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A Perturbation Solution Of The Mechanical Bidomain Model[1]

VANESSA PUNAL, BRAD ROTH — This research focuses on finding analytical solutions to the mechanical bidomain model of cardiac tissue. In particular, a perturbation expansion is used to analyze the equations, with the perturbation parameter being inversely proportional to the spring constant coupling the intracellular and extracellular spaces. The results indicate that the intracellular and extracellular pressures are not equal, and that the two spaces move relative to each other. This calculation is complicated enough to illustrate the implications of the mechanical bidomain model, but is nevertheless simple enough to solve analytically. The zeroth-order of the perturbation expansion reveals that the intracellular and extracellular displacements are equal, thus making it unnecessary to account for either space on an individual basis. Yet, in the first-order of the expansion we see a shift and the intracellular and extracellular displacements are unequal. One application of the calculation is to the mechanical behavior of active cardiac tissue surrounding an ischemic region. Also, a hypothesis for the physical meaning of the pressure inequality is if this inequality is held for an extended period of time it may cause fluid to flow across the cell membrane and in the tissue.

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Vanessa Punal

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