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Characterization of a Tissue-like Hyperelastic Polymer

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ABSTRACT

Abdominal Aortic Aneurysms (AAAs) are an often fatal medical condition that frequently remains asymptomatic. There is considerable interest in research associated with AAAs as they have a reported mortality rate of up to 90% in the event of rupture. Most present studies completed on AAAs are in silico due to the challenges associated with using human tissue, or human participants. These studies mainly consist of computer simulations, modelling the AAA as a hyperelastic material, many of which rely on the same material strain energy function (SEF) that was introduced in literature. However, to date no in vitro studies have been completed to validate these computational models.

This will part one of a two part investigation into validating the computational models most frequently utilized in literature. This first part of the investigation focuses on the process of selecting and characterizing a tissue-like material (i.e., hyperelastic behavior) that could be used in an in vitro test. The second part will concentrate on validating the existing computational models. In several articles, silicone has been used as a tissue-like material exhibiting hyperelastic behavior. Accordingly, in the present work, silicone is adopted for experimental testing. Two molds of different thicknesses and a die cutter were manufactured to prepare specimens for tensile testing. Different thicknesses' specimens were tested under uniaxial tension. The reported testing results were analyzed to determine the true stress-strain behavior, so that the mechanical behavior could be compared to that of the aortic tissue reported in literature. The same methodology used in literature to determine the hyperelastic coefficients of aortic tissue was then applied to determine the silicone hyperelastic coefficients.

Experimental results from the present work showed a similar material behavior when compared to a healthy aortic tissue. In addition, varying the thickness of the specimen had a minimal effect on the hyperelastic properties. This conclusion opens up the possibility of completing the model validation of the SEF via an in vivo silicone test setup and comparing the results with an in silico model of the same properties.

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