Automated Localization of Focal Ventricular Tachycardia from Implanted Devices Electrograms: A Combined Physics-AI approach

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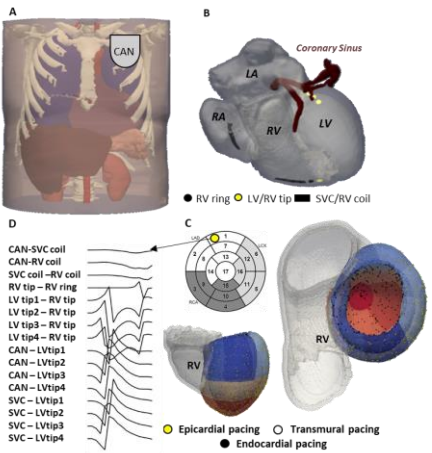
Focal Ventricular Tachycardia (VT) is driven by early and repetitive firing from regions other than the Sino-atrial node. Localization and radiofrequency ablation of such sites are the basis of VT treatment; however, accurate localization is often highly invasive, requiring VT induction and pacing from different ventricular sites. In a previous study, automated detection was achieved from 12-leads ECG analysis; here, we propose a convolutional neural network (CNN) algorithm which detects focal VT from implanted device electrograms (EGMs), simulated in a virtual environment. To do this, we generated a highly detailed 3D torso model from CT data (**A)**, and paced the left ventricle (LV) in more than 1000 locations (**C)**; 50% of these were transmural, 25% endocardial and 25% epicardial. LV was divided into 17 segments (**C**) according to American Heart Association (AHA). EGMs were then calculated from right and left ventricular leads of an implanted device (**B, D)**, for a total of 16 signals. Pre-processing on the data was performed for data augmentation, including addition of noise and small lead placement variations. Accuracy of the network to identify the location of pacing sites according to the 17-segment-AHA model (**C**) was compared with the previous study. We also tested the algorithm for 1-D, 2-D and 3-D data – by manipulating the computational EGM data - and in presence of a long short-term memory (LSTM) network after the CNN, showing the limitations of current ECG-based CNNs. Our study shows the possibility of improving pre-ablation planning of focal VT by using stored information in implanted devices, and automating the localization problem using a combination of deep learning algorithms and computational data.



A; 3D Model, **B**; Implanted Device, **C**; Pacing protocol and AHA model, **D**; Example EGM localization