Customized Stent-Grafts for Endovascular Aneurysm Repair with Challenging Necks: a Numerical Proof of Concept

Abstract:
Endovascular aortic repair (EVAR) is a challenging intervention whose long-term success strongly depends on the appropriate stent graft (SG) selection and sizing. Most off-the-shelf SGs are straight and cylindrical. Especially in challenging vessel morphologies, the morphology of off-the-shelf SGs is not able to meet the patient-specific demands. Advanced manufacturing technologies facilitate the development of highly customized SGs. Customized SGs that have the same morphology as the luminal vessel surface could considerably improve the quality of the EVAR outcome with reduced likelihoods of EVAR related complications such as endoleaks type I and SG migration. In this contribution, we use an in silico EVAR methodology that approximates the deployed state of the elastically deformable SG in a hyperelastic, anisotropic vessel. The in silico EVAR results of off-the-shelf SGs and customized SGs are compared qualitatively and quantitatively in terms of mechanical and geometrical parameters such as stent stresses, contact tractions, SG fixation forces and the SG-vessel attachment. In a numerical proof of concept, eight different vessel morphologies, such as a conical vessel, a barrel shaped vessel and a curved vessel, are used to demonstrate the added value of customized SGs compared to
The numerical investigation has shown large benefits of the highly customized SGs compared to off-the-shelf SGs with respect to a better SG vessel attachment and a considerable increase in SG fixation forces of up to 50% which indicate decreased likelihoods of EVAR related complications. Hence, this numerical proof of concept motivates further research and development of highly customized SGs for the use in challenging vessel morphologies.

Stichworte:
abdominal aortic aneurysm; endovascular repair; customized stent-graft; personalized medicine

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