Abstract ESVS 2010, Amsterdam

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Title of abstract:

Virtual Bench Testing of Peripheral Stents: from Design Tool towards Virtual Procedure Planning

Introduction

The main task of a stent is to reopen and scaffold a stenosed lesion while minimizing possible vessel injury. To that extent, the stent requires adequate mechanical properties. Experimental evidence has shown that these mechanical properties are strongly design dependent and their assessment generally requires sophisticated and accurate test set-ups and protocols. Complementary to such experimental methods, we developed a virtual simulation environment to evaluate these mechanical properties and the potential of the developed virtual bench tests is illustrated for the Wallstent.

Materials/Methods

The virtual bench testing environment is developed by combining the finite element solver Abaqus with the open-source pyFormex design software and allows to accurately study the following stent characteristics: foreshortening, radial strength, flexibility, conformability, stent/catheter and stent/vessel interaction. The created virtual Wallstent model can easily be adapted in terms of wire diameter, number of wires and pitch angle, which allows to assess the impact of these design parameters on the stents mechanical behavior.

Results

The simulations show that reducing the foreshortening with 20%, while maintaining the radial strength, is feasible by increasing the wire diameter, the number of wires and the pitch angle. These results are in line with the available less shortening Wallstent design. Furthermore, the simulated stent release from the catheter corresponds well with available experimental data. Finally a novel and stable simulation strategy was developed to virtually insert the Wallstent into patient specific blood vessel models, which allows to assess the conformability and potential vessel injury.

Conclusions

Complementary to experimental bench tests we have developed a virtual environment to accurately quantify the mechanical properties of peripheral stents. This novel tool allows to virtually assess design variants / ideas without the need to actually fabricate prototypes. Next we will virtually test other self-expandable stents to provide objective information to the clinical practice that is potentially helpful for a well-considered choice of stent type.

Figures/Tables