Patient-specific modeling and predicting blood viscosity in sickle cell anemia

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Abstract: Sickle cell anemia (SCA) is a highly complex, inherited blood disorder exhibiting heterogeneous cell morphology and abnormal rheology. By using a multiscale red blood cell (RBC) model based on parameters derived from patient-specific data, we present a mesoscopic simulation study to explore the rheological and hemodynamic characteristics of blood from patients with SCA before and after treatment with hydroxyurea (HU). The shear viscosity of blood from treated and untreated patients and normal controls are determined. Our results show that treatment with HU may improve or worsen rheological characteristics of blood in SCA depending on the degree of hypoxia. However, SCA patients treated with HU always have higher levels of hematocrit--to--viscosity ratio (HVR) than those for untreated patients, indicating that HU can indeed improve oxygen transport potential of blood and therefore improve blood flow. Our patient-based simulations suggest that determination of HVR level rather than shear viscosity of sickle RBC suspensions may be a more reliable indicator in monitoring the response to HU treatment.

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