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Tissue-Cellular Deformation Coupling in Cell-Microintegrated Elastomeric Scaffolds

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Objectives:

In engineered tissues, the relation between scaffold and cellular deformations is a occurs at the meso-micro scale phenomenon that profoundly affects extracellular matrix protein production, tissue formation, growth, and remodeling. Cellular deformations are a complex function of scaffold mechanical properties, local fiber micro-architecture, and cellular coupling with the surrounding fibers. With our ability to incorporate viable cells using simultaneous cell electrospraying/polymer fiber electrospinning, we are provided with a unique platform to investigate cellular deformations within a three dimensional elastomeric fibrous scaffold.

Method:

Poly (ester urethane) urea (PEUU) was used due to its biodegradable and cyto-compatible properties. Viable vascular smooth muscle cells (VSMC) were electrosprayed along with electrospinning (ES) of PEUU fiber scaffolds. We then quantified cell deformations and related them to changes in scaffold structures in response to large (finite) tissue-level strains utilizing real-time laser scanning confocal microscopy.

Results:

Electrospinning produced continuous fiber scaffolds exhibiting a wide range of mechanical properties, while also providing suitable surfaces for cell proliferation and growth. While local fiber geometry depended on macro-tissue strains, cellular deformations depended *non-linearly* on changes in local fiber architecture. Moreover, once the scaffold fibers completely straightened at large strains, all measurable cell deformations ceased.

Conclusions:

We conclude that local scaffold micro-structural changes induced by macro-level applied strain dominated cellular deformations, so that monotonic increases in scaffold strain do not necessitate similar levels of cellular deformation. This result has fundamental implications when attempting to elucidate the events of de-novo tissue development and remodeling.

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