Electrogram Signatures of Atrial Fibrillation identified by Deep Learning

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Automatic detection of atrial fibrillation (AF) by cardiac devices is an increasingly important paradigm, yet confounded by 'high rate events' that group AF, flutter or tachycardia (AT) together, which may delay or misdirect therapy. We hypothesized that deep learning (DL) can be probed to identify novel Electrogram (EGM) signatures for AF.

We recruited 86 patients with AF or AT at ablation (61 male, 65±11 years). We developed convolutional neural networks in N=29,340 unipolar EGM segments (4 s.) recorded by multipole basket catheters. We then probed how DL made decisions, by assessing the impact of calibrated variation in shape, rate or timing regularity in 66,638 reconstructed EGM sequences (Fig. A-B).

Trained DL identified AF with a c-statistic of 0.97± 0.04 from unipolar EGMs. Signal irregularities in reconstructed EGMs led to AF classification (red) when cross-correlation of activation shape fell <0.48 (fig C), when timing irregularity > 15% (fig D) or when cycle length < 185 ms (fig E, p<0.001). We also identified specific EGM shapes able to explain the remaining AF classification by DL (Fig. F).

Deep learning identifies EGM signatures for AF even if traditional features overlap with AT. 'Opening the black box' of DL revealed computational phenotypes comprising EGM shapes, regularity and rate which could define patient subpopulations and guide therapy.