IN VITRO MEASUREMENTS OF FLOW OVER ENDOTHELIAL CELLS

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ABSTRACT

Endothelial cells form a cellular monolayer that lines the arterial walls and are located between the flowing blood in the lumen and smooth muscle cells. Due to their unique location, endothelial cells are subjected to hemodynamic loadings. Endothelial cell physiological response to hemodynamic loadings can be categorized into morphological and biological response. Cell morphological response includes re-orientation and geometric changes in shape, size, and height. Cell biological response known as mechanotransduction involves sensing mechanical loadings and transducing them into chemical signals involving gene and protein expression. Abnormal endothelial cell response has been implicated in the localization of arterial disease like atherosclerosis. Though cell response involves a coupled (*i.e.* morphological and biological) process, to date many investigations into endothelial cells are still done in a decoupled way. The ultimate goal of our study is to perform simultaneous flow and biological measurements to gain insights into the genesis of arterial diseases at the cellular and sub-cellular level.

The current research focuses on employing micro-particle image velocimetry (μPIV) as an optical diagnostic tool for *in vitro* measurements of cell morphology as well as stresses exerted on living cells subjected to shear flow. A series of experiments including steady and pulsatile flow were performed on fixed cells leading up to measurements on living cells. The results of measurements on steady and pulsatile flow show that cell topography can be accurately mapped using μPIV. Analysis of stresses acting on endothelial cells reveal that both shear stress and pressure contribute to cellular response. Living cells were subjected to step change in shear stress from zero to 18 dynes/cm^2 and measurements were made at the 0^{th}, 3^{rd}, 6^{th}, and 18^{th} hour after applying shear. Changes in cell morphology are measured and the role of both shear stress and pressure are determined to be equally important in remodeling of living cells. The μPIV technique allows real-time measurements to be performed and this current study has provided a solid framework for possible simultaneous or coupled measurements of morphological and biological response.