Can Machine Learning of Monophasic Action Potentials Predict Long-Term Ventricular Arrhythmias?

Anojan Selvalingam
Mahmood I. Alhusseini
Albert J. Rogers
David E. Krummen
Firas Abujaied
Junaid A.B. Zaman
Tina Baykaner
Paul Clopton
Peter Bailis
Matei Zaharia
Sanjiv M. Narayan

Introduction: Predicting sustained ventricular tachycardia/fibrillation (VT) is difficult even in patients with coronary disease (CAD), left ventricular (LV) dysfunction and other risk factors. The objective of this study is to train deep neural networks (DNN) on features of monophasic action potentials (MAP) that reflect cellular remodeling. We then tested the hypothesis that deep learning of ventricular MAPs can predict freedom from VT on long-term follow-up.

Methods: We studied 26 patients with CAD and left ventricular ejection fraction (LVEF) ≤ 40%, in whom MAPs were recorded at electrophysiological study from right ventricle (RV) and LV (Fig. A). Voltage-time series MAPs were input to the DNN, for the binary output label of ICD therapy (1/0). Training was performed using k-cross validation (CV) with k = 7. The network was developed using a total of 3580 MAPs in training and validation cohorts.

Result: Patients were 62.0±18.7 years old with LVEF 28.0±8.3%. Average follow up duration was 752±493 days. DNN training accuracy converged to 100% (Fig B). MAP duration and other parameters did not differ between groups (p=NS). In independent validation cohorts, the trained DNN predicted appropriate ICD therapy with accuracy as high as 78%.

Conclusion: Deep learning models of ventricular MAPs, which may reflect pathological remodeling, may predict VT-freedom on long-term follow-up. Data from more studies is needed to determine if this approach enables novel risk prediction.