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Flow stagnation volume and abdominal aortic aneurysm growth: insights from patient-specific computational flow dynamics of Lagrangian-coherent structures

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I. Abstract

Abdominal aortic aneurysms (AAA) are localized, commonly-occurring dilations of the aorta. When equilibrium between blood pressure (loading) and wall mechanical resistance is lost, rupture ensues, and patient death follows, if not treated immediately.

Experimental and numerical analyses of flow patterns in arteries show direct correlations between wall shear stress and wall mechano-adaptation with the development of zones prone to thrombus formation. For further insights into AAA flow topology/growth interaction, a workout of patient-specific computational flow dynamics (CFD) is proposed to compute finite-time Lyapunov exponents and extract Lagrangian-coherent structures (LCS). This computational model was first compared with 4-D phase-contrast magnetic resonance imaging (MRI) in 5 patients.

To better understand the impact of flow topology and transport on AAA growth, hyperbolic,