Computational Modeling for the Pre-Treatment Planning of Flow Diverting Stents

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INTRODUCTION

Sizing flow diverters (FDs) can be challenging during cerebral aneurysm pre-treatment planning. FDs can differ from their labelled lengths by 30% after deployment because of changes in vessel curvature and diameter. Current FD sizing tools do not account for vessel shape or predict device apposition, which can lead to sub-optimal clinical deployments, as shown in Figure 1.

METHODS

Twenty-four patient cases in three hospitals were selected for treatment with the Pipeline Embolization Device (Medtronic, Inc). Twelve of the cases were pre-planned using the SurgicalPreview® computational modeling software (EndoVantage, LLC), while the remaining cases were conventionally planned.

In the simulated cases, the attending physician first identified an appropriate device size using conventional measurements in an imaging software. After initial device selection, a wider range of sizes were evaluated using SurgicalPreview®. SurgicalPreview® uses high-fidelity finite element simulations to virtually deploy different device sizes into the patient’s vessel, as shown in Figure 2.

RESULTS AND CONCLUSIONS

According to physician responses, computational modeling was useful for all cases and it improved confidence in device selection. The simulation results changed the physician’s original device selection in approximately 59% of the cases, as presented in Figure 3.

Comparison between simulated and clinical deployments showed good agreement. Simulations predicted the post-treatment proximal device landing, device shape, and regions of the vessel with poor device apposition, as shown in Figure 4.

The pilot study showed improvements in FD pre-treatment planning using computational modeling. Simulation results helped physicians predict the behavior of FDs in tortuous vessels and maximize apposition. Improvements to FD selection can potentially lead to better patient outcomes.

We present a pilot study to evaluate the use of computational modeling for FD sizing. The modeling software is based on the finite element approach and has been shown to simulate FD deployments that closely match clinical deployments.

Following treatment, the attending physician completed a questionnaire on the usefulness of the simulations. Flat-detector CT data were also acquired to verify the accuracy of simulated deployments.