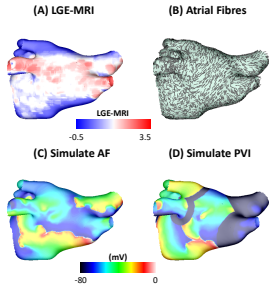
Constructing Virtual Patient Cohorts for Simulating Atrial Fibrillation Ablation

Caroline H Roney, Marianne Beach, Arihant Mehta, Iain Sim, Cesare Corrado, Rokas Bendikas, Jose Alonso Solis-Lemus, Orod Razeghi, John Whitaker, Louisa O'Neill, Gernot Plank, Edward Vigmond, Steven E Williams, Mark D O'Neill, Steven A Niederer.

King's College London
London, UK

Introduction: Determining optimal treatment approaches for atrial fibrillation (AF) patients is difficult because the patient specific mechanisms underlying the arrhythmia are typically unknown. These mechanisms and the effects of the atrial anatomy, electrical and structural substrate on potential AF ablation treatments may be investigated using virtual patient cohorts. However, constructing patient specific biophysical models for virtual cohort simulations is time consuming and there is large variability in atrial morphology between patients. Models within a virtual cohort should be constructed using a consistent approach regardless of variations in atrial morphology so that virtual patient ablation outcomes can be compared between cases. In this study, we developed a standardised pipeline for constructing personalised biophysical left atrial models to simulate AF and test different ablation approaches.

Methods: Late-gadolinium enhancement (LGE)-MRI data were segmented using the CemrgApp and meshed to create an anatomical shell. The pulmonary veins and left atrial appendage were labelled and the effects of repolarisation heterogeneity was incorporated as different maximal ionic conductances for the Courtemanche et al human atrial model in each of these regions. Fibrotic remodelling was included according to the distribution of LGE intensity values as changes in conductivity and the ionic cell model properties. Atrial fibres were mapped to each model from a DTMRI atlas distribution using the universal atrial coordinate system. AF was initiated by seeding four spiral wave reentries at standard locations across the anatomies. Pulmonary vein isolation ablation was simulated.



Methodology schematic

Conclusion: We presented a methodology for testing ablation approaches across a large virtual patient cohort of personalised left atrial models.