

Mapping of Atrial Fibrillation:

Centroid Frequency of High Resolution Electrograms Identifies Circuit Density

Background

Atrial fibrillation (AF) increases morbidity and mortality. Despite its clinical impact ablation therapy is effective in only 75% of patients. This inefficacy is due in part to an inability to identify sites responsible for AF perpetuation. We have previously demonstrated that AF is perpetuated by spatially and temporally dynamic excitation circuits and that ablation lines are more effective when delivered in areas of high circuit density (Cd). Unfortunately identifying reentrant circuits through isochronal activation maps is impractical. We postulated that tissue frequency (TF) would be highest at sites of circuit cores. We have demonstrated that electrogram frequency does not accurately reflect TF if recording spatial resolution is too large. We tested the hypothesis that the accuracy with which electrogram frequency identifies Cd improves as spatial resolution improves.

Methods

Using a computational model of excitation we varied tissue electrical properties to create AF with regional variation of Cd. Cd was mapped by tracking wave-end location over time and identifying those wave-end paths that form complete circuits. A 10x10x2 electrode-array was placed at a height of 1 and 4mm above the tissue. Unipolar and bipolar electrograms were calculated. The Fast Fourier transform of each electrogram was calculated and the dominant frequency (DF) and centroid frequency (CF) were identified. DF and CF were compared to TF beneath the electrodes.

Results

We found a strong correlation between Cd and TF ($r=0.7608$). Bipolar electrogram frequency (higher spatial resolution) more accurately reflected Cd than unipolar recordings (unipolar DF, $r=-0.0082$ vs. bipolar DF, $r=0.5691$; unipolar CF, $r=0.4195$ vs. bipolar CF, $r=0.7358$). As the number of high Cd areas increased the correlation between Cd and TF decreased. The correlation between electrogram frequency and Cd improved as the Cd gradient increased.

Conclusion

During AF TF correlates with Cd. The centroid frequency of bipolar electrograms accurately identified Cd. These data indicate a method for electrogram guidance for AF ablation.