Research Abstract

Parametric Study of Mechanical Stress in Abdominal Aortic Aneurysms

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ABSTRACT

An aneurysm is defined as a dilation of a blood vessel by more than 50% of its original diameter. Other than the brain, the majority of aneurysms occur in the infrarenal abdominal aorta. An untreated abdominal aortic aneurysm (AAA) may rupture, leading to drop in blood pressure, rapid heart rate, and death in 90% of patients. Currently aneurysms are not treated with intravascular or open surgery until they reach a maximum diameter of 5 to 5.5cm. However, this size criterion does not take into account the unique properties of an individual patient's arterial wall. Aneurysms much smaller than 5cm have ruptured, while aneurysms much larger have not. Rupture of an AAA occurs when the mechanical stress in the artery wall exceeds the maximum allowable stress of the wall. Mechanical stress depends not only on the maximum diameter, but the overall geometry, wall thickness, elastic properties, and pressure load of the aneurysm. Accurately determining stress within the artery wall of an aneurysm will allow a more accurate prediction of rupture. Mechanical stresses within an AAA can be computed by the following procedure: (1) create a geometry model from segmented CT scans of the AAA, (2) mesh the AAA geometry model, and (3) compute stresses in the meshed model using a finite element analysis program such as ABAQUS. Current parameter values used in the model were obtained from population averaged measurements found in literature. Since these parameters vary from patient to patient the sensitivity of the stress calculations to changes in these parameters needs to be determined. Using two AAA geometry models created by previous students, sensitivity studies of the wall thickness, elastic properties of both thrombus and artery wall, and pressure load on mechanical stresses were conducted using ABAQUS. One of the geometries includes the bifurcation of the abdominal aorta into the iliac arteries, while the other does not include the bifurcation. In both cases the rupture location is known and is accurately predicted using the patient average parameters. Preliminary studies indicate the maximum stress depends on the wall thickness especially for a thinner wall, assuming a linear elastic model for thrombus and the arterial wall. Present studies compare this linear model to a hyper-elastic model.