Blebs, actin cortex mechanics and shape instabilities during cytokinesis

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Abstract:

Cytokinesis, the process by which a cell physically splits into two daughter cells, is an intrinsically mechanical event regulated by elaborate biochemical pathways. Most studies of the physical changes occurring during cytokinesis have focused on the formation and ingression of the contractile ring at the cell equator. However, a layer of contractile acto-myosin is also present away from the equator, in the polar regions of the dividing cell. By investigating the mechanics of the polar cortex, we show that polar contractions can lead to shape instabilities during cytokinesis. We observe that small shape oscillations, where cytoplasm flows from one pole to the other, occur during control divisions. Moreover, a strong contractility imbalance between the two poles of the cell or a global increase in cortex tension can lead to dramatic shape oscillations and cytokinesis failure. By analyzing cortex dynamics during oscillations and by perturbing polar cortex stability, we then show that the formation of membrane blebs at the poles of dividing cells acts to limit oscillations. We propose that bleb growth releases cortical tension and intracellular pressure, and thus helps stabilise the bipolar shape of the cell during cytokinesis.

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