Non-Symmetric Fiber Dispersion of the Aortic Wall: A Computational Analysis

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ABSTRACT

Changes in structural components of soft biological tissues have been shown to play a significant role in the pathogenesis of aortic degeneration. Therefore, there is an essential need for meaningful constitutive models which capture these micro-structural changes accurately. As recent findings have shown that in-plane and out-of-plane dispersions of collagen fibers vary significantly between healthy and aneurysmatic aortic walls [1], we aim to investigate the influence of an accurate inclusion of fiber dispersion and accurate material parameters in the constitutive model on simulation results.

In this study we systematically compared the impact of three fiber dispersions: (i) no fiber dispersion, (ii) rotationally symmetric fiber dispersion and (iii) non-rotationally symmetric fiber dispersion for a set of healthy and diseased material parameters. All three cases were captured by a recently proposed model [2]. Three exemplary finite element simulations were performed: biaxial extension, the inflation of a residually stressed and pre-stretched tube and the inflation of an idealized Abdominal Aortic Aneurysm (AAA) geometry.

A strong influence of the fiber structure on magnitude and distribution of stresses was observed. In particular, remarkable differences between healthy and aneurysmatic material parameters were found. The stresses varied significantly especially in the AAA case where material stiffening is influenced expressively by the fiber distribution.

The results highlight the need to incorporate structural differences into finite element simulations to obtain actual *in vivo* stresses and the capability of one single model to represent all the studied cases and hence being capable of studying the reorientation of collagen during disease progression.

REFERENCES

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