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Well-posedness of Unsteady Poroelastohydrodynamics in Solid Tumors.

Abstract

In this study, we present a mathematical model to describe the interstitial hydrodynamics and mechanical properties within solid tumors. Solid tumor tissues are complex viscoporoelastic biomaterials comprising a cellular phase, an extracellular matrix (ECM) as the solid component (including a small volume of blood vessels), and physiological extracellular fluid as the fluid component. We unify intravascular blood and interstitial fluid into a single fluid phase and develop mass and momentum balance equations for these multi-phases using continuum biphasic mixture theory. The momentum equations are inherently coupled due to the interaction forces, or drag, between these phases. Our investigation establishes the well-posedness of governed unsteady poroelastohydrodynamics model in a weak sense. We use the semi-discrete Galerkin and weak convergence methods to establish the well-posedness. Further, we simulate some analytical results corresponding to the one-dimensional spherical symmetry model. Our results on the unsteady poroelastohydrodynamic model would give an idea about the time required for the necrosis formation from the initial stage of perfusion based on the system energy which can be computed using L2 and H1 norms.