Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Spiral blood flows in an idealized 180-degree curved artery model[1]

KARTIK V. BULUSU, George Washington University, VARUN KULKARNI, University of Illinois, Chicago, MICHAEL W. PLESNIAK, George Washington University — Understanding of cardiovascular flows has been greatly advanced by the Magnetic Resonance Velocimetry (MRV) technique and its potential for three-dimensional velocity encoding in regions of anatomic interest. The MRV experiments were performed on a 180-degree curved artery model using a Newtonian blood analog fluid at the Richard M. Lucas Center at Stanford University employing a 3 Tesla General Electric (Discovery 750 MRI system) whole body scanner with an eight-channel cardiac coil. Analysis in two regions of the model-artery was performed for flow with Womersley number=4.2. In the entrance region (or straight-inlet pipe) the unsteady pressure drop per unit length, in-plane vorticity and wall shear stress for the pulsatile, carotid artery-based flow rate waveform were calculated. Along the 180-degree curved pipe (curvature ratio =1/7) the near-wall vorticity and the stretching of the particle paths in the vorticity field are visualized. The resultant flow behavior in the idealized curved artery model is associated with parameters such as Dean number and Womersley number. Additionally, using length scales corresponding to the axial and secondary flow we attempt to understand the mechanisms leading to the formation of various structures observed during the pulsatile flow cycle.

[1]supported by GW Center for Biomimetics and Bioinspired Engineering (COBRE), MRV measurements in collaboration with Prof. John K. Eaton and, Dr. Chris Elkins at Stanford University

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Date submitted: 29 Jul 2017 Electronic form version 1.4