Personalised Modelling Pipeline for Cardiac Electrophysiology Simulations of Infarct patients

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Cardiac Resynchronization Therapy (CRT) is an effective treatment for heart failure. However, it may be arrhythmogenic in infarct patients depending on pacing location. While personalised computational models allow studying the complex interaction between cardiac electrophysiology and anatomy, building such models and simulating cardiac electrophysiology at clinical time-scales remains a challenging task. Thus, we developed a personalisation pipeline, which allows fast development of infarct model cohorts and simulation of cardiac electrophysiology. LGE-MRI were acquired from 11 infarct patients undergoing CRT. Left ventricular (LV) endocardium and epicardium contours were manually drawn in each short-axis slice. A finite element (FE) mesh of tetrahedral elements was generated by interpolating the contours. A binary mask representing the LV wall was also generated. The infarct scar and border zone were segmented by thresholding the voxel intensity within the LV wall. These were used to label the tetrahedral FE. Fibre orientations were assigned to the labelled mesh using a rule-based method. Activation and repolarisation sequences were computed using a Reaction-Eikonal model. The models were assigned experimentally measured values of conduction velocity (healthy and border zone). Scar was modelled as an insulator. Propagation was initiated at different LV lead locations for each patient. Each model was generated within 2 hours and each simulation took less than 2 minutes on a desktop workstation. Comparison against the LGE-MRI shows that the models accurately represent LV anatomy and scar morphology. Simulations show that CRT alters repolarisation properties around the scar depending on pacing location, which may be arrhythmogenic. The modelling pipeline provides a robust framework for the development of personalised infarct model cohorts and fast simulations to investigate the role of CRT in arrhythmogenesis. This time-frame for model generation is compatible with clinical time-scales and allows for fast clinical translation of computational modelling.