COMPARISON OF NANOMECHANICAL MODELS TO ASSESS CELL MECHANICS IN AFM INDENTATION EXPERIMENTS

Dokukin M.E.[1,2], Sokolov I.Yu.[2,3,4]

[1]Sarov Physical and Technical Institute, National Research Nuclear University MEPhI, Nizhegorodskaya region, Sarov, 607186, Russia, MEDokukin@mephi.ru
[2]Department of Mechanical Engineering, [3]Department of Biomedical Engineering, [4]Department of Physics, Tufts University, Medford, MA, 02155, USA

Here we present a comparative overview of nanomechanical models that were used to calculate mechanical properties (elastic modulus) of biological cells in atomic force microscopy (AFM) indentation experiments. We investigated the question if cell, being a highly heterogeneous object, could be described with the elastic modulus in a self-consistent way. The different probe shapes and sizes, as well as various nanomechanical models, were compared [1, 2]. The cell was approximated as a homogeneous elastic medium that had either a smooth hemispherical boundary (Hertz/Sneddon model) or the boundary covered with a layer of glycocalyx and membrane protrusions ("brush" model). The further extensions of the brush model for multicomponent brushes and brushes larger than the height of the AFM probe were investigated [3]. We demonstrated that only the brush model showed self-consistency when processing the indentation data collected with large spherical AFM probes [4]. In all other models: Hertz/Sneddon models (no brush took into account) and when the brush model was applied to the data collected with sharp conical probes, the elastic modulus demonstrated strong depth dependence. The nature of these results is discussed.

References

1. *M.E. Dokukin, N.V. Guz, I. Sokolov.* Quantitative study of the elastic modulus of loosely attached cells in AFM indentation experiments // Biophysical Journal **Vol. 104**, No. 10, Year 2013. Pp. 2123-2131.
2. *N. Guz, M. Dokukin, V. Kalaparthi, I. Sokolov.* If Cell Mechanics Can Be Described by Elastic Modulus: Study of Different Models and Probes Used in Indentation Experiments // Biophysical Journal **Vol. 107**, No. 3, Year 2014. Pp. 564–575.
3. *M. Dokukin, Y. Ablaeva, V. Kalaparthi, A. Seluanov, V. Gorbunova, I. Sokolov.* Pericellular Brush and Mechanics of Guinea Pig Fibroblast Cells Studied with AFM // Biophysical Journal **Vol. 111,** No. 1, Year 2016. Pp. 236–246.
4. *I. Sokolov, M.E. Dokukin, N.V. Guz.* Method for quantitative measurements of the elastic modulus of biological cells in AFM indentation experiments // Methods **Vol. 60**, No. 2, Year 2013. Pp. 202-213.