SUPPLEMENTAL MATERIAL

Unipolar Electrogram Phase Maps

Phase mapping was applied when isochronal maps did not readily explain AF termination at sites of localized ablation.

Phase was computed for each patient from unipolar electrograms in AF using non-proprietary methods (supplementary figure 2). The sequence of N activation times at the ith electrode (j=1,..,N) was used to determine N-1 signals. Signals were normalized by the time interval , resulting in a signal starting at T=0 and ending at T=1. Normalized signals were averaged by adding them and dividing the sum by the total number of time intervals (N-1). This was repeated to result in an average electrogram shape for each electrode in that individual, . The signal was baseline corrected so that the signals are zero at T=0 and T=1, with maximum value normalized to 1 to produce the final signal . These signals were used for each electrode by mapping the normalized time interval to the interval .

Phase maps were computed as previously described [1]. We defined a rotational circuit (rotor) as a phase singularity where complete phase transitions (-π to +π) were observed [2,3]. A phase singularity for more than 3 cycles and located within a 2x2 electrode grid provides evidence for a rotational source that may explain termination by targeted ablation at that site.

Supplemental figure legends

Supplemental figure 1. Electrogram annotation methods did not impact AF isochronal maps.

A) Three examples of electrogram annotation are shown, with red (-dv/dt) and blue (max

amplitude) criteria agreeing in activation sequence. (i) Isochronal activation maps using the -dv/dt criteria show rotational activity and focal impulses. (ii) The corresponding isochronal maps using the peak annotation method were similar.
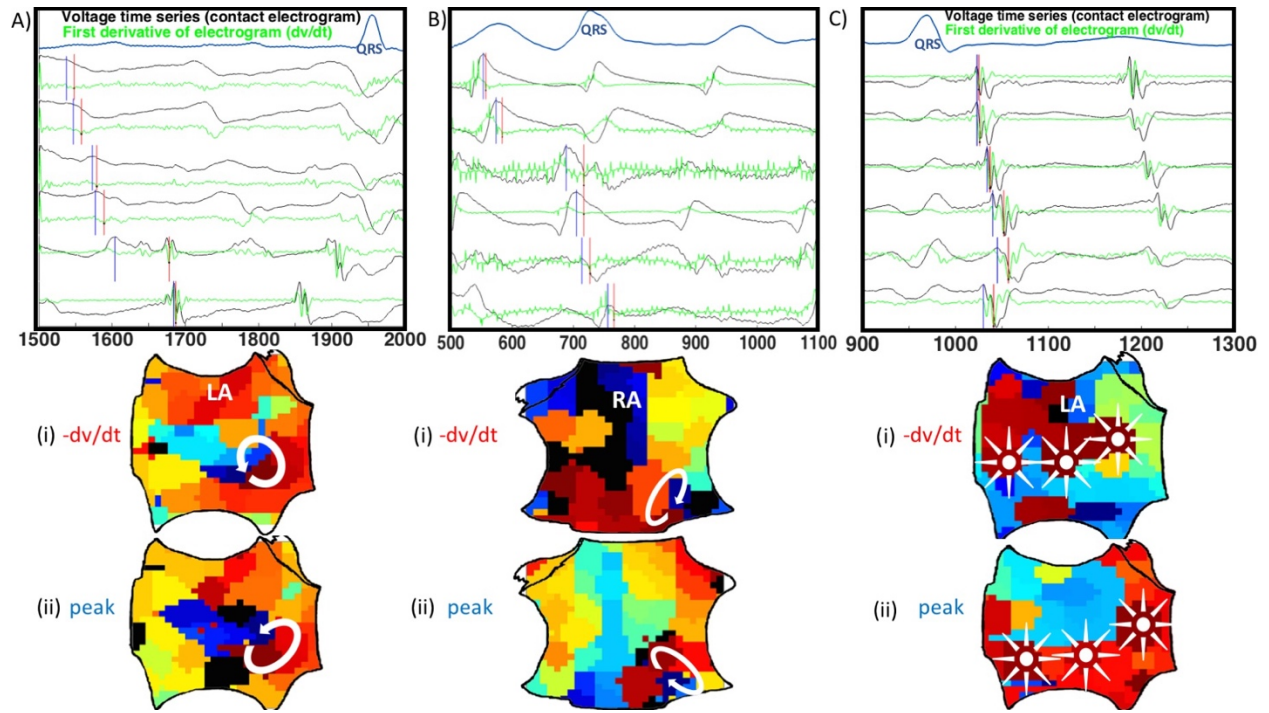
Supplemental figure 2. Phase analysis of data from a 64-pole basket catheter in AF in a 54-year-old man. A) Average unipolar electrogram shape for this patient and electrode from raw tracings (inset). B) Snapshot of phase map, as a color plot with red/blue corresponding to high/low phase. A clock-wise rotating spiral wave is shown, and represented by the white arrow. C) Corresponding activation map showing head-tail interaction at same site.

Supplemental references:

1.   Narayan SM, Krummen DE, Enyeart MW, Rappel W-J. Computational mapping identifies localized mechanisms for ablation of atrial fibrillation. *PLoS One* [Internet]. 2012;7:e46034.
2.   Zou R, Kneller J, Leon LJ, Nattel S. Development of a computer algorithm for the detection of phase singularities and initial application to analyze simulations of atrial fibrillation. *Chaos* [Internet]. 2002;12:764–778.
3.   Umapathy K, Nair K, Masse S, Krishnan S, Rogers J, Nash MP, Nanthakumar K. Phase mapping of cardiac fibrillation. *Circ Arrhythm Electrophysiol* [Internet]. 2010;3:105–14.

Supplemental Figure 1

Supplemental Figure 2.