**Patient-specific modeling of biomechanics and biorheology of red blood cells in sickle cell anemia**

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**Abstract:** Sickle cell anemia (SCA) is an inherited blood disorder exhibiting heterogeneous cell morphology and abnormal rheology, especially under hypoxic conditions. By using a kinetic cell sickling model with parameters derived from patient-specific data, we present a mesoscopic computational study of the biomechanics of sickle erythrocyte and hemorheology of SCA blood. First, we have developed a patchy particle model to model the evolution of a sickling crisis at the subcellular level. Our simulations show that the molecular chirality to be the main driver for the formation of sickle hemoglobin twisted fiber structure. Second, we have employed a two-step RBC morphological sickling model to investigate the dynamic behavior of individual sickle erythrocytes under transient hypoxia. We show that the hypoxia-affected cells undergo sickling significantly alter the cell dynamics. Finally, we have developed a unique predictive patient-specific model of SCA to quantify the collective dynamics and rheology of blood flow in SCA. Our results suggest that the hematocrit-to-viscosity level, rather than the blood viscosity, may be a more reliable indicator in assessing the response to hydroxyurea treatment.

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