

Fibrosis Explains Atrial Fibrillation Recurrences After Pulmonary Vein Isolations; A Simulation Study

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Background: More than 20% of atrial fibrillation (AF) patients experience AF recurrences after pulmonary vein isolation (PVI) in the absence of documented PV reconnections. This is suggesting that non-PVI foci may play an important role in AF initiation. It has been shown clinically that the extent of fibrosis in a patient is well correlated with the intervention outcome success. We hypothesized that the interaction between non-PVI triggers and higher degrees of fibrosis explains higher AF recurrences 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, an increase in the degree of fibrosis led to an increased AF initiation rate. In simulations with either line or balloon ablation, AF recurrence probability decreased significantly in simulations with 0% and 50% fibrosis. The efficacy of PVI in AF susceptibility reduction, was reduced in the presence of 70% fibrosis. AF conduction pattern complexity, quantified as number of waves, reduced in PVI simulations compared to control in 0% and 50% fibrosis but not in 70% fibrosis.

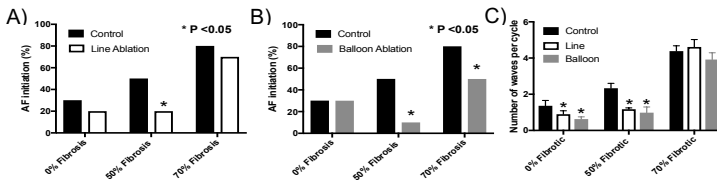


Figure: AF initiation likelihood in Control and PVI simulations with different degrees of fibrosis. A) Line ablation. B) Balloon ablation. C) Number of fibrillation waves in control and PVI simulations.

Conclusion: A computer model in which fibrosis degree was increased showed an increase in AF initiation prior to PVI and an increase in AF recurrences after PVI. These results suggest that in addition to isolation of PV ectopic foci, the substrate modification caused by PVI only prevents AF recurrences in atria with low and moderate fibrosis but not severe fibrosis.