Time-dependent adhesion strength profile along discrete cell-substrate interfacial sites

Adhesion of cells to an extra-cellular matrix (ECM) plays a significant role in cellular processes such as cell growth, differentiation, mobility, apoptosis and tissue formation. Evolution of adhesion sites is governed by mechanical signals leading to an array of biochemical processes which, in turn, can generate structural and mechanical changes in the cells consecutively leading to additional mechanical and biochemical effects. A shear-lag type mechanical model classically used in the field of composite material science was adapted to the context of a cell adhering to a substrate through focal adhesion (FA) sites. The shear stress profile along the cell-substrate interface was calculated as a function of various material and geometrical characteristics of the adhesion region. The shape of the shear stress profile along the cell-substrate interface may suggest a likely mechanism for the biochemical feedback activity leading to FA growth and disintegration. Next, using rat embryonic fibroblasts, the growth and disintegration process of individual focal adhesion sites was monitored and analyzed in details for the first time. This allowed us to examine if there is a well-defined recurrent geometric pattern in the time evolution of FA growing/decaying sites and the relationship between the experimentally observed FA evolution and the associated shear stress profile generated at the FA-ECM interface. Such a correlation between the experimental data and the shear stress profiles may contribute to better understanding of the mechano-sensing mechanisms. Further more, the experimental data from image analysis of single FA sites can also be compared with different theoretical calculations of FA evolution which were suggested recently.

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Selected publications

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