Transient FSI Simulation of Vascular Blood Flow

Colorado Health Science Center

Biomedical

U.S.A.

www.uchsc.edu/peds/subs/cardio/

ANSYS® FSI Solution

Overview

Cardiology research engineers at the University of Colorado Health Science Center use mechanics-based models of varying complexity to gain insight into pulmonary arterial hypertension (PAH) for the advancement of basic knowledge of the disease and development of new disease diagnostics.

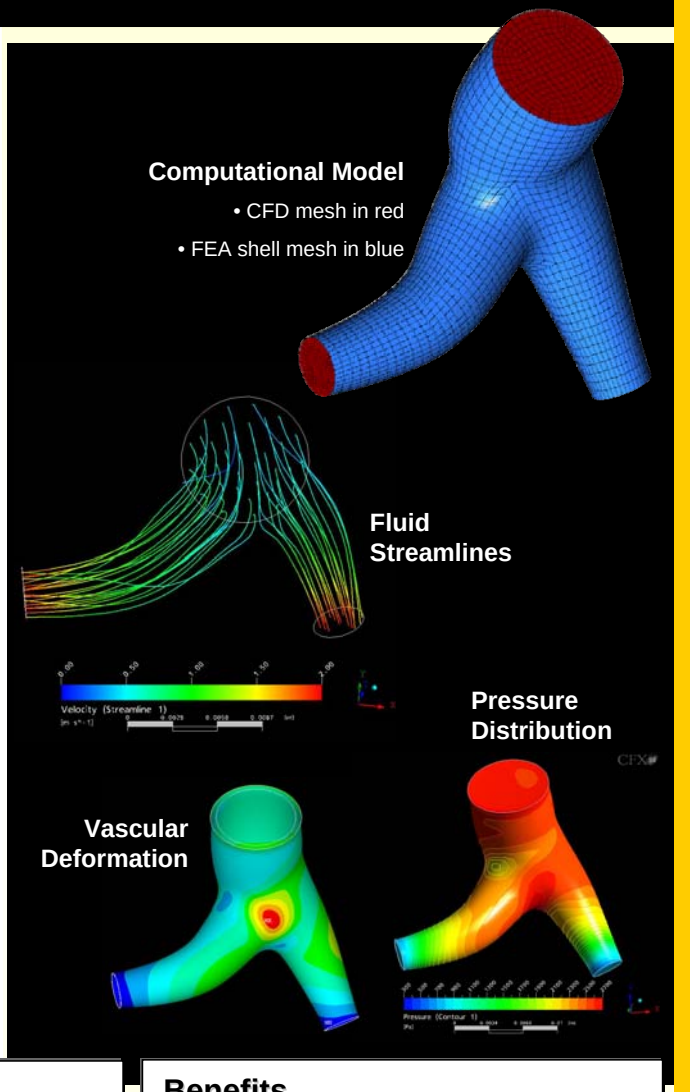
PAH is a condition of persistent elevated pressure in the vessels that carry oxygen-poor blood from the right ventricle of the heart to the small arteries in the lungs. Over time, the increased loading due to PAH can cause the heart to weaken, leading to premature heart failure and death.

Current clinical methods for diagnosis and evaluation of PAH are invasive and consider only mean flow rate and pressure drop across the vasculature. By using simulation, researchers can gain a better understanding of transient physics and the effects of vascular stiffness.

Testimonial

"The ANSYS® fluid structure interaction capabilities have enabled us to take our 3-D patient-specific modelling to the next level. Our previous models, created with a competitor's FEA-CFD package, were less flexible in terms of element libraries, geometric and material constitutive nonlinearities, and fluid and solid boundary conditions. They also took more compute time to solve!"

Kendall Hunter, Ph.D.
Postdoctoral Research Fellow
Department of Pediatric Cardiology



Challenge

- Simulation of transient hemodynamics and arterial motion requires solution of the coupled solid and fluid domains.
- Geometry definition comes from medical imaging.
- The constitutive modelling of the vasculature is difficult (hyperelastic materials, complex constraint relationships).
- The fluid boundary conditions cannot be characterized simply.

Solution

- ANSYS provides a complete solution for the coupled simulation of fluid structure interaction.
- ANSYS® ICEM CFD™ Hexa provides high-quality quad and hex element shell and volume meshes for geometries determined from imaging data.
- ANSYS FEA solid modelling capabilities allow the definition hyperelastic material models and complex constraint equations.
- ANSYS CFX provides a robust CFD solver coupled with FEA and key features such an expression language that allow for the definition of various physiological boundary conditions.

Benefits

- Preliminary studies have demonstrated the feasibility of FSI simulation of transient hemodynamics. From these simulations, researchers can gain a better understanding of the transient physics involved in PAH and insight into the effects of vascular stiffness.
- Upcoming studies with improved clinical and imaging data will allow validation and refinement of the simulation methodology.
- Eventually, the clinical use of non-invasive patient-specific simulation may provide better understanding of the progression of PAH as well as improved predictions of the potential outcomes of treatments.

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