Fibrosis explains atrial fibrillation recurrences after pulmonary vein isolations. A simulation study

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Abstract

Background Understanding the mechanisms underlying atrial fibrillation (AF) recurrences after pulmonary vein isolations (PVI) can bring us valuable insights into improving AF treatment methods. It has been shown clinically that the extent of fibrosis in a patient is well correlated with the intervention outcome success. However, causal relationships between these two phenomena have not been demonstrated yet.

Purpose Our goal was to test the hypothesis that an increase in atrial fibrosis level leads to an increase in AF recurrence likelihood after PVI.

Methods We simulated the effect of fibrosis on AF recurrence rate after PVI in a highly detailed 3-dimensional model of the human atria with realistic electrophysiology and fibre orientations. The model geometry was based on MR images and histo-anatomical studies. Both standard-of-care ablation methods, line and balloon ablations, were simulated. AF was initiated in each simulation by a train of stimuli that lasted 2 seconds with progressive reduction in pacing intervals applied to 10 different pacing locations in both atria.

Results In control simulations, without PVI, AF initiation rate was increased by an increase in the degree of fibrosis. In simulations with both line and balloon ablation, AF recurrence probability decreased significantly in 50 % fibrosis simulations. However, this efficacy was reduced in 70 % fibrosis simulations.

Conclusion A computer model in which fibrosis degree was increased, in isolation from other pathological changes, showed increases in AF initiation prior to PVI and increases in AF recurrences after PVI. Thus, fibrosis can explain both phenomena.