Multiscale Multiphysics Model of Thrombus Biomechanics in Aortic Dissection

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Increasing evidence suggests that biologically active intraluminal and intramural thrombus exacerbate proteolytic breakdown of the aortic wall, thus compromising structural integrity. We use an angiotensin-II infusion model of hypertension in the mouse to create aortic dissections containing intramural thrombus. Using in vivo and in vitro imaging, in vitro materials testing, and immunohistological methods, we are documenting longitudinally the development, progression, and resolution of the thrombus and its effects on the aortic wall. These data, in turn, are informing computational models of the associated hemodynamics, wall mechanics, and thrombus. Specifically, we have developed a unique experimental – computational (inverse) method to characterize regional wall properties in complex lesions; we have developed both continuum and particle-based constitutive models of the healthy and diseased aortic wall, including a new method for modeling damage and failure; and we have developed both continuum and particle-based models of thrombus development within complex flow fields, including both platelet activation and aggregation and fibrin formation and dissolution. The goal of this presentation is to show how these many diverse advances can be integrated to reveal new insight into roles of intramural thrombus in aortic disease.

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