8-Day Implantation of Silicon Nanopore Hemofilter

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Background:

End-stage renal disease (ESRD) patients face a severely limited supply of donor organs and disappointing mortality and morbidity on maintenance dialysis. Existing hollow-fiber membranes are thrombogenic, foul quickly, and require high driving pressures. An implantable artificial kidney could improve outcomes and quality of life in ESRD. Our work is focused on development of new ultrathin, uniform pore size, silicon membrane technology. We report the first implant of the high efficiency filtration membrane.

Methods:

Parallel plate hemofiltration cartridges were designed using computational fluid dynamics to guide geometry. A silicon nanopore membrane (SNM) with porous surface area of 0.36 cm^2 and critical pore dimension of 5.6 nm was surface-modified with polyethylene glycol (PEG) and mounted in a cartridge. We implanted the cartridge in an adult purpose bred dog. All experiments were approved by the Institutional Animal Care and Use Committee. 6 mm PTFE grafts were anastomosed to the aorta and common Iliac as inflow and outflow conduits to the device. Low-molecular weight heparin (1.0 mg/kg) was administered perioperatively. Graft patency was serially assessed by Doppler ultrasound. On post-op day 8 the animal was euthanized by protocol and the cartridge explanted.

Results:

We report the first successful prolonged implantation of an SNM hemofilter. The animal displayed no signs of distress during the postoperative period. Evidence of graft patency was noted on each post-op observation. At explant, brisk flow was noted through the grafts and 27.5 mL of ultrafiltrate were collected. There were no signs of thrombus within the device. These findings demonstrate meticulous attention to surface chemistry and conduit geometry can permit implementation of this novel technology.