Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Twisting of Red Blood Cells Entering a Constriction NANCY ZENG, WILLIAM RISTENPART, Dept. Chemical Engineering and Materials Science — Most work on the dynamic response of red blood cells (RBCs) to hydrodynamic stress has focused on linear velocity profiles. Relatively little experimental work has examined how individual RBCs respond to pressure driven flow in more complex geometries, such as the flow at the entrance of a capillary. Here, we establish the mechanical behaviors of healthy 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 4,400 RBCs. We show that approximately 85% of RBCs undergo one of four distinct modes of motion: stretching, twisting, tumbling, or rolling. Intriguingly, a plurality of cells (∼30%) exhibited twisting (rotation around the major axis parallel to the flow direction), a mechanical behavior that is not typically observed in linear velocity profiles. We examine the mechanical origin of twisting using, as a limiting case, the equations of motion for rigid ellipsoids, and we demonstrate that the observed rotation is qualitatively consistent with rigid body theory.

William Ristenpart
Dept. Chemical Engineering and Materials Science

Date submitted: 30 Jul 2014 Electronic form version 1.4