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A Computational Framework to Optimize Subject-Specific Hemodialysis Blood Flow Rate to Prevent Intimal Hyperplasia JAVID MAHMOUDZADEH, MARTA WLODARCZYK, KEVIN CASSEL, Illinois Institute of Technology — Development of excessive intimal hyperplasia (IH) in the cephalic vein of renal failure patients who receive chronic hemodialysis treatment results in vascular access failure and multiple treatment complications. Specifically, cephalic arch stenosis (CAS) is known to exacerbate hypertensive blood pressure, thrombosis, and subsequent cardiovascular incidents that would necessitate costly interventional procedures with low success rates. It has been hypothesized that excessive blood flow rate post access maturation which strongly violates the venous homeostasis is the main hemodynamic factor that orchestrates the onset and development of CAS. In this article, a computational framework based on a strong coupling of computational fluid dynamics (CFD) and shape optimization is proposed that aims to identify the effective blood flow rate on a patient-specific basis that avoids the onset of CAS while providing the adequate blood flow rate required to facilitate hemodialysis. This effective flow rate can be achieved through implementation of Miller's surgical banding method after the maturation of the arteriovenous fistula and is rooted in the relaxation of wall stresses back to a homeostatic target value. The results are indicative that this optimized hemodialysis blood flow rate is, in fact, a subject-specific value that can be assessed post vascular access maturation and prior to the initiation of chronic hemodialysis treatment as a mitigative action against CAS-related access failure. This computational technology can be employed for individualized dialysis treatment.

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