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STRESS-BASED AND STRAIN-BASED HEMOLYSIS ESTIMATION FOR MEDICAL DEVICES

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The development of reliable blood damage models is a key issue for virtual design of new blood-contacting medical devices. In that context, we compare stress-based and strain-based models for numerical estimation of mechanical hemolysis. Both approaches quantify the release of hemoglobin from red blood cells (RBCs) to blood plasma by a scalar advection-reaction equation. The stress-based model relies on the instantaneous shear stress in the blood flow. The strain-based model uses a tensorial evolution equation to estimate distortion of RBCs in the flow field. Earlier studies tracked the deformation of the cells along their pathlines [1]. Such a Lagrangian approach does not cover the whole flow domain and is difficult to parallelize. The newer field-based approaches overcome these shortcomings, but can introduce numerical instabilities. We will present our current numerical methods to solve the advection-reaction as well as the tensor equation. The methods are based on GLS stabilization or LSFEM [2]. Simulations will be discussed for a 3D centrifugal blood pump based on a geometry defined by the U.S. Food and Drug Administration. Overall, the strain-based test is found to deliver more reasonable results since it incorporates more biophysical phenomena into the simulation process [3].

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