Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Multiscale modeling and simulation of blood flow in coronary artery bypass graft surgeries[1] SETHURAMAN SANKARAN, MAHDI ESMAILY MOGHADAM, ANDY KAHN, ALISON MARSDEN, UCSD — We present a computational framework for modeling and simulation of blood flow in patients who undergo coronary artery bypass graft (CABG) surgeries. We evaluate the influence of shape on the homeostatic state, cardiac output, and other quantities of interest. We present a case study on a patient with multiple CABG. We build a patient-specific model of the blood vessels comprised of the aorta, vessels branching from the top of the aorta (brachiocephalic artery and carotids) and the coronary arteries, in addition to bypass grafts. The rest of the circulatory system is modeled using lumped parameter 0D models comprised of resistances, compliances, inertances and elastance. An algorithm is presented that computes these parameters automatically given constraints on the flow. A Finite element framework is used to compute blood flow and pressure in the 3D model to which the 0D code is coupled at the model inlets and outlets. An adaptive closed loop BC is used to capture the coupling of the various outlets of the model with inlets, and is compared with a model with fixed inlet BC. We compare and contrast the pressure, flowrate, coronary perfusion, and PV curves obtained in the different cases. Further, we compare and contrast quantities of interest such as wall shear stress, wall shear stress gradients and oscillatory shear index for different surgical geometries and discuss implications of patient-specific optimization.

[1]I would like to acknowlege AHA for funding this work

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Date submitted: 12 Aug 2011 Electronic form version 1.4