Biomed Tech 2012; 57 (Suppl. 1) © 2012 by Walter de Gruyter · Berlin · Boston. DOI 10.1515/bmt-2012-4196

Impact of Antiarrhythmic Drugs on a Virtual Model of Atrial Fibrillation

M. Wilhelms, L.P. Holl, O. Dössel, G. Seemann, Institute of Biomedical Engineering, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, publications@ibt.kit.edu

Introduction

Atrial fibrillation (AF) is the most common cardiac arrhythmia affecting around 1% of the population. Several antiarrhythmic drugs such as e.g. amiodarone or dronedarone influence cardiac electrophysiology reducing arrhythmias. However, the electrophysiological mechanisms underlying the initiation and persistence of AF are not completely understood yet.

Methods

A mathematical model of atrial electrophysiology was modified to simulate the effects of chronic AF (cAF). Furthermore, ion channel conductivities were reduced according to the inhibition caused by two different concentrations of amiodarone and dronedarone. The resulting drug effects were investigated in healthy and cAF single-cells as well as in tissue. In a 1D tissue strand, restitution curves of the effective refractory period (ERP), the conduction velocity (CV) and the wavelength (WL) were computed. Furthermore, persistence of rotors in a 2D tissue patch was analyzed. For this purpose, four rotors were initiated in the cAF patch and then the drug effects were incorporated.

Results

Dronedarone and amiodarone prolonged the atrial action potential duration of cAF cells, whereas high concentration of amiodarone slightly shortened it in healthy cells. Furthermore, both drugs increased the ERP and slowed the CV. Dronedarone shows the longer ERP and also a higher CV. As a result, the WL was prolonged by dronedarone and shortened by high concentration of amiodarone. Low concentration of amiodarone did not change the WL. In the 2D tissue patch, dronedarone altered significantly the trajectory of rotors, but did not terminate them.

Conclusion

Computer simulations of the effects of antiarrhythmic drugs on cardiac electrophysiology are a helpful tool to better understand the mechanisms responsible for persistence and termination of AF. However, ion current measurement data available in literature show great variability of values depending on the species or temperature. Therefore, integration of drug effects into models of cardiac electrophysiology still needs to be improved.