

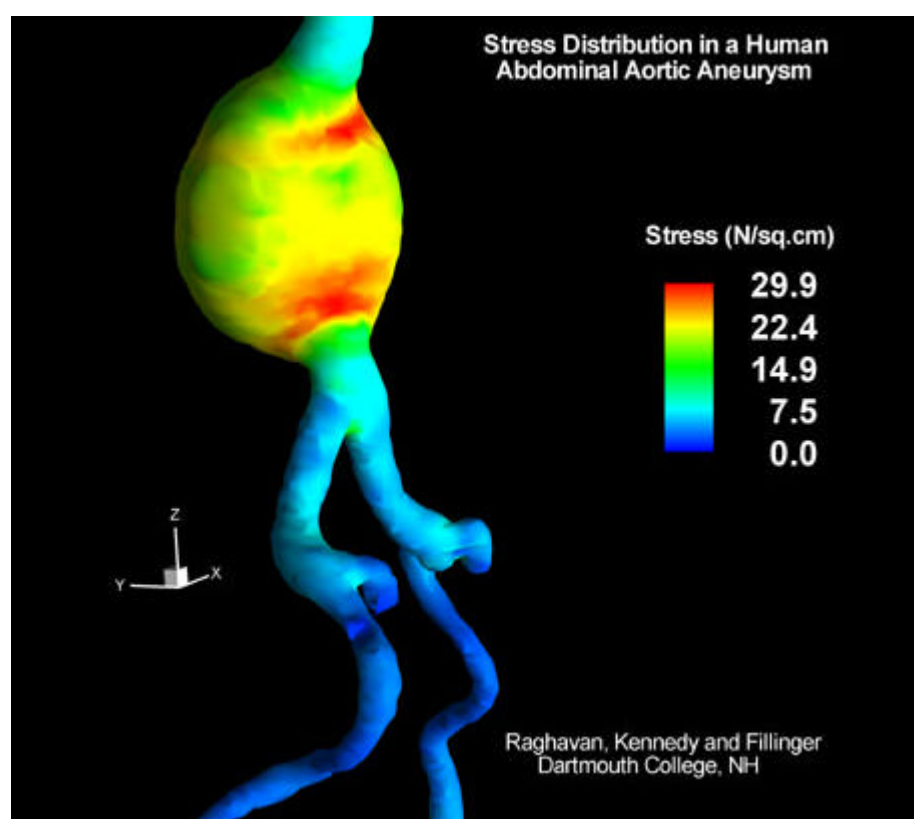
## Case Studies

### Abdominal Aortic Aneurysm Stress

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Contributed by:  
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Stress Distribution in a Human Abdominal Aortic Aneurysm.

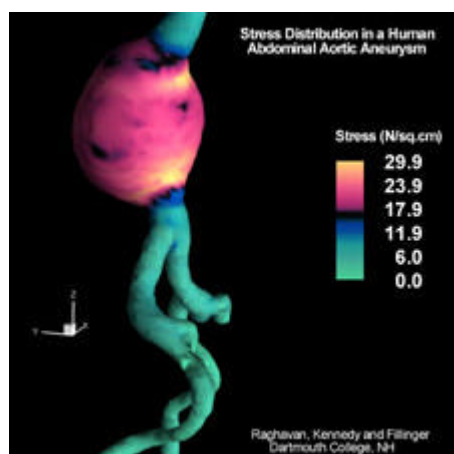
M. L. Raghavan, an Assistant Professor in [Biomedical Engineering](#) at the [University of Iowa](#), uses Tecplot extensively because it provides the broad range of functionality and ease-of-use that he requires to quickly analyze his FEA (finite-element analysis) results. His animations and plots play an important role in presenting to groups such as the [National Institute of Health](#) and the [Whitaker Foundation](#).

While working at the [School of Engineering](#) at [Dartmouth College](#) as a research associate, Dr. Raghavan, in collaboration with Dr. Kennedy and Dr. M. F. Fillinger, researched the biomechanics of aneurysm disease. The goal of their research was to make aneurysm surgical planning more safe and effective.

In the clinical management of patients with aneurysm disease, it is important to know whether a particular aneurysm is at a high or low risk of rupture. By visualizing the stress distribution, the surgeon can get a clearer idea of the aneurysm's rupture risk, the most susceptible region, whether or not to perform the surgery, and then plan their surgical intervention accordingly.

Typically, they would perform a AAA (abdominal aortic aneurysm) resection, wherein they would cut open the abdomen, cut open the AAA and then stitch a synthetic tube (called vascular graft) in the place of the aneurysm. The vascular graft allows the blood to flow through the tube rather than the aneurysmal aorta. Since the surgery is risky (patients have died from the procedure), the surgeon needs to balance the risk of rupture with the risk of surgery before deciding to perform the AAA resection.

Our Image of the Month represents the distribution of von Mises Stress (an aggregate index of the three principal components of stress) on the wall of an abdominal aortic aneurysm. Von Mises Stress is considered the best indicator of rupture, though it is open to debate and a topic of research.



Main image with a custom color map applied. This color map follows well-accepted mapping conventions in the medical imaging community.

The geometry of the aneurysm was reconstructed from CT scan images of the subject's abdomen. The 3-D reconstruction is done through manually-assisted automated digitization. The image processing and 3-D reconstruction were performed by [Medical Media Systems, Inc.](#) in West Lebanon, NH in collaboration with Dr. Steve Peiper.

Dr. Raghavan takes the image-processed 3-D data and creates a computational mesh that represents the AAA surface using custom mesh refinement algorithms. The mesh is then used to perform a finite element stress analysis using [ABAQUS](#) software. Input used for the FEA is a homogenous hyper-elastic, isotropic and incompressible material model. Material properties of the model were determined from previously published experimental work that Dr. Raghavan did as a graduate student under Dr. David Vorp at University of Pittsburgh. The boundary conditions are peak internal pressure of the patient as measured in a clinic.

The von Mises Stress output from ABAQUS is converted to a Tecplot input data file using a program written by Dr. Raghavan. A Tecplot macro, also written by Dr. Raghavan, reads the Tecplot data file, sets the plot attributes and style, animates the 3-D rotation of the AAA, and exports an AVI file of the resulting 3-D stress distribution.