mathematics

Article

Myocardial Fibrosis in a 3D Model: Effect of Texture on Wave Propagation

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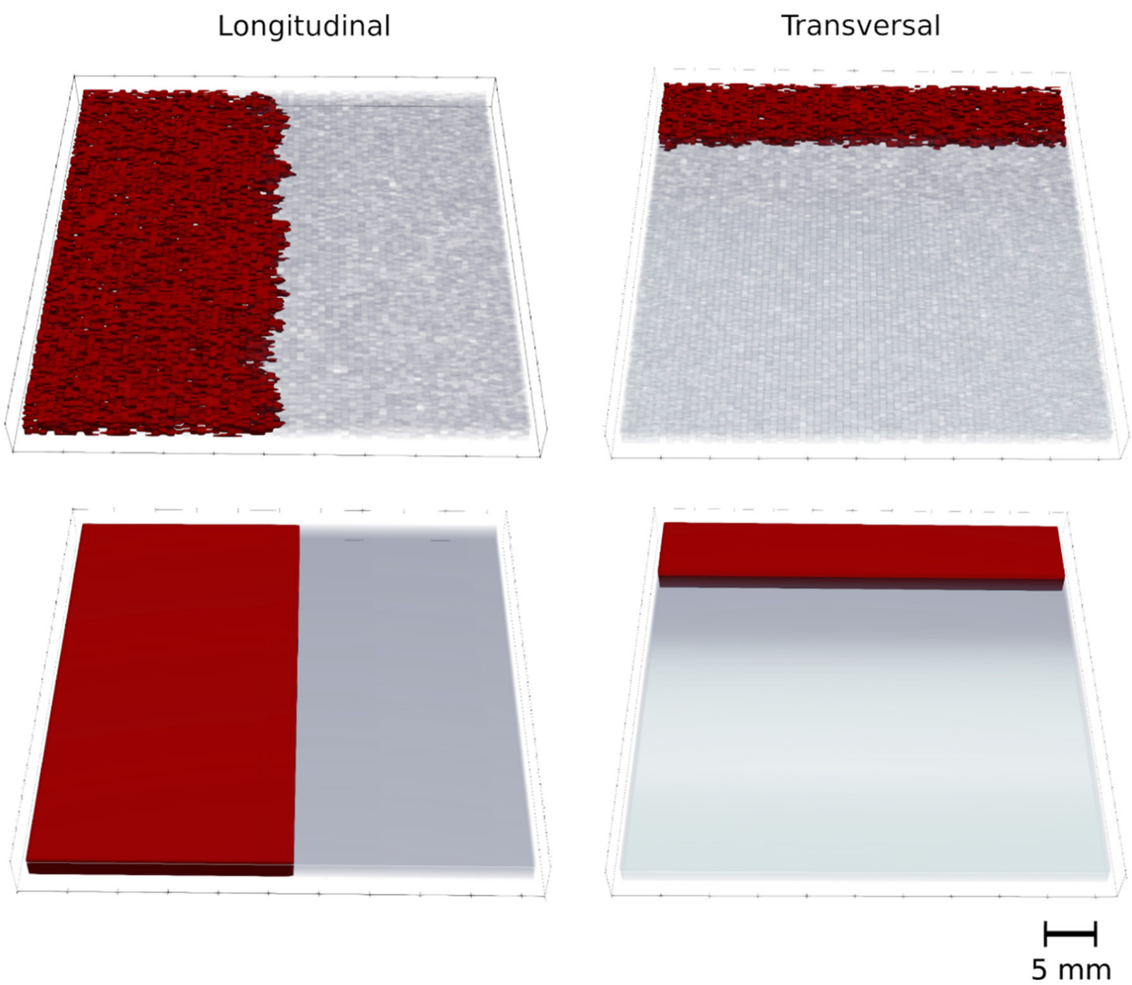

Figure S1. Electrical wave propagation in a model with structural fibrosis and a reduced model simulating propagation timing in the fibrosis tissue.

Here we use a myocardial slab of $50 \times 50 \times 2.5$ mm^3 SIZE. The models are computed with a spatial step of 0.25 mm and time step of 0.02 ms.

Upper panels show a model with elongated fibrosis texture of linear $3 \times 1 \times 1$ elements of 3 \$ × \$-node length and preexisting anisotropy 1:0.25:0.25 in terms of the electro-diffusion coefficient in the monodomain equation in the longitudinal (x-axis) and transversal (y,z-axe) direction.

Wave propagation in the 3D myocardial slab was initiated on the left lateral surface of the cuboid for the longitudinal propagation and on the upper lateral surface for the transversal propagation. The red color shows activated cells, the gray color indicates non-activated cells and transparent cells within the gray zone indicates fibrosis. Fibrosis density is 50\%. Snapshots of excitation propagation are shown at 50 ms after excitation onset.

Lower panels show the slab without fibrotic elements with diffusion coefficients fitted to obtain the same conduction velocities in the longitudinal and transversal direction. It is shown that the decrease in the velocities in the fibrotic tissue can be reproduced by a decrease in the electro-diffusion coefficients by 1.75, 2.08, 2.08 for the longitudinal and 2 transversal directions, respectively. In this case the anisotropy ratio in the reduced model increases to 1:0.21:0.21 ratio.

This example shows that fibrosis decreases conduction velocity and changes (here, increases) tissue anisotropy, as compared to the inherent model without fibrosis. This behaviour can be mimicked by the phenomenological change in the parameters of electro-diffusion.

Summary of the parameters in the models is shown in Table S1.

Table S1. Electro-diffusion coefficients (D), anisotropy (longitudinal to transverse ratio) and conduction velocity (CV) in the models with structural fibrosis and corresponding reduced model.

	D, cm^2/s	d_L:d_T	CV longit, mm/ms	CV transv, mm/ms	CV ratio
anisotropic myocardium without fibrotic obstacles	1.80	1:0.25	0.70	0.29	1:0.42= 2.26
anisotropic myocardium with fibrotic obstacles	1.80	1:0.25	0.50	0.17	1:0.34= 2,98
reduced model (anisotropic myocardium with reduced conductivity)	1.02	1:0.21	0.50	0.17	1:0.34= 2,98