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TOWARDS FULLY PATIENT-SPECIFIC NON-INVASIVE RUPTURE RISK ESTIMATION OF ABDOMINAL AORTIC ANEURYSMS

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An abdominal aortic aneurysm (AAA) is a pathological dilatation of the infrarenal aorta, which can be fatal in case of rupture. Personalized computational models provide better rupture risk indicators for small to medium sized AAAs than the maximum diameter criterion used in clinical practice [1, 2]. Uncertainties in patient-specific models, however, represent a challenge and need to be quantified accordingly, while the simulation models have to remain sufficiently accurate to account for inter- and intra-patient variabilities. To that end, we present a framework that incorporates elaborate personalized models and individual input uncertainties. Bayesian regression models for predicting wall thickness, stiffness and strength are employed following [3]. Gaussian process surrogate models are trained using an active learning approach to establish a link between uncertain input quantities and peak wall stress in the aneurysm. Lastly, rupture risk estimation is accomplished based on a probabilistic rupture risk index introduced in [4]. The proposed framework allows for a fully patient-specific non-invasive rupture risk estimation of AAAs and results in a single index for decision making that takes into account the uncertainties in the predictions.

REFERENCES

[1] Maier, A., Gee, M.W., Reeps, C., Wall, W.A. et al. A Comparison of Diameter, Wall Stress, and Rupture Potential Index for Abdominal Aortic Aneurysm Rupture Risk Prediction. *Ann Biomed Eng* (2010) **38**: 3124.

[2] Gasser, T. C, Auer, M., Labruto, F., Roy, J. et al. Biomechanical Rupture Risk Assessment of Abdominal Aortic Aneurysms: Model Complexity versus Predictability of Finite Element Simulations. *Eur J Vasc Endovasc Surg* (2010) **40**: 176-185

[3] Biehler, J., Kehl, S., Gee, M.W., Wall, W.A. et al. Probabilistic noninvasive prediction of wall properties of abdominal aortic aneurysms using Bayesian regression. *Biomech Model Mechanobiol* (2017) **16**: 45

[4] Polzer, S. and Gasser, T. C. Biomechanical rupture risk assessment of abdominal aortic aneurysms based on a novel probabilistic rupture risk index. *J. R. Soc. Interface* (2015) **12**: 20150852