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**Mechanical Characterization of Arteries:
Comparison of Square and Cruciform Biaxial Tests Using Inverse Modeling Technique**

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Background

The elastic behaviour of arteries is nonlinear when subjected to large deformations. In order to measure their anisotropic behaviour, planar biaxial tests are often used. Typically, hooks are attached along the borders of a square sample of arterial tissue^{1,2,3,4}. Cruciform samples clamped with grips are often used for testing industrial materials. The effect of different biaxial test boundary conditions has been evaluated with computer simulations⁵. In this study, we demonstrate the use of inverse modeling to fit the material properties, and discuss the differences between the two types of tests.

Methods

Square and cruciform samples were dissected from pig aortas and tested equi-biaxially. On the square samples, forces were applied on each side and strains were measured in the center using optical tracking of ink dots. On the cruciform samples, displacements were applied on the grips and forces were measured on the grips. Each type of experiment was simulated with the finite element method. Mooney-Rivlin and Ogden constitutive models were adjusted with an optimization algorithm so that the simulation predictions fitted the experimental results.

Results and Discussion

Higher stretch ratios (> 1.5) were reached with the cruciform samples than with the square samples before failure. Convergence of the optimization algorithm was easier with the Mooney-Rivlin than with Ogden model. Advantages of cruciform samples over square samples include: 1) higher strain range; 2) simpler data acquisition. However, the non uniform stress distribution in cruciform samples requires the use of inverse modeling adjustment of constitutive model parameters.

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