QUANTIFYING CELLULAR FORCES AND BIOMECHANICAL PROPERTIES BY CORRELATIVE MICROPILLAR TRACTION FORCE AND BRILLOUIN MICROSCOPY

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ABSTRACT:

Cells experience a myriad of mechanical and physical cues within their three-dimensional microenvironment, and in turn, they respond by exerting forces, regulating their shape, internal cytoskeletal tension, and elastic modulus. Over the past decade, several studies demonstrated that such physical forces are sufficient to differentiate mesenchymal stem cells, initiate transcriptional programs, drive morphogenesis, and direct cell migration. Disruption of the cellular forces, as well as variations in subcellular mechanical properties, can lead to altered pathophysiological conditions and to the onset of diseases. As a result, assessing the cellular forces and mechanical properties is of crucial importance to provide a better understanding of disease mechanisms. Yet no methods exist to simultaneously gather this information.

In this work, we demonstrate the combination of micropillar traction force [1] and noncontact Brillouin microscopy [2] to non-invasively evaluate both cellular forces and biomechanical properties at optical resolution. Actin filaments of 3T3 fibroblasts showed significantly higher Brillouin shifts, indicating a potential increase in stiffness when adhering on fibronectin-coated glass compared to soft PDMS micropillars. Our findings demonstrate the complementarity of micropillar traction force and Brillouin microscopy to better understand the relation between cell force generation and the intracellular mechanical properties.

REFERENCES:

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