D tissue model, and simulations were conducted using openCARP. The parameter selection included two discretization methods (uniform and adaptive tetrahedral meshes), timesteps ranging from 5 to 20 μs, and three initialization state variable generation methods: default model states, pacing the single cell model 10 times with a basic cycle length of 600 ms (sv_init), and pre-pacing the 3D tissue model for 10 cycles with default model states. Reentry characteristics were analyzed with different parameter selections.

Results: Our simulations demonstrated that the conduction velocity (CV) in the model with an adaptive tetrahedral mesh was faster than that with the uniform mesh, resulting in a more rounded reentry with less wave break (Figure 1A). The reentry trajectory differed between the two mesh types for all timesteps (Figure 1B). In models with the same timestep and mesh type, the CV was fastest in the model with default state values, and the reentry trajectories were distinct from each other (Figure 1C). Reentry disappeared in the sv_init model but persisted throughout the simulation in the other two models.

Conclusions: Reentry characteristics in the 3D slab simulation were significantly influenced by different parameter selections. Careful selection of appropriate parameters in cardiac modeling is crucial for accurately interpreting the mechanisms of arrhythmia.

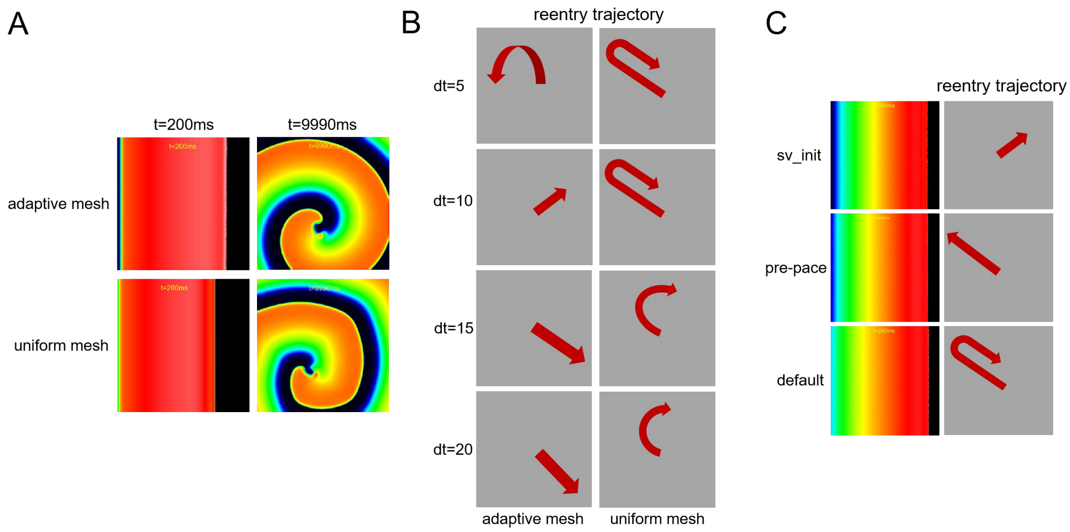

Figure 1