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Fibroblast proliferation alters cardiac excitation conduction and contraction: a computational study

成纤维细胞增殖改变心脏兴奋传导和收缩的仿真研究

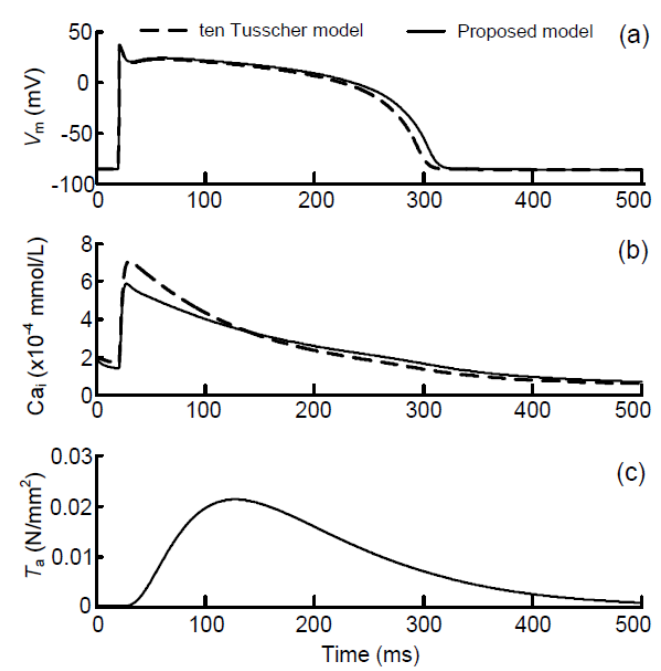
Key words: Cardiac model, Electromechanics, Fibroblast proliferation

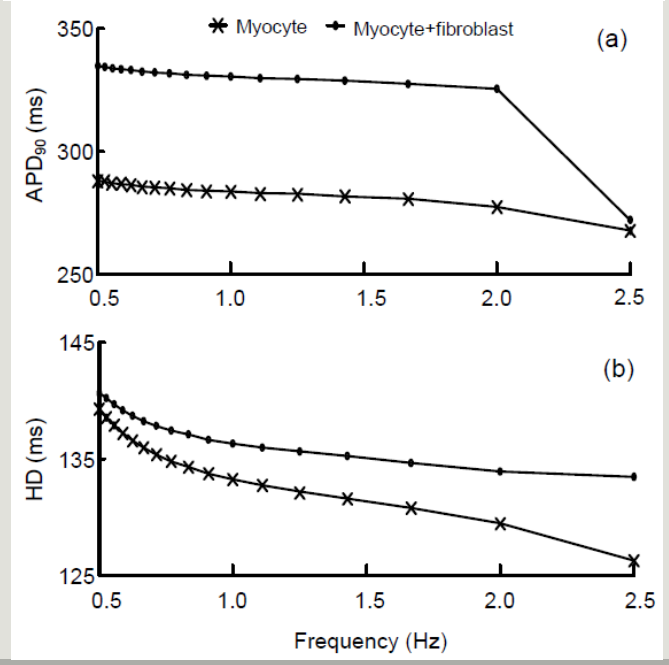
关键词：心脏模型；电力耦合；成纤维细胞增殖

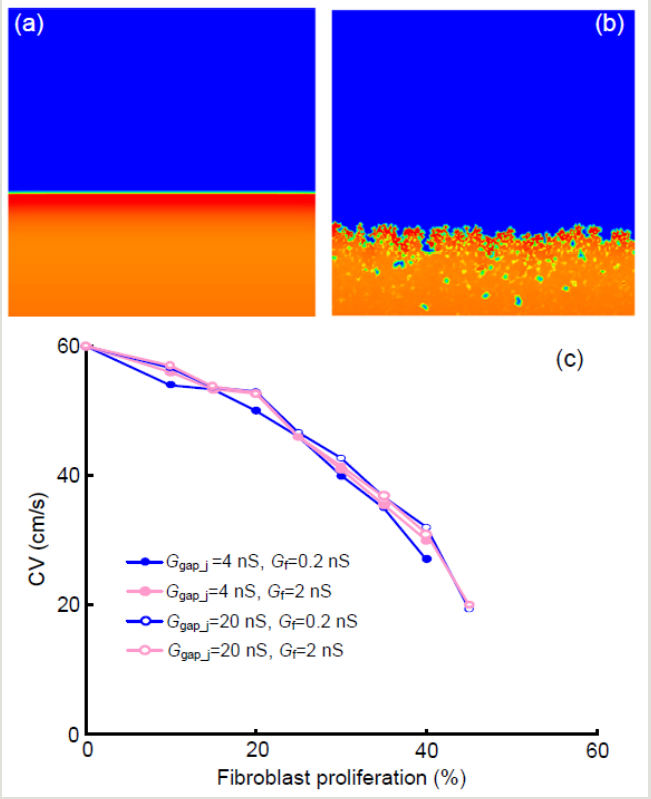
- A strongly coupled myocardial fibroblastic electromechanical model is proposed to investigate the effect of fibroblasts on cardiac excitation conduction and contraction.

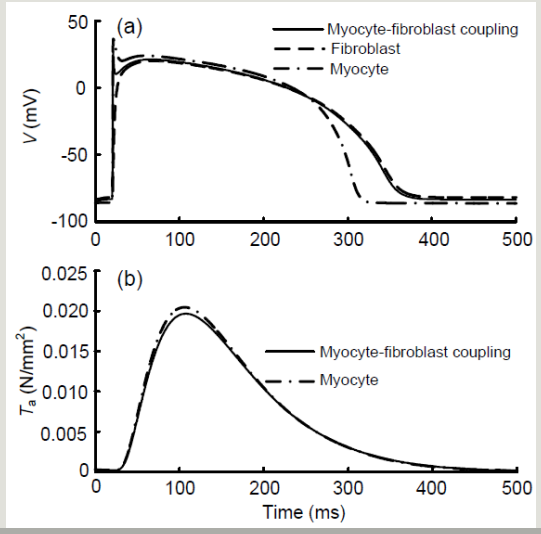
- The influence of diffuse fibroblast proliferation on wave propagation, the importance of various parameters in determining the spatial distribution of action potential duration (APD), strain maps and temporal traces of strain at different points of both normal and fibroblast proliferous tissues, and electromechanical models of a central point stimulus and re-entry were investigated.

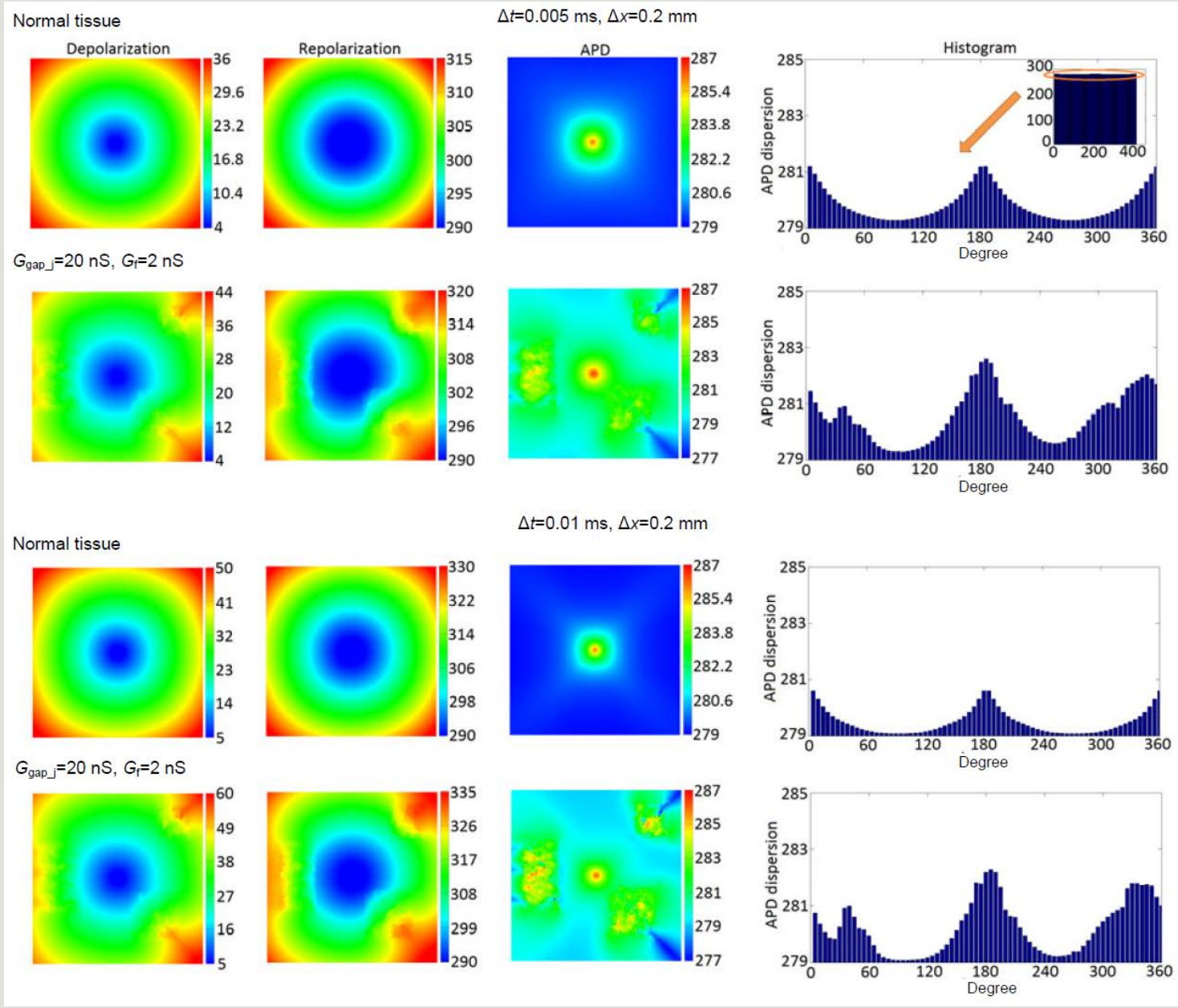
- The fibroblasts slowed wave propagation, induced a conduction block, decreased strains in fibroblast proliferous tissue, increased the dispersions in depolarization, repolarization and APD, changed wave forms, and sustained re-entry.


ten Tusscher model
Proposed model
(a)
V_m (mV)
(b)
Ca_i (x10^{-4} mmol/L)
(c)
T_a (N/mm^2)
Time (ms)


Myocyte
Myocyte+fibroblast
(a)
APD_{90} (ms)
(b)
HD (ms)
Frequency (Hz)


(a)
(b)
(c)
CV (cm/s)
G_{gap_j} =4 nS, G_f=0.2 nS
G_{gap_j}=4 nS, G_f=2 nS
G_{gap_j}=20 nS, G_f=0.2 nS
G_{gap_j}=20 nS, G_f=2 nS
Fibroblast proliferation (%)


(a)
Myocyte-fibroblast coupling
Fibroblast
Myocyte
V (mV)
(b)
Myocyte-fibroblast coupling
Myocyte
T_a (N/mm^2)
Time (ms)


Normal tissue
Δt=0.005 ms, Δx=0.2 mm
Depolarization
Repolarization
APD
Histogram
APD dispersion
Degree
G_gap_j=20 nS, G_f=2 nS
Δt=0.01 ms, Δx=0.2 mm
Normal tissue
G_gap_j=20 nS, G_f=2 nS