IGSSE International Graduate School of Science and Engineering



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Mechanics goes Hospital



25,000 AAAs diagnosed per year in Germany 12,200 AAAs repaired surgically 1,300 deaths from ruptured AAAs

> Rupture probability of untreated AAAs: (during patient's lifetime)

30-day mortality for open AAA repair:

4.7 %

25 %

Diameter criterion for surgical treatment:

	Max AAA Diameter ≥ \$				
	60 -				
a)	50 -	🔶 untreated			









Refinement of in vivo patient-specific AAA rupture risk prediction is needed to save unnecessary surgeries and costs!

Materials testing & modeling

Uni- and biaxial testing of AAA constituents



sagittal CT image

Patient-specific finite element modeling



Hexahedron-dominant hybrid meshing of the *in vivo* patient-specific AAA geometry

Biaxial tension test machine with op-

Incompressible AAA wall material model: $W = \alpha (I_1 - 3) + \beta (I_1 - 3)^2$

AAA geometry reconstruction from computed tomography or magnetic resonance imaging

Theory of finite deformation elasticity Balance equation: $\operatorname{Div}(\mathbf{FS}) + \mathbf{b}_0 = \mathbf{0} \text{ in } \Omega_0$ $\mathbf{u} = \mathbf{u}_D^0$ on Γ_D (DBC) $\mathbf{P} \mathbf{N}_{\Gamma} = \mathbf{t}_0 \quad \text{on } \Gamma_N (\mathsf{NBC})$

- CT images show a loaded state of the $AAA \rightarrow Prestressing$ (Gee et al., 2009)
- Blood pressure acting on the deformed spatial configuration of the blood lumen





Impact on society and benefit for the patient



	total	asympt	sympt/rupt
n	53	30	23
male/female	38/15	24/6	14/9
AAA family history	3	1	2
symptoms	9	0	9
patient age [years]	72.4±9.2	68.8±7.4	77.0±9.5
max Ø [mm]	64.5±16.6	56.4±11.0	75.1±16.8
55 <max [mm]<="" td="" ø=""><td>16</td><td>15</td><td>1</td></max>	16	15	1
$55 < \max \emptyset < 75$	25	13	12
$75 < \max \emptyset$ [mm]	12	2	10

REFERENCES

[1] A. Maier, M. W. Gee, C. Reeps, H.-H. Eckstein, W. A. Wall, Impact of Calcifications on Patient-Specific Wall Stress Analyses of Abdominal Aortic Aneurysms, Biomechanics and Modeling in Mechanobiology, 2010, 9, 511-521.

[2] A. Maier, M. W. Gee, C. Reeps, J. Pongratz, H.-H. Eckstein, W. A. Wall, A Comparison of Diameter, Wall Stress and Rupture Potential Index for Abdominal Aortic Aneurysm Rupture Risk Prediction, Annals of Biomedical Engineering, 2010, 38, 3124-3134.



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