Non-Invasive Electrogram Estimation from Body Surface Potential Mapping using Artificial Intelligence

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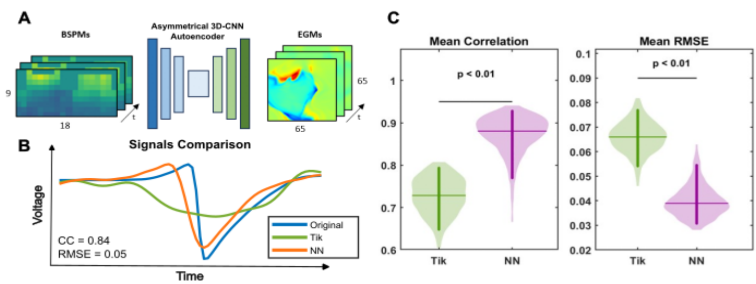
Background. Electrocardiographic imaging (ECGI) is a non-invasively method for reconstructing cardiac electrograms (EGMs) from body surface potential mapping (BSPM), that can be affected by signal and geometrical uncertainties. To overcome this problem, this study introduces a Convolutional Neural Network (CNN) autoencoder to directly estimate EGMs from BSPMs.

Methods. A comprehensive database with 16,800 simulations explored sinus and ectopic stimulations across 42 atrial geometries with different locations, propagated to 16,800 torsos with added noise for realistic BSPM signals, and then transformed into volumetric images to facilitate spatial and temporal feature extraction.

A 3D-CNN asymmetrical autoencoder model was developed for EGM signal reconstruction from BSPM signals (Fig. A). Model performance was evaluated by comparing original signals, Tikhonov regularization solutions, and model predictions. To evaluate the performance, correlation (CC) and root mean squared error (RMSE) were considered.

Results. Predictions demonstrate enhanced recovery of EGM morphology and amplitude compared to classical ECGI (Fig. B). The network yielded an average EGM CC of 0.87±0.05 vs. 0.73±0.05 for classical ECGI's (Tik) and RMSE of 0.04±0.01 vs. 0.07±0.01 (Fig. C), showcasing enhanced accuracy and offering promising advancements for ECGI in the clinical practice.



__A__ – Autoencoder schematic. __B__ – Signal comparison. __C__ – Violin plots of CC and RMSE metrics with Tikhonov regularization (green) and predictions (purple).