BMED 4699, Mahdi Al-Husseini

Simulating Blood Flow through a Hypothetical Modified Fontan Procedure

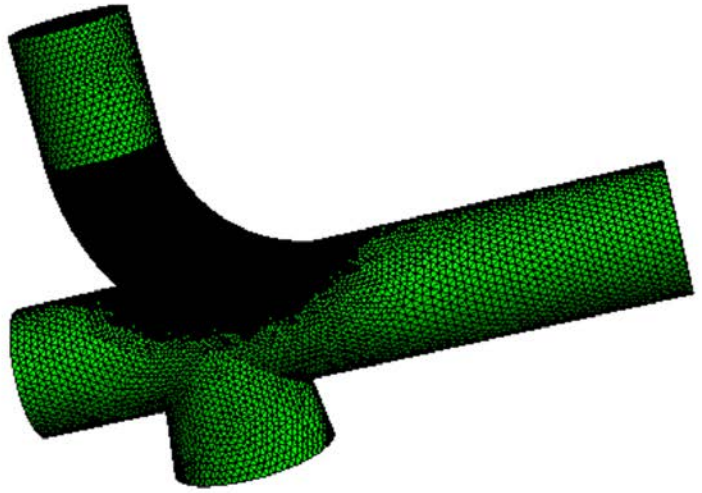
Emory Center for Mathematics and Computing in Medicine E(CM)^2

Fall Semester Plan

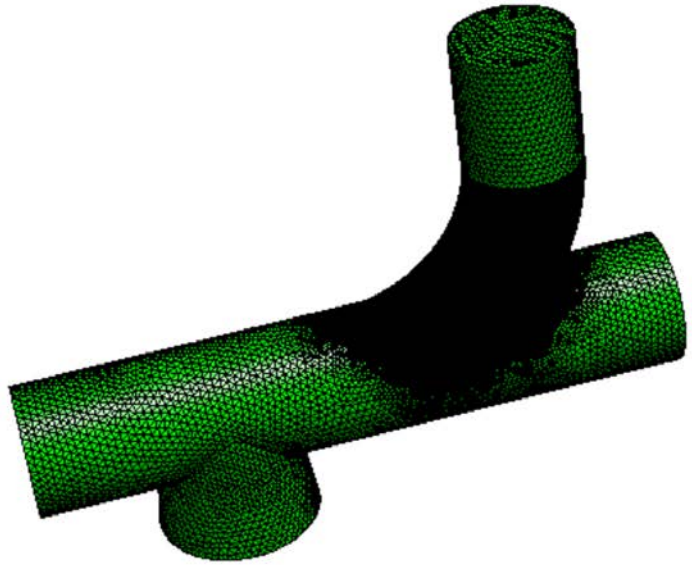
- Develop a Fundamental Understanding of Finite Element Methods (FEM) and Review Navier-Stokes Formulations for FEM
- Develop MATLAB Pre-Processor and Processor Files that take Patient Specific IVC/SVC/PA Measurements from Dr. Anthony Corno, and output Constructive Geometry Mesh Files
- Identify Relevant Boundary Conditions for the Fontan Procedure from the Academic Literature
- Develop C++ Navier-Stokes Solver (.edp file) and specify Boundary Conditions in NetGen

Constructive Geometry Mesh Files developed in MATLAB and visualized in NetGen

Fontan



Modified Fontan



Identified Boundary Conditions of Note

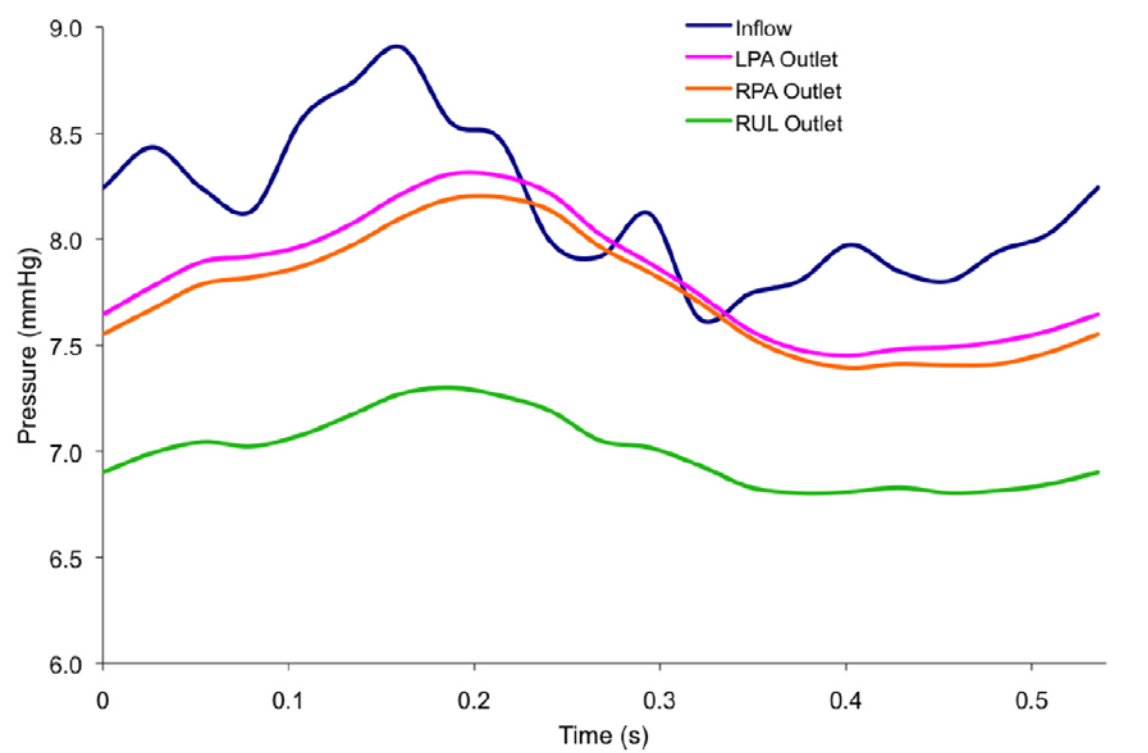
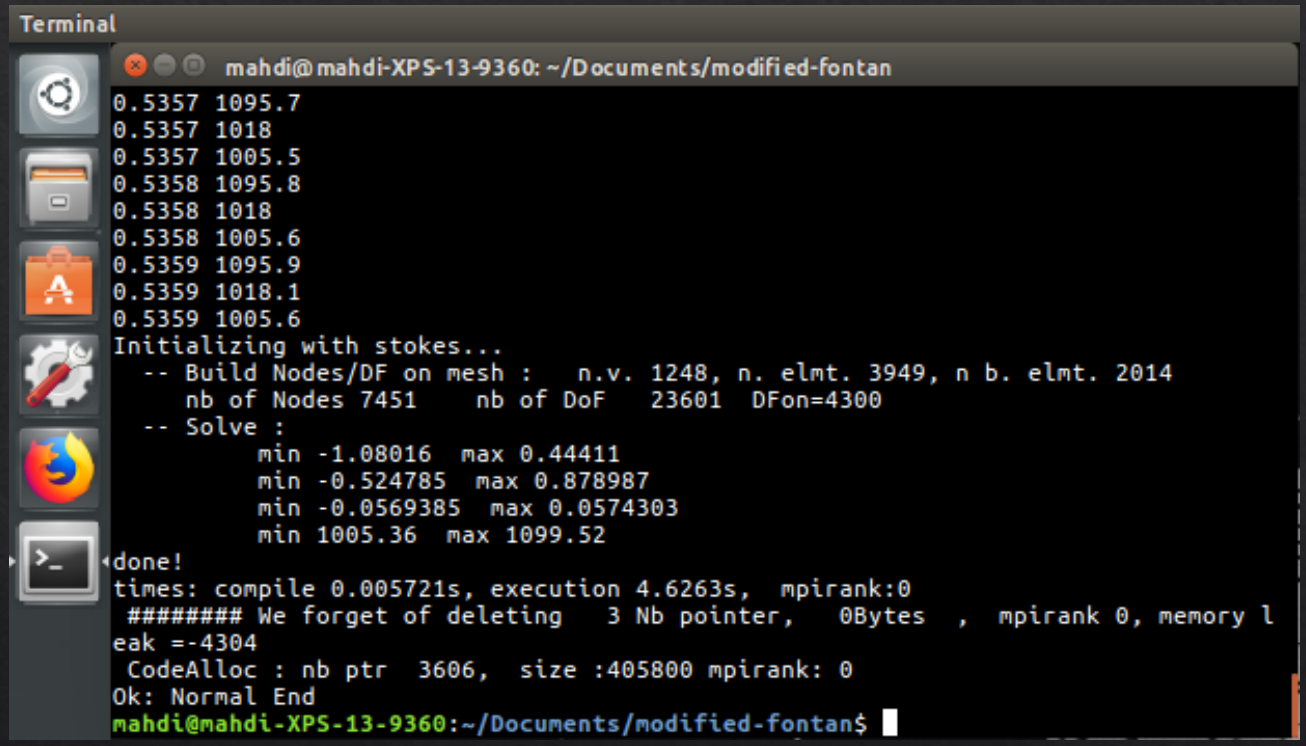


Fig. 5 Pressure and flow waveforms for patient A probed at the inlet (blue) and outlet of RUL (green), LPA (purple) and RPA (orange). The mean value of the flow at the inlet is 27.8$cm^3.s^{-1}$ (1.67$L.\ min^{-1}$) while the mean flow at the outlets are 2.99 $cm^3.s^{-1}$ (0.18 L. min^{-1}) at the LPA, 2.54 $cm^3.s^{-1}$ (0.15$L.\ min^{-1}$) at the RPA and 1.36 $cm^3.s^{-1}$ (0.08$L.\ min^{-1}$) at the RUL.

Troianowski, G., Taylor, C. A., Feinstein, J. A., & Vignon-Clementel, I. E. (2011). Three-dimensional simulations in Glenn patients: clinically based boundary conditions, hemodynamic results and sensitivity to input data. *Journal of biomechanical engineering*, *133*(11), 111006.

Finite Element Treatment of Navier Stokes



Spring Semester Plan (Looking Forwards)

- Finalize C++ Navier-Stokes Solver (.edp file) and specify Boundary Conditions in NetGen
- Visualize in ParaView
- If Significant Difference Detected between Fontan and Modified Fontan:
  - Begin Developing Patient-Specific Mesh using CT Scan
  - Reapply Navier-Stokes Solver to both Models
  - Write-up and Publish Results