Realistic model of action potential propagation in rabbit heart: Application to defibrillation studies

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In this work I have developed a realistic numerical model of the propagation of the action potential through the ventricles of a rabbit heart. The model contains two fields, the external electric potential and the intra-cellular electric potential[1] . Realistic geometry as well as fiber orientation inside the heart are taken into consideration[2]. It is well known that the electric conductivity is one order of magnitude larger in the direction of the fiber with respect to orientation perpendicular to the fibers[3]. The resulting wave speed of the action potential is substantially affected by the anisotropy of the local conductivity tensor and is a crucial parameter to consider in realistic simulations. In addition to the geometry and the topology of the fibers, the physiology of the cell membrane is also modeled in a realistic manner (different models for the membrane of the myocites have been considered: e.g. Flavio-Fenton model[4]; Luo-Rudy[5]; Ashihara-Trayanova[6]).

Aiming at determining the influence of a strong applied external electric shock to restore a correct state of the heart, we have used the following proctocol: The model parameters are chosen in order to facilitate a fibrillation state of the heart then through excitation at different choosen points one induces a turbulent electric state (i.e. fibrillation). The next step consists in applying an electric shock to reset the membrane potential.

The parameters of interests in the present study are: strength of the applied electric field; localization of the electric field and finally one also investigate the influence of the temporal dynamics related to the application of the field.

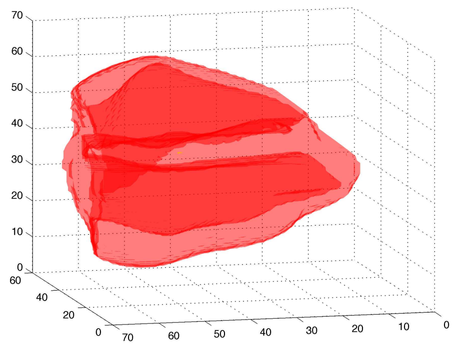

Figura 1. Computational domain.

The final goal of this study is the design of an optimal strategy to follow in defibrillating the heart while avoiding the application of huge electric fields that are responsible for irreversible damages to the heart structure.

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