

Myocardial Transmural Electrical Disruption Affects Electrogram Pattern

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Background: Myocardial structural remodeling leads to atrial fibrillation (AF). Interstitial collagen deposits remodel myocardium, causing disruption of electrical propagation from the epicardium (Epi) to the endocardium (Endo). How these changes manifest on the electrogram (EGM) is unclear.

Objective: Here we investigate the consequences of Epi-Endo electrical dissociation on EGM.

Method: Left atrial patient-specific bilayer computational models (fig.a) with interstitial collagen deposit distribution (fibrosis content 14.5 - 42.2%) were constructed using MRI from AF patients ($n=11$). Interstitial collagen was incorporated as microstructural discontinuities (fig.b) causing transmural dissociation in the high fibrotic areas. Changes in the EGM were computed relative to the non-fibrotic models, considered as controls. For each patient, changes in the unipolar EGM (fig.d) characteristics, including amplitude, duration, number of deflections, shape asymmetry and correlation coefficient were computed in the fibrotic areas.

Results: The electrical wave propagation was faster on Epi than the propagation on Endo. A delay of 17 ± 7 ms (fig.c) was observed between Epi and Endo electrical propagations. The asymmetry between Epi and Endo EGM was 0.03 ± 0.33 . Relative to the non-fibrotic models; the correlation coefficient was 0.27 ± 0.30 ($p < 0.05$); the surface under EGM curve, its duration and the number of deflections increased by $18 \pm 13\%$, $29 \pm 47\%$ and $58 \pm 55\%$ respectively; the amplitude decreased by $39 \pm 14\%$.

Conclusion: Transmural electrical dissociation due to collagen deposits leads to significant changes in the EGM pattern. Finally, combine EGM morphology together with clinical imaging data can be useful to distinguish substrate modifications, and select better ablation targets.

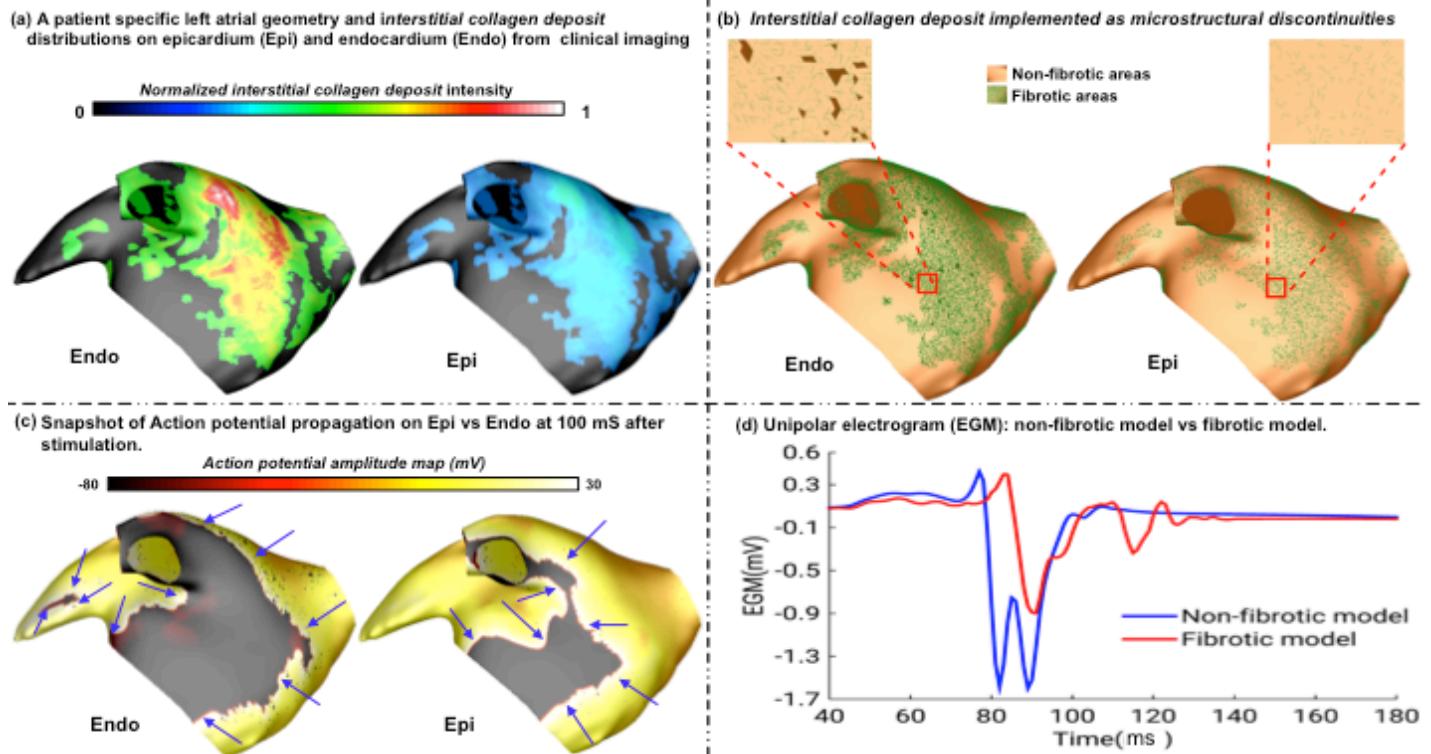


Figure: (a) Interstitial collagen deposit distribution from clinical imaging of a patient with persistent atrial fibrillation. (b) Microstructural discontinuities distribution representing interstitial collagen deposit. The difference in fibrosis distribution between Epi and Endo is reflected here. (c) Electrical wave propagation. Arrows indicate the wave front propagation direction. A delay is observed on Endo. (d) A sample of unipolar electrogram (EGM) plots. Differences between EGM morphologies from control and fibrotic models are observed.