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Validating Commonly used Computer Models for Abdominal Aortic Aneurysms

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ABSTRACT

Abdominal Aortic Aneurysms (AAAs) occur when an area of the aorta dilates causing weakening of the aortic walls and localization of stresses. AAAs are an area of interest for research as they run the risk of rupture. They are also often asymptomatic, and it is reported that the fatality rate is up to 90% in cases that experience a rupture. Due to the complexity associated with using human tissue for research, many studies on this topic are completed in silico. Many of these in silico studies do not account for the complex mechanical properties of the aortic tissue, or wall thinning in their computational models. The in silico studies previously completed repeatedly made the same assumptions regarding the material properties and utilized the same coefficients for the strain energy function (SEF) in their analyses. However, no testing has been completed to validate the numerically obtained results.

Current work investigates the accuracy of these simplified computational models. The first phase of this study includes a testing plan is developed to validate these computational models. The testing plan includes creating a physical model made of silicone to mimic the artery in question. The same silicone that was tested in part one of this study is used to manufacture the physical model, confirming its "tissue-like" behavior and determining the appropriate hyperelastic coefficients. This physical model is to be pressure tested in a fluid circuit that is instrumented such that the strain in the wall of the model is recorded at particular pressures. These strains will provide a benchmark study for validating the results of the computational models.

The second phase of this study generates a computational model with the exact geometry of the physical model. This model will utilize the strain energy functions most commonly utilized in simplified aortic simulations. However, the coefficients utilized in the SEF will be those corresponding to the silicone material utilized in the wall stress and strain.

Numerically obtained strains/stresses are to be validated against the physical model measurements, which will provide an insight into the validity of commonly used simplified models of an aorta. The results will allow for recommendations to be made regarding a path forward for simplified aortic simulations.

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