

Simulated Blood Flow through a Patient's Coronary Arteries

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The Multiscale Hemodynamics project is a collaboration of doctors, physicists, and computational scientists working together with the goals of gaining a better understanding of heart disease through fundamental fluid mechanics, and developing a method to non-invasively detect regions of atherosclerotic lesion formation and areas of rapid disease progression. By identifying high risk areas in the coronary arteries, a doctor is able to facilitate targeted interventions (e.g., stent placement) to prevent further disease progression possibly leading to a heart attack.

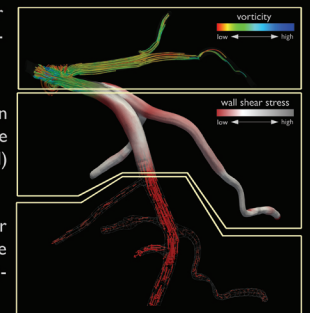
To this end, the project has collected computed tomography angiography (CTA) data from patients in order to obtain coronary geometries and then accurately model human blood flow through the coronary arteries. The CTA data is gathered using a 320 detector row Toshiba AquilionONE scanner and then the data is registered and segmented. The end result is a series of 3D surfaces representing the heart and coronary arteries. These geometries are then loaded into MUPHY, a multi-physics and multi-scale code combining microscopic Molecular Dynamics (MD) with a hydro-kinetic Lattice Boltzmann (LB) method, to model the blood flow through the static geometries. The result is a full 3D representation over time of the simulated blood flow and associated properties indicative of disease progression including endothelial shear stress (ESS), which cannot be measured in a living patient, for an entire arterial tree.

To learn more about the project, go to: <http://hemo.seas.harvard.edu>

The streamlines follow the velocity vector field of the blood flow, and the color represents the magnitude of the vorticity.

The surface representation shows the lumen of the artery, and the color represents the magnitude of the endothelial (i.e., inner wall) shear stress.

The 3D arrows show the velocity vector field with the arrow oriented along the vector field and scaled in size by the magnitude of the velocity.



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