Investigating the nanomechanical properties of living smooth muscle cells by atomic force microscopy and numerical simulations

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ABSTRACT

We investigate the impact of LOXL1 knockout on the cell's response. Such genetically modification mimic the major aspects of female pelvic floor disorders [1] and suggests that both vaginal extracellular matrix and smooth muscle play a crucial role in mediating tissue adaptation for delivery and postpartum recovery [2]. To address and predict microstructural dependence of the cell's stiffness, simulations around idealized conditions during AFM indentation are performed. A mechanical model is presented to analyse the stiffness of vaginal smooth muscle cells during indentation. The cell is filled with a soft core and a thin shell behaving according to an active network model [3]. Such model provides a characterization of the time-dependent mechanical properties of the actomyosin cortex defining it as an active solid at short timescales and as an active 'fluid' at longer timescale.
The simulations indicate contractile cells with stiffer responses and spatiotemporal dependence on the rate of the mechanical stimuli and serve as a framework to improve current diagnosis and treatments for postpartum recovery.

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