Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Mechanical Response of Red Blood Cells Entering a Constriction NANCY ZENG, WILLIAM RISTENPART, Dept. Chemical Engineering & Materials Science, University of California, Davis — Most work on RBC dynamic response to hydrodynamic stress has focused on linear velocity gradients. Relatively little experimental work has examined how RBCs respond to pressure driven flow in more complex geometries, such as in an abrupt contraction. Here, we establish the mechanical behaviors of RBCs undergoing a sudden increase in shear stress at the entrance of a narrow constriction. We pumped RBCs through a constriction in an ex vivo microfluidic device and used high speed video to visualize and track the flow behavior of more than 4,000 RBCs. We show that approximately 90% of RBCs undergo one of four distinct modes of motion: stretching, twisting, tumbling, or rolling. Intriguingly, almost 40% of the cells exhibited twisting (rotation around the major axis parallel to the flow direction), a mechanical behavior that is not typically observed in linear velocity gradients. We present detailed statistical analyses on the dynamics of each motion and demonstrate that the behavior is highly sensitive to the location of the RBC within the channel. Finally, we show that the tumbling and rolling motions can be rationalized qualitatively in terms of rigid body rotation, whereas twisting motion cannot, suggesting that twisting is a consequence of the viscoelastic nature of the RBCs.

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Date submitted: 02 Aug 2013

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