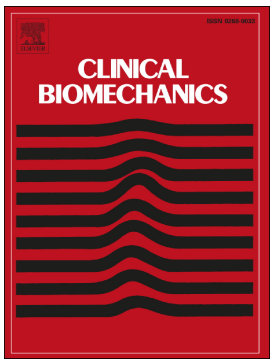

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Comparison of Aneurysmal and Non-pathologic Human Ascending Aortic Tissue in Shear

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Abstract

Background: The mechanical properties of the aorta may provide some guidance to cardiovascular surgeons treating aortic disease. While tensile tests are traditional, recent work suggests that shear is important in aortic dissection. Characterizing the differences or similarities in the mechanical shear stress response of non-pathologic human ascending aortic tissue and of tissue that has remodeled to become aneurysmal contributes to understanding the differences in behavior of the two tissues.

Methods: Fresh non-pathological and aneurysmal tissue acquired from the operating room is deformed in translational shear at approximately physiological rates to 67% deformation followed by stress relaxation to allow comparison of their mechanical behavior. Aneurysmal tissue is tested at 1 mm/s or 12 mm/s and normal tissue at 12 mm/s. The deformation is either in the circumferential or longitudinal direction for a total of 48 specimens.

Findings: The shear response at 12 mm/s in non-pathological and aneurysmal tissue is similar in the circumferential direction but different in the longitudinal direction. Tissue type accounts for up to 30% of the variation in the longitudinal direction. The aneurysmal tissue response is rate-dependent. Both tissues exhibit significant shear stress relaxation.

Interpretation: Remodeling to create the aneurysm modifies the bond strength between collagen fibers and the extracellular matrix. The time-dependent response is probably due to interstitial fluid behavior. Thoracic surgeons must use caution in applying aortic stress values in the literature because they depend on the deformation rate.

Keywords: aneurysmal ascending aorta; aortic remodeling; viscoelasticity of ascending aorta; translational shear deformation rate-dependence; stress relaxation