Prosthetic Dacron grafts are widely used as a synthetic substitute following aortic resection in cases of ascending aorta aneurysms, aortic dilatations, and aortic dissections. While these polyester grafts are readily available, extremely durable, and highly biocompatible, they exhibit mechanical properties inconsistent with native aortic tissue. Most notably, the discrepancy in circumferential elastic moduli between the graft and host artery introduces hemodynamic irregularities by reducing arterial compliance and significantly increasing system arterial characteristic impedance. This immediately results in an elevated systolic pressure, which, over time, can contribute to the development of hypertrophic cardiomyopathy. While Dacron grafts provide an urgent solution to a possibly fatal incident, its long-term effects are, nevertheless, detrimental. An improved replacement that mimics native tissue compliance is imperative.

The aim of this study is to quantify the differences in viscoelastic behavior between Dacron and healthy ascending aorta tissue to investigate long-term mechanical properties. The primary consequence of Dacron graft insertion is demonstrated by impairment of the Windkessel effect, the ability for arteries to convert pulsatile energy into steady flow by the aorta’s elastic reservoir. A non-compliant artery in the ascending aorta fails to fulfill the principal goal of the ascending aorta’s elevated elastin content: act as an energy-dissipating damper proximal to the turbulent aortic jet flow. While disparities in elastic moduli between native and prosthetic aortas are established in literature, there is little understood about the role of viscoelasticity in sustaining the aortic wall’s dissipative properties. Dacron’s creep behavior under pulsatile flow has been observed via postsurgical imaging data, which confirms an immediate diametral expansion of grafts implanted in the ascending aorta. Developing a viscoelastic creep model for this time-dependent Dacron deformation will not only provide surgeons with confidence in choosing proper graft size, but also aid in the development of biomimetic large-diameter vascular grafts.