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Experimental and Analytical Studies of Tumor Growth

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Abstract: Most biological phenomena commonly involve with mechanics. In this work, we proposed an innovative model that tumor is considered as a pyroelastic medium consisting of two parts: solid and fluid. The variation of solid part depends on whether the drug has been effectively delivered to the tumor site. We derived the governing equations of the tumor, in which large deformation is incorporated. Meanwhile, the finite element equations for coupled displacement field and pressure field are formulated. We proposed two sets of porosity and growth tensor. In both cases the continuum theory and FEM are accompanied by accurate numerical simulations. To verify the feasibility of the model, we established a epithelial human breast cancer (BrCa) cell line known as MDA-MB-231, which was cultured into small (<400 μm) tumor spheres in order to observe their growth patterns in both constrained growth environment (microwells) and unconstrained growth environment (Ultra-Low Adherence plates). Moreover, the tumor spheres used in the experiment were grown with and without the FDA approved anti-breast cancer anthracycline, Doxorubicin (Dox), in order to observe the influence it has on tumor-growth mechanics.

Keywords: Tumor growth; porosity; finite element analysis; biological growth tensor; seepage velocity; large strain; hyperelasticity

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