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Loss of deformability of malaria-infected red blood cells S. MAJID HOSSEINI, JAMES FENG, University of British Columbia — The pathogenesis of malaria is largely due to stiffening of the infected red blood cells (RBCs). Contemporary understanding ascribes the loss of RBC deformability to a 10-fold increase in membrane stiffness caused by extra cross-linking in the spectrin network. Local measurements by micropipette aspiration, however, have reported only an increase of 3-fold in the shear modulus. We believe the discrepancy stems from the rigid parasite particles inside infected cells, and have carried out numerical simulations to demonstrate this mechanism. The cell membrane is represented by a set of discrete particles connected by linearly elastic springs. The cytosol is modeled as a homogeneous Newtonian fluid, and discretized by particles as in standard smoothed particle hydrodynamics. The malaria parasite is modeled as an aggregate of particles constrained to rigid-body motion. We simulate RBC stretching tests by optical tweezers in three dimensions. The results demonstrate that the presence of a sizeable parasite greatly reduces the ability of RBCs to deform under stretching. With the solid inclusion, the observed loss of deformability can be predicted quantitatively using the local membrane elasticity measured by micropipettes.

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