IMPORTANCE OF MATERIAL MODEL IN WALL STRESS PREDICTION IN ABDOMINAL AORTIC ANEURYSMS

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Introduction

Results of biomechanical simulations of an abdominal aortic aneurysm (AAA) depend on the constitutive description of the wall. Based on in-vitro and in-vivo experimental data several constitutive models for the AAA wall have been proposed in literature. Those models differ strongly from each other and their impact on the computed stress in biomechanical simulations is not clearly understood.

Methods

Finite Element (FE) models of AAAs from 7 patients who underwent elective surgical repair were used to compute wall stresses. AAA geometry was reconstructed from CT angiography (CTA) data and patient-specific constitutive descriptions of the wall were derived from planar biaxial testing of anterior wall tissue samples. In total 28 FE models were used, where the wall was described either by patient-specific (PS) or previously reported properties. This data was either quasi-linear (QL)[van't Veer,2009] based on the in-vivo measured distensibility or derived from uniaxial (RV)[Raghavan,2000] or biaxial (VG) [Vande Geest,2006]testing. Computed wall stress fields were compared on node-by-node basis.

Results

Different constitutive models for the AAA wall cause significantly different predictions of wall stress. While VG data from biaxial testing gives globally the same stress field as the PS wall properties, the RV material model overestimates the wall stress on average by 30kPa while QL description leads to a completely altered stress field and overestimates the wall stress by about 75kPa. Differences are statistically significant.

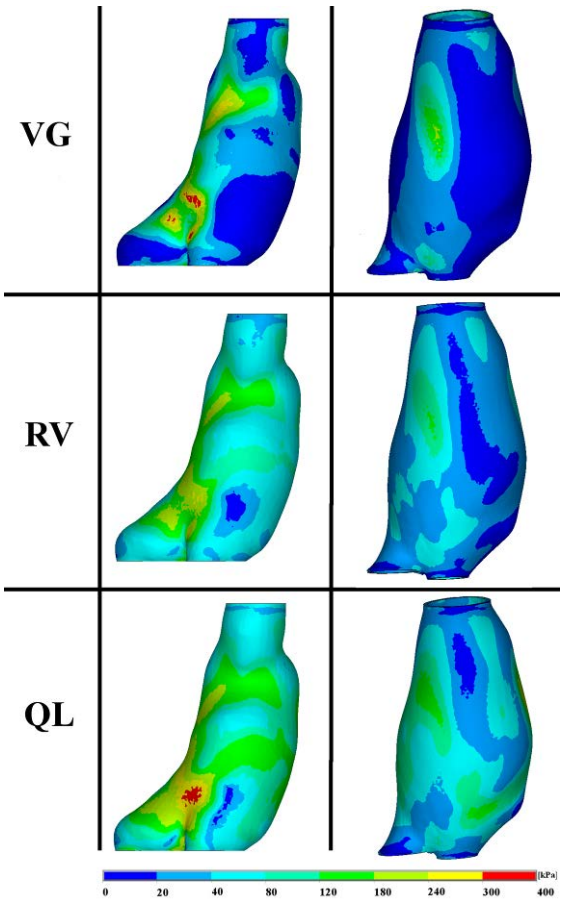

Figure 1. Effect of different material models on computed wall stress in two AAAs. Each material model gives different stress field.

Discussion

The constitutive description of the wall is crucial for AAA wall stress prediction. Consequently, results obtained using different models should not be mutually compared unless different stress gradients across the wall are not taken into account.

References

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