A diamond in the rough: computational flow modeling of fenestrated stent repair

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Fenestrated stent repair has offered a unique alternative to the morbidity of open surgical repair for complex aortic aneurysms. Is should be no surprise that lining an aneurysmal aorta with stents dramatically alters flow patterns within the aorta, but the hemodynamic impact on perfusion remains poorly understood. The ability to make stent design and planning more objective with computational flow modeling (CFM) is especially attractive in this often subjective area of vascular surgery.

The pilot study by Tran et al,[1] entitled "Patient-specific computational flow modelling for assessing hemodynamic changes following fenestrated endovascular aneurysm repair," offers a unique assessment of hemodynamics of fenestrated stents by means of CFM.

Despite the appeal of objective computational assessment after a fenestrated stent, there remain several important considerations of this approach. An inherent requirement for CFM is the requirement for mechanical and physiologic assumptions. As highlighted in the study of Carsten et al,[2] CFM often makes assumptions for values that are not available to the clinician. In the study of Tran et al, specifically, physiologic assumptions were made for viscosity of blood and vascular resistance, whereas mechanical assumptions included "expected physiologic flow splits from the literature." As a result, the hemodynamic results are predicated on values that may, or may not, represent the true clinical picture for individual patients.

CFM findings would be especially useful if they could be validated with ultrasonic flow measurement, for example, but doing so is logistically impractical in the human clinical setting of this endovascular procedure.

Ultimately, CFM analysis would be most useful to clinical care if it was predictive of clinical outcome. In that role, CFM could be useful in device refinement or to inform the clinician on critical technical aspects, such as branch angle and branch graft protrusion, for example. The findings of the Tran study predicted a 70% improvement and 20% unchanged renal perfusion, and yet clinically, 40% of their small cohort experienced a decline in renal function. Although renal deterioration is clearly multifactorial, this discrepancy highlights that further investigation is essential to correlate computational with clinical outcomes.

In summary, larger scale studies and a closer alignment with clinical surrogates of improved perfusion will be essential to both further refinement and validation of the potentially powerful approach of CFM in the assessment/prediction of fenestrated stent repair.

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