Investigating cell mechanics on nanopatterned surfaces by Atomic Force Microscopy

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In order to ensure rapid osseointegration and long-term stability of permanent bone implants, the control of osteogenic differentiation of mesenchymal stem cells (MSCs) on the surface of the implant is fundamental. A new and increasingly harnessed approach to induce osteodifferentiation of MSCs is the modulation of surface topography at nanoscale. Previous studies have shown that topographical cues may promote osteogenic differentiation by inducing mechanical signals to the cell, which are converted into biochemical signals through mechanotransduction pathways [1]. Nevertheless, to date, the phenomenon has been only qualitatively investigated, and a systematic quantitative study elucidating the spatio-temporal mechanisms involved in the interactions between nanopatterns and cells is still missing.
We propose a new AFM-based method, consisting in the combined use of Quantitative Imaging (QI), single cell force spectroscopy (SCFS) and microfluidic AFM, to systematically study the mechanical behavior of cells interacting with nanopatterns in order to: i) quantify their elastic modulus and adhesion force; ii) find a relationship between cells mechanical properties and osteogenic capability of specific nanopatterns; iii) investigate if cells mechanical properties can be considered as early markers for nanopattern-induced differentiation and used for screening and optimization of osteogenic topographies.

[1] Dobbenga S., Fratila-Apachitei E.L., Zadpoor A.A., Acta Biomaterialia 46 (2016) 3-14