Mechanotransduction Study and Focal Adhesion Recruitment in Endothelial Cells
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Cells exert forces on adjacent cells or the extracellular matrix via various transmembrane adhesion proteins. As a pathway for force transmission to the cytoskeleton, focal adhesion proteins play an important role in mechanotransduction for cells. In our study, the effect of mechanical force is studied to understand the functionality of focal adhesion proteins in endothelial cells in different length scales from nano to micro. In nano scale, MD (Molecular Dynamics) along with FEM (Finite Element Method) are employed to study receptor activations and protein conformational changes. In micro scale, a new microfluidic platform has been developed to confine a single cell into a customized location exposing a square-shaped membrane segment to a functionalized bead. An optical laser tweezers is used to facilitate and apply mechanical tension on specific membrane receptors in a horizontal direction perpendicular to the membrane. In the current framework, any specific transmembrane receptors (e.g. integrin) or cell adhesion proteins can be probed and recruitment of intracellular proteins (e.g. vinculin) can be studied under a tensile mechanical force. Protein assembly or recruitment to a focal adhesion complex are monitored and identified using immunofluorescent imaging. The presented method is unique in that it has a defined boundary condition, pure local tensile force, and facilitates computational simulation, traceability, imaging, and activation control of different transmembrane proteins. In addition, it has all the advantages of controlled microfluidic environment. This method provides a foundation for further studies of mechanotransduction and tensile stiffness of protein structures in single cells.

Peyman Honarmandi received his Ph.D. from Department of Mechanical and Industrial Engineering, University of Toronto, in 2007. There, he has received high prestigious awards such as Ontario Graduate Studies (OGS), and Natural Sciences & Engineering Research Council (NSERC) of Canada. From 2007 to 2010, he was doing research as a Postdoctoral Associate in the Mechanical and Bioengineering Department at Massachusetts Institute of Technology (MIT). His research interests are under the umbrella of solid mechanics and design with especial focus on bioengineering applications. He is a member of many engineering societies such as ASME, AIAA, and a registered PE license holder. Since 2010, Dr. Honarmandi has been a faculty member of Mechanical Engineering Department at CCNY-CUNY. He has active research collaborations with both BME and ME faculties and teaches graduate and undergraduate courses to over 150 students in a semester.