Determination of Cell Elasticity in the Optical Stretcher

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Introduction and Background: The optical stretcher is a novel dual-laserbeam trap, capable of ensnaring living cells and exerting a surface force sufficient to stretch the cell along the beam axis (1-2). Applications include single-cell biopsy to identify cancerous cells, and evaluating the response of individual bone cells to mechanical strain.
Methods: We compute the optical pressure on the cell using a geometric optics model of light propagation and force generation, and measure the deformation of the cell using a high resolution CCD camera. Together, these quantities indicate the elasticity of the living cell. Intracellular nitric oxide and calcium changes were measured with Fluo-4 and DAF-FM fluorescence imaging of stretched cells.
Results: Calibration studies show excellent agreement with model predictions, and RBC elasticity measurements are consistent with literature values. Murine 2T3 osteoblast-like cells are approximately 12 times stiffer than RBCs.
Discussion and Conclusions: Comparison of elasticity of individual osteogenic cells may indicate the cells potential to function as a mechanosensor, and elucidate mechanisms of bone diseases, such as osteoporosis and atrophy of bone in low-gravity environments. Furthermore, fluorescence based methods provide an excellent means of measuring cell signaling in response to mechanical strain.

1. J.Guck et al. (2001) Biophys J. 81:767-784.
2. R.Ananthakrishnan et al. (2005) Current Sci. 88: 1434-1440
This project was supported by NIH P20 RR016469 from the INBRE program of the NCRR.