Body-Surface Atrial Vector Similarity as a New Way to Investigate Atrial Fibrillation Propagation Dynamics

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Aims: Atrial propagation patterns during atrial fibrillation (AF) can be characterize by a certain degree of recurrence, which is associated with different types of reentrant circuits that can drive the arrhythmia. In this study, we investigate this recurrent activity at the level of the body-surface, by measuring the level of similarity between pairs of consecutive atrial vectors.

Methods: High-density body surface potential maps (120 anterior, 64 posterior electrodes) were recorded in 75 patients in persistent AF. For each patient, atrial vectors were created by taking the samples from all electrodes at each time instant. Similarity between consecutive vectors was measured in terms of the value of the cosine of the angle between two vectors. We then analyzed the time and frequency properties of the series of cosine values, and also whether it correlates with the long-term recurrent behavior of the atrial propagation patterns.

Results: In all patients, the series of cosine values shows a quasi-periodic behavior, with periods of values close to 1 (similar vectors), and very short periods of values close to 0 (sometimes negative; dissimilar vectors), and quick transitions between the two. This suggests that the vectors alternate between phases of slow motion (values close to 1), and phases of fast motion (values close to 0). Moreover, the frequency of this behavior is about twice the AF dominant frequency, which suggests that within one AF cycle there are two phases of slow motion and two of fast motion, alternating. Finally, the amount of slow phases is positively correlated with a higher long-term recurrent behavior of the atrial propagation patterns.

Conclusion: The noninvasive analysis of atrial vectors provides a new way to investigate atrial fibrillation dynamics, and it can capture some information about the organization of the underlying atrial activity propagation patterns.