
Characterization of the anisotropic viscoelastic behavior in aneurysm tissue of the ascending thoracic aorta using biaxial tensile tests and constitutive modeling

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Abstract

Objectives. The aim of this study is to characterize the viscoelastic behavior of aneurysm tissue of the ascending thoracic aorta (ATAA) using quasi-static and relaxation biaxial tensile mechanical tests along with state-of-the-art constitutive modeling.

Method. Samples were collected from ATAA patients and sectioned into six regional specimens: three from the major curvature (proximal to distal), one from the minor curvature, and two from the anterior and posterior regions. Each specimen was subjected to quasi-static biaxial stretching and biaxial relaxation tensile tests. Planar deformation was assessed using digital image correlation. After testing, the specimens were chemically fixed, dehydrated and optically cleared. The architecture of the collagen fibers was examined through the thickness using second harmonic generation microscopy in the central region of the specimen. Based on previous work (1,2), a new constitutive material model was developed to describe the anisotropic viscoelastic behavior of the tissues.

Results and Discussion. Fiber dispersion was quantified using von Mises distributions and incorporated into the discrete fiber constitutive model. Elastic and viscoelastic material parameters were determined by curve fitting. The viscoelastic model independently accounts for anisotropic and isotropic viscous components.

References

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