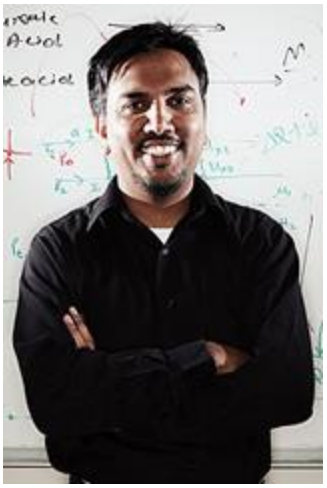

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Microfluidic investigation of mechanical response of cancer cells in flow

Flow-induced transport of cancer cells in narrow capillaries is an essential step in cancer metastasis. Yet, little is understood about how the transport properties are affected by cancer cell rheology, cell confinement, fluid stresses and timescales of deformation. In this study, a microfluidic model of a capillary is used and the excess pressure drop (P+) as a function of cell confinement is quantified at millisecond timescales. In addition to several cancer cell lines, the P+ of synthetic deformable particles including viscous drops, elastic particles and poroelastic drops is also measured. P+ of cancer cells from different tissues lie within the bounds delineated by low and high viscosity drops and does not scale with the elastic modulus of either the elastic particles or the poroelastic drops. These results indicate that the rheological response of cancer cells at short timescales is dominated by intracellular viscous dissipation. These results can be explained using a poroelastic cell model where dissipation arises from the rapid flow of cytosol relative to the deformed poroelastic network within a cell. This cytosol flow resistance is characterized as an effective cell viscosity and highly metastatic cancer cells are found to have a higher effective viscosity than lowly metastatic and benign cells. I will discuss the implications of this finding for the ability of circulating tumor cells to squeeze, arrest and fragment in microvasculature.