Mesoscopic modeling of biomechanics and biorheology of red blood cells in type 2 diabetes mellitus

Hung-Yu Chang, Xuejin Li, and George Em Karniadakis
Division of Applied Mathematics, Brown University, Providence, RI 02912, USA

Erythrocytes in patients with type-2 diabetes mellitus (T2DM) exhibit decreased deformability and elevated blood rheology, which contribute to impaired blood flow and other pathophysiological aspects of diabetes-related vascular complications. By using a multiscale red blood cell (RBC) model with a diverse set of biological parameters, we present an *in-silico* study of the biomechanical properties of T2DM RBCs and hemorheological properties of T2DM blood. First, we examine the elastic deformability of T2DM RBCs under static and dynamic tensile forcing and quantify the altered biomechanical properties of the RBC membrane. Second, we investigate the tank-treading (TT) motion of RBCs oriented in a steady-state shear flow and explore the effects of cell shape and membrane viscosity on the TT frequency. Finally, we simulate erythrocyte suspensions in shear flow and quantitatively predict the T2DM blood viscosity. Our simulations clearly indicate that the diabetes-induced RBC morphology changes associated with impaired elasticity and elevated membrane viscosity play important roles in the determination of cell membrane mechanical, rheological and dynamical properties of T2DM RBCs.

Key words: Red Blood Cell, Multiscale Modeling, Diabetes Mellitus