Evaluation of Hemodynamic Performance of a Novel Carotid Covered Stent

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We have recently developed a novel membrane design for carotid covered stents that prevents emboli while preserving the external carotid artery (ECA) branch flow. Our earlier in vitro studies have shown that this novel design can maintain more than 83% of the original ECA flow and has the potential to considerably reduce the chance of emboli release as compared to bare metal stents. In the present study, utilizing CFD simulations and fluid-structure interaction analyses, we further investigated the influence of this novel covered stent on the blood flow regime and distribution of hemodynamic parameters at the carotid artery bifurcation and within the branches. Simulation results of the effect of the covered stent on the flow division at the carotid bifurcation were comparable with the earlier experimental results and further verified that this covered stent can considerably preserve the ECA flow. The results also showed that this covered stent may affect the flow regime and the distribution of hemodynamic parameters at the opening of the ECA branch and at the apex of the divider wall. These altered local hemodynamic characteristics may promote the post-stenting patency of the ECA branch. Evaluation of shear-induced platelet activation suggested that activation of platelets due to the blood flow through this membrane is unlikely. This study further demonstrated the potential of this novel covered stent design for the treatment of carotid atherosclerotic stenosis. Future in vivo investigations of the biological effects and mechanical performance of this covered stent design is warranted.

Keywords: Fluid-Structure Interaction (FSI); Computational Fluid Dynamics (CFD); Stroke; Hemodynamic Parameters; Wall Shear Stress (WSS); Platelet Activation