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From Red Cells to Soft Porous Lubrication QIANHONG WU, THOMAS GACKA, Villanova University, RUNGUN NATHAN, Penn State Berks, ROBERT CRAWFORD, Villanova University, VUCBMSS TEAM — Biological scientists have wondered, since the motion of red cells was first observed in capillaries, how the highly flexible red cell can move with so little friction in tightly fitting microvessels without being damaged or undergoing hemolysis. Theoretical studies (Feng and Weinbaum, 2000, JFM; Wu et al., 2004, PRL) attributed this frictionless motion to the dramatically enhanced hydrodynamic lifting force generated inside the soft, porous, endothelial surface layer (ESL) covering the inner surfaces of our capillaries, as a red blood cell glides over it. Herein we report the first experimental examination of this concept. The results conclusively demonstrate that significant fraction of the overall lifting force generated in a soft porous layer as a planing surface glides over it, is contributed by the pore fluid pressure, and thus frictional loss is reduced significantly. Moreover, the experimental predictions showed excellent agreement with the experimental data. This finding has the potential of dramatically changing existing lubrication approaches, and can result in substantial savings in energy consumption and thus reduction in greenhouse gas emissions.

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