Effect of Fiber Direction and Ionic Heterogeneities in Atrial Driver Location

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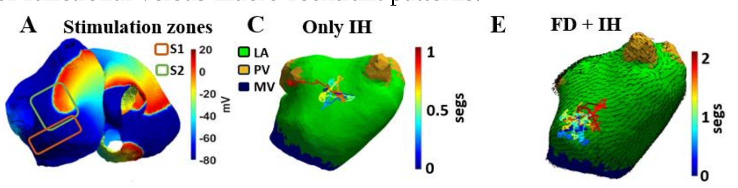
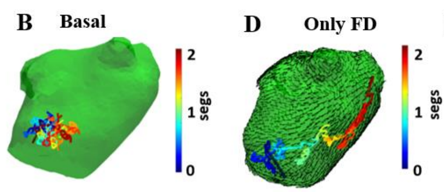
Detail of in-silico atrial arrhythmia models to faithfully reproduce different-reentrant drivers is still unknown. In this study, fiber direction (FD) and ionic heterogeneities (IH) effects are measured for multiple atrial reentrant drivers.

A set of 228 pro-arrhythmic simulations was performed in a 3d model (284578 nodes, resolution 0.5 mm), in basal conditions (isotropic and homogeneous tissue) and then adding FD (region-dependent anisotropic conduction) and IH (regional variations in cellular ionic profiles). Reentrant drivers were initiated using a multiple S1-S2 protocol on the posterior left atrial wall (PLAW, A), and location and trajectory of the reentrant driver were tracked by phase singularity identification.

Basal model generated reentrant drivers on PLAW, 23% of which remained as functional (B) while the others reconverted to macro-reentry. Presence of IH attracted all drivers to regions with different ionic profiles as pulmonary veins (C), turning into a macro-reentrant pattern. Presence of FD caused the reentrant driver to meander following the fiber orientation, both in absence (D) and presence (E) of IH, keeping many drivers as functional (7-14%) while converting others to macro-reentries. In the 87 arrhythmic cases (F), only presence/absence of FD showed differences in number of arrhythmic cases, and IH tended to convert functional reentries to macro-reentrant patterns.

Simulations of atrial arrhythmias will require the use of FD to accurately identify arrhythmic substrates, as well as IH to faithfully balance the presence of functional versus macro-reentrant patterns.





F

	Arrhythmic cases (%)	Functional drivers(%)	Driving Sites
Basal	23	23	MV, LPV, AS, PLA
Only IH	24	0	MV, LPV
Only FD	51	7	MV, IC, LPV, RPV, PLA
FD + IH	51	14	MV, IC, AS, PLA

MV: mitral valve, LPV: left pulmonary veins, RPV: right pulmonary veins AS: atrial septum, PLA: posterior left atria, IC: inferior cava