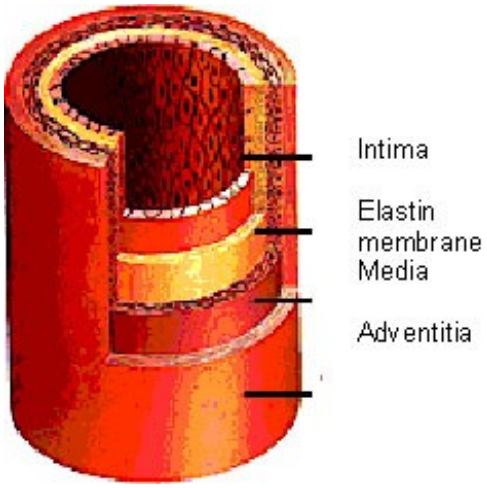
Material properties of arterial layers

An artery wall consists of three layers with very different purposes and characteristics. These three layers are the Intima, the Media, and the Adventitia.



The Intima is the inner-most layer of the artery wall. This thin wall lines the wall of the artery with mostly endothelial cells separating blood flow from the other layers of the wall.
The Media is the middle, and thickest layer of the wall. This is the wall that contains the most strength mechanisms such as smooth muscle cells, elastin, and collagen.
The Adventitia is the outer layer of the wall and consists of mostly collagen. This provides form and strength to the artery wall.

Because of the thin nature of the intima, most attention in stress calculations is paid to the Media and the Adventitia.

Why a hyper-elastic model?

Because the artery wall is a complex, living tissue with many fibers it can not be treated with a simple linear response using Hooke's Law. Instead, a hyper-elastic model, which takes into account the different properties of the collagen and elastin fibers, must be used. For more information on this model see slide 10 and 11 of my presentation.

What does an AAA do to the wall of the artery?

Abdominal aortic aneurysms are not only caused by a weakening of the artery wall, but also cause additional weakening as the expansion increases stress concentration on the artery wall. In M.L. Raghavan's lecture notes: Cardiovascular Bio-solid Mechanics Section a more visual representation is given:

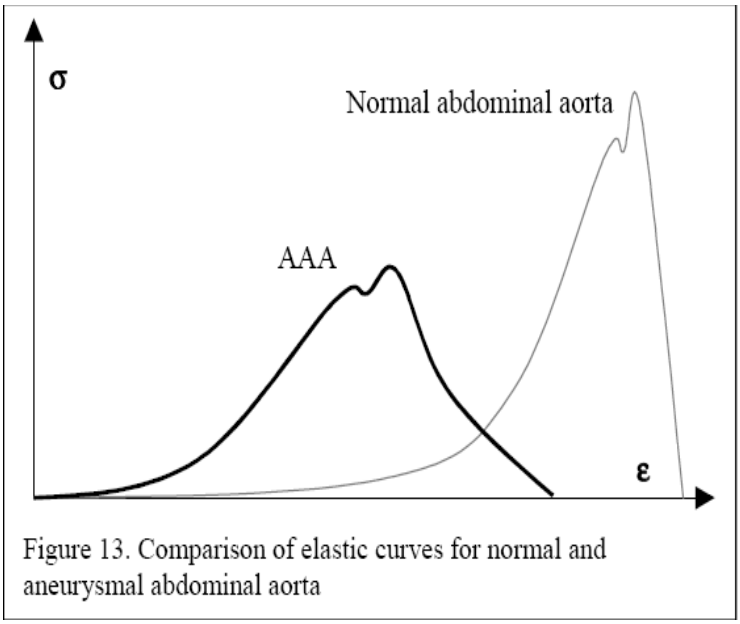


Figure 13. Comparison of elastic curves for normal and aneurysmal abdominal aorta

As shown from this figure the AAA curve is shifted to the left due to a decrease in elastin. This causes a greater stiffness earlier on in the extension test. The slope of the elastic region of the curve is also lower for the AAA. This slope (Young's modulus, E) represents the stiffness. The stiffness at this time during and extension test is therefore lower for a AAA due to a decrease in fibers and strength. The peak stress for the AAA is also lower than the normal model due to this decrease in fibers and continues to decrease as the AAA expands.