Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

A Computational Model of Optimal Vein Graft Adaptation in an Arterial Environment ABHAY B. RAMACHANDRA, SETHURAMAN SANKARAN, Department of Mechanical and Aerospace Engineering, UCSD, JAY HUMPHREY, Department of Biomedical Engineering, Yale University, ALISON MARSDEN, Department of Mechanical and Aerospace Engineering, UCSD — In coronary artery disease, surgical revascularization using venous bypass grafts is performed to relieve symptoms and prolong life. Coronary bypass graft surgery is performed on approximately 500,000 people every year in the United States, with graft failure rates as high as 50% within 5 years. When a vein graft is implanted in the arterial system it adapts to the high flow rate and high pressure of the arterial environment by changing composition and geometry, and thus stiffness. Hemodynamic loads, resulting in altered wall shear and intramural stresses, are major factors impacting vein graft remodeling. Here, a constrained mixture theory of growth and remodeling for arteries is extended to model the evolution of a vein graft subjected to arterial flow and pressure conditions. A derivative-free optimization method is used to estimate the optimal set of constitutive parameters that best match passive biaxial mouse inferior vena cava data from experiments. Optimization is performed using surrogate management framework, a pattern search method with established convergence theory. The resulting parameter set is used to predict optimal vein adaptation in an arterial environment for two illustrative cases: a) Step change b) Gradual change in loading. Results are compared against vein graft data from the literature and a possible set of mechanisms for sub-optimal vein graft remodeling is suggested.

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Date submitted: 10 Aug 2012 Electronic form version 1.4