A Combined In-Silico and Machine Learning Approach Towards Predicting Arrhythmic Risk in Post-Infarction Patients

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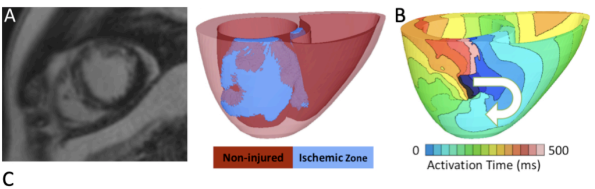
Background: Remodeling due to myocardial infarction (MI) increases patient arrhythmic risk. Simulations using patient-specific models have shown promise in predicting personalised risk to arrhythmias. However, the simulations are computationally and time intensive, hindering their translation to clinical practice.
Objective: The goal of this study is to demonstrate that machine learning (ML) algorithms based solely on infarct and ventricular geometry can be used to accurately predict occurrence of arrhythmias as predicted by simulations.
Methods: MRI-based computational models were constructed from 38 patients 5 days postMI (Fig A). Arrhythmia induction was attempted via programmed stimulation at 17 sites that correspond to AHA LV segments. We used the myocardial volume and scar volume, and the segment-specific myocardial volume and scar transmurality as input to the ML algorithms. We trained one clustering and three classification models to predict the simulation outcome from the geometric features. The ML models were trained on 70% of randomly selected segments, the remaining 30% was used for validation.
Results: Stimulation from 120 sites resulted in reentry in 17 patients (Fig B). We trained multiple ML models, each with a different train/validation split of the segments. The best performing model is a neural network, which correctly predicted simulation outcome in 87.6% of the cases, with 1.3% standard deviation (Fig C).
Conclusion: ML techniques combined with the simulations can provide important insights for clinicians in a fast and efficient way. This paves the way for using data-driven simulations for prediction of dangerous arrhythmia in MI patients.



C

Machine Learning Model	Average	Std	Max	Min
K-Means	76.8%	3.0%	83.0%	70.6%
Gaussian Support Vector Machine	85.1%	2.1%	88.7%	80.4%
Decision Tree	85.9%	2.0%	89.2%	80.9%
Neural Network	87.6%	1.3%	89.3%	84.5%