Computer Simulations of Composite Maps for Detection of Atrial Fibrillation Mechanisms

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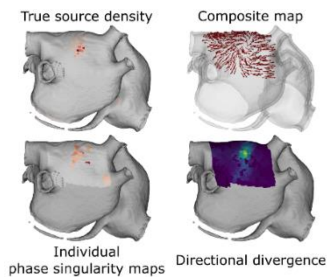
Aims: In atria of patients with atrial fibrillation (AF), regions with repetitive conduction patterns may represent AF drivers and thus candidate ablation targets. Current mapping catheters are limited by either low spatial coverage or resolution. In this in-silico study, we investigated the superiority of composite high-coverage maps, obtained from linking repetitive patterns from high-density recordings, against individual maps, with respect to their ability to localize AF drivers. **Methods:** Three AF driver scenarios were simulated in a volumetric 3D model of the atria: a stable reentry, a meandering reentry, and a reentry with wave collisions. Electrograms were sequentially recorded from 30 overlapping locations on the left posterior wall (4x4 grid, 3mm spacing, 230 to 800 ms). Preferential conduction direction vectors of repetitive patterns detected in neighboring locations were linked together when showing similar conduction direction (cosine distance<0.25) and cycle length (CL, differences<10%). Regions of high directional divergence, associated with reentrant and focal patterns, were obtained from composite maps to estimate the locations of the AF drivers. These locations were compared to those estimated through phase singularities and CL coverage maps from the individual recordings (Figure). The algorithm's dependency on the mapping density was also investigated.



Examples of source density maps obtained with each technique

Results: The proposed algorithm led to better estimation of the underlying source density (sensitivity: 0.88/0.87/0.69, specificity: 0.85/0.85/0.68 for stable reentry, meandering reentry, and collision, respectively), compared to the maps from individual recordings (sensitivities 0.85/0.70/0.65 and 0.84/0.86/0.47, specificities 0.87/0.70/0.64 and 0.85/0.87/0.51 for phase singularity and CL coverage, respectively). Reduction in the mapping density led to decreased performance (>20% drop in sensitivity and specificity upon 50% reduction in density). **Conclusion**: Analysis of composite maps of simulated atrial conduction patterns improved detection of AF drivers as compared to separate analysis of individual sequential maps.