Biatrial Modelling for In Silico Prediction of Atrial Fibrillation Inducibility

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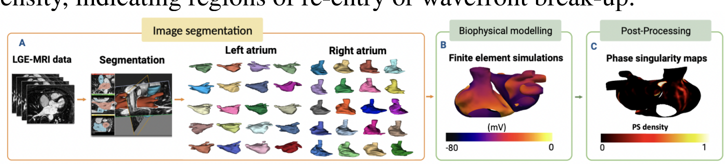
Background: Recent clinical and mechanistic modelling studies have identified the significance of the right atrium (RA) in understanding the mechanisms underlying atrial fibrillation (AF) recurrence, though its role remains unclear. The aim of this study was to employ an open-source biatrial modelling pipeline to develop biatrial models for assessing AF inducibility and their ability to predict AF outcomes on clinical timescales.

Methods: Patient-specific models were constructed from late-gadolinium enhanced-MRI scans for a total of 20 patients from the Atrial Segmentation Challenge Dataset (2018). The construction of such models entailed manually delineating atrial substructures (Figure **A**) and pre-processing meshes to quantify scar fibrosis, followed by landmark selection and registration using universal atrial coordinates and fibres using Python. Each patient-specific model incorporated atrial fibres, structures, and electrical parameters to portray variances in atrial properties and assess AF inducibility. Finally, simulation stress tests were performed (Figure **B**) and post-processed to evaluate variations in atrial fibrillation wavefront patterns (Figure **C**).

Results: The integration of the right atrial substrate resulted in significant increases in rotor activity and total number of phase singularities in the posterior region of the left atrium (LA) across the cohort, indicating that AF is more likely to be sustained. The LA had a greater mean phase singularity density of 3.8 rotors/cm^2 than the RA, indicating that targeting the LA is critical in preventing AF recurrence. The biatrial phase singularity density maps demonstrated a significant increase in localised regions with elevated phase singularity density, indicating regions of re-entry or wavefront break-up.



Conclusion: A model construction pipeline demonstrates that biatrial models have the potential to be efficient tools for predicting AF treatment outcomes and personalising therapy on clinical timescales. We are using our pipeline to compare different ablation approaches and anti-arrhythmic drug therapies.