

Effect Of Pulmonary Vein Isolations And Reconnections On P-wave Morphology in Atrial Fibrillation Patients. A Simulation Study

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Abstract

Background Successful electrical isolation of focal sources in the muscle sleeves surrounding pulmonary veins (PVs) may terminate atrial fibrillation (AF) and prevent its recurrence. However, in a substantial subset of patients reconnection occurs, leading to AF recurrence.

Objective Non-invasive detection of PV reconnection is of high clinical value in recommending a new PVI or in indicating a non-PV dependent trigger of AF recurrence.

Methods We constructed a highly detailed and fully 3-dimensional human atrial computer model including epicardial layer, all major endocardial bundle structures, and realistic one to three layers of fiber orientations. PVI was simulated by positioning two transmural ablation lines around the PVs. Reconnection simulations were run with one to four gaps randomly distributed. The model was incorporated into an inhomogeneous torso model, which was used to simulate 256 body surface and 10 transesophageal electrograms (TE-ECG).

Results Morphological changes in the second half of the simulated P waves (PW) were observed after PVI. PVI caused a reduction in both PW durations and amplitudes. Averaged PW area for all 256 leads decreased significantly from 1.4 ± 0.7 in control to 1.1 ± 0.5 in PVI simulations. Observed morphological changes in PWs in a 12 lead ECG were subtle, whereas most significant changes were observed on the posterior side of the thorax. PV reconnections caused morphological changes in the final part of PWs and double potentials in TE-ECG.

Conclusion Successful PVI and PV reconnection caused morphological changes in PWs. Our simulation results revealed that the most significant differences were observed in the posterior side of the thorax.

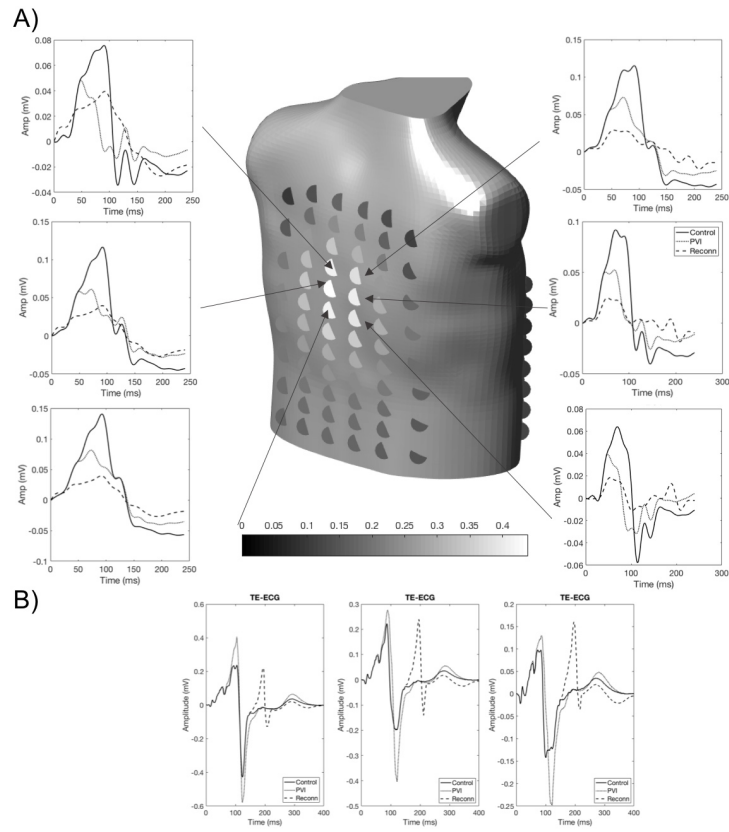


Figure. A) Posterior view of the thorax with examples of P-waves at the locations with the highest differences between pre- and post PVI (white and black colors indicate the highest and the lowest differences respectively). B) Examples of three TE-ECGs.