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Non-Newtonian Rheology of Cell Suspension in a Porous Scaffold During Perfusion Cell Seeding

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ABSTRACT

The process of perfusion seeding of cells into a porous scaffold represents a pivotal initial stage in the development of tissue-engineered bones. The rheological behavior of the cell suspension plays a crucial role in influencing the transport and distribution of cells within the scaffold. Currently, there is limited understanding of the non-Newtonian rheology of cell suspensions in complex pores which differs significantly from simple channels or linear shear flow. In this study, we utilize our previously developed mesoscopic model of perfusion cell seeding to investigate the rheological behavior of cell suspensions at the cellular scale. This model integrates the lattice Boltzmann method (LBM), finite element method (IBM), and immersed boundary method (IBM) to simulate the hyperelastic cells in flow. We focus on a triply-periodic minimal surface (TPMS) -based scaffold with Gyroid architecture. Both the perfusion flow rate and cell concentration of the suspension exhibit a significant impact on its rheological characteristics within the porous scaffold. The findings not only provide valuable insights into the rheology of cell suspensions in porous scaffolds but also contribute to the selection of optimal seeding parameters.

KEYWORDS

Cell suspension; lattice Boltzmann; immersed boundary method; non-newtonian rheology; porous flow

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