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A NON-LOCAL CONSTITUTIVE MODEL OF BLOOD

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Blood is a complex fluid with a dynamic microstructure. It is well-accepted that blood flowing through large vessels behaves as a viscous Newtonian fluid. In the smaller vessels the coupled chemo-mechanical dynamics of blood's microstructure become important and the numerous non-Newtonian models proposed in the literature highlight the inherent difficulties encountered in properly describing the mechanisms of blood flow at smaller length scales. Most of these models need many parameters in order to agree with *in vitro* experiments. However, finding these parameters *in vivo* is very difficult due to the active chemo-mechanical dynamics of blood and its surroundings existing in a living body. Given today's efforts in making biocompatible implants for health monitoring and interacting with the living blood flow, using models whose parameters can be found only in the lab could not only inhibit technological progress but also create devices that could be potentially dangerous in medical applications. Finding parameters that can accurately characterize the complex blood flow *in vivo* requires novel mathematical models. Recently, we used a fractional model of continuum mechanics to blood flow [1]. In this model the Cauchy stress tensor depends linearly on a generalized rate of deformation tensor whose representation involves Caputo fractional order spatial derivatives. The fractional model uses non-local integro-differential operators in the representation of the rate of deformation tensor which *entangle* the aggregation of particles and the chemo-mechanical deformation of blood. On the other hand, in the non-Newtonian models the stress tensor is the product between the classical rate of deformation tensor and an apparent viscosity that may depend on time, temperature, mechanical invariants, or concentrations of blood's components. Such a representation of the stress tensor does not account for the chemo-mechanical coupling present during blood flow *in vivo* because the rate of deformation tensor is separated from the mechano-chemical interactions of the blood's components and therefore the chemically-driven part of the flow is not accounted for. We compare the Poiseuille flows of blood through an axi-symmetric circular rigid and impermeable pipe where the blood is described by the fractional, Casson's, and the power law models. Our results show that the velocity profiles of these three models look similar. However, the fractional model provides a better fitting to some published experimental data [2].

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