Stress on Abdominal Aortic Aneurysms

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The aorta is the largest artery in the human body and is oriented from the left ventricle of the heart down past the abdomen where it branches into smaller arteries. When this artery becomes dilated it is considered an aortic aneurysm. These aneurysms cause the artery wall to weaken and could cause the artery to rupture. This is a serious condition, which can lead to death if left untreated or unrecognized.

It can be very difficult to predict an aortic aneurysm because symptoms may not occur until it is too late. There are two ways to diagnose an aneurysm before symptoms occur. One would be having a physician listen for any abnormalities; this can be nearly impossible depending on the patients' physical condition. The other way of determining an aneurysm is by a medical imaging study; such as a CT scan, MRI or an ultrasound.

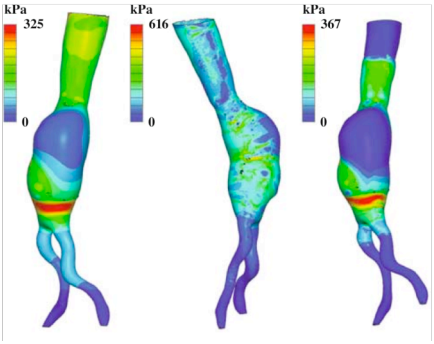
Once an aortic aneurysm is detected, it is hard to tell where exactly it is located, the size, and growth rate. This is critical information for the doctor to determine because this will help deduce whether or when the patient will require surgery.

A team of engineers recognized the significance of detecting the severity of this condition. As a result, a study involving five patients at Allegheny General Hospital in Pennsylvania was constructed. The purpose of this study was to model a 3-dimensional representation of the aorta with only a 2-D image. By obtaining a 3-D model, the doctors will be able to determine the amount of stress on the aortic wall and therefore predicting how vital the patient's condition is.

To do this, first three mathematical expressions of the stress on the aortic wall were derived; two for an anisotropic behavior (the framework provided by two different scientists) and one for an isotropic behavior of the arterial wall. All of these models were based on the aneurysm wall being a hyperelastic material. With these equations, a CT scan from each patient, and the help of MATLAB, three graphical models were created.

From these models, the engineers were able to deduce that the first and third models were in agreement with each other, and proved to be the most accurate description of the stress and location. As you can see from the figure above, the second model differs greatly from the location of the maximum principal stress.

Isotropic Anisotropic (1) Anisotropic (2)



Once the proper calculations are completed, the physician will decide whether surgery is needed. Open heart surgery can be done for those who have low to average risk of complications. This involves opening the abdomen, locating the aneurysm, removing it and sewing a synthetic tube in. Endovascular is suggested for those with high risk because it is less invasive. This process allows grafts to be guided from the groin area to the aorta, where the fabric tube reinforces the weak points of the wall.

Works Cited:

-The Effect of Material Model Formulation in the Stress Analysis of Abdominal
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