Rotational Anisotropy Prevents Transition of Tachycardia to Fibrillation in the Ventricular Wall Model with Large Transmural Dispersion of Repolarization: A Simulation Study

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Background: We have recently demonstrated in computer simulations that rotational anisotropy of ventricular fiber orientation decreases the sustainability of ventricular fibrillation (VF) even under the large transmural dispersion of repolarization (TDR). However, how the rotational anisotropy restrains VF is still unclear. Methods: To clarify this issue, we repeated simulations of scroll wave (SW) reentry in ventricular wall slab models, incorporating varying degrees of rotational anisotropy. Transmural gradient (electrical heterogeneity through the wall; epi-, midmyo-, and endo-cardial layers) was achieved by modifications of potassium currents. Then, we analyzed the dynamics of both SW and its filament (3-dimensional organizing center of SW). Results: In the control model without rotational anisotropy, larger TDR increased the difference of SW cycle lengths among the layers. Then such asynchronous SW meandering destabilized the transmural I-shaped filament, causing filament fragmentation, i.e., VF. In contrast, as the degree of rotational anisotropy increased, the I-shaped filament became more stable, preventing the degeneration into VF. Conclusions: Large TDR and rotational anisotropy increase independently the SW complexity; however, such combinations might prevent transition of stable SW to chaotic VF via the control of SW filament. Our finding might contribute to clarify the physiological significance of rotational anisotropy in ventricles. Keywords: simulation, filament, scroll wave re-entry