Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Mechanical Dissociation of Platelet Aggregates in Blood Stream[1]

MASOUD HOORE, DMITRY A. FEDOSOV, GERHARD GOMPPER, Theoretical Soft Matter and Biophysics, Institute of Complex Systems and Institute for Advanced Simulation, Forschungszentrum Juelich, COMPLEX AND BIOLOGICAL FLUIDS GROUP TEAM — von Willebrand factor (VWF) and platelet aggregation is a key phenomenon in blood clotting. These aggregates form critically in high shear rates and dissolve reversibly in low shear rates (Chen et al. Nat Comm 4 (2013): 1333). The emergence of a critical shear rate, beyond which aggregates form and below which they dissolve, has an interesting impact on aggregation in blood flow. As red blood cells (RBCs) migrate to the center of the vessel in blood flow, a RBC free layer (RBC-FL) is left close to the walls into which the platelets and VWFs are pushed back from the bulk flow (Müller et al Sci Rep 4 (2014): 4871). This margination process provides maximal VWF-platelet aggregation probability in the RBC-FL. Using mesoscale hydrodynamic simulations of aggregate dynamics in blood flow, it is shown that the aggregates form and grow in RBC-FL wherein shear rate is high for VWF stretching. By growing, the aggregates penetrate to the bulk flow and get under order of magnitude lower shear rates. Consequently, they dissolve and get back into the RBC-FL. This mechanical limitation for aggregates prohibits undesired thrombosis and vessel blockage by aggregates, while letting the VWFs and platelets to aggregate close to the walls where they are actually needed.

[1]The support by the DFG Research Unit FOR 1543 SHENC and CPU time grant by the Julich Supercomputing Center are acknowledged.

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Date submitted: 17 Jul 2017 Electronic form version 1.4