Mechanotransduction of cells has significant implications on cell biology and cell mechanics. Recently, cell-cell adhesion junctions have been implicated as mechanosensors through observations of reinforcement of cell junctions and activation of downstream signaling pathways. Cell-cell adhesion proteins, such as cadherins and catenins, are thought to play a role in altering these cellular functions under mechanical stimuli. However, studies to date have focused on disrupting cell-generated forces using pharmacological treatments. Here we report devices, methods and imaging for direct observations on the effects of mechanical loading on epithelial cells grown on stretchable membranes. These tools apply mechanical stress to confluent monolayers of cells using real-time fluorescence cell imaging. Such dynamic cell culture tools will enable research on the effects of mechanical stimulation of cells for open questions in tissue engineering, biomedical device design, and fundamental biology. Our stretchable cell culture array uses deformable membranes pulled down over posts of varied diameter in 96-well format using controlled vacuum on unsupported annuli. The central region of the membrane is stretched over circular or elliptical pillars to generate biaxial or uniaxial strain fields, respectively. Strain magnitude depends on applied pressure, post shape and post dimensions; strain fields are calibrated using micropatterned fiducials and modeled using finite element analysis. Substrate tension applied to the epithelium is hypothesized to strengthen cell-cell adhesions by recruiting cytoskeletal binding proteins (e.g. vinculin) to cadherins cell adhesion complexes. Such recruitment could be enabled through mechanical conformation changes in adhesion complex proteins including cadherin and catenins. We incubated MDCK epithelial cells overnight and visualized fluorescently-labeled cell-cell adhesion proteins during 1-3 hours of cyclic strain. We quantified the co-localization of proteins (e.g., vinculin) to cadherin complexes using image processing to threshold and mask the intensities of these proteins vs. strain magnitude. Preliminary results confirm that cells are healthy for 3 days on these PDMS devices, that we can image cell area, alignment, and protein localization in living cells, as well as in fixed cells processed for immunofluorescence staining with specific antibodies. Preliminary results suggest that vinculin localization does change with strain and that it depends on the degree of monolayer confluence. These studies provide a foundation for further studies of how mechanical stimuli regulate adherent cell behavior.