Model-based rupture risk prognoses on abdominal aortic aneurysms

Model-based Rupture Risk Prognoses on Abdominal Aortic Aneurysms

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Introduction

Current clinical decision making on the treatment of Abdominal Aortic Aneuryms (AAA's) is mainly based on global AAA geometry and the surgeon's experience. Surgery is considered necessary when the diameter exceeds an absolute maximum of 5 cm and risk of rupture is assumed present.
The prediction of AAA development on the long term has yet been shown difficult. As rupture has also been demonstrated for smaller AAA's, in some cases surgical repair may already be advisable at an ealier stage [1].
For a more specific assessment of the rupture risk, a finite element model is introduced to study the interaction between the blood and the aortic wall. By relating the blood-pressure induced wall stress pattern to the mechanical strength of the wall tissue, an improved prognosis can be made.

Methods

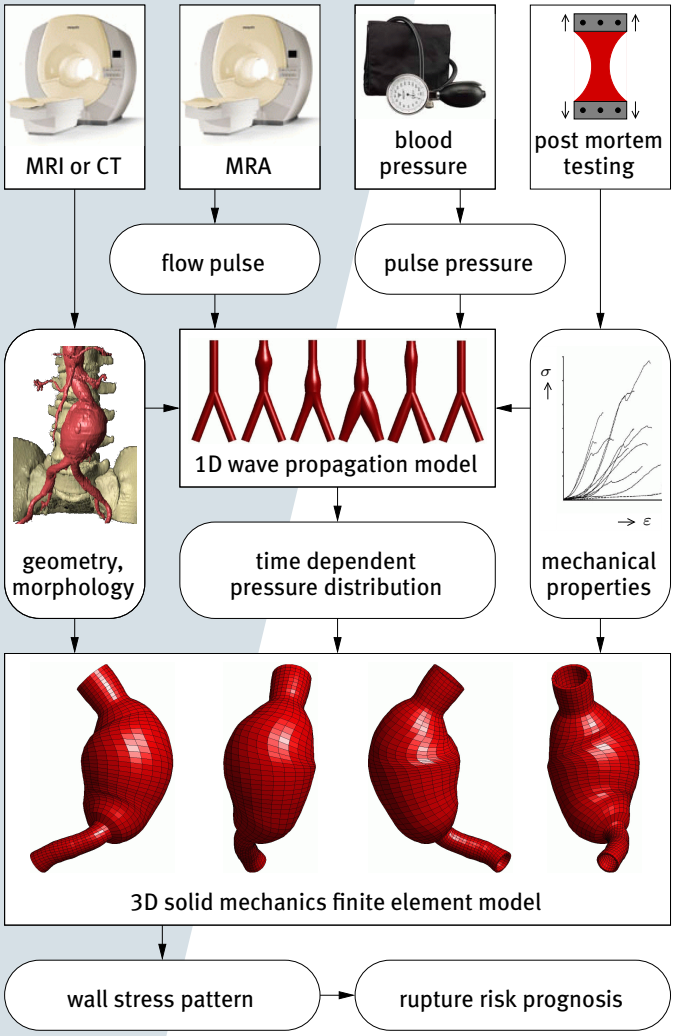

Figure 1 *Outline of the AAA rupture risk prognosis procedure.*

Results

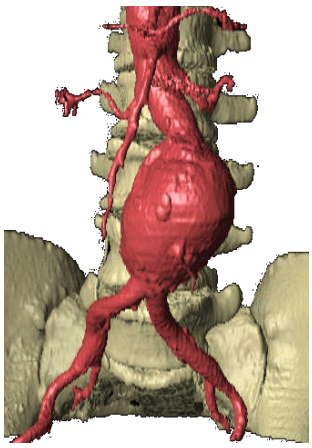

Figure 2 *Visualisation of the CT angiography image data on which the AAA model geometry is based. From the segmented images, centerline and diameter profiles were determined that were used to transform an automatically generated tubular mesh. The segmentation and visualisation were performed using the EasyVision workstation of Philips Medical Systems.*

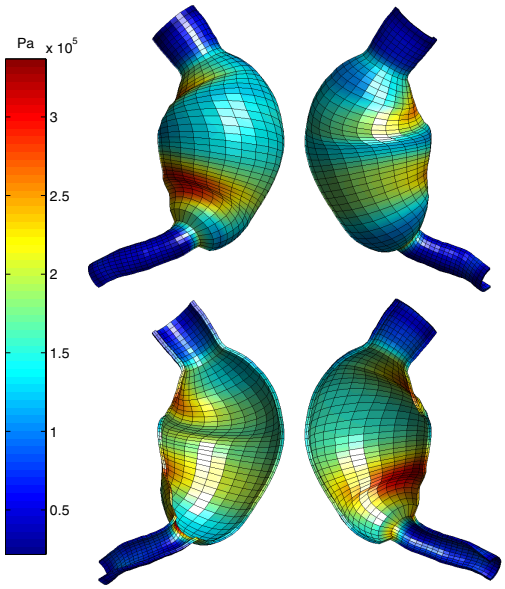

Figure 3 *Top and bottom: computed Von Mises stress pattern at the respective outer and inner walls of the pressurised AAA model (p = 16 kPa) using a linear elastic material (E = 1.0 MPa, ν = 0.45).*

Discussion

Highest stresses occur at local indentations of the AAA bulge, which may suggest that those sites are more prone to rupture. Yet, as the wall thickness is assumed proportional to the local healthy aortic diameter, this should be verified using a measured wall thickness distribution. Furthermore, material properties should be spatially varied, discriminating between different morphological structures.

Acknowledgement

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References:

[1] Wolf YG, Bernstein EF. *A current perspective on the natural history of abdominal aortic aneurysms.* Cardiovasc Surg 1994;2:16-22.

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