Inducibility of Atrial Fibrillation Depends Chaotically on Ionic Model Parameters

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Abstract

Previous work has shown that fibrillation can be induced by rapid pacing in a computer model of the human atria without fibrosis or repolarization heterogeneity. The purpose of this study was to investigate how sensitive this type of arrhythmia induction is to the parameters of the ionic model.

Simulations were performed with a monodomain reaction-diffusion model with Courtemanche dynamics on a volumetric atrial mesh with all the major bundle structures and layered fiber orientation. The mesh size was 0.2 mm. The ionic model parameters were modified to represent electrically remodeled atria, uniformly. The model was stimulated with decreasing cycle length such as to drive the atria to maximum rate, and simulated over 10 seconds or until activity died out. This was tried with 10 different pacing locations. The simulations were repeated with the conductivity, GCaL, of the L-type calcium current increasing in 10 steps of 1 % and then in 8 steps of 10 %.

For GCaL values up to 130 % of the initial value, on average 3 out of 10 pacing sites induced AF. However, the positive sites were different for each tested GCaL level, even at 1 % increments. Beyond 130 %, the AF induction rate decreased, still with a different set of positive sites for each level. Every pacing site yielded AF for a subset of parameter values, but some sites more frequently.

In conclusion, AF induction is highly sensitive to parameter values. The global decrease in induction seen for large GCaL may be due to the increased wavelenth, which was harder to fit in the atria. The short-range variations, on the other hand, suggest a chaotic dependence of AF induction on on parameter values.

1. Introduction

2. Methods

3. Results

4. Discussion

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References

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