Sequential Omnipolar Mapping Technique: Extending Omnipolar Mapping to Sequential Recordings for Improved Voltage Estimation

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Aims: The aim of this study was to evaluate a sequential formulation of OT capable of operating independently of catheter geometry, enabling its application with arbitrary clinical mapping catheters. Specifically, we assessed whether bipolar electrograms acquired at different time instants with varying positions and orientations could be integrated to estimate local voltage, conduction velocity, and wavefront direction.

Methods: Sequential OT was evaluated on clinical electroanatomical maps acquired during coronary sinus pacing. For each estimation point, local neighborhoods of radius $r = 1.5$ to 3.5mm were defined to collect nearby bipolar recordings acquired at different time instants. A bipolar measurement was included only if both electrodes were located within the neighborhood. To enable OT estimation with a reduced minimum number of measurements, electrode coordinates were projected onto a best-fitting plane estimated by principal component analysis. OT was then applied, when feasible, to estimate voltage, conduction velocity, and wavefront direction. For comparison, a conventional bipolar voltage estimate was defined as the maximum peak-to-peak amplitude among all bipolar electrograms in the same neighborhood. Feasibility and agreement between OT and bipolar estimates were analyzed as a function of neighborhood size.

Results: The percentage of OT-feasible points increased with neighborhood radius, reaching 51% at $r = 3.5$ mm. For $r \leq 2.5$ mm, OT voltage estimates were higher than the corresponding bipolar values, this relationship was reversed for larger radii. In a reference subset of points where OT-estimated propagation direction agreed with bipole orientation, OT and bipolar voltages showed good agreement at small radii, with a Pearson correlation coefficient of 0.948 for $r = 2.5$mm. These findings support the feasibility of sequential OT in clinical settings as a tool to enhance conventional bipolar voltage maps, suggesting that omnipolar information can be recovered from sequentially acquired recordings even when standard clinical catheters are used.