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STUDY OF COMPLIANCE MISMATCH WITHIN A STENTED ARTERY

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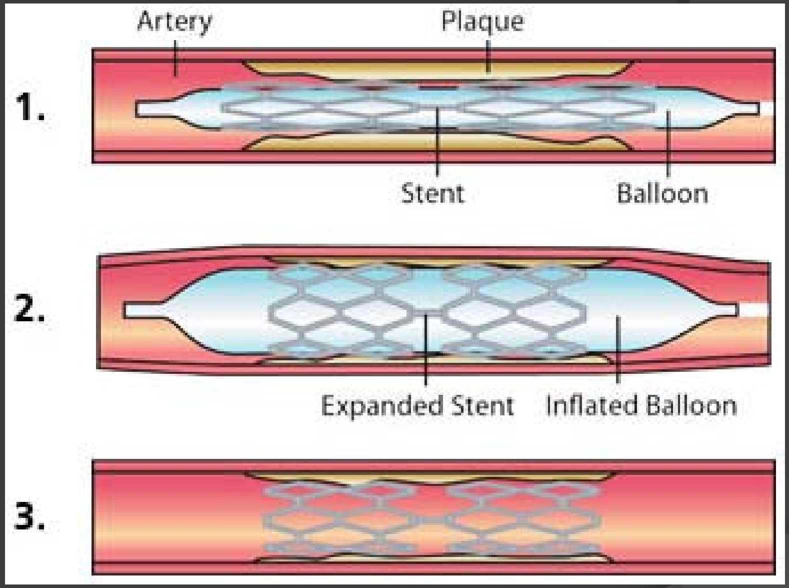
AGENDA

- Introduction
- Formulation and Boundary Conditions
- Comsol Model
- Simulation Results
- Conclusion
- Future Work

Introduction

- Atherosclerosis is a chronic inflammatory response in the walls of arteries
- Angioplasty with vascular stenting is a method to aid blood flow
- Studies show that restenosis occurs in 20-50% of patients after balloon angioplasty at the site treated within 6 months

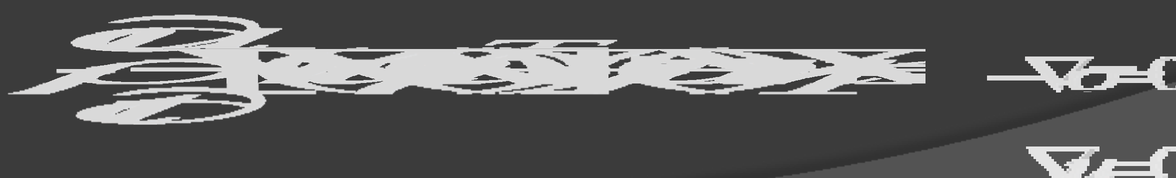


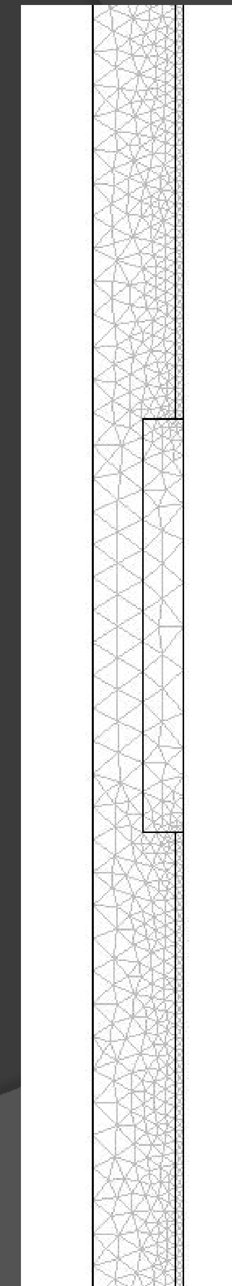
Introduction (continued)

- Some studies predict that this is closely related to the presence of irregular flow, in which layer separation and vorticity cause an unnatural distribution in wall shear stress
- As the result of angioplasty, the mechanical properties of the artery differ from those of the stented artery. This is referred to as compliance mismatch.

Formulation

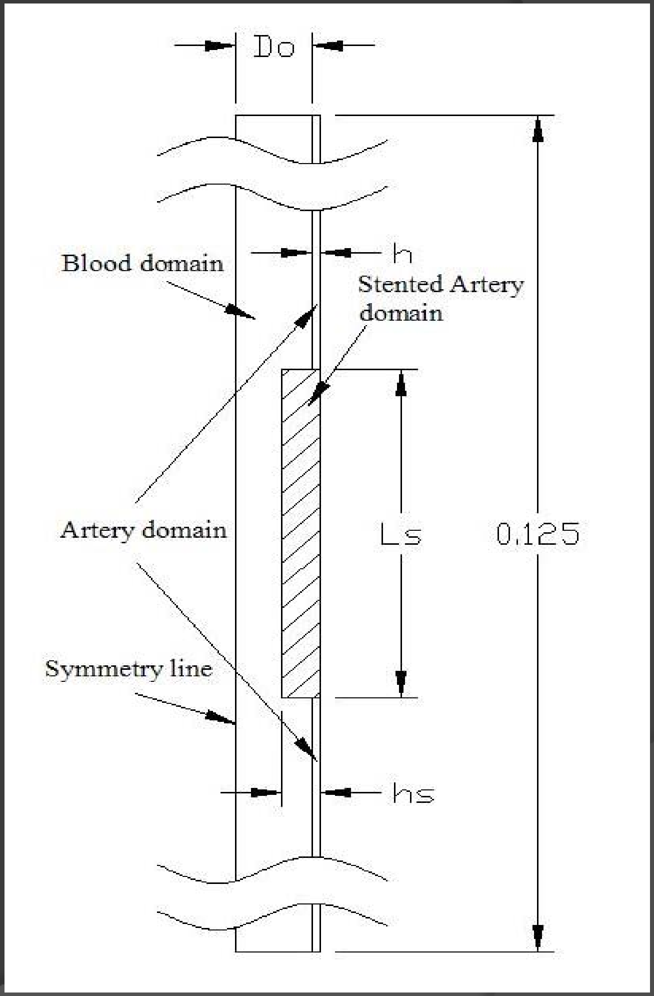
- Inertance large compared to the resistance
- Navier-Stokes and field continuity equations implemented within the (ns) Comsol mode.
- Global equilibrium equations implemented using the axial symmetric stress-strain Comsol mode
- Moving Mesh (ALE) Comsol mode





Comsol Model

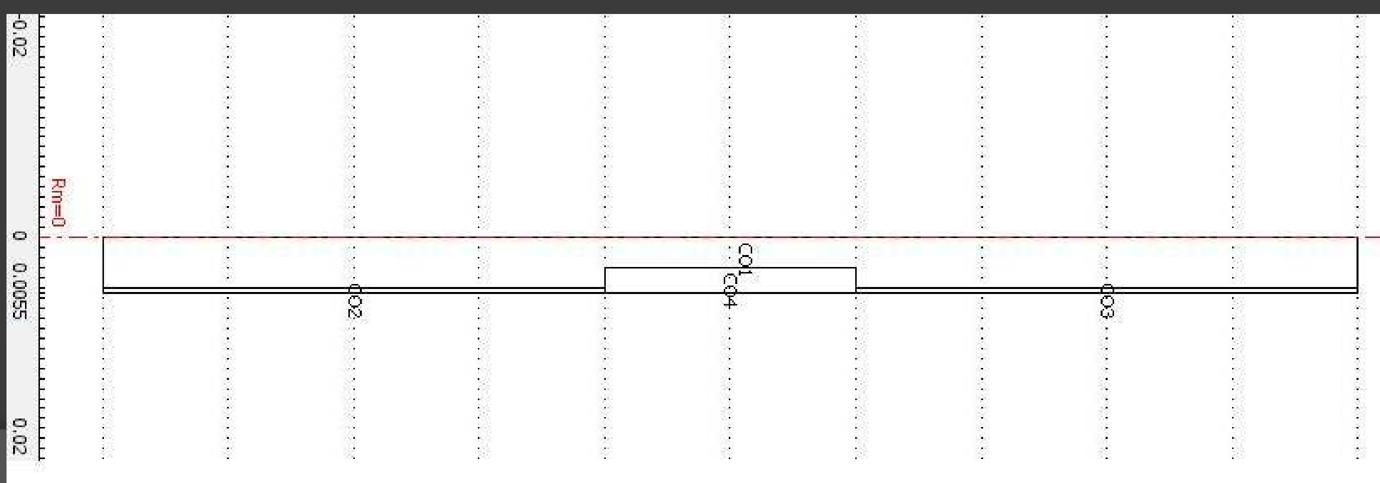
- Axial symmetric model
- Model dimensions: Ls=0.025 m, hs=0.0025 m, h=0.0005 m and Do=0.005 m, resulting in hs/Do=0.5
- For simplicity, $Ea=10^7$ Pa
- Es=nEa for stented artery domain
- Two ends of the artery wall are fixed



Model (continued)

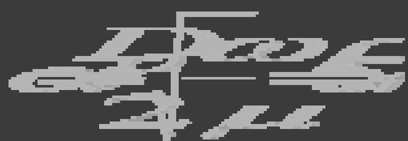
- Blood Flow is assumed to be Newtonian, incompressible, viscous, and laminar
- $v=0.005$ Pa·s, $\rho=1060 kg/m^3$
- Pressure at the boundaries varied in a sinusoidal fashion. This is given by the relation:

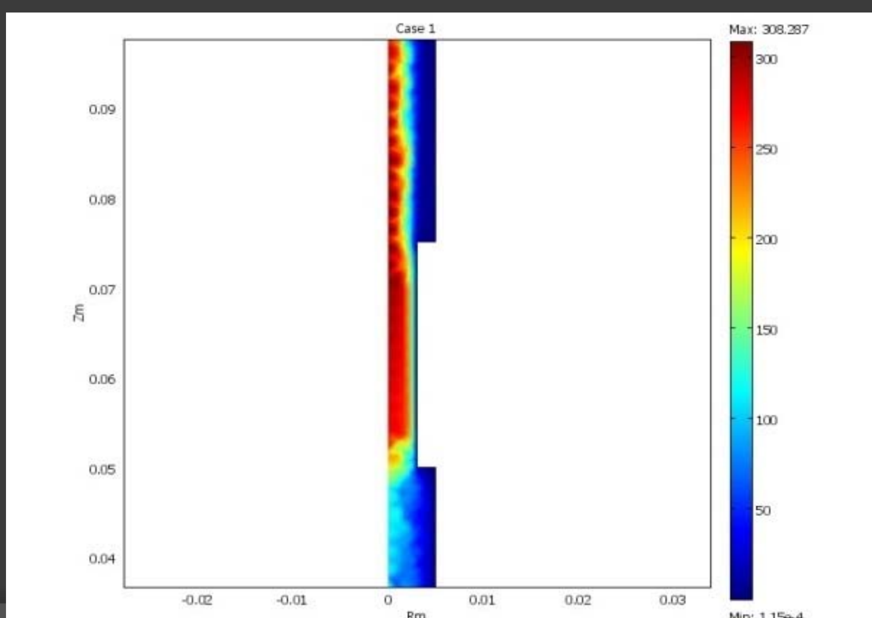
  $P=P_{dia}+(P_{sys}-P_{dia})\sin(\omega t)$, $\omega=2\pi$
- Comsol Heaviside function: flc2hs

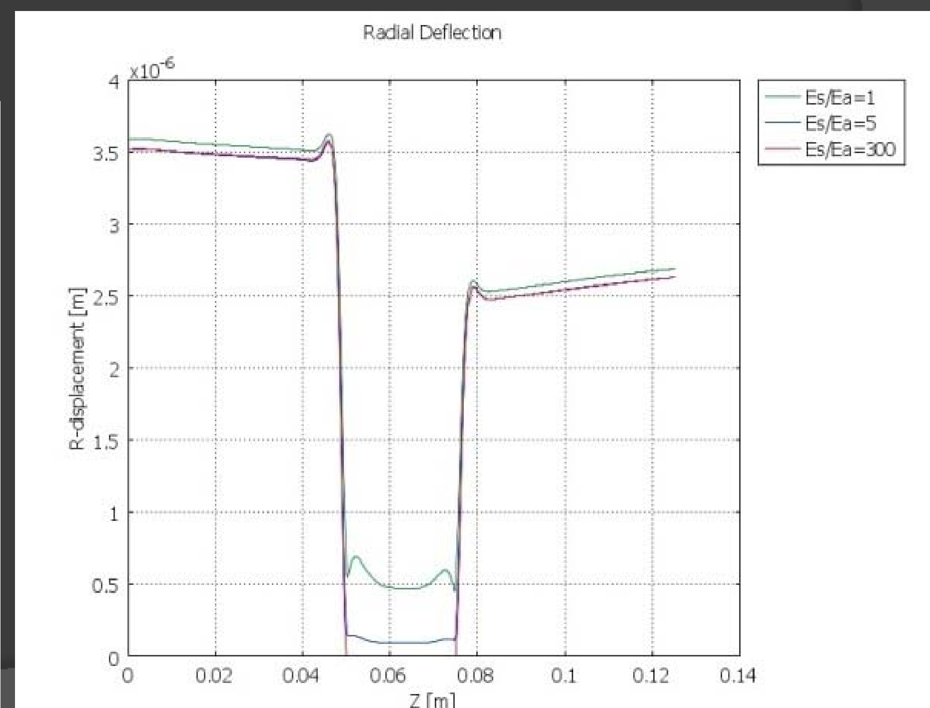


Simulation Results

- Our results correspond to an average bulk Reynolds number of 154 and a Womersley number of 5.77

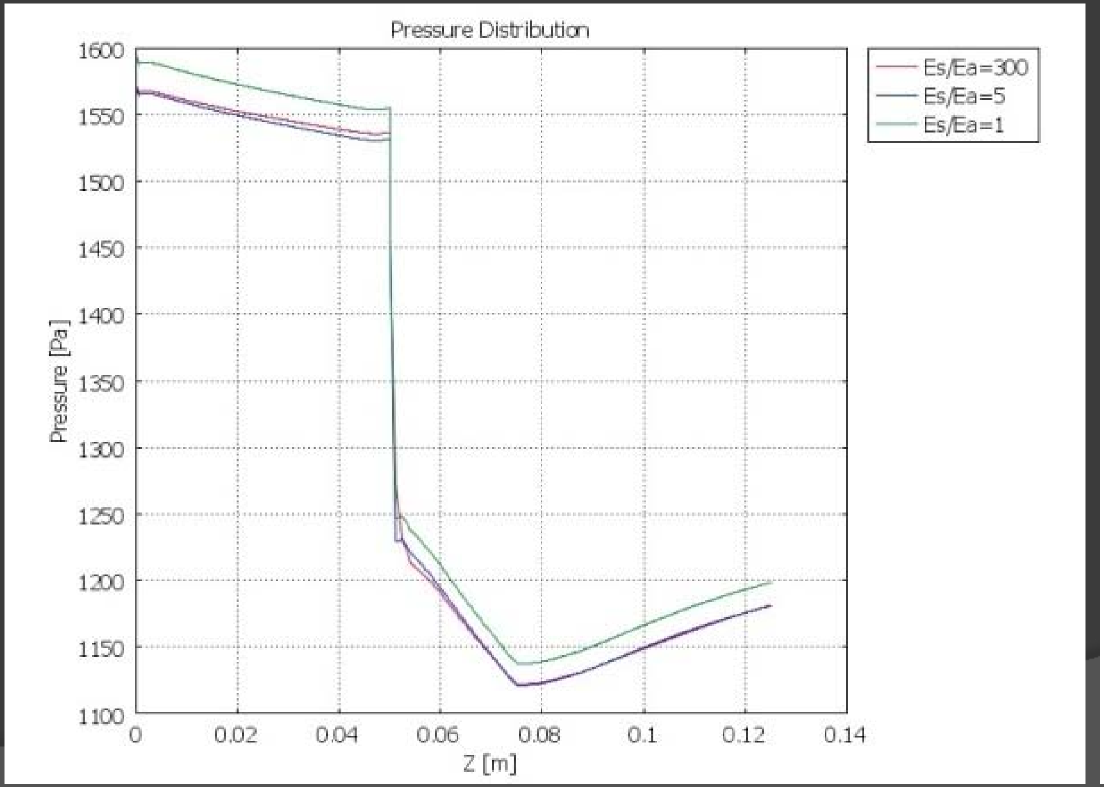


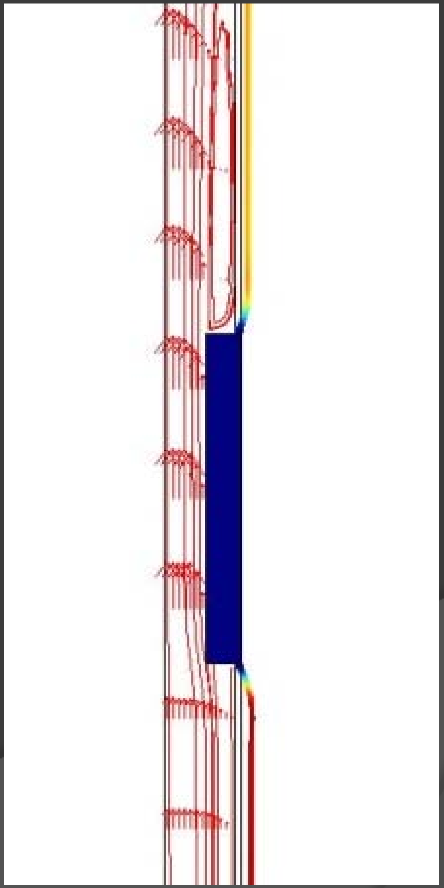




Results (continued)

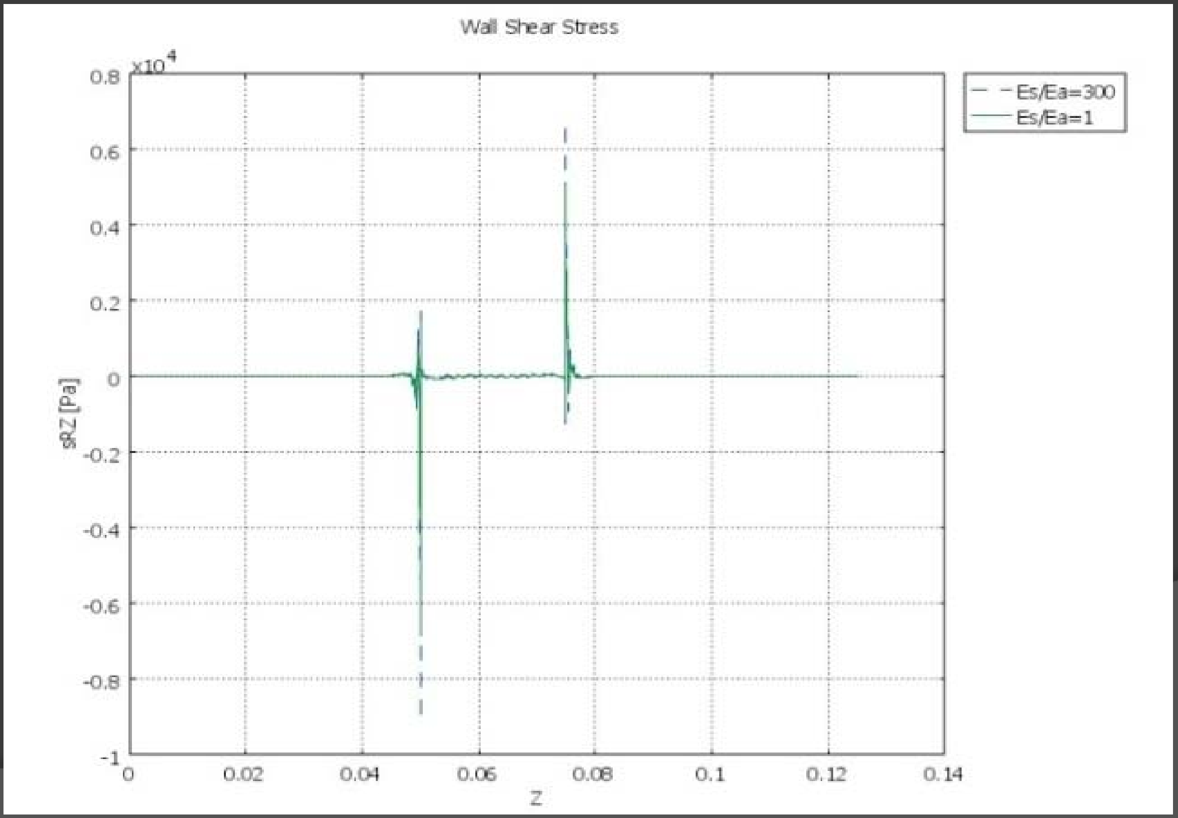
- A noticeable increase in pressure exists within the distal region of the vessel - distal pressure recovery zone





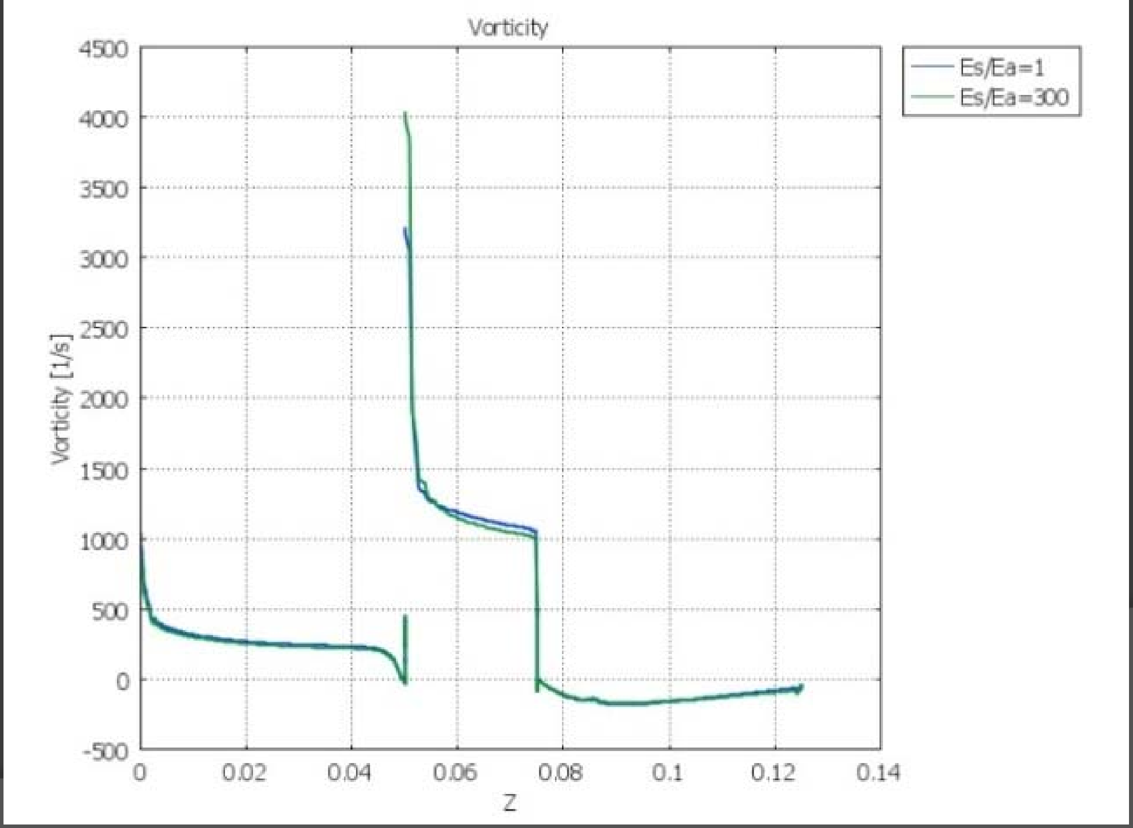
Results (continued)

- Shear stress in the artery directly at the wall, which is exactly equal and opposite to the shear stress in the fluid at the wall



Results (continued)

- Sharp peak at the transition zone from the proximal region onto the arterial stented region



Conclusions

- Interaction of the fluid and structure within a stented artery has been numerically studied using Comsol Multiphysics.

- Main focus – compliance mismatch connection with possible restenosis.

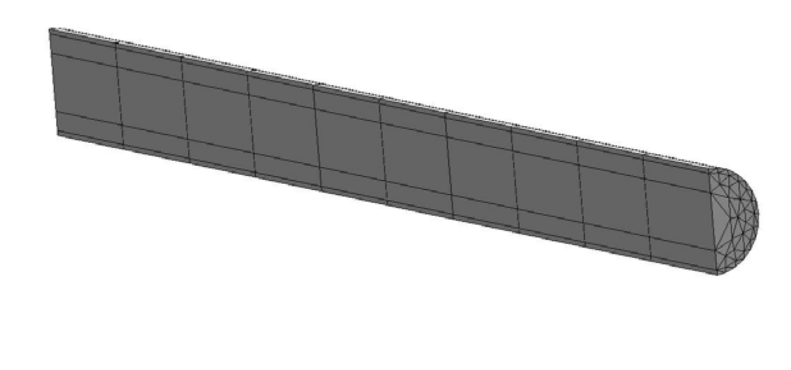
Conclusions (continued)

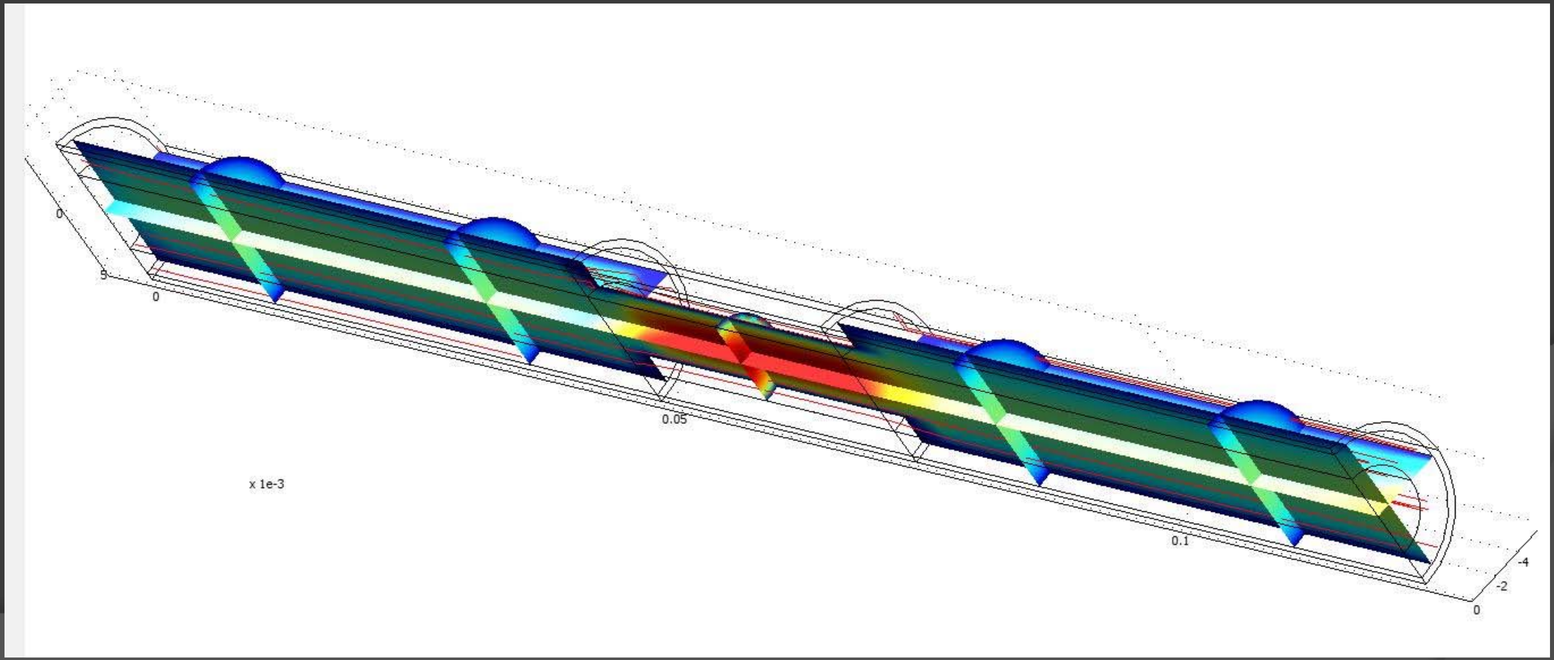
- Results show that a concurrence of a variation in elasticity of the stented arterial segment gives rise to anomalous distributions in mechanical effects throughout the vessel.

- Future work is needed to further study the anomalies.

Future Work

- 3D model to further study and find answers to questions





Questions?