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A Numerical Multiscale Framework for Modeling Patient-Specific Coronary Artery Bypass Surgeries ABHAY B. RAMACHANDRA, Department of Mechanical and Aerospace Engineering, UCSD, ANDREW KAHN, Department of Medicine, UCSD, ALISON MARSDEN, Department of Mechanical and Aerospace Engineering, UCSD — Coronary artery bypass graft (CABG) surgery is performed to revascularize diseased coronary arteries, using arterial, venous or synthetic grafts. Vein grafts, used in more than 70% of procedures, have failure rates as high as 50% in less than 10 years. Hemodynamics is known to play a key role in the mechano-biological response of vein grafts, but current non-invasive imaging techniques cannot fully characterize the hemodynamic and biomechanical environment. We numerically compute hemodynamics and wall mechanics in patient-specific 3D CABG geometries using stabilized finite element methods. The 3D patient-specific domain is coupled to a 0D lumped parameter circulatory model and parameters are tuned to match patient-specific blood pressures, stroke volumes, heart rates and heuristic flow-split values. We quantify differences in hemodynamics between arterial and venous grafts and discuss possible correlations to graft failure. Extension to a deformable wall approximation will also be discussed. The quantification of wall mechanics and hemodynamics is a necessary step towards coupling continuum models in solid and fluid mechanics with the cellular and sub-cellular responses of grafts, which in turn, should lead to a more accurate prediction of the long term outcome of CABG surgeries, including predictions of growth and remodeling.

Abhay B. Ramachandra
Department of Mechanical and Aerospace Engineering, UCSD

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