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A non-cell autonomous actin redistribution enables isotropic retinal growth

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For many developing tissues, their shape is established early in development. In order to maintain this shape during subsequent growth, these tissues need to scale isotropically. The way by which cells inside tissues enable coordinated, isotropic tissue scaling is not understood, however, as most studies focused on changing, rather than maintaining tissue shapes during development. In this study, using light sheet fluorescence microscopy of both fixed and live samples, we follow tissue shape with cellular resolution in the zebrafish retinal neuroepithelium. This vertebrate neural progenitor tissue forms a smooth cup early in development and keeps its architecture as it grows. By combining 3D analysis and theory, we identify global cell elongation as a cellular mechanism to maintain retinal shape during growth. Timely cell height increase occurs concurrently with a non-cell autonomous actin redistribution, during which actin gets depleted from the lateral cell-cell interfaces. Blocking actin redistribution and cell height increase perturbs isotropic tissue scaling and we observe, using long light sheet timelapses, the emergence of the resulting disturbed, folded tissue shape. Taken together, from our whole-tissue imaging and analysis, we propose a model in which timely tissue-wide actin redistribution permits global cell elongation, which enables isotropic growth of the developing retinal neuroepithelium, a concept that could be applied to other systems.

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