Intrinsic Mode Function Complexity Index Tracks the Pivot Point of a Numerically Simulated Meandering Rotor

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Introduction: Atrial Fibrillation is the most common sustained cardiac arrhythmia, a known prognostic marker for stroke, heart failure and even death. Reentrant mechanisms of rotor formation which are stable electrical sources of cardiac excitation are believed to cause AF. The pivot points of rotor are believed to be good ablation targets to terminate AF in patients. Current mapping methods such as Local Activation (LAT) map, Complex Fractionated Atrial Electrograms (CFAE)- mean map, Dominant Frequency (DF) map and Phase Analysis maps are inadequate to identify the rotor pivot zones due to various noises, misleading phase and activation times. The purpose of this research was to test the feasibility of intrinsic mode function (IMF) complexity index to accurately track the pivot point of a numerically simulated meandering rotor.

Materials and Methods: Electrical activity in a 30x30mm human atrial tissue was simulated using an extended bi-domain model that incorporates both fibroblasts and myocytes in a bi-layer scheme. Also, incorporation of diffuse fibrosis allowed easy control over the extent of rotor meandering. The numerically simulated meandering rotor data was obtained with 100x100 pixel resolution at 1000 frames per second. Pixel locations are labeled at the rotor pivot point and the periphery at a particular time frame for reference purposes. Custom MATLAB software was written to compute 2D IMF and Shannon Entropy map to track rotor pivot point for comparison.

Results and Discussion: The 2D IMF map demonstrated accurate tracking of the rotor pivot point verified with visual inspection with higher IMF complexity values at the reference pixel locations at the rotor core compared to the periphery. Validation of this technique with meandering rotors at different diffuse fibrosis levels can further demonstrate the efficacy of IMF complexity approach.

Conclusions: IMF complexity based mapping technology accurately tracked pivot point of a numerically simulated meandering rotor.