
Force Probing the Molecular Mechanics of Cell Rounding

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During mitosis tissue culture cells undergo a dramatic shape change, from essentially flat to nearly spherical. The forces and mechanisms that drive this shape change remain unexplained. Here we use assays based on atomic force microscopy to measure the height and rounding force of single mitotic cells. We show that under our conditions, human cells exert forces approaching 100 nN when they round up. The force depends not only on the actomyosin cortex but also on trans-membrane ion gradients. In further experiments we demonstrate which membrane proteins are coupled to and regulated by the actomyosin cortex to establish a hydrostatic pressure that rounds up the cell. By using single-molecule force spectroscopy we look inside these individual membrane proteins to quantify interactions and mechanisms they are functionally regulated. Based on these results we introduce an advanced model of cell rounding in which a hydrostatic outward pressure, and contractile actomyosin cortex forces govern shape.