Pushability Model of a Microcatheter for Intravascular Procedures

M. Miliani[1], F. Piccagli[1]

[1]Medtronic Invatec S.p.A., Roncadelle, BS, Italy

Abstract

Background

During peripheral intravascular interventions one of the main issues is the correct deployment of the guidewire (GW) to the anatomical site which has to be treated. Usually the anatomical site which requires an intervention is occluded by a lesion of the vessel, and the occlusion can be a very hard calcium cap. Hence, the interventional GW should not only reach the lesion, but it should be able to cross it somehow, in order to allow the physician to track a dilatation balloon across the lesion and restore the originale vessel patency by means of balloon dilatation of the lesion. In these cases microcatheter-type devices are used in order to give mechanical support to the GW and enhance its ability to transmit push force to the occlusion. The crossing of the lesion often requires high force that should be applied by the tip of the microcatheter, but on the other hand, the microcatheter itself should be as flexible as possible in order to reach the lesion tracking on the GW through any kind of tortuous anatomy. So, there is a trade-off between the microcatheter flexibility and its push-ability.

Materials and methods

In order to achieve a good balance between the microcatheter flexibility and its push-ability the catheter design has been defined with 2 transition zones. A parametric geometry has been defined in COMSOL Multiphysics® and each catheter section is defined using specified design parameters. The microcatheter has been designed inside an anatomical model of the vessel, and a FEA simulation has been developed. Different type of elements have been used (3D, shell) and contact properties have been manually defined when using shell elements.

Results and discussion

The microcatheter has been moved proximally inside the anatomical model applying a controlled displacement over time and the catheter tip has been fixed using a rigid connector. The push-ability force generated at the tip has been calculated.

Conclusion

This model can be used as a starting point for an optimization of the microcatheter design

parameters, aiming to a maximization of the push-ability force with the catheter outer diameter as low as possible.