Acute Changes in P-Wave Morphology by Pulmonary Vein Isolation in Atrial Fibrillation patients

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Introduction:

Pulmonary vein (PV) plays an important role in atrial fibrillation (AF) initiation, progression, and stability. Successful PV isolation (PVI) may terminate AF and prevent its recurrence. Whereas, incomplete PVI may cause AF recurrences. Hence, defining parameters able to predict a successful PVI and detect reconnections can assist clinicians in treatment of patients.

Method:

We constructed a highly detailed human atrial computer model including epicardial layer and all major endocardial bundle structures. The model also includes realistic one to three layers of fiber orientations, corresponding to their location in the atrium. PVI were simulated by positioning two transmural ablation lines, containing non-conducting elements, around PVs. The 3D human atrial model was incorporated into an inhomogeneous torso model, which was used to simulate 256 body surface atrial activity electrograms. Finally, the simulation results were compared and validated by clinical recorded ECGs from patients before and after PVI procedure.

Results:

In both simulated electrograms, and recorded ECGs from patients pre-and post- PVI, we observed morphological changes in the final part of the P-wave. However, in the simulation significant changes were mainly observed in the posterior side of the thorax. P-wave duration reduced from 130 ± 5.7 in control simulation to 110 ± 3.7 in PVI simulation. The same reduction was observed in the clinical recordings. Maximum amplitude of P-wave decreased from 0.0309(mV) ± 0.011 in control to 0.0284(mv) ± 0.0104 in PVI simulation.

Conclusion:

A reduction of P-wave duration and amplitude is a sign of successful PV isolation. Our simulation results revealed that the most significant differences between pre-and post-ablation P-waves were observed in the posterior side of the thorax. Therefore, simulation study may provide insights into better locations for ECG recording to detect successful PVI.

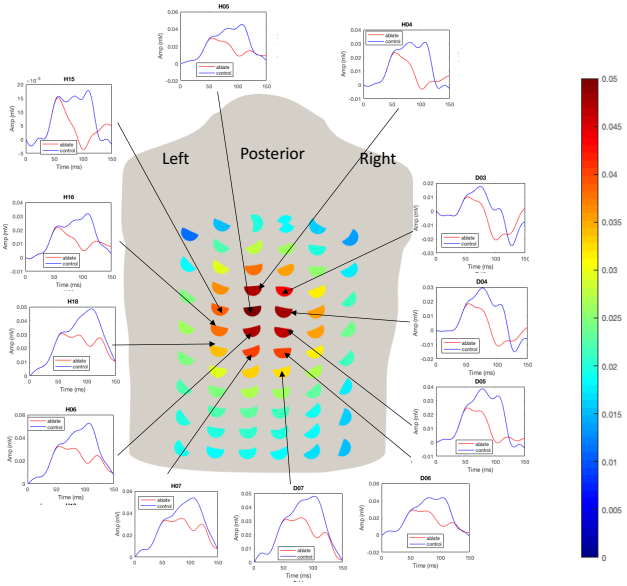

Figure. The Euclidean distance between pre- and post-simulated P-wave, color coded. Red shows the highest difference and blue shows the lowest difference. Top: Anterior view. Bottom: Posterior view.