3D Displacement Fields of Migrating Neutrophil

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The preferred movement of cells towards a concentration gradient, known as chemotaxis, plays an imperative role in pathological and physiological processes in the body. Such examples are skin and mucosa wound healing, morphogenesis, inflammation and tumor growth. It has also been shown that cancer cells can migrate through both individual and collective cell-migration strategies. More importantly, the understanding of 3D migration and traction forces created by neutrophils will help researchers better comprehend extravasation of neutrophils from the blood into the tissue and then through interstitial tissue, which can correlate to understanding cancer cell metastasis.

Modern 3D chemotaxis assays to study this movement, have many shortcomings. To overcome such obstacles, the aim of the present work is the development and use of a novel direct-viewing chamber for chemotaxis studies, which allows one to overcome these limitations of the existing assays and is based on time-lapse microscopy with motorized sample positioning and stage incubation, coupled with image analysis techniques to measure cell forces in a 3D environment.

In this novel assay, presented in this work, a pure chemoattractant linear concentration gradient in a 3D collagen gel sample was generated by diffusion while the addition of fluorescence beads were dispersed, for the first time, to measure cell forces generated during migration. Experimental and mathematical models were derived to measure the diffusion coefficient through the 3D collagen matrix and measure neutrophil 3D displacement during migration. The presented Tecplot video is the first measured time-point (dt) during cell (white object) migration through Type-I collagen and its accompany 3D displacements (iso-surfaces) and future direction (streamlines).