P.01 Force localization in contracting cell layers

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A primary mechanism by which cells sense the mechanical properties of their environments is by exploiting the contractility of their internal cytoskeletal networks to 'pull' on the external gel. For single cells, the strength of this pulling force is traditionally measured using Traction Force Microscopy (TFM). In TFM the amount that a cell displaces the gel is carefully measured and correlated to the mechanical activity of the individual cell [1]. However in tissues, interpreting these results is significantly complicated and usually we are left to infer the magnitudes of cellular forces through indirect methods such as by mechanical relaxation after laser cutting [2].

We here present a different approach, using theoretical modelling to interpret tissue level experimental observations. We develop a continuum elasticity model for a TFM experiment of a contractile epithelial cell sheet on an underlying gel substrate [3]. This model is used to show how the observation of greater displacement at the sheet edges can be explained by uniformly contractile cells rather than necessarily implying increased mechanical activity at the edges as has often been assumed. We show that the observed profiles of displacements is determined by a single non-dimensional parameter and that this parameter interpolates between linear and exponential force profiles for the extreme cases of very soft and very stiff substrates, respectively. If contractility is sufficiently increased at the periphery, we predict that outward directed displacements can occur at intermediate positions, although the edge itself will still retract. We also show that anisotropic extracellular stiffness leads to force localization in the stiffer direction, as observed experimentally.

[1] Sabass, B. et al. *High resolution traction force microscopy based on experimental and computational advances*. (2008) Biophys. J. 94 207-220

[2] Hutson, M. S. et al. *Forces for Morphogenesis Investigated with Laser Microsurgery and Quantitative Modeling*. (2003) Science 300(145) 145-149

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