In Vivo Analysis of Conduction Pattern Dynamics: System Development and Application Using OpenEP

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Introduction: Atrial low voltage, which may indicate fibrosis, has been implicated in atrial fibrillation perpetuation. Low voltage is a marker of the underlying substrate, but it is the electrophysiological properties of this substrate which are critical to arrhythmogenesis. Nevertheless, the influence of low voltage on *in vivo* conduction pattern dynamics is uncertain. Here, we develop a method for dynamic conduction velocity (CV) assessment.

Method: 22 patients were included. A central electrode pair of a Pentaray catheter, placed in contact with the atrial wall, was used to apply a series of pacing trains (S1) at fixed basic cycle lengths with a coupled premature extra stimulus (S2). The S1S2 interval was progressively reduced to 200ms or loss of capture. For each S1S2 interval, two perpendicular electrodes were selected to calculate CV in longitudinal and transverse directions.

Local activation times were automatically calculated using a non-linear energy operator applied on bipolar signals. CV restitution curves were generated by plotting CV at each S1-S2 interval. Two lines were fitted to the plateau and the descending part of the curve. The slope of the descending line was used to quantify CV restitution. To quantify conducting path low voltage, the geodesic paths between pacing and recording electrodes were calculated. For each path and its 3mm corridor, low voltage area was quantified as the proportion of mesh elements with bipolar voltages below 0.5mV. All analysis was implemented in OpenEP (https://openep.io).

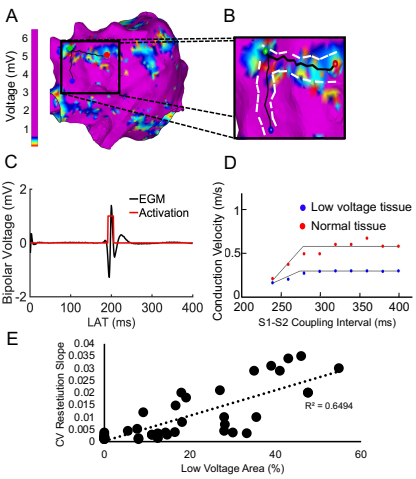

Figure: A) An example of voltage map and recording sites (Green: pacing, Blue and Red: recording). B) Magnified recording area (Black: geodesic path, White: area in which low voltage area was quantified). C) An example of activation time detection. D) CV restitution curves in normal and low voltage area. E) Slope of fitted line to the descendent part of CV restitution curve versus low voltage area percentage.

Result: An example of CV restitution curves in regions with and without low voltage areas are shown. CV restitution slope showed a very good correlation with the low voltage underlying the geodesic path ($R^2 = 0.64$).

Conclusion: Using this novel method, we could achieve intraprocedural assessment of the effect of low voltage regions on conduction pattern dynamics.