Virtual Bench Testing of Carotid Wallstents: from Design to Clinic

Background

Carotid Artery Stenting (CAS) has emerged as a safe and cost-effective endovascular treatment for patients at high-risk for endarterectomy. The success rate of CAS depends on the appropriate device selection. In this study, the mechanical performance of the Wallstent in two size variants is evaluated using the Finite Element Method in a stent-only testing and a patient-specific scenario.

Methods

Using dedicated computer simulation tools, two variants of the Wallstent (8 versus 10 mm diameter, though assuming the same wire diameter, number and braiding angle) are modelled and subjected to virtual mechanical tests. Stents are first compressed radially to assess the foreshortening and the radial stiffness. Next the stents are deployed into a patient-specific carotid artery lesion reconstructed from CTA in order to predict the impact of stent size on the lumen gain.

Results

The virtual bench testing predicts a diameter-length relation in good agreement with experimental data provided by the manufacturer, and reveals a non-linear radial stiffness response. The patient-specific carotid artery model simulations underline the potential inefficacy of Wallstent oversizing due to the intrinsic mechanical behaviour of its braided design.

Conclusion

The non-linear mechanics of the Wallstent strongly influences the final geometry of the stented carotid artery, making the stent design and size selection not trivial. By taking into account realistic geometries and materials, the proposed simulation framework supports the understanding of the mechanical behaviour of the braided stent and its interaction with a patient-specific lesion, providing a first step towards virtual CAS as a pre-treatment planning tool.