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Human dilated ascending aorta: mechanical characterization *via* uniaxial tensile tests

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Abstract

Aneurysms of the ascending aorta (AsAA), i.e., a progressive and localized dilatation of the first part of the aorta, represent a severe life-threatening condition, often occurring with no symptom. AsAA formation is associated with a degeneration of the aortic wall tissue, which leads to changes in the tissue mechanical properties, and in particular to increased wall stress and/or decreased wall ultimate strength. Nowadays, the decision to surgically operate is usually based on the AsAA diameter, although such a criterion is not always predictive.

The present study focuses on the mechanical characterization of the AsAA tissues. Specimens were cut from portions of dilated ascending aorta excised from 46 patients through open-heart surgery. Peak strain, peak stress, and maximum elastic modulus (i.e., tissue stiffness) were measured from uniaxial stress-strain curves. Such (ultimate) mechanical properties were collected for different regions of the aortic wall (anterior and posterior) as well as for different specimen orientations (circumferential and longitudinal). Relationships of ultimate mechanical properties with patient age and sex were also investigated.

The obtained results highlighted a significant anisotropy of the AsAA tissue (as also observed for healthy aortic tissues), with higher value of strength and stiffness in the circumferential than in the longitudinal direction. Higher strength and stiffness were also found in the posterior region with respect to the anterior one for the circumferential orientation, whereas an opposite result was found for the longitudinal orientation. A decreasing trend of ultimate mechanical properties with aging was also highlighted. Finally, a significant difference in the strength between male and female was observed only in the circumferential direction.

Keywords: Ascending aorta aneurysm, dilated aorta, ultimate mechanical properties, uniaxial tensile tests.

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