Mathematical modeling of ionic currents of the heart

Project Summary

In this project, the ionic currents of the heart will be modeled. First, a literature review and the selection of suitable models will be performed. The subsequent implementation of the models will be done in MATLAB. The evaluation and validation of the models concludes the work. Optional the ionic current models can be integrated into an existing 3D finite element model of the heart to simulate the electrocardiogram [1, 2].

Project Type

- BA Thesis (3-6 months)
- MA Thesis (6 months)

Required Qualifications

- Interest in physiological modelling
- Programming skills in MATLAB

Contact

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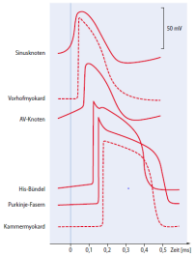

Figure 1: Characteristic shapes of action potentials in different areas of the heart. Figure taken from [3].

Detailed Description

Cardiac muscle cells, like skeletal and nerve cells, belong to electrically excitable tissue. The membrane ion current of the cardiac cells ensures the generation of action potentials. This electrical excitation leads to mechanical contraction of the heart through electromechanical coupling. In the heart, an orderly sequence of excitation occurs through a division into an excitation generation or conduction system and the working myocardium. The cardiac myocytes in these regions exhibit characteristic action potential shapes that differ from each other. [3]

The electrical excitation in the heart results in an electric field, which can be conducted by electrodes on the skin surface. Since the different areas of the heart are excited with a time delay, signals of atrial and ventricular excitation as well as excitation regression in the ventricles can be distinguished in the derived electrocardiogram (ECG). [3]

References

[1]: Oltmann et al.: „Spatial Sensitivity of ECG electrode placement“. 2021.

[2]: Sovilj, S. et al.: „A Simplified 3D Model of Whole Heart Electrical Activity and 12-Lead ECG Generation“. 2013.

[3]: Brandes, R. et al.: „Physiologie des Menschen“. 2019.