Force scaling with length in actin stress fibers

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Keywords: *actin, myosin, stress fiber, force, contraction.*

Abstract

Actin stress fibers are important mechanical elements of many cells generating contraction and integrating the cytoskeleton, but for typical cells, the geometry and interconnectedness of the cytoskeleton makes it hard to get a quantitative understanding of how an individual stress fiber behaves and, in particular, how much force it generates. Growing cells on a micropatterned substrate constrains their shape and can simplify the stress fiber geometry. By using data from cells grown on such a substrate, we construct a simple model of actomyosin force production. The model predicts that, depending on the fiber length and strengths of adhesion and actin crosslinking, myosin aggregates either to the center or the edge of the fiber. Furthermore, the model predicts, counterintuitively, that there is a peak in force production at intermediate stress fiber lengths. The model predictions are confirmed by the experiment, and we conclude that actin dynamics – actin flow limited by friction – is the key for force transmission along the actomyosin stress fiber.