Estimation of the Ablated Area size based on Local Conduction Velocity: Simulations and animal experiments

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Aims: This study aimed to validate a method termed the circle method to estimate local conduction velocity (CVL) magnitude and direction based on optical mapping action potentials (OAPs) to characterize the ablated area.

Method: Simulations of the wavefront propagation (planar and curve) were done using the Fenton-Karma 3V model, where an ablated area was modeled by changing the conductivity parameter. Additionally, radio-frequency ablation (RFA) was performed in isolated atrium of rats and isolated guinea pigs' hearts for different RFA durations ranging from 0.5 s to 14.5 s. Optical mapping imaging was done using voltage-sensitive dyes to acquire OAPs and construct local activation time (LAT) maps. For each pixel in a selected region with the ablated area, CVL's magnitude and direction were calculated long a circular disposition spanning from 0° to 180° outlining a circle of specific radius. In this fashion, the maximal CVL corresponds to the direction parallel to the propagating wavefront, allowing estimation of the actual CVL located at the angular distance of 90°.

Results: CVL at the center of the ablation area showed a logarithmic curve increasing with larger radii, suitable for estimating the ablated area size. From the CVL maps, distinct regions of substantially lower CVLs (from 2.95 to 2.40 cm/s for simulation, 70 to 30 cm/s for the atrium, and 120 to 100 cm/s for the ventricle) showed the ablated area's location. Maps of CLV directions around the ablated area show characteristic deviation symmetric regarding the propagating wavefront allowing for more accurate delineation of ablated area.

Conclusions: The method is validated for different ablation geometries and sizes, wavefront curvatures and different animal experiments. Estimation of ablated area's size and its location could be performed without prior knowledge of the wavefront propagation direction.

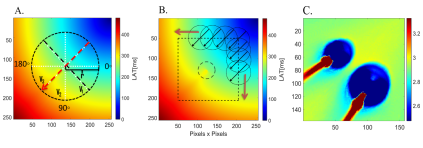

Figure 1. A. Circle method. B. CVLs calculated at different locations. C. CVL map outlining the ablation area