Accuracy of Classic Features versus Deep Learning to Detect Atrial Fibrillation on Intracardiac Electrograms

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Cardiac devices face difficulties in differentiating atrial fibrillation (AF) from other tachycardias (AT) from single electrograms (EGM), and they tend to group arrhythmias by a rate threshold. We have carried out a comparative study to assess the accuracy of using multiple clinically-intuitive EGM features to differentiate AF from AT versus a deep learning (DL) logic.

In 86 patients undergoing ablation (61 male, age 65±11) we obtained a total of 29,340 intracardiac basket EGMs (4 s. length) of AF (fig A, red) and AT (purple). We comprehensively probed EGMs using 49 clinically-intuitive features based on cycle length, frequency and amplitude (fig B), used both individually and in combination to identify AF. We also developed custom convolutional (CNN) and recurrent (RNN) neural networks for the same purpose. Classifiers were tested using the same 10-fold cross-validation folds (80% patients for training, and 20% for testing).

Single EGM features modestly separated AF from AT with c-statistics ranging from 0.55 (number of peaks, i.e. rate) to 0.82 (autocorrelation of EGM shape). Accuracy increased when features were combined (fig C) Linearly (c-statistic 0.95 ± 0.04), by Bagged Trees (0.95 ± 0.04), K-Nearest Neighbors (0.95 ± 0.04) or Support Vector Machines (0.95 ± 0.04). DL on raw EGMs provided similar accuracy without the need to calculate features, with c-statistics of 0.95 ± 0.04 (CNN) and 0.97 ± 0.04 (RNN; fig C).

Deep learning of raw EGMs provides similar outcomes than traditional rule- and feature-based identification of AF from other arrhythmias, with no need to previous feature and rule identification. This approach could improve device diagnosis and may shed insights into AF classification and characterization beyond classical features such as rate and regularity.