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A continuum description of the damage process in the arterial wall of abdominal aortic aneurysms.

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Summary: We develop a three-dimensional isotropic finite-strain damage model for an abdominal aortic aneurysm (AAA) wall that considers both the characteristic softening of the material caused by damage and the spatial variation of the material properties. A strain energy function is formulated that accounts for a hyperelastic, slightly compressible, isotropic material behavior during the elastic phase, whereas the damage process only contributes to the material response when the elastic limit of the AAA wall is exceeded. Material and damage parameters are obtained by fitting the strain energy function to the experimental data obtained by uniaxial tensile tests of freshly harvested AAA wall samples. The damage model extends the validity of the material law to a strain range of up to 50%. Purely elastic material laws for AAA wall are only valid for a strain range of up to 17%. In a series of finite element simulations of patient-specific AAAs, serving as numerical examples, we investigate the applicability of the damage model. The use of the damage model does not yield a more distinct identification of rupture-prone AAAs than other computational-based risk indices. However, the benefit of the finite-strain damage model is the potential capability to trigger growth and remodeling processes in mechanobiological models.

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