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Development of fibroblast-seeded collagen gels under planar biaxial mechanical constraints: A biomechanical study

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Prior studies indicated that mechanical loading influences cell turnover and matrix remodeling in tissues, suggesting that mechanical stimuli can play an active role in engineering artificial tissues. While most tissue culture studies focus on influence of uniaxial mechanical loading/constraints, effects of multi-axial loading/constraints on tissue development are far from clear. In this study, we examined biaxial mechanical properties of fibroblast-seeded collagen gels cultured under four different static mechanical constraints for six days: free floating, equibiaxial stretching (with three different stretch ratios), strip-biaxial stretching and uniaxial stretching conditions. Results showed that gels cultured free floating and under equibiaxial stretching exhibited a nearly isotropic mechanical behavior, while gels cultured under strip-biaxial and uniaxial stretching developed a significant mechanical anisotropy. In particular, gels cultured under equibiaxial stretching with a greater stretch ratio appeared to be stiffer than those with a smaller stretch ratio. Passive mechanical behavior of the gels, which were determined after cell removal, appeared to be stiffer than its cell-contained counterpart. For gels cultured under uniaxial stretching and strip-biaxial stretching, the retained mechanical anisotropy after cell removal revealed an irreversible matrix remodeling. Finally, a continuum-based 2-D Fung model was used to characterize the mechanical behavior of the decellularized gels. In the future, cell-seeded collagen gels will be subjected to dynamic mechanical stimuli in a custom-made planar biaxial mechano-active bioreactor and tissue development under the dynamic conditions will be examined.

Biography

Jin-Jia Hu received his Ph.D. degree in Biomedical Engineering at Texas A&M University. He is currently an Assistant Professor in Department of Biomedical Engineering at National Cheng Kung University. His research interest focuses on mechanobiology, soft tissue biomechanics and soft tissue engineering.

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