CFD Simulations Prevent Brain Aneurysms

Wright, Joseph (School: Dayton Regional STEM School)

Many intracranial aneurysms can be treated using flow diversion, in which a finely meshed stent is used to reduce blood flow into an aneurysm. Over time, this leads to endothelial tissue regrowth and aneurysm occlusion. Most commercial flow diverter stents use the same mesh pattern, but improved patterns could prevent aneurysm rupture more effectively. This project tested novel mesh patterns using computational fluid dynamics (CFD) simulations incorporating realistic aneurysm geometry. All stents had a porosity of 70% to mimic commercial stents. A consistent aneurysm model was simulated with no stent, with a conventional stent, and with four novel stents based on fractal geometry. After analyzing results from fractal stent testing, three “line stent” designs consisting of a single set of parallel wires were tested: one with wires parallel to the inlet, one with wires perpendicular to the inlet, and one with parallelogram-shaped wires. Compared to the simulation with no stent, the conventional stent and the best fractal stent reduced area-averaged wall shear stress (WSS) by 74-76%, whereas the other fractal stents reduced WSS by 50-60%. The most effective line stent reduced WSS by 88%. Flow velocity at the aneurysm neck was used to verify the comparative efficacy of each stent that was determined from WSS data. Fractal stents did not exceed the effectiveness of the conventional stent, but the best line stent produced a greater reduction in both WSS and flow velocity. Consequently, the best line stent may be more effective than the conventional stent for preventing aneurysm rupture.