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Mathematical Modelling of Aortic Dissection

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Aortic dissection is a tear that occurs in the aortic wall, where high pressure penetrates the intima and enters the media layer, and blood enters the media at the point of the tear. The stresses in the wall may cause the tear to extend to form a false lumen. The dissection may lead to death due to aortic regurgitation or haemocardium. We study the linear theory of a tear in a residually and pre-stressed Green elastic material. with a physiological strain energy function. A cohesive zone resolves the stress singularity at the tear in an axisymmetric fluid-filled arterial configuration. The finitely deformed equilibrium configuration is found and then examined using the incremental equations, with displacement discontinuities representing the presence of a tear. A hypersingular integral equation relates the crack opening to the traction on the crack faces, in which the kernel captures the geometry and boundary conditions on the elastic solid without the tear. We formulate the integral equation for a finite-length axisymmetric crack parallel to the axis of an elastic tube. The equation can be inverted to find the tear opening given any distribution of traction on the crack faces. We study the equilibrium configurations of axisymmetric dissections, and derive conditions under which the tear will propagate. This work is complemented by finite-element numerical studies for large deformations.

Keywords: Aortic dissection;Soft tissue mechanics;Elasticity;

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