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Comparing the Sphere and a conventional flow-diverter device: Modelling aneurysm thrombosis following virtual treatment

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We present updated results of a computational fluid dynamics (CFD) study comparing a novel cerebral flow-diverter device, the Sphere, and conventional flow-diverters currently in clinical use. The Sphere is intended to treat cerebral aneurysms at vessel bifurcations and offers a number of favourable design features compared to conventional flow-diverters, which themselves remain a controversial treatment choice for bifurcation aneurysms.

The Sphere device consists of a dense mesh-face that is secured at the aneurysm neck by a pair of looped legs that are located in the bifurcation aneurysm parent-daughter vessel junction. The device is formed from a single loop of Nitinol wire and, after microocatheter deployment, adopts a profile similar to the surface of a sphere. The innovative design efficiently utilises the maximum fraction of the device mesh for flow diversion, while the securing leg configuration eliminates the risks of emboli or occlusion associated with daughter vessel jailing.

The virtual treatment study compared the novel device to a generic cylindrical flow-diverter with 70% porosity—similar to the SILK flow-diverter or Pipeline Embolization Device. Previous work, which indicated an equivalent level of flow reduction between conventional and novel devices, was extended to incorporate a model of aneurysm thrombosis following device placement.[1]

The thrombosis model assumes that a clot is initiated at a site of low shear rate, where Thrombin is released. Zones of thrombus then form with reduced porosity, which in turn alters aneurysm flow patterns and hemodynamic parameters. The model incorporates a time-varying Thrombin concentration curve that may be modified to provide patient-specific thrombosis predictions and also allows for the incorporation of anti-coagulant effects.[2]

Results show subtle variations in aneurysm thrombosis patterns and progression over time, depending on choice of implanted device. These results illustrate a further step in an analysis pipeline capable of prediction cerebral aneurysm device performance in-silico.

[1] Peach, T., Cornhill, J.F., Nguyen, A. et al. Cardiovasc Eng Tech (2014) 5: 334. https://doi.org/10.1007/s13239-014-0188-4
[2] Ngoepe MN, Ventikos Y. Computational modelling of clot development in patient-specific cerebral aneurysm cases. J Thromb Haemost 2016; 14: 262–72.

Figure 1: