Pulmonary vein isolation increases efficacy of antiarrhythmic drugs in a 3D computer model for atrial fibrillation
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Background:
The success rate of antiarrhythmic drugs (AADs) and pulmonary vein isolation (PVI) in atrial fibrillation (AF) termination or recurrence significantly depends on the degrees of structural remodelling, fibrosis, induced by AF. Not all triggers initiating AF are located within the PVs as evidenced by AF recurrences in patients with proven PV isolation. Recent clinical study showed that the AADs and PVI have a synergy to reduce AF recurrences. However, the underlying mechanisms are not well understood. We hypothesized that the presence of AADs can suppress induction of AF by residual non-PV triggers.

Methods:
We simulated the effect of fibrosis on AF initiation likelihood in the presence of AADs, PVI, and the combination of AAD and 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. AF was initiated in each simulation by a train of stimuli that lasted 2 seconds with progressive reduction in pacing intervals applied to 20 different pacing locations, outside of ablated area, in both atria. Two different AADs were simulated by either 60% reduction in I_{Na} conductivity (Na+ - Block) or 30% reduction in I_{K1} conductivity (K- - Block).

Results:
In simulations without PVI, an increase in the degree of fibrosis led to a significant efficacy loss of both Na+ - Block and K- - Block in AF recurrence prevention. PVI, only reduced significantly AF recurrences in simulation with 0% and 50% of fibrosis but not in simulations with 70% of fibrosis. The combination of AAD and PVI showed a significantly higher efficacy compare to PVI or AAD only simulations in simulations with 50% and 70% fibrosis.

Figure: A) AF initiation likelihood in simulations with AADs only. B) AF initiation likelihood in simulations with PVI and PVI accompanied by AADs.

Conclusions:
In this simulation study, we showed that AADs, despite being ineffective before ablation, effectively suppress induction of AF after ablation.