P169. On The Influence Of Scaffold Anisotropy On Engineered Heart Valve Function

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OBJECTIVES: Tissue engineered pulmonary valves (TEPV) represent a conceptually appealing alternative for the repair of congenital or acquired lesions in pediatric patients. TEPV require scaffolds with anisotropic mechanical properties that undergo large deformations coupled with controllable biodegradative and cell-adhesive characteristics. In the present study, we conducted a finite element based analysis of TEPV leaflets under quasi-static transvalvular pressure to demonstrate the impact of ES-PEUU mechanical anisotropy on scaffold strain distributions.

METHODS: The ES-PEUU biomechanical mechanical behviors were implemented into a computational model in which simulations characterizing varied magnitudes of material anisotropy were performed under quasi-static loading. Tissue response in terms of cellular level deformation and strain field homogeneity were evaluated.

RESULTS: Finite element simulations demonstrating that for the isotropic case, substantial regional variations were observed. In contrast, use of a mechanically anisotropic scaffold resulted in a more uniform principal strain distributions (Fig 1). Moreover, modulating the uniformity of the fiber preferred direction did not significantly impact the homogeneity qualities of the stress field, suggesting that a uniform directional scaffold materials can be used.

CONCLUSIONS: These results demonstrated that modulating the scaffold properties can play a major role in the mechanical response of the TEPV tissue stress. Tailoring the fabrication process may provide effective and practical method to introduce a moderate degree of anisotropy into scaffold material. These qualities can be controlled to provide a biomechanical response to provide a physiologically relevant deformation state for the stimulation of the micro-integrated cell population. Thresholds of force, stress and strain under normal physiologic conditions were also considered.

Figure 1

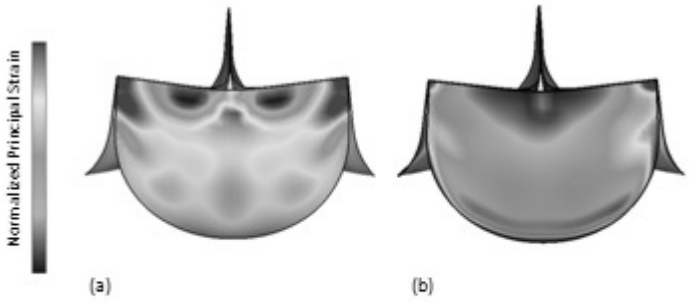

Figure 1 – Analysis of fixtured TE valves – principal strains. Comparing an (a) isotropic to a (b) moderate anisotropic (9 m/s ES-PEUU). These results demonstrate the significant differences in the nature of the strain field as a function of material anisotropy.