Deep Learning-based Prediction of Atrial Local Fibrosis from *In Silico* Intracavitary Electrograms

Santiago Moreno-Pineda, Giada S. Romitti, Duna De Luis-Moura, María Termenón-Rivas, Alejandro Liberos, Miguel Rodrigo

CoMMLab, Universitat de València, València, Spain

Atrial fibrillation (AF) is the most common arrhythmia, and detecting its fibrotic substrate is crucial for patient prognosis and optimal targeted therapies. Currently, non-invasive assessment relies heavily on late gadolinium enhancement (LGE-MRI), a modality limited by reproducibility and clinical accessibility. Detailed 3D anatomical simulations with fibrotic infiltration provide a robust computational alternative. By offering an exact ground-truth, they enable precise fibrosis prediction directly from clinically routine intracavitary electrograms (EGMs).

Using 5 anatomically realistic anatomies with different degrees of fibrosis infiltration, we simulated AF patterns and generated EGMs on a virtual endocardial shell (1 mm offset, N= 163,412 EGMs). Ground-truth fibrosis was defined for each EGM as the amount of fibrosis within a radius of 3mm. We have developed a preliminary deep learning method to predict presence/absence of local fibrosis (>5%) from temporally windowed (200 ms) unipolar EGMs: a 1D Convolutional Neural Network with 2 convolutional blocks, optimized to detect high-frequency fragmentations and signal amplitude variance.

Evaluated on the test cohort (32,002 EGMs, unseen virtual patient), the model achieved a Balanced Accuracy score of 0.73 and an AUROC of 0.81.

This approach has the potential to predict high-resolution substrate mapping from clinical recordings, helping the personalization of digital twins for targeted ablation therapies.

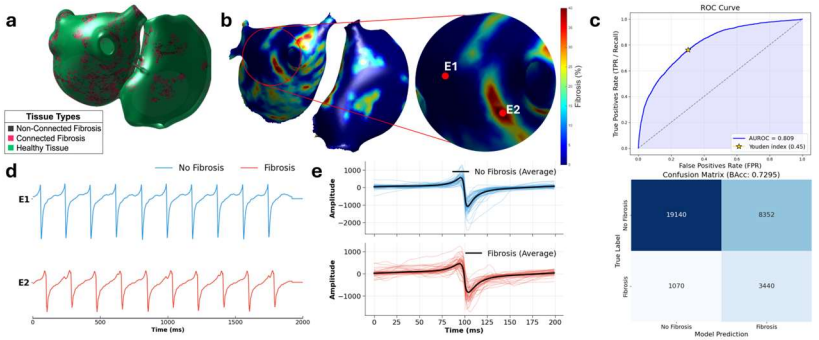

Figure 1. a) 3D anatomical model with fibrosis infiltration; b) ground-truth fibrosis map; c) Confusion matrix and ROC curve; d) simulated unipolar EGMs from healthy (E1) and fibrotic (E2) regions marked in blue and red, respectively; e) EGM windows cohorts.